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THE CAPCO INSTITUTE

JOURNAL

OF FINANCIAL TRANSFORMATION

INSURANCE

#54 NOVEMBER 2021

THE CAPCO INSTITUTE

JOURNAL OF FINANCIAL TRANSFORMATION

RECIPIENT OF THE APEX AWARD FOR PUBLICATION EXCELLENCE

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DEAR READER,

Welcome to edition 54 of the Capco Institute Journal of Financial Transformation.

In this edition we explore recent transformative developments in the insurance industry, through Capco's Global Insurance Survey of consumers in 13 key markets, which highlights that the future of insurance will be personalized, digitalized, and connected. Other important papers cover topics high on global corporate and political agendas, from ESG and climate change to artificial intelligence and regulation.

The insurance industry has been undergoing transformation in recent years, with insurers responding to the needs and expectation of tomorrow's customers, for products that were tailored, flexible, and available anytime, anyplace, and at a competitive price.

COVID-19 has accelerated such change, forcing insurers to immediately implement programs to ensure they can continue selling their products and services in digital environments without face-to-face interaction. New entrants have also spurred innovation, and are reshaping the competitive landscape, through digital transformation.

The contributions in this edition come from a range of world-class experts across industry and academia in our continued effort to curate the very best expertise, independent thinking and strategic insight for a future-focused financial services sector.

As ever, I hope you find the latest edition of the Capco Journal to be engaging and informative.

Thank you to all our contributors and thank you for reading.

Lance Levy, **Capco CEO**

RISKS

HOW THE INSURANCE INDUSTRY IS FIGHTING CLIMATE CHANGE AND TRANSFORMING ITSELF BY DOING SO

LUDOVIC SUBRAN | Chief Economist, Allianz SE
ARNE HOLZHAUSEN | Head of Economic Research's Insurance, Wealth, and ESG team, Allianz SE

ABSTRACT

Climate change has a very simple effect: risk is rising in the world. This poses an existential challenge for the business model of insurance, the transfer of risk. Impact underwriting and impact investing describe the new mindset: the industry no longer only prices and transfers risk but tries to change outcomes from non-sustainable to sustainable ones. For that, public-private partnerships are essential, both on the strategic level, steering the transition with long-term policy guidance, and on the operational level, building adequate risk-protection schemes and supporting investment. But climate change is not the only challenge that threatens today's societies. Behind lurks the protracted issue of growing inequality, which could easily be exacerbated by climate policy. Consequently, a new social contract is urgently needed. Insurers can play an important role here too, not only as good corporate citizens but also by embracing the pivot to equality in their business models.

1. FROM TRANSFERRING RISK TO REDUCING IT: THE PIVOT TO SUSTAINABILITY

Sustainability is an age-old concept. In earlier times, it was essentially about preserving the natural balance as a basic prerequisite for human activity. With the dawn of the 21st century, this premise can no longer be upheld. For in the Anthropocene, as a result of unrestrained global industrialization, the natural balance has been destroyed. Sustainability is, therefore, mutating from an inherently conservative concept – the preservation of the existing – to a revolutionary one: restoring balance through radical changes to the way we live – how we get around, what we eat and consume, and, most importantly, how we produce the things we need every day.

Insurance, too, is an age-old concept. The idea of transferring and distributing risks goes back to the early days of trading centuries ago. However, like the idea of sustainability, it has reached a turning point where old concepts no longer work. Risk is only rising in the world, be it caused by natural catastrophes, extreme weather, or cyberattacks. This rising tide renders inadequate the mere transfer of risk. To stay relevant, the industry has to change accordingly, moving beyond pricing and transferring risk to changing outcomes from non-sustainable behaviors and processes to sustainable ones.

Its double role as risk underwriter and major investor puts the insurance industry in a unique position to drive this transformation and bring about economic, social, and environmental sustainability.

In underwriting, this requires the implementation of more impact activities. But impact underwriting is not just about having sustainable insurance solutions in the portfolio; rather, it is about actively shaping and contributing to society, having long-term impact. Take renewable energy as an example: global capacities will more than triple by 2050. Accordingly, the demand for insuring renewable energy installations against physical, development, or operational risks will rise. Risk consulting and risk service solutions support establishing new technologies or developing new territories. Mobility is another example: electric vehicles will dominate new car sales before long. Impact underwriting can support this transition by offering insurance solutions to the areas of mobility sharing, as well as autonomous driving, and can seize new opportunities in the sector coupling of vehicle batteries with the energy infrastructure. In a nutshell, impact underwriting means that insurers work together with their customers on adapting to climate change, increasing the resilience of their infrastructure, facilities, or supply chains.

Impact insurance, however, does not have to stop with underwriting. Claims are important as well. Sustainable insurance-claim regulation can allow for upgrades to eco-labeled appliances and machinery, and, due to a life-cycle analysis of the emissions associated with a product, appliances could be repaired instead of replaced. In a nutshell, impact claims means to evolve from compensating financially to rebuilding and renewing in a much more sustainable way. Both impact underwriting and claims establish insurers as change agents for sustainable outcomes.

Similarly, when it comes to impact investing, insurers occupy a crucial role. There are two reasons for this: first, their investment horizon is long term. They are not subject to the "tragedy of the horizon", as defined by former Bank of England governor Mark Carney, but automatically take the (very) long term into account in their investment decisions because of their own commitments, which extend over decades. Their investment strategy is geared towards achieving long-term current returns, not short-term increases in value. Interim fluctuations in value hardly play a role here because, unlike banks, they do not generate any short-term liquidity requirements. Secondly, insurers' investment calculus is comprehensive, their perspective resembling that of a public good maximizer (the so-called social planner). This is because the large number of assets in their portfolios means that they are interested not only in the profitability of the individual investment, but also in the cost to the other assets by which that profitability is achieved. For example, if a company increases its profitability by emitting more greenhouse gases, it increases the likelihood of climate damage to other companies. In this way, a broadly diversified portfolio leads to congruence of goals: what makes a society as a whole prosper and grow sustainably is also reflected in the balance sheets of institutional investors. In a nutshell, impact investing takes the 360 degree/100 years approach.

> *"Insurers need to transform from being institutions that transfer risk to ones that change outcomes."*

However, for insurers to fulfill their new role, for successfully transforming from being institutions that transfer risk to ones that change outcomes – nothing less than changing from being conservative to being revolutionary – a societal consensus is needed on the direction, extent, and speed of the green transformation. Even in the 21st century, the political revolution precedes changes at the material base. Without reliable, long-term policy guidance, institutional investors like insurers cannot live up to their ambitions and aspired roles.

2. PUBLIC-PRIVATE PARTNERSHIPS ARE THE NAME OF THE SUSTAINABILITY GAME

These public-private partnerships, however, should not stop at forging a broad social consensus and support for the green transition. They also have to encompass the operational level for a simple reason: if the risk in the system increases over time, it is in the end the public sector that ends up holding most of it, an outcome that can hardly be described as sustainable.

The COVID-19 crisis and the recent flooding in Germany are a case in point: the dimensions of damage were simply overwhelming. The state had to step in as the rescuer of last resort, and ad-hoc measures to save lives and livelihoods were clearly inevitable. Still, they created some negative consequences. And that is not to mention the resulting debt mountains and the increasing entanglement of the state in the private sector. The behavioral consequences might even

count more as unprecedented measures can set a dangerous precedent: the expectation that the state will always act as the safety net protecting households and companies from all big risks – whatever it takes. This goes far beyond pandemics but may also include climate change, cyberattacks, and old-age poverty. It could herald the return of the almighty state, which renders self-responsibility and own efforts to mitigate risks obsolete. But it goes without saying that without self-vigilance, risks are only to grow bigger and bigger.

For that reason, it is so important to build ex-ante public-private risk-protection schemes. There already are some in place – for example, for flooding (U.K.) or terrorism (U.S.) – but this should be done more systematically across all possible systemic hazards, be it pandemics, natural catastrophes, or cyberattacks. As long as all participants retain skin in the game, they have a strong self-interest in taking preventive and preparatory measures. In such a system, private insurers could form a kind of plumbing system: they check the claims and make the payments. And unlike the state, which is used to putting up protective umbrellas with guarantees but struggles to distribute funds quickly, directly, and un-bureaucratically, insurers have the necessary know-how, processes, and structures. Financial support is not only promised quickly, but also provided efficiently and precisely.

The same logic for public-private partnerships applies for investments. The requirements for creating a sustainable economy are gigantic: the transformation of our energy system toward climate neutrality alone will account for about 2% of global value added annually for the foreseeable future – equivalent to about €1.5 trillion. This is clearly beyond the means of the state. Mobilizing private capital is key – and the good news is that there is plenty of it: the supply of capital is not the bottleneck of the green transformation. Private households worldwide have around €200 trillion in financial assets; insurers and pension funds account for just under 30% of this.

Demand for capital has been rather subdued in recent years; this applies to both public and private investment. However, a paradigm shift is taking place as a result of the pandemic: governments are massively increasing their spending on infrastructure, exemplified by the Biden Plan in the U.S. or the NextGenerationEU Fund, a large part of which is to flow into the green transformation. But there are also signs of a turnaround in the private sector. Many companies, spurred by the prospect of rising demand when the economy reopens, have significantly increased their investment plans. The post-COVID-19 recovery thus offers a great opportunity to make decisive progress on the road to climate neutrality.

To further increase and stabilize demand for sustainable investments at the necessary elevated level, it is essential to create a level playing field for these investments. A prerequisite for this is that the pricing of greenhouse gases is oriented to the market and works across national borders.

The expected development of levies and costs for greenhouse gas emissions is a central steering element for investments. Price signals and the long-term development paths of CO_2 taxes or emissions-trading systems must be consistent with climate policy goals. However, even under these conditions, some investments – due to path dependencies and long investment cycles (especially in sectors with very high CO_2 abatement costs, such as metals, cement, or chemicals) – may currently be postponed for market reasons, even if they would be socially beneficial in the long term.

This could be remedied by further suitable public-private partnerships; for example, long-term customer contracts with industry in the form of government-backed contracts for difference, so-called carbon contracts for difference (CCfD). This significantly reduces price and volume risks for investments in the energy turnaround by making operating costs – independent of short- to medium-term fluctuations in CO_2 prices – much easier to calculate. This enables favorable capital backing in line with regulatory requirements: if, for example, capital costs are reduced from 7% to 5% because part of the risk is shouldered by the state, projects can do with 20% less own capital, increasing the financing capacity of institutional investors.

This example touches on two key issues of a sustainable capital market and the role of institutional investors in it: adaptation pathways and capital requirements. The big transformation is not simply about implementing a green investment policy, i.e., portfolio shifts into “clean” companies such as manufacturers of electric cars or solar panels. That would be far too simple – and would likely lead to a green capital market bubble. It is much more important to mitigate emissions in the existing portfolio, i.e., to provide capital to companies with emissions that are still too high today, enabling them to meet their science-based reduction targets in line with the

1.5 degree target. This implies that not all investments will be 100% green, i.e., emission-free, overnight, but they must be on the defined adaptation path. Again, it is all about changing outcomes.

In turn, the regulatory requirements for risk capital adequacy are a key factor in the provision of sufficient capital, which brings the regulatory framework for insurers, namely Solvency II, into focus. A decidedly conservative approach is emerging in the current revision. In particular, changes to the extrapolation method for the risk-free yield curve and the volatility adjustment could lead to the creation of artificial (i.e., irrelevant in the context of the business model) volatility in solvency ratios, which would compromise the capacity to hold long-term investments without an economic rationale. This would be counterproductive. The result could be pro-cyclical investment incentives and "de-risking" of the portfolio. This would cause a reduction rather than an increase in long-term investments, which would not least affect investments in sustainable infrastructure and in 1.5-degree target-compliant industry adaptation pathways.

The revision of Solvency II must first and foremost avoid weakening insurers' positions as long-term investors. At the same time, other opportunities to strengthen them should be exploited. These include, for example, so-called "credit enhancement" arrangements that enable project promoters to improve the quality of their bonds, thereby making them more attractive to institutional investors. It is another example of a public-private partnership on the operational level in which the greater risk-bearing capacity of public institutions and the expertise and availability of private capital form a winning combination.

3. FROM EMISSIONS REDUCTION TO SOCIAL JUSTICE: REPAIRING THE SOCIAL CONTRACT

Climate change is an existential threat. Mastering it at the operational level, i.e., reducing greenhouse gas emissions fast enough to meet the 1.5 degree target, is in itself a paramount challenge. The even bigger challenge, however, lies elsewhere.

The real Achilles' heel of most societies is not greenhouse gas emissions, it is growing inequality, the increasing polarization into different groups with particular interests, fostered by social media. The keywords for this are identity politics and populism: what counts is belonging to one's own group or bubble; exchange or even reconciliation with others hardly takes place anymore. The sad irony: social media has brought the social contract to its knees.

The problem is that climate policy is likely to reinforce this polarization. Politicians still give the impression that the green transformation is a great opportunity for everyone. But the reality is that we have long since passed the point in time when a gradual and largely smooth transformation of the economy would still have been possible. Today, radical, rapid action is needed to achieve the Paris goals; in other words: we need a shock therapy.

In the long run, the net zero economy will very likely provide as much material prosperity for all as today's fuel-based economy does; living conditions and circumstances should even be significantly better. But along the way there will be dislocations, many workers will lose their jobs, many companies will go bust, and many investments will lose their value. This unequal distribution of the resulting adaptation costs could further exacerbate inequality.

Moreover, climate policy measures, such as the mandatory energetic renovation of existing buildings or carbon taxes, come with a hefty price tag that can be more than challenging for low-income households. It is, therefore, essential to use the revenues from carbon-pricing policies to compensate for financial hardships and secure a just transition. This can be done in different forms, for example, as direct lump-sum transfers like the so-called climate bonus or as a stabilization of electricity prices, which would also particularly benefit lower-income households.

But reducing inequality and restoring social justice go far beyond engineering social transfers in the name of a just green transition. What is required is nothing less than a new social contract to stop undermining the social fabric further and fueling greater political bifurcation and populism down the road.

This, however, is a mammoth task – for the public as well as the private sector. Simply relying on more government and social benefits is certainly not enough, and could even be counterproductive: the antagonism between the so-called establishment and anti-establishment would only intensify. This is especially true of the universal basic income, which would cement social dependence and ignore the dignity of one's own performance. The guiding principle of a new social contract should not be alimentation but rather resilience, the ability to bounce back after setbacks. Massive investments must be made in this resilience, e.g., through an expansion of educational opportunities at all levels. The ultimate goal is to reduce inequality, not by giving mildly, but by strengthening the capabilities of each and every individual.

In this process, all companies (and not only insurers), as modern social units, have an important role to play. They represent the few social places – after "cancel culture" has increasingly taken hold at universities – where people with different convictions and cultures, experiences, and values come together to achieve success together. Precisely this diversity is the key to build a successful company, which can thus act as an important role model for an inclusive society.

But for the finance industry, and insurers in particular, being a role model is not sufficient. Insurers should spearhead the pivot to sustainability and equality by embracing wholeheartedly the concept of ESG (environment, social, governance) in business models. And not only the macroeconomically connoted "E", but also the more microeconomic "S", which means in essence equality of opportunity. This entails new forms of cooperation between social policy and corporate responsibility to ensure that as few as possible are left behind during the green transition. For example, new insurance products could be tailored to the specific needs of low-income customers, customers with disabilities, elderly customers, and minorities, enhancing the provision of inclusive and accessible insurance (micro insurance).

4. CONCLUSION

Fighting climate change is the challenge of the century. But cutting greenhouse gas emissions is only one half of the task. Paraphrasing Matthew 16:26: for what will it profit a man if he saves the climate and forfeits social justice? Repairing the social contract is as important as achieving net-zero. This requires public-private partnerships at a new scale. And insurers will have to play a crucial role in both parts. In doing so, the new insurance model will be born: insurers can become the standard-bearer of change, actively reducing risk in the system by impact underwriting and investing, and thus leading the pivot to sustainability.

THE IMPACT OF EXTREME CYBER EVENTS ON CAPITAL MARKETS AND INSURERS' ASSET PORTFOLIOS

MARTIN ELING | Director, Institute of Insurance Economics, and Professor in Insurance Management, University of St. Gallen
WERNER SCHNELL | Researcher, Institute of Insurance Economics, University of St. Gallen[1]

ABSTRACT

We study the extent to which extreme cyber-risk events affect capital markets and propose a concrete model framework that might be implemented in internal risk models of insurance companies. The literature on disaster risks looks at extreme scenarios in an area of 15% or larger decline in GDP (world wars, financial crises), while the cyber scenarios discussed in the literature are typically of smaller magnitude, i.e., up to 2% of GDP; only some very extreme cyber scenarios go up to 10% of GDP. To empirically analyze the relationship between extreme cyber risk events and capital markets, we implemented two models: a simple model based on historical data showing an impact of up to -4.26% on an insurer's assets for a stylized asset portfolio in two predefined cyber scenarios and an extended model in which we additionally implement the response of monetary policy and a consumption-based stock market response function. The latter model provides economically more sound estimators for the central parameters of interest (risk-free interest rate, credit spreads, stock returns, etc.) and shows an impact of up to -1.99% for the stylized insurer's asset portfolio. We conclude that the impact of extreme cyber risk events on capital markets exists so long as the asset side of insurance companies remains limited, which is mainly due to the hedging properties of different asset classes.

1. RESEARCH QUESTION

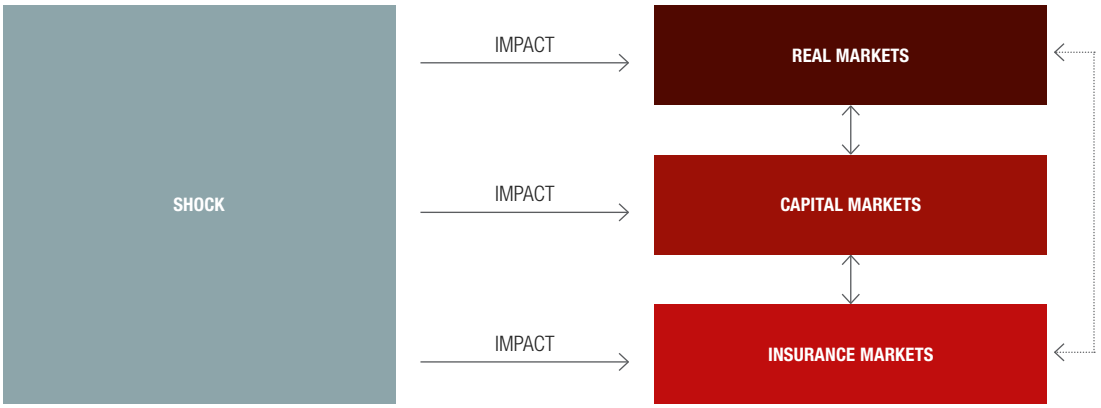
We study the impact of extreme (cyber) scenarios on the asset side of an insurer's balance sheet. While the effects of extreme scenarios on liabilities are relatively well understood and are a core feature of an insurer's risk modeling, relatively little is known about their potential implications on an insurer's assets.[2] For the purpose of this paper, we consider a representative, hypothetical insurer that holds a globally diversified portfolio with different asset classes, among which are stocks (equity), government bonds, and corporate bonds.

We consider the asset side of the insurer's balance sheet in isolation, while recognizing that interactions with the liabilities side is also important for interpretation of the results. We develop a general model to analyze the impact of extreme scenarios that we calibrate with information on extreme cyber scenarios. However, the model is formulated in such a way that it can be applied to different extreme events.

In Figure 1, we consider different types of shocks and their effect on the real economy, capital markets, and insurance markets. A shock can in principle be any extreme event, such as natural or man-made catastrophes, pandemics, extreme

[1] We acknowledge the support of Marcel Freyschmidt, Patricia Lehmann, and Dingchen Ning (University of St. Gallen), as well as comments and support from Eric Durand, Peter Middelkamp, Stephan Schreckenberg, and Jolanta Tubis (Swiss Re). An extended version of the article that contains all data, a complete formal description of the models, and more robustness tests is available from the authors upon request.
[2] In most internal risk models, the link is either neglected or modeled in a simplistic way, based on expert judgment.

Figure 1: Impact of a shock on real markets, capital markets, and insurance markets



cyber events, and wars. While our focus in this article is on cyber risk, other shocks have similar economic transmission mechanisms, hence we can also use historical observations from these other events to better understand the potential implications of an extreme cyber incident. Our motivation for doing this is that extreme cyber risks have not yet been observed historically, meaning that a direct empirical analysis is not possible.

A shock might have a direct impact on real markets. On one hand, it can result in reduced economic activity by hindering production (typically damaging the capital stock) and reducing consumer spending, while on the other hand, a shock might also increase economic activity due to the need for rebuilding the damaged capital stock (i.e., reconstruction after a catastrophic event). Because of these different effects, the impact on sectors might differ as well. Some studies have found that while cyber events cause a fall in the market value of the affected companies, they also helped certain IT security providers gain in market value.[3] We also saw how some biotech firms benefited from the COVID-19 pandemic.

A shock can also directly affect capital markets. The uncertainty created by an extreme event changes investor confidence and expectations, for example, about monetary and political interventions. Different types of events (e.g., natural versus man-made) might induce different changes in expectations, especially when diversification potential is considered. For example, regionally limited natural catastrophes can be diversified in a global portfolio, so long as they do not hit a critical economic center such as San Francisco or Tokyo and that the effect does not ripple through major supply chains.[4] Global events like the current pandemic, in contrast, are undiversifiable.

Through underwriting, a shock also has a direct effect on an insurer's liabilities. The direct loss (property loss and lives lost) is relevant for both the life and non-life insurance companies. There could also be various indirect links that need to be considered. For example, a decline in economic activity in real markets might impact expectations in the capital markets and reduce insurance demand. Conversely, an adverse development in the capital markets might negatively impact the supply of capital to the real economy and reduce the investment returns of insurance companies' portfolios. A difficult underwriting event might force insurers to liquidate some assets, putting pressure on the capital markets and potentially increasing insurance prices for the real economy.

[3] Cavusoglu et al. (2004) find that stock prices of information security providers increase on average by 1.36% after the announcement of another company's security breach.

[4] According to a study by Risk Management Solutions (1995) cited in Cummins (2006), a severe earthquake in Tokyo could cause losses in the range of U.S.$2.1 to U.S.$3.3 trillion, representing between 44% and 70% of the GDP of Japan.

2. LITERATURE REVIEW

Existing cyber-risk research uses the event study methodology to investigate the impact of data breaches or other cyber-risk events on the market value of firms. For example, Cavusoglu et al. (2004) show in an event study that a security breach negatively affects a company's stock price. They estimate the loss to be 2.1 percent of the market value, or U.S.$1.65 billion, per security breach. Campbell et al. (2003) and Hovav & D'Arcy (2003), on the other hand, find only limited evidence that data breaches or denial of service (DoS) attacks negatively impact the company's stock price. However, Campbell et al. (2003) provide evidence that a breach of confidential data has a larger negative effect on the stock price than a breach of non-classified information; Hovav & D'Arcy (2003) show a negative price effect for companies with a business model that is heavily based on the internet. Thus, the markets seem to behave rationally, as the discount is proportional to the expected loss associated with different data.

To overcome data limitation and to raise attention for the potential relevance of cyber risks among policymakers, media, the public, and executives, a variety of scenarios have been proposed in the applied business literature and in industry studies. These worst-case scenarios include various incidents that lead to a disruption of critical infrastructure and, thus, to more extreme economic losses. The economic effects of the scenarios show some extreme variations, ranging from 0.2% to 2% of the GDP in the year of the event with a few extreme scenarios going as far as 10% of world GDP [Eling et al. (2020), Ruffle et al. (2014)].

Overall, since there have been no extreme cyber events so far, the literature that investigates the effect of cyber risk on the economy and financial markets remains relatively limited. The largest cyber loss has been Wannacry with U.S.$8 billion economic loss [Gallin (2017)]. Based on the results presented by Mahalingam et al. (2018), one might argue that for an event to be so extreme to create an impact on the capital markets, an economic loss of at least U.S.$1 trillion (or 1-2% of world GDP) is necessary. The extreme magnitude needed is quite likely the reason why event studies for other catastrophic events arrive at mixed and inconclusive results [Wang and Kutan (2013)].

The fact that there has been no systematic impact of cyber-risk shock events, or other types of risks for that matter, does not, however, necessarily mean that such an impact does not exist. It might well be that investors in capital markets anticipate that large extreme events might happen and thus require a disaster risk premium, especially for companies that are more exposed to selected aspects of disaster risk. This idea has been included in recent asset pricing models, which show that rare disasters influence financial markets and are relevant for pricing. Barro (2006) uses rare disasters, those leading to a GDP loss of more than 15% (such as world wars, severe depressions, oil price shocks), over a 100-year period to explain the risk premia observed in the financial markets. He shows that investors do indeed demand a disaster risk premium, in the sense that higher-risk premiums are required to compensate investors for bearing the risks of extreme events. Since data on real disasters are scarce, Berkman et al. (2011) propose a crisis index that reflects expectations about potential disasters (disaster risk), instead of actual observations. They show that their disaster index has a large impact on the mean and volatility of stock markets and that industries with higher exposure to disasters yield higher returns.

In conclusion, several papers address the potential of rare disasters to explain the aggregate stock market development, such as mean returns and their variances, and find that disaster risk is relevant for asset pricing and could help explain certain aspects of a number of widely discussed asset pricing puzzles (such as the equity premium puzzle). It is also notable that the economic implications of extreme cyber scenarios do not currently seem large enough to expect a big impact from these events on the capital markets. The aforementioned studies usually consider shocks that result in a 15% fall in a country's GDP, our extreme cyber scenarios are typically around 2% of GDP. Event studies show that for a large diversified portfolio the impact of severe catastrophes on the capital markets should not be extreme. However, typically natural catastrophes are considered, which can be diversified globally, while that might not be the case with cyber risks. Furthermore, the results for man-made catastrophes, such as 9/11, show that there could be some impact on volatility and correlation, potentially due to the political reactions that investors anticipate.[5]

[5] Also for 9/11, most market indices recovered to pre-9/11 levels within a month [Mahalingam et al. (2018)]. More recently, the impact of other extreme non-diversifiable events, such as the risk of a pandemic, might be considered; the maximum drawdown for the MSCI World has been one-third (from 2400 on February 21st, 2020, to 1600 on March 23rd, 2020), but by the end of May it was already back to 2200. It is difficult to disentangle the effects of the crisis caused by the pandemic from certain response measures, such as the activities of central banks. For this reason, it is important to also model the response of the monetary authorities when analyzing extreme events.

We also note that while the aforementioned event studies of cyber risk predominantly focus on stock prices, we are also interested in the risk-free interest rates and credit spreads. The only paper we found that looks at the topic more holistically (not only stocks) is the working paper by Swanson (2019), which is based on a theoretical model and is not an empirical paper. We will implement some aspects of the model by Swanson (2019) to analyze the potential impact of extreme scenarios empirically.[6]

Table 1: Cyber scenarios

ELING ET AL. (2020)	RUFFLE ET AL. (2014)
Scenarios based on input-output model	Sybil logic bomb scenario analyzed using the Oxford Economics Model
Modeling of inoperability and recovery time across sectors, including spillover effects	Estimate the potential shock to the global GDP when a critical IT provider is compromised
0.64%-1.55% of GDP	4.7%-10.1% of world GDP

3. METHODOLOGY

We build on previous scenarios that model extreme cyber events and their impact on the economy. Most of these cyber scenarios do not estimate the effects on financial markets but provide an estimate for the potential losses to the economy. These numbers, and the applied methodologies, are very heterogeneous across different scenarios. Some estimate the loss for a certain sector or a certain region. The types of costs included in these estimates are also different. Some contain estimates for liabilities, some for the business interruption, and only a few estimate comprehensive aggregate economic losses. To derive the effects on the overall capital markets, we aggregate the losses at the country or at the global level, i.e., the country GDP or "world GDP" [as done in the input-output model by Eling et al., 2020], taking the geographical and sectoral dependencies into account. We use the two scenarios presented in Table 1 to illustrate our approach.

A model needs to consider shocks due to cyber-risk scenarios to both the underwriting and an insurer's assets. Thus, we need to model the connection between the estimated aggregated losses and the financial markets. However, it is difficult to identify an empirical relationship between the real economy and the stock market. The reason is that the forward-looking characteristics of the stock market and mitigations by monetary policy blunt the empirical relationship. For a stylized two period model (that is, a short-term shock) the situation could be described as shown in Figure 2.[7]

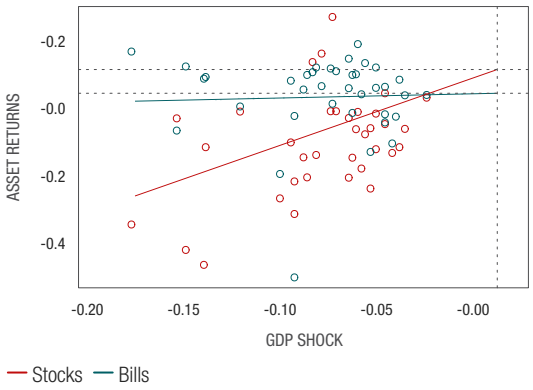
The assets would react quickly to the shock, long before the real economy (especially the delayed economic indicators) is reflecting the new situation. If we assume that financial markets do not make systematic errors in the relevant estimations, we can empirically estimate the relationship between the asset market price and the realized GDP. In the following section, we evaluate an empirical model where the severity of a cyber scenario, measured by a shock in GDP, is mapped on the severity of previous crisis events. The financial market reaction of these previous mapped events is then used as an estimate for the effects of a cyber scenario on financial markets. With this – as for any other statistical interference – we assume that a cyber scenario's effect on the asset market is comparable to other extreme events observed in the past.

Figure 2: Stock timeline

[6] Swanson (2019) also notes that traditional macroeconomic models typically ignore asset prices and risk premia, while at the same time, traditional finance models typically ignore the real economy, emphasizing the lack of holistic research.

[7] To understand the empirical relationship between GDP and stock markets, we also consider the empirical correlation between GDP and stock markets (e.g., world GDP against MSCI World). Our results confirm what is known from Ritter (2005), i.e., the correlation is negative; with a lag of one year, the correlation is positive (0.27 for the world GDP against MSCI World).

Figure 3: Asset prices (y-axis) versus GDP shock (x-axis)



Note: The data contains a selection of asset returns and GDP shocks for the period between 1900-2016 for different countries. Both asset returns and GDP are annualized.

4. EMPIRICAL ANALYSIS

4.1 Simple model

One advantage of the following simple approach, which purely looks at the empirical relationship between realized GDP losses and asset prices, is that it not only incorporates the shock on asset returns due to a change in fundamentals, but it implicitly also takes into account changes in other pricing relevant parameters as well (such as changes in risk premium, risk aversion, sentiment, and monetary policy). We estimate the linear model $r = \beta_0 + \beta_r(\Delta y)$, where r stands for the asset returns (either stocks or bonds), Y for the GDP, y for logarithm of Y, and Δy for the percentage changes in the GDP. Using an extended version of the data from Barro (2006) for 53 global events between 1900 and 2016, we derive the relationship between GDP shocks (x-axis) and the reaction in the stock and bond markets (y-axis; see Figure 3). The data is available from the authors upon request.

As expected, the extreme events lead to a negative return on the stock market. Moreover, the treasury interest rates decrease with the shock size. This can be explained by flight-to-security and monetary interventions in times of crises. Lower short-term interest rates would mean an increase in risk-free bond prices with short-term maturity. Thus, the allocation to government bonds serves as a hedge against the shock to the other assets and liabilities.

We approximate the shocks to the value of government bonds Δgb as the shock to the risk-free interest rate Δi_{rf} (treasury bill) times the interest rate sensitivity D [modified duration; Ruffle et al. (2014)], i.e., $\Delta gb \approx -D(\Delta i_{rf})$. For corporate bonds, we use a similar approach. However, we need to additionally account for the change in credit spreads ψ_c. The credit spread is the difference in the yields on corporate and government bonds. Thus, the corporate bonds yield is defined as $i_{cb} = i_{rf} + \psi_{cb}$. In times of crisis, it is likely that the default probability of companies increases and so does the credit spread. Thus, we have $\Delta = \hat{\psi}_{cb} + \hat{\beta}_{\psi_{cb}} \Delta y$. We assume that the credit spread ψ_{cb} increases linearly with negative GDP shocks [Gilchrist and Zakrajšek (2012), Swanson (2019)].[8] The change in value of corporate bonds would then be proportional to the change in risk free interest rate plus the change in credit spreads, i.e., $\Delta cb \approx -D(\Delta i_{rf} + \Delta \psi_{cb})$. The duration is again set as for government bonds. The change in stock prices is modeled according to the regression underlying Figure 4 (i.e., the sensitivity to GDP changes is 2.0073).

Table 2: Parameter choices for simple model

PARAMETER		VALUE	SOURCES
GDP growth	$(\Delta\overline{y})$	2.2%	Historical average global yearly GDP growth [Barro (2006)]
Risk-free interest rate	$\hat{\imath}_{rf}$	1.7%	Historical average risk free (treasury bill) interest rate [Barro (2006)]
Duration	D	5.7	Average duration of non-life insurers' assets in 2019 [EIOPA (2019)]
Credit spread	$\hat{\psi}_{cb}$	2.0%	Difference between investment grade corporate bonds and government bonds, historical average (1973-2010) for U.S. corporate bonds (excl. financials) [Gilchrist and Zakrajšek (2012)]
Credit spread cyclicality	$\hat{\beta}_{\psi_{cb}}$	-0.34	Difference between investment grade corporate bonds and government bonds, historical average (1973-2010) for U.S. corporate bonds (excl. financials) [Gilchrist and Zakrajšek (2012)]

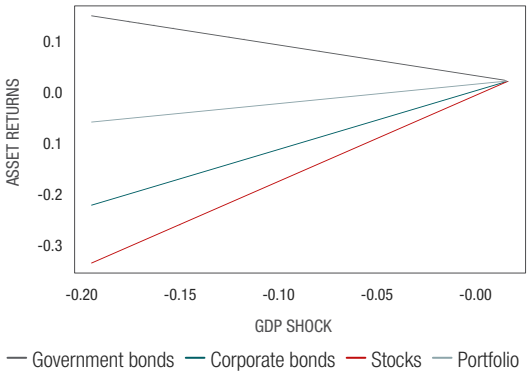
[8] Gilchrist & Zakrajšek (2012) measure the difference between investment grade corporate bonds and government bonds as historical average from 1973 to 2010 for U.S. corporate bonds (excluding financials). It would be intriguing to add credit spreads to Figure 3, but due to data limitations this is only possible for some of the points plotted in Figure 3 (historical credit spreads are only available for the U.S., but not for many of the markets included in Figure 3).

Table 3: Input parameters and results for the simple model

VARIABLE		BASIS SCENARIO	ELING ET AL. (2020) SCENARIOS		RUFFLE ET AL. (2014) SYBIL LOGIC BOMB		ASSET WEIGHT
Absolute GDP growth	Δy	2.20%	1.56%	0.65%	-2.50%	-7.90%	
Relative shock GDP	$(\Delta\tilde{y})$	0.00%	-0.64%	-1.55%	-4.70%	-10.10%	
Risk-free interest rate	i_{rf}	1.70%	1.63%	1.52%	1.15%	0.52%	
Government bonds return	Δgb	0.00%	0.43%	1.03%	3.13%	6.72%	50.00%
Corporate bond yield	i_{cb}	3.70%	3.84%	4.05%	4.75%	5.95%	
Corporate bonds return	Δcb	0.00%	-0.81%	-1.97%	-5.98%	-12.85%	30.00%
Stock market return	i_e	8.70%	7.51%	5.81%	-0.06%	-10.13%	
Equity return	Δe	0.00%	-1.19%	-2.89%	-8.76%	-18.83%	20.00%
Insurer's portfolio return	Δp	0.00%	-0.27%	-0.65%	-1.98%	-4.26%	

For the two cyber scenarios introduced above, we calculate the change in the value of a typical insurance investment portfolio and assume a 50% allocation to risk-free investments (government bonds, other relatively risk-free investments), 20% to stocks (equity), and 30% to corporate bonds (or other investments with a credit spread) [Gal et al. (2016)]. For simplification, we do not model other investment classes, such as real estate or alternative investments. The chosen parameters and results are presented in Tables 2 and 3. With this, we build a prototypical portfolio for an insurer's assets composed of government bonds, corporate bonds, and stocks and calculate the change in the portfolio as $\Delta p = \Delta \cdot w$, where the vector of returns on different assets is $\Delta = (\Delta gb, \Delta cb, \Delta e)$ and w is the portfolio weights.

Figure 4: Asset returns for different GDP shocks



The analysis shows that government bonds generally perform well and increase in value in cyber scenarios. We also see that the shock to corporate bonds is composed of two elements: first, the reduction in interest rate increases bond values and second, the increase in credit spreads decreases the bond value. In our case, the second effect dominates the first one. Still, the hedging property of government bonds would compensate most of the losses on the other positions so that even for the most extreme scenario (-10.1% GDP) the value of the insurer's assets would only decrease by -4.26%. The magnitude of this decline seems plausible in light of the aforementioned results of the literature review. We also present the results for a continuum of shock sizes in Figure 4.

While this first empirical analysis is useful in terms of getting an overview of the possible direction and economic magnitude, there are numerous limitations we need to address in order to arrive at an economically more profound analysis. Firstly, it must be recognized that modified duration only applies to incremental changes, not to 10% changes. Secondly, we need to take the interactions with the liability side into account (the modified duration used here only applies to the asset side, but to understand the economic impact of an interest rate change, we need to look at both sides of the balance sheet). Finally, we need to be cognizant of the fact that the results presented here are sensitive to outliers in the data and to changes in the input parameters (e.g., modified duration, asset weights). We need more detailed specifications in order to model the assets of a specific insurer adequately. To start with, the weights

for the different asset classes need to be adapted. Second, differentiation between bonds with different rating (i.e., AAA, BBB, non-investment grade) would yield more realistic results. And last, the geographical asset allocation needs to be taken into account. The data used in Barro (2006) makes projections for individual economies, but not for the world GDP. For a worldwide diversified portfolio, we might thus expect fewer extreme effects.[9] However, it is also not completely clear how far extreme cyber scenarios can be diversified globally. One disadvantage of our empirical approach is that we assume that a cyber event would affect the economy and financial markets in a similar way as previous events. For example, the financial crisis of 2008 had a large impact on the financial markets but a relatively small impact on the real economy and thus might not be representative of a cyber event that affects the real economy (i.e., reduction in production efficiency). For this reason, we recommend digging deeper on the modeling side (see the extended model).

4.2 Extended model

The extended model relies on the macroeconomic model presented by Swanson (2019). We assume that a cyber event reduces the efficiency of production via a technological factor. We consider a classical (Cobb-Douglas) production function, where the production (Y) is a function of labor (l), capital (k), and the employed technology (A), i.e., $Y = A \cdot k^{1-\theta} \cdot l^{\theta}$. We assume that the labor and capital supply is exogenous and does not, therefore, change due to the shock. The shock to the technology factor translates one-to-one to a shock in the production; we assume that, in equilibrium, production equals consumption. With respect to the GDP dynamics over time, we assume that after the initial shock, $\Delta\tilde{y}$, in the first period, the output returns to the long-term growth path. This would mean that the growth rate in period 2 is bigger than the long-term growth rate in order to compensate for the output lost. In robustness tests (available upon request) we consider alternative scenarios where the GDP deviates from the long-term growth path by more than one period.

We model the behavior of the monetary authority by using the so-called Taylor rule [Swanson (2019)]. The Taylor rule describes how the short-term interest rates (target rate, such as the three-month Libor) are changed in response to a shock to the GDP. It has been shown that nonlinear versions of the Taylor rule fit the behavior of monetary authority best [Nitschka and Markov (2016)]. The most frequently used nonlinear model is the logistic function [Gerlach and Lewis (2014)] $\Delta i_{rf} = \frac{i^{max}}{1+e^{-\beta_M r \Delta y}} - i_{min}$, where i_{max} and i_{min} are the upper and lower limits for the possible interest rates, β_M is the slope of the response function, and $\Delta y = \Delta ln(Y)$ is the output gap (in %).[10] Thus, a negative output gap $\Delta y < 0$ would cause central banks to lower interest rates. However, compared to a simple linear Taylor rule, this function describes a s-shaped reaction, meaning central banks are reluctant to lower already low interest rates further or even push them into negative territory. The reason is that while there is little evidence that lowering interest rates below zero would further stimulate the economy [see liquidity trap; Krugman et al. (1998)], negative interest rates harm society by reducing pensions and savings.[11]

To complete the modeling of the interest rates, we need to analyze the effect of the short-term interest rates on the longer end of the yield curve. Thus, we use the monetary reaction function as an input to model yield curves for government bills (risk free), corporate bonds, and stocks. We refer to an extended version of the paper available upon request for more details about modeling yield curves. Combined with the interest rate sensitivity, we also calculate the shock to government bonds. For corporate bonds, we again consider countercyclical credit spreads and define them as in the simple model above. For stocks, we use the classical Gordon growth model and discount the companies' future cash flows to attain the present value with a shock $(\tilde{S})$ and without a shock (S). Again, we refer to the extended version of the paper (available upon request) for all modeling details. We consider stocks as a leveraged claim on the overall consumption C^{λ}, where λ is the leverage [Abel (1999), Bansal and Yaron (2004), Gourio (2012), Swanson (2019)].[12] The expected return for stocks is composed of the risk-free interest rate and the equity risk premium, $i_e = i_{rf} + \psi_e$. Like the credit spread above, we assume that the equity risk premium increases in times of

[9] We note, however, that the U.S. accounts for approximately 50% of the MSCI World and 25% of global GDP. In this respect, there are also strict limits to diversification for the global market portfolio.

[10] To calibrate the logistic function, we use long-term average maximum (i_{max} = 6%) and minimum (i_{min} = 0.5%) for the interest rate. Swanson (2019) explicitly models the monetary response as a function of the output gap (i.e., in our context the GDP reduction) and inflation. We do not explicitly model inflation and focus instead on the effect of the GDP reduction only.

[11] Note that the Taylor rule describes short-term interest rates only; it would be possible to also include monetary interventions at the longer end of the yield curve (so called quantitative easing, yield curve control), which might reduce long-term interest rates and credit spreads. A more aggressive monetary intervention would thus generally support asset prices and further dampen the shock to the insurer's portfolio.

[12] The leverage parameter describes the leveraged claim on a company's future cash flows. This is due to fixed costs (operation leverage) and fixed amount of debt (financial leverage) [Gourio (2012)].

Table 4: Parameter choice for extended model

PARAMETER		VALUE	SOURCES
Monetary policy response	$\hat{\beta}_M$	0.70	Carvalho et al. (2018, table 1a) for U.S.; other sources: 0.75 [Swanson (2019, p.13)], 0.5-1 [Taylor (1993, 1999)]; empirical for Switzerland (2000-2012) 0.58-0.63 [Nitschka and Markov (2016, table A.3)]
Min. interest rates	i_{min}	0.5%	Nominal short term interest rates observed for the U.S.
Duration	D	5.7	Average duration of non-life insurers' assets in 2019 [EIOPA (2019, p. 71)]
Risk premium cyclicality	$\hat{\beta}_{\psi_e}$	0.97	Empirical sensitivity of the equity risk premium to shocks in GDP for U.S. equity (1948-2005) [Cooper and Priestley (2009, p. 2808)]
Leverage	$\hat{\lambda}$	3.0	Assumption by Swanson (2019, p. 18) based on estimated/model derived values in Abel (1999)/Bansal and Yaron (2004)

Table 5: Input parameters and results for the extended model

VARIABLE		BASIS SCENARIO	ELING ET AL. (2020) SCENARIOS		RUFFLE ET AL. (2014) SYBIL LOGIC BOMB		ASSET WEIGHT
Absolute GDP growth	Δy	2.20%	1.57%	0.65%	-2.50%	-7.90%	
Relative shock GDP	$(\Delta\tilde{y})$	0.00%	-0.63%	-1.55%	-4.70%	-10.10%	
Risk-free interest rate	i_{rf}	1.70%	1.32%	0.96%	0.55%	0.50%	
Government bonds return	Δgb	0.00%	0.36%	0.70%	1.09%	1.14%	50.00%
Corporate bonds yield	i_{cb}	3.70%	3.54%	3.48%	4.15%	5.94%	
Corporate bonds return	Δcb	0.00%	0.15%	0.20%	-0.43%	-2.09%	30.00%
Equity premium	ψ_e	8.70%	8.93%	9.46%	12.11%	17.30%	
Equity return	Δe	-0.00%	-0.48%	-1.14%	-4.13%	-9.68%	20.00%
Insurer's portfolio return	Δp	-0.00%	0.13%	0.18%	-0.41%	-1.99%	

crisis, thus $\psi_e = \hat{\psi}_e + \hat{\beta}_{\psi_e}\Delta y$. Such a countercyclical equity risk premium is well documented in the literature [Campbell and Cochrane (1999), Swanson (2019)]. Table 5 reports the changes in the value of an insurer's portfolio for different scenarios (the parameters are chosen as in Tables 3 and 4).

While the sensitivity of the insurer's portfolio to shocks is slightly lower here than in the empirical model above, the results are quite similar. For the most extreme GDP shock (-10.1%), the portfolio return would be -1.99% (compared to -4.26% above). The difference between the simple and expanded models is mainly driven by the different interest rates used to calculate the assets sensitivity. Here, we calculate the assets' sensitivities to the longer end of the interest rate curve, which is less sensitive to the shock than the short-term interest rates used above.

Figure 5 shows the return on the insurer's portfolio for the whole space of different shocks. Compared to the results above, the curves are now concave and not linear anymore. The reason for that is that here we assume that the monetary authority reaction is limited. For corporate bonds and the whole insurance portfolio, the curves are first increasing and then decreasing for larger shocks. The reason is that for small shocks the monetary authority dominates (risk-free rates) but for larger shocks, the credit spreads and equity risk premia start to bend the curves downwards.

4.3 Robustness checks

To judge the reliability of our results, we let all estimated parameters vary over a meaningful range of values. One important parameter is how the monetary authority reacts with

Figure 5: Asset returns for different GDP shocks (extended model)

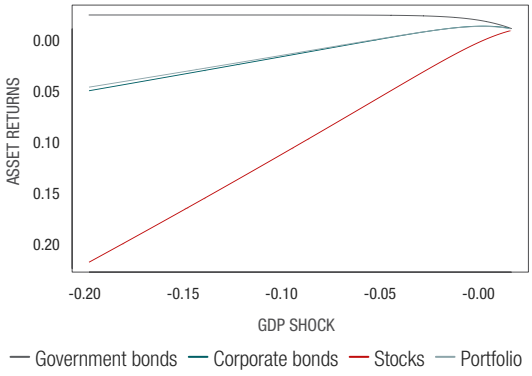


Figure 6: Portfolio returns for different monetary policies (β_M)

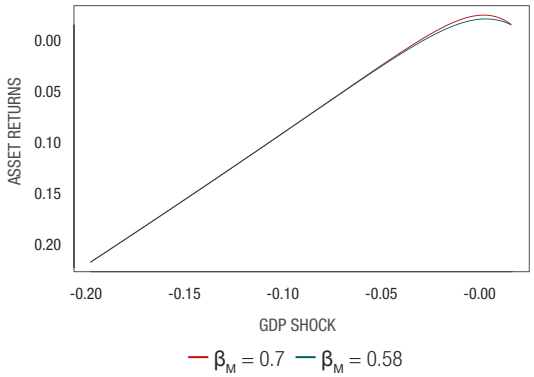


Figure 7: Portfolio returns for different monetary policies (extended model; i_{min})

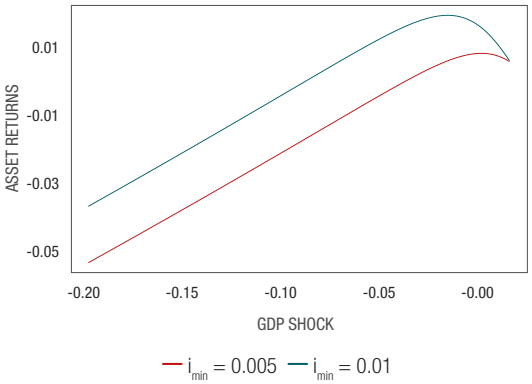
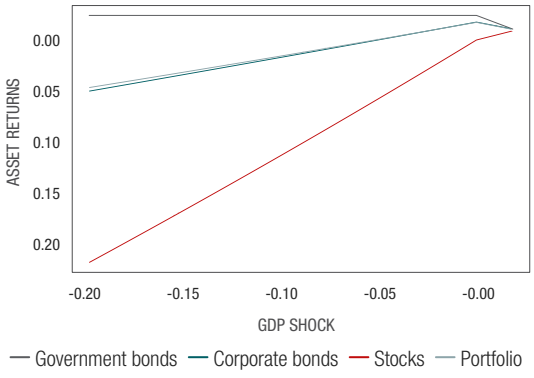


Figure 8: Portfolio returns for linear Taylor rule



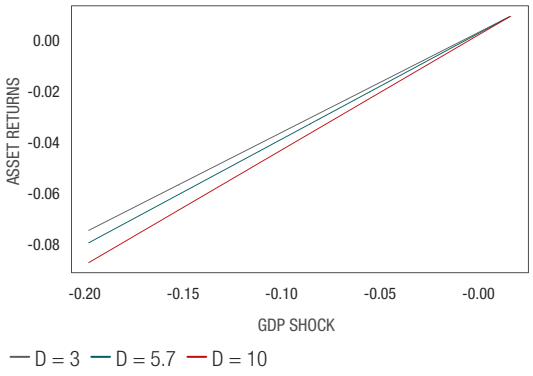
interest rate cuts to the shock, $\hat{\beta}_M$. Figure 6 shows the return on the insurer's assets for different $\hat{\beta}_M$. A less aggressive lowering of interest rates as a reaction to a shock ($\hat{\beta}_M = 0.58$) would decrease, ceteris paribus, the present value of all assets and the negative shock to the insurer's aggregated assets would be larger. The government bonds would especially benefit from lowering interest rates. Hence, essentially if we believe that central banks will react to the shock, there will be no negative impact on asset returns. It would be possible to also include monetary interventions at the longer end of the yield curve (so-called quantitative easing), which might reduce long-term interest rates and credit spreads. A more aggressive monetary intervention would support asset prices and further dampen the shock to the insurer's portfolio.

Another important parameter is how the monetary authority reacts with interest rates cuts to the shock, i_{min}. Figure 7, shows the return on the insurer's assets for different i_{min}. A more aggressive lowering of interest rates as a reaction to a shock (i.e., i_{min} = -1%) would increase, ceteris paribus, the present value of all assets and the negative shock to the insurer's aggregated assets would be smaller. Hence, essentially if we believe that the central banks will react more strongly to the shock, there will be less negative impact on asset returns.

We not only let the parameter values vary to analyze parameter risk, but we also vary the modeling itself to get a better understanding of the potential model risk. An alternative to the logistic model for the monetary response is to use a simple linear function, which is cut off at the minimum and maximum interest rates, again showing robust results (see Figure 8).

We also analyze the sensitivity of our results to the duration (focusing on the effects on the assets only; for the influence of the interest rate change on the entire risk capital of an insurer, the liabilities are relevant as well). Figure 9 presents the return on the insurer's asset portfolio for different duration levels based on the simple model. A portfolio with higher duration would perform relatively worse.

Figure 9: Portfolio returns for different durations (simple model)



5. CONCLUSIONS, LIMITATIONS, AND FUTURE RESEARCH

We propose a general framework to model the effects of extreme risks on an insurer's assets and apply it in the context of extreme cyber risk events. We reviewed a wide range of literature, mainly for non-cyber disasters and show how we can apply the respective insights to future extreme cyber disasters and their impacts on the financial markets. Extreme cyber scenarios might have a profound effect on an insurer's assets, but the overall effect remains, to some extent, limited mainly due to hedging properties of different asset classes. First, such an event would lower current and expected interest rates and thus increase the value of (risk-free) government bonds. Due to this property, government bonds have frequently served as a safe haven in times of crisis. Second, the effect on corporate bonds is ambiguous, since in times of crisis we frequently observe spikes in credit spreads. Third, stocks would suffer major losses. The reason is that a cyber disaster would reduce the economy's productivity and capital stock. After the initial hit to the production, the economic multiplier would cause demand and production to plunge further. All this hurts companies' earnings and increases in the risk premium would further reduce the value of future cash flows. Overall, the value of stocks declines and credit risk goes up, but the risk-free interest rate decreases, which in turn increases the value of government bonds and other relatively risk-free investments. This important hedging property may exist when we only look at the asset side of the balance sheet of a (re-) insurer, but lower interest rates, particularly, may lead to a large increase in the market values of liabilities and materially impact solvency (via discounting used for market value margin/risk margin calculation).

There are a number of limitations to our analyses that might serve as motivation for future research. First, since we have never observed a catastrophic cyber event, we do not exactly know whether previous disasters are representative and whether different types of cyber events will have different effects on assets.[13] Second, for a real-life implementation, insurers need to adapt our model to reflect their concrete asset portfolio with respect to the geographic, asset class, strategic, and duration allocations. As mentioned above, there might be sectors that could even benefit from a cyber event (e.g., cyber security providers). From an empirical perspective, we illustrated that the main challenge is to identify the time dimension of the connections between an event and the reaction of the financial markets. Since financial markets are forward-looking, their reactions run in front of other relevant economic measures. By looking at several periods and using unexpected shocks, we could mitigate this problem to some extent. It also means that insurers should be aware that asset shocks might precede underwriting losses for cyber risks. The timing of the losses is thus different, which again might cause some diversification potential. However, insurers will need to put provisions on the balance sheet as soon as the cyber event occurs.

Future research could aim to provide better estimates for the potential economic damage a cyber disaster could cause. We addressed the uncertainty so far by providing results for a whole range of shock severities, as measured by the GDP decline. Clearly, for risk management purposes, we should have a more sophisticated understanding of the size of the shock, the time it takes for the crisis to resolve, and the likelihood of such an event. Moreover, to apply our model to the concrete exposure of an insurer, we would need to be more precise about the sectoral and geographical regions that are affected. An input-output model as presented in Eling et al. (2020) could be informative on such questions. Furthermore, this analysis is limited to studying the implications of such shocks to the asset side of the balance sheet of an insurance company. To understand the full impact on the balance sheet of an insurance company, the liability side also needs to be incorporated in the analysis, which is not the focus of this analysis. In addition to the impact of an extreme scenario on the insured losses, the interest rate effects also need to be considered. Furthermore, the increase in credit spreads might also have an impact on the underwriting side.

[13] For example, we look at scenarios where stock prices go down, but what we have not considered is what happens if a cyberattack directly disrupts trading on the capital markets. For example, what happens if virulent malware stops the NYSE exchange for two weeks, or what happens if malware disconnects an insurance company from the capital market for two weeks?

Another promising avenue for future research might be to apply our model to other institutions in the financial services sector, especially to the banking industry. The findings in this paper indicate that the impact of extreme scenarios on the asset side of the insurer's balance sheet is relatively limited because of hedging effects, but it is not clear how the model would behave in the context of a banking balance sheet. The outcome of such an analysis might also provide some relevant policy implications on differences and commonalities in the business model of banks and insurance companies.

The results of the paper can be useful to improve internal capital models with respect to the link between extreme (cyber) events and the capital markets. The general results derived here are also relevant in light of the discussion around the development of solvency models that assume a linear correlation of 0.25 between the investment and underwriting.[14] Given the results we have seen so far, this seems too conservative. Moreover, the relationship should be modeled non-linearly, that is, in normal times the correlation is very likely lower and closer to 0, while in extreme scenarios we might expect to observe a link (e.g., 9/11), at least in the short- to medium-term. Given that the time horizon of solvency models is not short term (daily, weekly), but one year, the strengths of the actual correlation might again be questioned in light of the results presented here.

[14] A linear correlation of 0.25 is the assumption in many regulatory standard models, such as Solvency II in the European Union [Eling and Jung (2020)]. Insurance companies that work with internal models use our specific dependencies, including dependencies between investment and underwriting risks.

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ASSESSING THE ECONOMIC IMPACT OF CLIMATE CHANGE

JÉRÔME JEAN HAEGELI | Group Chief Economist, Swiss Re
PATRICK SANER | Head Macro Strategy, Global Economic Research & Strategy, Swiss Re

ABSTRACT

The extreme weather events seen worldwide this year underline the need for decisive global action on climate change, one of the biggest societal risks of our era. Rising global temperatures and more extreme weather events will increasingly set economies back through physical risks such as property damage, disruption to trade, and lost productivity. There will also be transition costs as we move away from systems and infrastructure underpinned by fossil fuels and carbon-intensive resources. Swiss Re Institute set out to assess how climate risks will impact economic output (GDP) in countries globally. The analysis covers 48 countries representing 90% of the world economy, using global warming of 2.0-2.6°C by mid-century as a baseline scenario. For the economic impact of climate change, the tail of possible economic outcomes is what matters. The research uses a scenario approach to capture uncertainties around temperature paths and economic implications, complementing typical climate risk models that identify the average expected GDP loss. The research also tested countries' resilience by building a model that combines the findings on the economic impact of gradual climate change with countries' vulnerability to extreme weather events and their adaptive capacity.

The research finds that the world stands to lose around 10% of GDP by mid-century if climate change stays on the same trajectory and the Paris Agreement and 2050 net-zero emissions targets are not met. Achieving the Paris Agreement target would reduce the impact, but there would still be a global GDP loss. The extreme weather analysis indicates higher likelihood of droughts in southeast Asia and Latin America, and higher excess precipitation and flooding in northern and eastern Europe. The Swiss Re Institute Climate Economics Index ranking finds that those most negatively impacted by rising global temperatures are often those with fewest resources to adapt to and mitigate the effects. More global, coordinated action to mitigate climate change is an imperative. Swiss Re Institute makes policy recommendations for both the public and private sectors to accelerate climate-related action and collaborate to ensure equitable progress in greening economies.

1. INTRODUCTION

Climate change affects us all. The extreme weather events across Europe and North America this summer were just the latest forewarning of what we might expect from our climate in future. Encouragingly, we see increasingly loud and clear responses in global political and policy spheres. The latest U.N. Intergovernmental Panel on Climate Change (IPCC) report in August issued a "code red" alert for humanity on global warming, while at the June G7 meeting, world leaders pledged to end the use of coal-fired power generation.

Swiss Re Institute analysis finds that the world stands to lose about 10% of total economic value (GDP) by the middle of this century if climate change stays on the same trajectory and the Paris Agreement and 2050 net-zero emissions targets are not met. Rising global temperatures and more extreme weather events will increasingly set economies back through physical risks such as property damage, disruption to trade, and lost productivity.

A green economy is ultimately to everyone's benefit, and though there will be transition costs as we move away from systems and infrastructure underpinned by fossil fuels and carbon-intensive resources, the ecological and economic cost of doing nothing is even higher. We stress-test how climate risks will impact 48 countries representing 90% of the world economy, and their resilience to change. Our analysis finds that all countries will be affected, but some more than others. No action is not an option.

2. THE ECONOMIC IMPACT OF CLIMATE CHANGE: THE STING IS IN THE TAIL

Models of the economic impact of climate change typically seek to identify the average expected GDP loss. Other than considering effects such as negative feedback loops, most do not account for high-impact disasters such as drought and severe precipitation that can significantly increase the GDP loss.

Climate change research[1] indicates that the trajectory of temperature increases, assuming action with respect to climate change mitigation pledges, points to global warming of 2.0-2.6°C by mid-century. We use this as a baseline to simulate the impact of rising temperatures, while also taking into account uncertainties around severe possible physical outcomes such as the potential effects of disruption to global trade, migration, and biodiversity. The result, shown in Table 1, is that global GDP would be 11-14% less than in a world without climate change (i.e., 0°C temperature change).

Achieving the Paris Agreement target, of limiting the rise in global temperatures to well below 2°C, would also entail a negative GDP impact, but much smaller (-4.2%). We also consider a severe scenario in which temperatures rise by 3.2°C by mid-century, with society doing nothing to combat climate change. In this scenario, the global economy would be 18% smaller than in a world without warming. The analysis reinforces the imperative need for, if anything, more action on climate change than is already under way.

In economic terms, no country is immune to climate change. Outcomes vary by country based on: 1) where they lie geographically and 2) their economic composition. Countries in the more exposed geographic regions, such as Southeast Asia or Africa, face worse economic outcomes than, for example, those in Northern Europe. Emerging economies often rely more on agriculture and tourism to drive economic growth,

Table 1: Global temperature rises will negatively impact GDP in all regions by mid-century

TEMPERATURE RISE SCENARIO, BY MID-CENTURY	WELL BELOW 2°C INCREASE	2.0°C INCREASE	2.6°C INCREASE	3.2°C INCREASE
	PARIS TARGET	THE LIKELY RANGE OF GLOBAL TEMPERATURE GAINS		SEVERE CASE
	SIMULATING FOR SEVERE ECONOMIC IMPACTS FROM CLIMATE CHANGE EFFECTS			
World	-4.2%	-11.0%	-13.9%	-18.1%
OECD	-3.1%	-7.6%	-8.1%	-10.6%
North America	-3.1%	-6.9%	-7.4%	-9.5%
South America	-4.1%	-10.8%	-13.0%	-17.0%
Europe	-2.8%	-7.7%	-8.0%	-10.5%
Middle East and Africa	-4.7%	-14.0%	-21.5%	-27.6%
Asia	-5.5%	-14.9%	-20.4%	-26.5%
Advanced Asia	-3.3%	-9.5%	-11.7%	-15.4%
ASEAN	-4.2%	-17.0%	-29.0%	-37.4%
Oceania	-4.3%	-11.2%	-12.3%	-16.3%

Note: Temperature increases are from pre-industrial times to mid-21st century and from left to right relate to increasing emissions and/or increasing climate sensitivity (reaction of temperatures to emissions). To measure the impact of temperature rise, the economic loss is represented as a percentage of GDP in a world without climate change.

Source: Swiss Re Institute

[1] Intergovernmental Panel on Climate Change (IPCC), 2014. Fifth Assessment Report (AR 5), https://bit.ly/3ENIpoX

which are more adversely exposed to significantly higher temperatures. In contrast, more services-orientated advanced economies are more insulated from the direct effects of rising temperatures, albeit not completely.

2.1 The Paris Agreement temperature target is the most desirable outcome

Up to 10% of the GDP loss we expect by mid-century could be prevented if the world meets the Paris Agreement target rather than reaching 2.6°C warming. In more exposed regions, meeting the target could prevent more than 25% of the GDP loss associated with 2.6°C warming. Emerging markets would mitigate a large part of their expected GDP losses, with Indonesia, Thailand, and Saudi Arabia the biggest relative winners.

2.2 Extreme weather events: The physical impacts of climate change

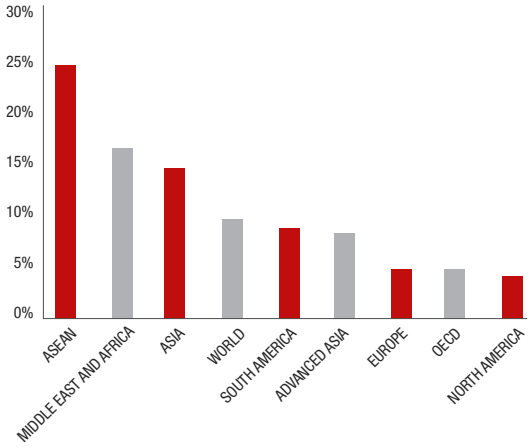
Economies will feel the consequences of more extreme weather events as well as the economic impact of gradually rising temperatures.

We assess the potential outcomes of severe weather events by constructing hazard-based climate risk scores (CRS). On a scale of 1 to 10, these scores reflect the relative exposure of different locations to extreme dry and wet conditions in the environment of gradual climate change.[2] There are two main dimensions: 1) changes in extreme and mean temperatures (dry scores) and 2) changes to extreme and mean precipitation (wet scores). The two CRS sub-scores are proxies for actual weather-related catastrophes such as wildfires, heat waves, and droughts (dry); and river and flash floods (wet).[3]

As Figure 2 highlights, rising temperatures will likely cause more drought in Southeast Asia and Latin America. Figure 3 illustrates the likely increase in excess precipitation and flooding events in northern and eastern European countries.

The U.K. is vulnerable to both extreme dry and wet conditions as global temperatures rise over time. For some large countries that span several climate regimes (e.g., Russia, Australia, China), regional disparity also exists given the diversity of locations in each country. For example, in Australia, the southeast is expected to become drier and the north wetter, especially in summer.

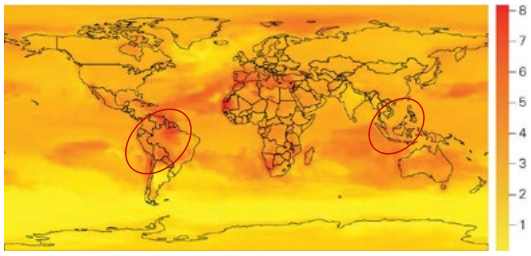
Figure 1: Mitigated GDP loss (in %) by mid-century if Paris Agreement target is met, versus 2.6°C rise scenario



Note: Here, we simulate severe economic impacts from climate change. The figures shown represent the difference between the 2.6°C scenario and the Paris scenario, as % of GDP in a world without climate change.

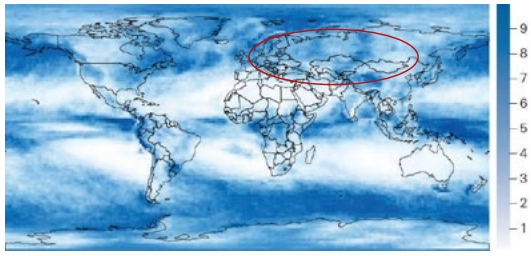
Source: Swiss Re Institute

Figure 2: Dry scores, as of 2030, under RCP8.5 scenario



Source: Swiss Re Institute

Figure 3: Wet scores, as of 2030, under RCP8.5 scenario



Source: Swiss Re Institute

[2] Lüthi, S., M. Gloor, and M. Walz, "Climate risk score – a framework to quantify an insurance portfolio's exposure and contribution to climate change," EGU General Assembly 2020, Online, 4–8 May 2020, EGU2020-9877, https://bit.ly/3tZYDFm

[3] The scales of the dry and wet scores assess the hazard risk on a scale from zero (lowest) to 10 (highest) risk.

Table 2: Swiss Re Institute Climate Economics Index, top and bottom five rankings

RANK	COUNTRY	PHYSICAL RISK			CURRENT ADAPTIVE CAPABILITY RANKING**	TOTAL INDEX
		GDP IMPACT RANKING	EXTREME WEATHER RISK RANKINGS*			
			DRY	WET		
1	Finland	3	8	32	8	11.3
2	Switzerland	4	12	37	2	11.6
3	Austria	7	15	41	6	15.1
4	Portugal	9	21	30	10	15.9
5	Canada	12	18	20	16	16.0
44	Thailand	45	43	11	39	36.0
45	India	42	37	13	46	36.4
46	Philippines	46	48	5	43	37.3
47	Malaysia	48	47	23	33	38.3
48	Indonesia	44	45	19	44	39.2

*Extreme weather risk is proxied by Swiss Re Institute's climate risk scores that reflect individual country potential exposures to extreme dry and wet weather conditions/events on account of changes to the climate. **The adaptive capacity rankings are based on the Climate Change Adaptive Capacity Index from Verisk Maplecroft. Our sample analysis covers 48 countries accounting for 91% of global GDP in 2019.

Source: Verisk Maplecroft, Swiss Re Institute

3. CLIMATE CHANGE RESILIENCE: WHICH COUNTRIES ARE GETTING PREPARED?

Both the longer-term economic impact, and the exposure to extreme weather events, offer a good yardstick of the regions and countries likely to be most affected by climate risk. Knowing this, the next questions are: what are countries actually doing to mitigate climate risk, and how resilient are they overall? To provide an indication of resilience to climate risk, we built the Swiss Re Institute Climate Economics Index.

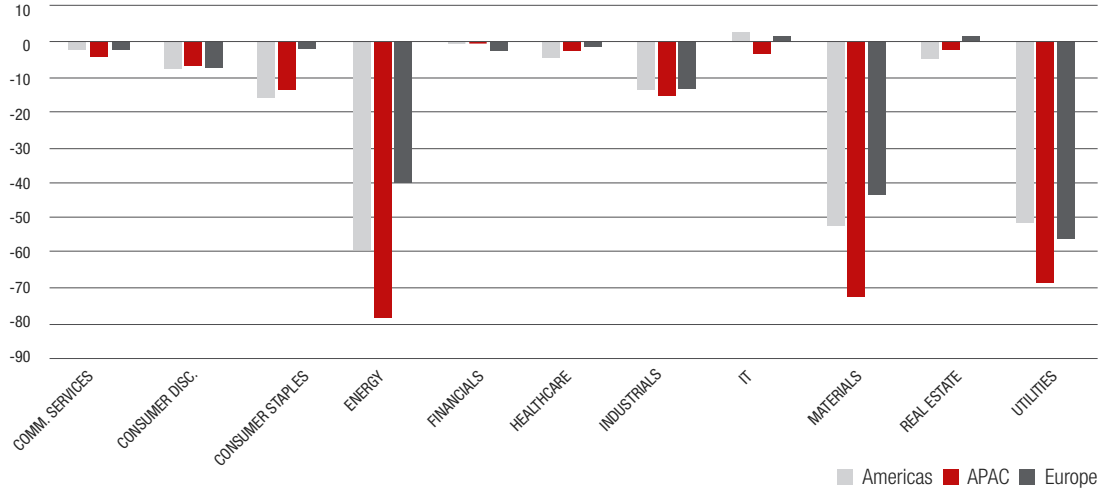
Our index incorporates the economic impact of gradual climate change, countries' vulnerability to extreme wet and dry weather events, and their adaptive capacity. We rank countries according to their 1) estimated GDP impact from an adverse temperature scenario, 2) vulnerability to extreme weather events, and 3) current adaptive capability to climate change. This provides a holistic measure of not only the risks countries face, but also their recognition of these risks and what they are doing about them.

The countries most negatively impacted are often the ones with fewest resources to adapt to and mitigate the effect of rising global temperatures. The index rankings show that many advanced economies in the northern hemisphere are most resilient to the overall effects of climate change, being both less exposed to the associated risks and better resourced to counter its effects. The U.S., Canada, and Germany are among the top 10 least vulnerable. Many emerging markets, which will make an increasing contribution to global growth in the future, are both heavily exposed and poorly resourced to adapt. Economies in Southeast Asia are particularly vulnerable to adverse effects of climate change. China ranks lower among the major economies, in part due to less adaptive capacity in place today relative to peers. However, with rising investment in green energy and awareness of climate risks, China is on course to catch up rapidly.

4. FALLING ASSET VALUES AND HIGHER BUSINESS COSTS: THE FINANCIAL IMPACTS OF CLIMATE CHANGE

The transition towards a low carbon economy is non-negotiable, but it has repercussions for asset valuations. Climate change gives rise to transition risks that can be seen, for example, in large shifts in asset values and higher cost of doing business as the world moves to a low-carbon economy. As a separate analysis, we use carbon-tax scenario analysis as a proxy to gauge the associated financial and economic impacts (see Figure 4).

Figure 4: Transition risk by economic sector and global region



Source: Blackrock Carbon Tax Impact Mode, Swiss Re Institute

It is clear that climate transition risks can have a substantial impact on equity and credit valuations. We find that earnings in the utilities, materials, and energy sectors would be the most impacted and lose between 40-80% of their earnings per share by the immediate imposition of a global carbon tax of U.S.$100 per metric ton. Regionally, Asia is again most exposed. Revenue-weighted earnings would fall by about a fifth in Asia Pacific, compared with 15% in the Americas and Europe. The timing and scope of policy decisions will influence the severity of asset value changes. The scale of loss depends on the speed at which carbon taxes and mitigation actions are implemented, and the pace of technological adoption.

5. WE HAVE THE VISION; WHAT WE NEED IS MORE EXECUTION

Most societies do not need to be sold on the vision of a greener economy: we all stand to benefit from a more predictable, sustainable future as much as we stand to suffer from a worse one. Many countries and companies already have net-zero targets in place. However, progress has been too slow. Climate change mitigation strategies should not be viewed as optional – nor should time and money spent be seen as a cost. It is an investment in the future. For example, the International Energy Agency estimates that roughly 9 million jobs a year will be created or saved if we were to commit a global annual investment of U.S.$1 trillion to the green economy between now and 2023.[4] That is only about 0.7% of current global GDP. It would also add 1.1 percentage points to economic growth, essentially paying for itself. Similarly, several studies suggest that the impact on consumer prices should be negligible.

The Paris Climate Agreement commitments share a common goal to work towards, but each signatory is following its own elected route, and progress around the world has been faltering. Pockets of innovation are encouraging, and many countries can point to examples of action in individual cities or sectors. Still, the impetus and direction to scale up projects and achieve outcomes that reverse the relentless march of carbon emissions are lacking.

Climate change is a global risk that requires global coordinated policy action to ensure equitable progress in greening economies, both for local benefit and to make the world economy more resilient in the long term. More action to mitigate climate change is an imperative. Both public and private sectors need to accelerate climate-related policy action and collaborate. Long-term tail risks need to be managed through coordinated global action, including via smart public-private investment into green infrastructure. Coordination between the top three global CO2 emitters (China 28%, U.S. 15%, and India 7%), which together account for roughly half of all emissions, is crucial.[5] We see the following as key areas to mitigate the worst-case climate outcomes:

[4] IEA, 2020, "IEA offers world governments a sustainable recovery plan to boost economic growth, create millions of jobs and put emissions into structural decline," International Energy Agency, Press Release, June 18, https://bit.ly/3AsBZry

[5] Statista, 2020, "Largest producers of fossil fuel CO2 emissions worldwide in 2018, by share of emissions," September 7, https://bit.ly/3ksg6Dd

Public sector

- **Meaningful carbon pricing:** a global carbon tax that supports long-term decision-making also supports the net zero transition. A carbon tax would, with increased familiarity and understanding, help promote more transparent pricing of climate-related financial risks and reflects this within financial markets.
- **Fiscal incentives for carbon capture and reduction and climate-resilient development:** tax incentives could encourage business to invest in carbon capture and GHG-emission reduction technologies. This could also lead to more research into and development of these areas and enable more finance flows towards climate-resilient development.
- **Transparency and standardization around taxonomy, data, standards, and metrics:** for example, the taxonomy around what is "green" and "sustainable" should be universal. Shared standards, allowing for some regional variation, are key for carbon price discovery and would strengthen comparability of corporate reporting.

Private sector

- **Begin practicing net-zero carbon emissions:** by joining the United Nation's Net Zero Asset Owner Alliance, institutional investors, including insurers, can deliver a bold commitment to transition their portfolios to net-zero GHG emissions by 2050. Insurers should consider deploying sustainable underwriting practices.
- **Corporations should disclose transition plans:** companies should show through transition plans how their business is future-proof and consistent with a net-zero carbon economy. Such transition plans should also feature interim updates of how to achieve longer-term goals.
- **Rating agencies should more explicitly take climate change into account:** climate change has financial implications, which rating agencies should take into account when assessing sovereign and corporate balance sheets in their rating methodology. They can play a key role in shaping best practice of what constitutes a "good climate" rating, to avoid "greenwashing" of capital flows.

Importantly, the transition to a low carbon economy is a collective learning journey. All participants should share risk knowledge and expertise. For example, the private sector, particularly re/insurance companies, can share expertise around risk models and new technologies to better understand and mitigate the effects of climate change and natural catastrophes.

6. CONCLUSION AND THE PATH FORWARD

Climate risk is potentially the biggest societal risk of our era. We believe it must be addressed through coordinated global policy action. Our scenario analysis estimates that in a severe, unmitigated climate-change scenario, global GDP could be 18% less by mid-century compared to a no-climate change world. Our motivation is not to be alarmist but to profile the severity of potential risks, including of tail exposures, if society does nothing about climate change. No country is immune to the effects of climate change, and no action is not an option. Many major economies would lose roughly 10% of their GDP in about 30 years' time, while some in southeast Asia could lose roughly half of their GDP in that timeframe.

We have a unique opportunity to green our economies. The public and private sectors, including insurers as providers of risk transfer capacity, risk knowledge, and long-term investment, can facilitate transition to a low-carbon economy. Increasing transparency, data, and disclosure to price and transfer risks is needed. To this end we should see more policy action on carbon pricing coupled with incentivizing nature-based and C02-offsetting solutions. International convergence on the taxonomy on what green and sustainable investments are is also needed. Institutions should also regularly disclose their roadmaps on how they intend to reach the Paris Agreement and 2050 net-zero emissions targets.

At Swiss Re, we have identified four key pillars where systemic intervention is needed: reduce direct emissions and decarbonize all of our business, support carbon removal through industrial pathways, expand and secure carbon removal via natural pathways, and adapt to and minimize consequences from the irreversible climate damage already locked in.

The pandemic has clearly been a great shock to society and the global economy, but it pales in comparison to the long-term impact of climate change. As with the pandemic, no country will be immune to its physical and economic consequences; the urgency and global coordination seen in the battle against the coronavirus needs to underpin the efforts to curb carbon emissions. A science-informed, globally orchestrated, and timely response strategy is the key factor to succeeding in combatting and adapting to climate change.

THE FUTURE OF INSURANCE: PERSONALIZED, DIGITALIZED AND CONNECTED

MATT HUTCHINS | Partner, Capco
ERNST RENNER | Partner, Capco

ABSTRACT

Even before the advent of COVID-19, the insurance industry was undergoing rapid transformation, with many firms putting plans in place to meet the needs and expectations of tomorrow's customers. There was already growing demand for insurance products that are tailored, flexible, and available anytime, anyplace at a competitive price. As for so many industries, COVID-19 has proved an accelerator, forcing insurers to escalate change programs to ensure they can continue selling their products and services in an environment where face-to-face interactions have been significantly curtailed. New entrants are further spurring innovation, establishing new paradigms for customer experiences, and reshaping the competitive landscape. In this article we highlight the key findings of Capco's 2021 survey of consumers in 13 major markets globally, which confirms that the future of the insurance will be personalized, digitalized, and connected.

1. INTRODUCTION

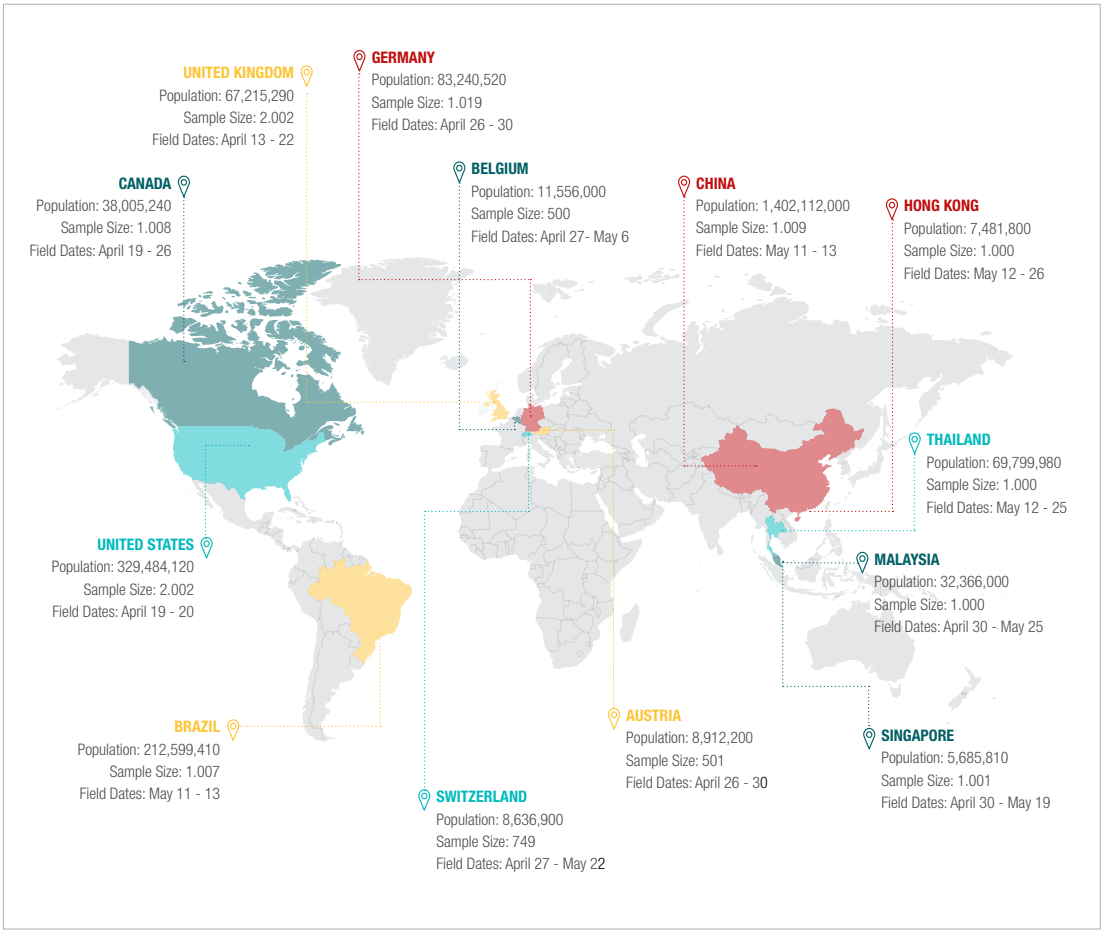
Individuals, companies, industries, and governments globally are currently confronting many changes, some of which look set to alter the nature and tenor of our daily lives in fundamental ways. COVID-19, in particular, has clearly been profoundly disruptive, and the reshaped landscape of the post-pandemic world has yet to fully reveal itself. However, at a time when our physical proximity and interactions have been significantly curtailed, new opportunities and avenues to connect and build relationships continue to emerge via technological innovation and digitalization.

New realities in insurance are coming to the fore as part of this evolutionary shift that will benefit service providers and consumers alike. Our survey of 13 key global markets captures a diverse range of today's consumer sentiments, alongside the key trends, challenges, and opportunities that will shape the industry tomorrow.

Many of the world's insurance markets are growing beyond the bounds of what was thought possible just 10 years ago. Large, traditional market players are coexisting and even partnering with new entrants, including niche insurtechs and other companies whose original business focus is far removed from the insurance world.

Innovation is everywhere. Robots are competing with your trusted insurance broker or agent to serve complex customer needs. Insurers are integrating environmental, social and governance (ESG) factors within their core business operations, as part of underwriting, investing and risk management decisions, and developing tailored ESG products and services.

If our survey highlights that there is no one-size-fits-all customer – and therefore no one-size-fits-all solution in the future of insurance – our data does confirm the future will be personalized, digitalized, and connected.



Source: data.worldbank.org

2. METHODOLOGY

Our survey was conducted online between April and May 2021 and collected responses from a total of 13,798 individuals.

The markets surveyed were the U.K., U.S., Canada, Brazil, Germany, Austria, Switzerland, Belgium, Hong Kong, China, Singapore, Thailand, and Malaysia. Country representative quotas were followed.

Survey respondents were drawn from six age demographics: 18-24, 25-34, 35-44, 45-54, 55-64, and 65+. 49% of respondents identified as male, 50% identified as female, and 1% identified as other.

3. EXECUTIVE SUMMARY

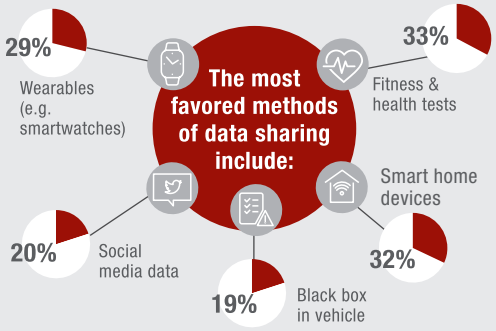
Capco surveyed nearly 14,000 consumers across 13 markets globally to gain a better understanding of public attitudes toward personal lines of insurance, the key products and services used, and emerging trends.

Based on our findings, insurers should focus on these four areas:

1 HYPER-PERSONALIZATION

72%

of insurance holders surveyed are willing to share **personal data** to get cheaper insurance premiums



2 EDUCATION

37% of consumers surveyed **do not feel well informed** about insurance and the products available today

WOMEN FEEL LESS CONFIDENT about the insurance offerings in 12 out of 13 countries

3 CROSS-SELLING

Only 40%

of insurance customers surveyed **have multiple policies with the same provider**

4 DIGITALIZATION

57% of policyholders surveyed want a better **online experience** from their insurer

65%

of all respondents, including uninsured customers, would use **an app that offers better transparency** across all financial products (bank accounts, pensions, insurance policies) in addition to providing personalized insights

FOUR OPPORTUNITIES FOR INSURERS

1 **EDUCATION**
Education is needed to increase consumer knowledge and engagement

2 **HYPER-PERSONALIZATION**
Hyper-personalization could drive better customer outcomes for certain demographics

3 **CROSS-SELLING**
Insurers can boost brand awareness, repeat business and retention through cross-selling

4 **DIGITALIZATION**
There is the demand for more sophisticated online services and tools

4. GLOBAL OVERVIEW: THEMES AND TRENDS

4.1 Top 10 insurance policies purchased

We asked our survey respondents which insurance policies they had bought in the last year.

Auto, health, and life were the most common insurance policies owned. It should be noted of course that in certain European and APAC markets, certain forms of insurance, such as health, are mandatory. Auto had particularly high ownership in the Americas, while health and life policies were most prevalent in APAC.

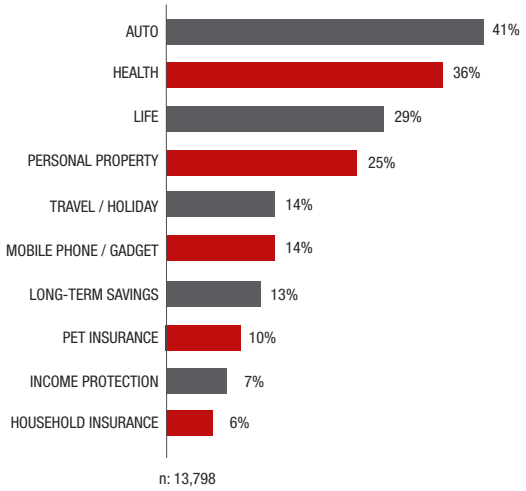
Personal property insurance came in fourth place, with high ownership in the U.K., Belgium, and Canada.

Despite COVID-19 lockdowns and travel restrictions around the world, which saw global travel and tourism revenues plummet by nearly 60% year on year,[1] travel/holiday insurance came in at fifth place, in joint position with mobile phone/gadget insurance – a product truly born of the digital age. U.K. respondents in particular were big spenders in both categories.

Long-term savings products were particularly popular with APAC and Belgium-based respondents.

U.K. and Hong Kong respondents were the biggest buyers of pet insurance. The petcare market in APAC is expected to see a 10% compound annual growth rate to reach U.S.$132 billion in 2027,[2] and in the U.K., pet insurance offers providers a potential £2.5 billion opportunity in untapped premiums, due to an estimated 48% of dogs and 69% of cats remaining uninsured.[3]

Figure 1: Top 10 insurance policies purchased in the past year



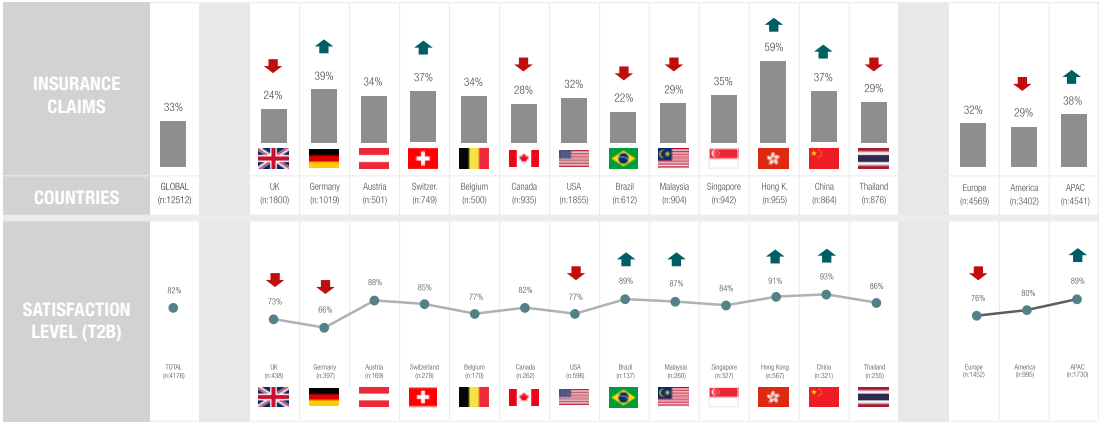
For the purposes of simplicity, Health included: medical insurance, health insurance through employer, disability insurance, critical illness insurance, or similar. Life insurance products included: life & savings insurance, term, whole, universal life products.

Thailand and Hong Kong respondents were the biggest buyers of income protection insurance. In June 2020, a survey by the Asia Foundation estimated that 70% of Thailand's workforce had seen their monthly income fall by an average of 47%.[4] Hong Kong's economy also suffered greatly in 2020, with GDP shrinking to a record 6.1%.[5]

Austria, Switzerland, and Germany were the biggest buyers of household insurance.

[1] https://bit.ly/3mLFsvB
[2] https://bit.ly/2YKd2dr
[3] https://bit.ly/3aK9jz7
[4] https://bit.ly/3FHXlnU
[5] https://bit.ly/3lxQjdf

Figure 2: Responses to "Have you made an insurance claim in the past two years?" and "How satisfied were you with the claims process?"



4.2 Claims

4.2.1 RESPONDENTS ARE STILL EXPERIENCING AGE-OLD CLAIMS ISSUES

Despite generally high satisfaction with the claims process across the markets surveyed, consumers complain about insurance response times and too much paperwork.

Claims play a critical part in a customer's experience and interaction with their provider. A claim can strengthen an individual's relationship with the insurer, potentially extending it for many years and driving recommendations to family and friends; or, if poorly handled, it can trigger a swift move to another provider.

As seen in Table 1, our survey identifies health, auto, and life insurance as the most claimed insurance products over the past two years across our respondents globally. Interestingly, Gen Y (25-34) were the biggest health claimants (43%), whereas second-generation Baby Boomers (55-64) submitted the most auto claims (49%). Older Baby Boomers (65+) made the most personal property insurance claims (31%) and Xennials (35-44) made the most life insurance claims (33%).

The acceleration in digitalization and smartphone use (48% of the world own one)[6] has catapulted mobile/gadget from being a relatively niche form of insurance into the survey's fourth most claimed product (and fifth most popular insurance).

Table 1: Top 10 types of claims

TOP 10 TYPES OF INSURANCE CLAIMS SUBMITTED IN THE PAST TWO YEARS	%
Health (e.g., medical insurance, health insurance through employer, disability insurance, critical illness insurance, or similar)	34%
Auto	32%
Life (e.g., life & savings insurance, term, whole, universal life products)	19%
Mobile/gadget	17%
Personal property	16%
Travel/holiday	15%
Long-term savings	13%
Pet insurance	12%
Income protection (e.g., credit)	10%
Household	6%

[6] https://bit.ly/3oQRc2A

The leading claimants are respondents from Germany (30%) and Brazil (28%), and perhaps predictably, digital native generations – Gen Z (18-24) and Gen Y Millennials (45%) – who are also the leading purchasers of mobile/gadget insurance.

Pet insurance similarly features prominently, both as a purchased and claimed-for product. Like mobile/gadget insurance, it is most favored by younger generations (13% of Gen Z, 11% of Gen Y, 10% of Xennials). The younger generations also made the most claims on this type of insurance (22% of Gen Z claimed on their pet insurance). The level of claims was higher in the U.K. (24%) than in other markets: as already mentioned, the pet insurance market in the U.K. is long-established. 45% of U.K. residents are pet owners (with over 3 million getting a pet since the pandemic struck[7]), and U.K. pet insurance claims have almost doubled in the past six years, from £452 million in 2012 to £815 million in 2019, with the average claim totaling £793.[8]

Our respondents were generally positive about recent claims experiences, but there is evidently room for improvement. The most satisfied region was APAC, with all countries surveyed registering satisfaction levels in excess of 80%. As many as 93% of China-based respondents selected either "highly satisfied" or "satisfied" in response to our question about their last claims experience. The least satisfied region was Europe, with 66% of German respondents selecting either "highly satisfied" or "satisfied"; 30% rated their experience as "neutral" and 4% were "highly unsatisfied" or "unsatisfied".

Looking at the reasons for dissatisfaction with a claim, three of the top five cited touch upon elements that could be supported by technology (see Table 2). Innovations, such as machine learning and AI, are improving the customer experience via digital claims handling capability, speeding up tasks, and reducing fraud and forms of data leakage. Blockchain is also starting to be used for managing claims as part of Know Your Customer (KYC) assessments and automated claims submission and processing.

From a customer perspective, the issues cited by respondents reinforce the importance of both financial literacy and simplification when it comes to insurance. The digital era has eroded customers' willingness to engage in deep reading, meaning they are less disposed to thoroughly check through paperwork. It has also changed expectations on how quickly key information can be accessed and claims issues solved.

Table 2: Top five issues with claims

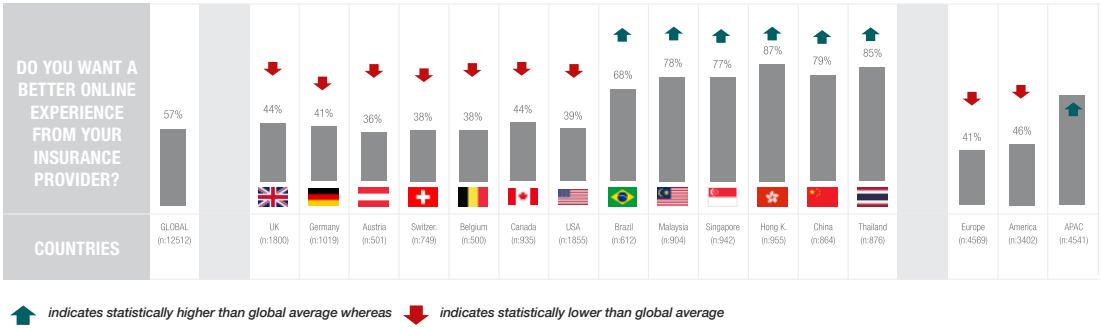
TOP FIVE ISSUES ENCOUNTERED DURING CLAIMS PROCESS	%	TOP ISSUES BY GENERATION SURVEYED
Slow to respond to process	42%	Gen Y Millennials (25-34), Gen X (45-54), Xennials (35-44), Baby Boomers (65+)
Too much paperwork to complete process	28%	Gen Z (18-24)
Slow to pay out	27%	
No payout	24%	Baby Boomers (55-64)
Insurance premium rose significantly after claiming	24%	

The events of 2020, which led to exceptionally hefty claims, have demonstrated the capacity of "black swan" occurrences – such as COVID-19 – and more predictable developments (like climate change) to expose the often complex and cumbersome nature of claims processes. While we do not know the full cost of the pandemic, some data can shed light on the magnitude of its effect. Lloyds of London priced industry costs from 2020 at £6.2 billion,[9] making it the market's most expensive year for three centuries. Similarly, Swiss Re quantified the natural and human-made catastrophes from 2020 at U.S.$89 billion, naming it the fifth costliest year for insurers since 1970.[10] 2021 is similarly already looking like an expensive year for insurers.

However, there is a clear opportunity for additional innovation to enhance the claims process. Customer pain points can also be reduced by keeping them informed at every stage of their claim. This is not just a case of creating digital products, but ensuring help and support is provided in a number of different forms to support all consumer needs throughout the policy term.

[7] https://bit.ly/3oW3GGa
[8] https://on.ft.com/3Dxyxgd
[9] https://bit.ly/2YDZbW9
[10] https://bit.ly/3aK9CKh

Figure 3: Question was asked to policyowners



5. DIGITALIZATION

5.1 Six out of 10 policyholding respondents want a better online insurance experience

While in the past insurance was considered to be less digitally advanced than some industries, the accelerating digitalization of daily experiences and activities, coupled more recently with the COVID-19 pandemic, has challenged convention and is increasingly driving customer journeys down digital paths. For example, Lemonade Inc., a U.S. and Europe-serving insurtech, tells its website visitors to "forget everything you know about insurance" and "get insured in seconds".[11] "Insurance, but simple," says European digital insurer WeFox. Tesla urges consumers to "get a quote with Tesla Insurance for competitive rates in as little as one minute".[12] Convenience and transparency have become vital in insurance, and digitalization is allowing industry players to significantly enhance both.

Table 3: Source of products

WHERE DO YOU TYPICALLY LOOK TO FIND INSURANCE PRODUCTS? (multiple choice question)	TOTAL
BASE	12443
From an insurance agent	38%
Direct from an insurer	38%
Through a price comparison or review aggregator website	32%
Through an insurance broker	24%
My bank	23%

Table 4: Decision factors for buying products

WHEN BUYING INSURANCE WHAT IS YOUR MOST IMPORTANT DECISION FACTOR?	TOTAL
BASE	12512
Value for money	30%
Ability of offer to meet your needs	19%
Trust in brand	18%
Advice	14%
Ease of doing business (e.g., application process, ability to purchase digitally and manage my policy online)	11%
Rewards/points/free gift or extra services (wellness platform, telehealth)	6%
None of the above	23%

Globally, six out of 10 have access to the internet,[13] and according to our survey, six out of 10 people want a better online experience from their insurance provider (Figure 3). This desire was strongest in APAC markets, where respondents are also most in favor of personal data sharing and using apps. However, this does not mean face-to-face advice is going away any time soon. As shown in Table 3, our respondents indicated that they look to source insurance products from a range of sources, and that the most important decision factor when buying insurance was "value for money" (30%) across every generation, gender, level of industry knowledge, and educational background (Table 4).

[11] https://bit.ly/3lyX1zD
[12] https://bit.ly/3ltuRWF
[13] https://bit.ly/3oYswFl

6. HYPER-PERSONALIZATION

Our survey reveals the potential for hyper-personalization to demonstrate value for money and product relevance to consumers, especially in a time of rising premiums and claims.

Personal data sharing is a key method to enable hyper-personalization of insurance products and services. The more widely established conduits for personal data sharing in most insurance markets today are fitness and health tests and telematics (black box technology).

Globally, 72% said they would share some form of personal data with their insurer (Table 5). However, personal data sharing can vary greatly depending on the respondent's gender, age, country, and industry knowledge-level, as well as the personal data asset in question. For example, globally we found that 75% of men surveyed would share some form of personal data, compared to 68% of women surveyed. On the other hand, in the APAC region, data sharing in exchange for a more personalized insurance product or premium was more enthusiastically embraced. In Hong Kong, for example, 92% of female respondents selected one of the personal data sharing options listed.

While there are benefits to be gleaned from the personalization of insurance products for both insurers and consumers, there are risks.

For example, pre-existing health conditions often mean a disadvantage when it comes to accessing a cheaper premium; this is exacerbated by an often poorly-tailored customer journey. In the U.K., 3 million people with disabilities have been turned down for insurance or have been charged extra. Citizen's Advice research found that only one in three people with severe mental health problems have home insurance or a savings account.

Table 5: Personalization methods

WOULD YOU CONSIDER ONE OF THE FOLLOWING METHODS TO GET A MORE PERSONALIZED INSURANCE PRODUCT OR PREMIUM?	%
Having a fitness or health test	33%
Using a smart device in my home	32%
Wearing a smart watch or another wireless wearable technology	29%
Sharing my social media data	20%
Putting a black box in my vehicle	19%
None of the above	18%
TOTAL	**12512**

Financial institutions need to make sure that vulnerable customers are not an afterthought but considered throughout the whole product and customer experience lifecycle. When designing and implementing a new product, firms should apply a "vulnerability lens", assessing on a rolling basis whether their offering is accessible to all.

6.1 Apps

There was a greater alignment of attitudes across the 13 countries surveyed when it comes to using personalized apps that provide transparency and insights into all financial products owned, such as savings, bank accounts, pensions, and insurance policies. 66% of policy-owning respondents responded in the affirmative – although just 8% answered "I already use one," highlighting the scope of this industry opportunity in this area (Figure 4).

Figure 4: Question asked to policyholders. These respondents answered in the affirmative

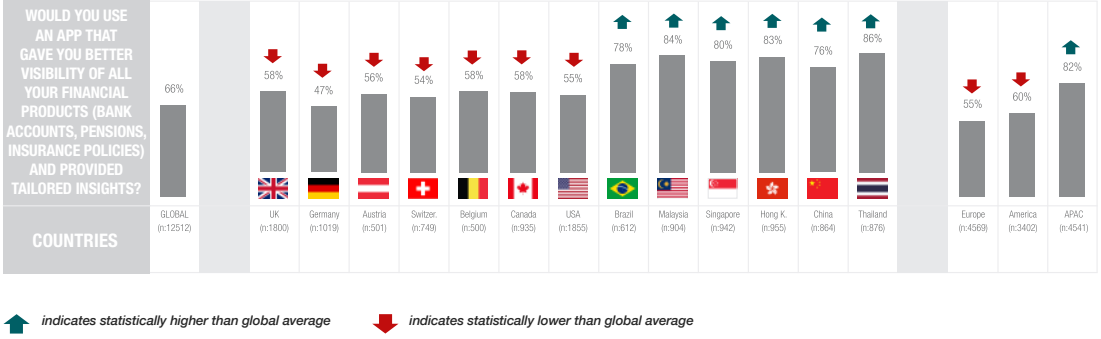
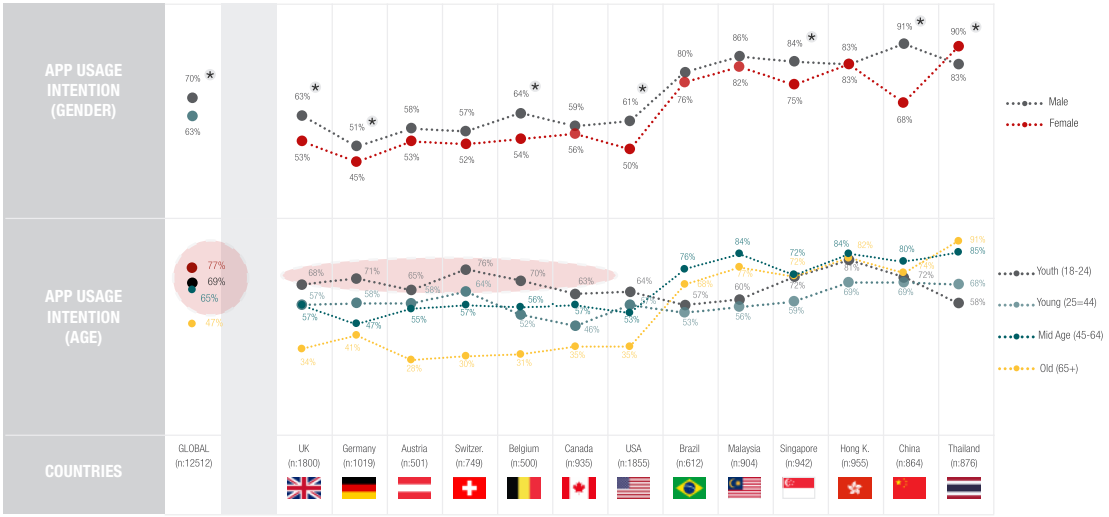


Figure 5: Responses to "Would you use an app that gave you better visibility of all your financial products (bank accounts, pensions, insurance policies) and provided personalized insights?"



*Significant difference at 95% CL

Demand for personalized apps was strongest in the APAC countries surveyed, and typically amongst those that were male-identifying; and among respondents based in Europe and the Americas, the young. Conversely, older generations of policyholder in APAC were keener on such apps than their juniors (Figure 5).

The data from our survey shows that respondents want a more connected customer experience that goes beyond the insurance space into other areas of financial services. Insurers can achieve this by developing digitally focused tools that educate the customer, provide personalized support and financial information.

Different customer segments have different needs and preferences when it comes to the sharing of personal data, however. Insurers could devise "two-way contracts" to better understand the extent of customer willingness to share data in exchange for more unique usage-based products while providing reassurances regarding the privacy and fair use of data.

As the insurance industry becomes increasingly data-centric, we could see the emergence of more niche insurance offerings to cater for consumers.

7. EDUCATION

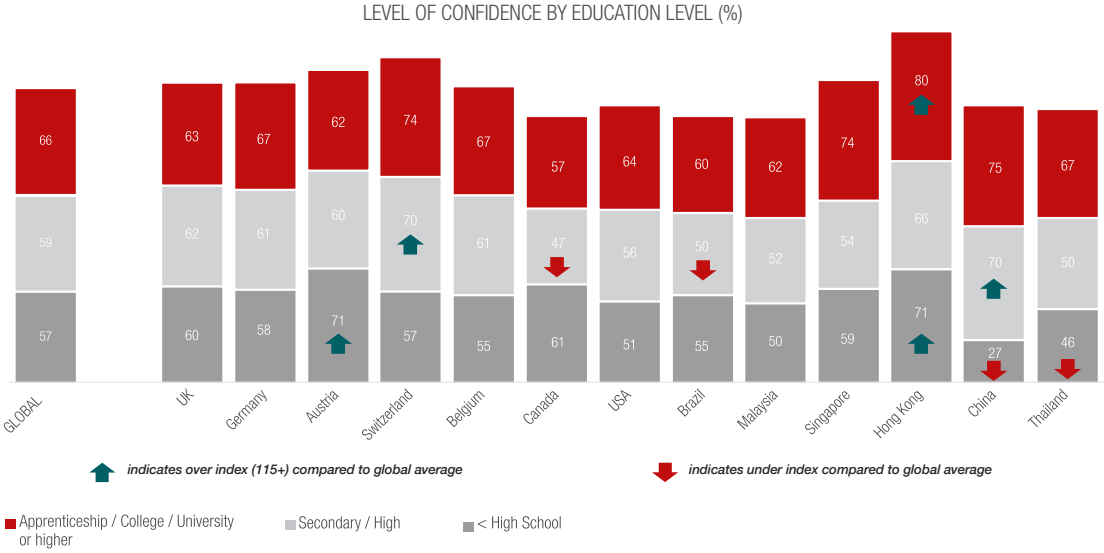
7.1 Over a third of respondents do not feel well-informed about insurance

Insurance by its very nature is a complex industry. Our survey demonstrates that many people worldwide outsource their policy decision making to a professional, such as a broker (24%) or agent (38%). Others visit a price comparison website (32%) or go direct to the insurer (38%) where they only need to consider a limited range of options without a need for deeper industry knowledge. Once their payment schedule is set up, most consumers rarely think about their policy again until they encounter an issue, must make a claim, or need to renew.

Our survey found 37% of respondents do not feel well-informed about insurance and the products available today (Figure 6). This level of uncertainty is particularly pronounced among women/female identifying respondents (41%), single policy holders (42%), the 18- to 24-year-old Gen Z demographic (43%) and the uninsured (71%).

APAC respondents considered themselves the best informed, although Swiss respondents were also highly confident. In Thailand, women were more confident than men – the only country surveyed where we found this to be the case. While we believe insurers should take this gender confidence gap

Figure 6: 'Yes' answers to "Do you feel well-informed about the range of insurance products available today?" question that was asked to all surveyed



with a pinch of salt (studies have found that women display lower "self-rates" and unfavorable attitudes to their ability or performance than men[14] – and studies have also found that compared with women, men are more prone to displaying optimism bias, considering themselves less threatened by the risks[15]), there is nevertheless a gap, which could be hindering women's engagement with insurance and therefore their overall insurance coverage protection. A U.S. report by Life Happens and LIMRA in 2021 found that just 47% of women have life coverage versus 58% of men.[16] We have also heard that women's careers and finances have been disproportionately affected by the pandemic.[17]

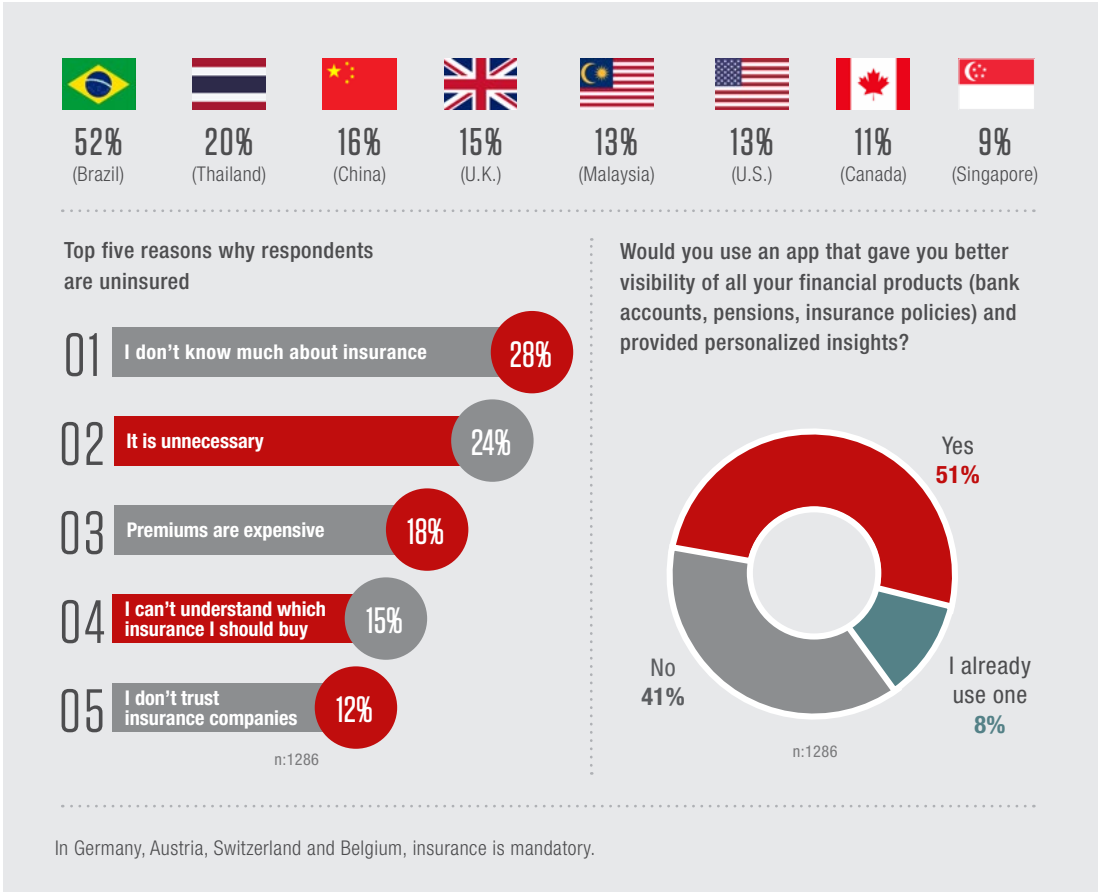
When assessing the responses to our question "Do you feel well-informed about the range of insurance products available today?", on the basis of education level, self-assurance tended to be more evident among the higher-educated respondents. Two-thirds (66%) of university-educated respondents felt well-informed about the industry in comparison to 57% of high-school graduates (Figure 6).

However, 25% of those who participated in further education (apprenticeship/college/university or higher) selected "don't know" when asked the question "As a result of COVID-19, do you feel that your existing insurance products provide the appropriate amount of protection?"

Our survey has revealed there is a big incentive for insurers to provide additional guidance around insurance policies; regardless of their country or origin, respondents who feel more confident about their knowledge level tend to buy more insurance than those who lack confidence. 74% of respondents owning four or more policies felt well-informed about the range of insurance products today, compared to 58% with a single policy. Just 29% of uninsured respondents felt well-informed.

[14] Ross, A. J, G. Scott, and C. D. Bruce, 2012, "The gender confidence gap in fractions knowledge: gender differences in student belief achievement relationships," School Science and Mathematics 112, 278-288
[15] Sharot, T., 2011, "Optimist bias," Current Biology 21:23, R941-R945
[16] https://bit.ly/3v7ydlA
[17] https://bit.ly/3AyKWyG

Figure 7: Percentage of uninsured respondents in countries surveyed



In Germany, Austria, Switzerland and Belgium, insurance is mandatory.

8. THE UNINSURED

8.1 Lack of financial literacy is a key barrier to policy ownership

After answering some basic background questions, such as age, gender and education, respondents were asked whether they currently owned an insurance policy. 1,286 respondents answered in the negative. 71% of these respondents had never had an insurance policy before, and 71% answered "no" or "not sure" to the question "Do you feel well-informed about the range of insurance products available today?"

While cost is a significant factor in policy ownership, the results of our survey suggest that insurance education and financial literacy could shift perceptions around the value of insurance, and in turn prompt a positive reassessment of the costs involved – and hence drive increased engagement and uptake.

Table 6: Previous insurance issues encountered by uninsured

SAMPLE SIZE: 1286	
The specific terms and conditions didn't fully cover my claim	25%
Insurance premium rose significantly after claiming	23%
Difficult to reach agents / call center customer representative	22%
I received less money than expected when I claimed	21%
Slow to respond and pay out	18%
Too much paperwork to complete the claims process	16%
My insurance documents never arrived	16%
My payout was refused	16%
Insurer's website or app was too complicated to use	9%
Other	7%

Table 7: What would convince you to have insurance?

More affordable premiums	37%
Finding a service that met my specific needs	29%
More detailed information about the benefits, terms and conditions, etc.	28%
Trust in the company and services provided	26%
More accessible services (apps, customer support via phone or internet)	22%
Receiving the policy quicker and making amendments more easily	15%
Other	4%

9. CROSS-SELLING

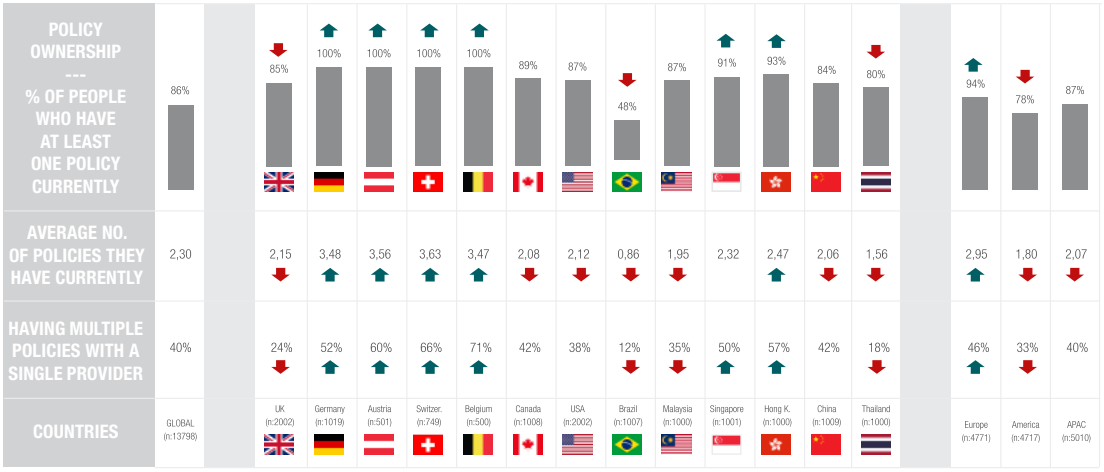
9.1 Value for money and cross-selling do not always go hand-in-hand

Less than half of policyowners told us they have multiple policies with the same provider (40% globally). We also found that 22% of global respondents have multiple policies, but each with a different insurance provider. This is the segment where the cross-selling opportunity lies. However, this is easier said than done.

Insurers are faced with a number of challenges in this field:

- In times of economic crisis and uncertainty, value for money is key. This was our respondents' biggest decision factor when buying insurance today (30%).
- Furthermore, in certain markets where customer disintermediation is high, it is harder to cross-sell. In the U.K., 63% of respondents looked for insurance through a price comparison or review aggregation website; and in Brazil, 46% of respondents bought insurance through their bank.
- Customers look at different products during different time horizons, and not all policies are renewed at the same time.

Figure 8: Responses by geography to questions "How many insurance policies do you have currently?" and "Do you have multiple insurance policies with one provider?"



indicates statistically higher than global average whereas *indicates statistically lower than global average*

**Significant difference at 95% CL*

- Cross-selling can be complex when a client's insurance risk profile differs between products.
- Regulation in certain markets means that insurers are only able to use their customer data for a specifically stated purpose.
- A substantial number of insurance companies are still operating on age-old platforms that are not agile enough to use the innovative tools, such as AI/machine learning, that go hand-in-hand with dynamic pricing and cross-selling.
- Many insurers' data repositories are not large enough to capture customer data, to analyze their customer base and then to leverage cross-sell opportunities.

Despite these challenges, cross-selling is an opportunity to boost brand awareness, repeat business and improve retention and is worth pursuing. But how?

To be successful in cross-selling, the power of data has to be unlocked. Up to this point, the insurance industry has not been as successful at cross-selling as the banking industry, for example, which has for a longer period prioritized digitalization and the concept of data as an asset.

While customer data has always been key to assess risk and determine premiums in an analogue world, digitalization is now unlocking further potential to create better insurance products and services at new price points and provide greater transparency and ease of access in a complex market.

By identifying the right stage of a customer journey where insurance is most needed and policy decisions are made, insurers could catch the best opportunities to bundle and cross-sell insurance products. In order to make this a success, providers must harness the data they have and find additional opportunities to collect more, then present it back to the customer in a meaningful way. For example, well-timed push notifications in apps or email alerts could help capture a specific need when intent to purchase is stronger.

10. CONCLUSION

Our global survey findings reveal that trust in the insurance industry is strong, despite the claims and servicing challenges posed by the COVID-19 pandemic. The way many firms have quickly responded and adapted to customers' needs in these most trying of times will prove valuable as insurers look to deepen existing relationships and broaden consumer engagement more generally.

It is certainly a positive that 63% of survey respondents consider themselves to be well informed about the range of insurance products available today. However, our research shows there remains a clear opportunity to drive a further uplift both in regards to the levels of financial education and the transparency of policies. Knowledge is power and leads to heightened confidence, more tailored protection and a greater appetite among consumers to explore additional insurance options.

That sort of empowerment dovetails with the fact that the majority of respondents also want more digitalized, personalized, and connected customer experiences. From a consumer's perspective, it is too easy for financial services products – past the point of initial engagement or need – to feel separate or disconnected from everyday life. Yet, despite sometimes feeling like a safeguard for tomorrow's problems, insurance is in reality offering protection for the here and now. Technological innovation and digitalization present insurers with the tools to make this truth more tangible, to the benefit of both sides in terms of the depth, breadth, and relevance of cover.

WHAT DRIVES POLICYHOLDERS' RELATIVE WILLINGNESS TO PAY?

FLORIAN KLEIN | Corporate Strategy Manager, Helvetia Insurance Group
HATO SCHMEISER | Professor of Insurance Economics and Risk Management, University of St. Gallen

ABSTRACT

An analysis of the empirical data acquired from an online survey reveals the key drivers for policyholders' relative willingness to pay against the background of high insured values. We apply the insurer's perspective to better understand which policyholder groups exhibit a high relative willingness to pay and which do not even cover the insurer's expected expenses. We find that the certainty effect underlies the probabilistic insurance, but not the underinsurance. This implies that insurance coverage does not have a relevant impact on the relative willingness to pay. Furthermore, the relative willingness to pay for high insured values decreases significantly with a higher default probability, older age, lower risk aversion, or lower wealth. In addition, the average relative willingness to pay for individuals with medium financial literacy is close to 1, but policyholders with the highest financial literacy pay substantially less (0.621). We also find that, for overinsurance and full coverage, policyholders significantly deviate from the results based on the Expected Utility Theory. This insight is independent of the initial wealth and the degree of risk aversion. Concerning underinsurance, the deviation is either less significant or not significant at all.

1. INTRODUCTION

Motivated by increasing digitization, the collection of information about policyholders and their behavior has become a ubiquitous part of insurance activity. In this context, a necessary, but insufficient, parameter for setting the optimal price of insurance contracts is the maximum willingness to pay.[1] Although a large number of studies have investigated policyholders' willingness to pay, a relatively small number has focused on high insured values and large potential damage events. Indeed, it is a core task of the insurer to protect policyholders against (relative to the subject's wealth) high damage events.

Our research approach is conducted from the insurance management and regulator perspectives. Firstly, an analysis of the willingness to pay for high insured values is conducted. From an insurance management perspective, it is important to recognize which policyholder groups exhibit a high willingness to pay and which do not even cover the insurer's expected payouts.[2] Secondly, from a regulatory perspective, it is important to understand for which customer segments price regulation might be necessary.

Wakker et al. (1997) investigate the willingness to pay for high insured values using a default probability and find that that willingness to pay decreases substantially for probabilistic insurance. Other studies corroborate this outcome for lower insured values [Zimmer et al. (2009, 2018)]. We extend previous research by developing and examining eight hypotheses derived from the insights of empirical research and insurance theory. We consider different coverage levels and

[1] The optimal price setting is affected by the maximum willingness to pay and the competition within the market. Hence, knowing the maximum willingness to pay is necessary for setting optimal prices. However, it is not sufficient, as competition results in full willingness to pay not being absorbed.
[2] This insight is especially important when the market is not fully competitive. Hence, premiums higher than the fair premium can be applied.

default probabilities. We also analyze the relative willingness to pay, which we define as the ratio between the maximum willingness to pay and the expected indemnity payments. Furthermore, we conduct an online survey that focuses on a hypothetical loss domain[3] and test the hypotheses. We examine the impact of insurance coverage on the relative willingness to pay. Consequently, we investigate whether the certainty effect only exists for probabilistic insurance or underinsurance. Moreover, we investigate whether policyholders increase their relative willingness to pay for overinsurance. In this context, we aim to determine whether policyholders' financial literacy has a significant impact on their relative willingness to pay.

To measure financial literacy, the framework introduced by Lusardi and Mitchell (2011) is applied. Similar to Holt and Laury (2002), we determine the degree of risk aversion and analyze how this influences the relative willingness to pay. Economic theory suggests that an increase in willingness to pay accompanies increasing risk aversion [Mossin (1968)]. In addition, we consider whether age is a key driver for the relative willingness to pay. Hansen et al. (2016) analyze house insurance claims in the Danish market and find that the insurance claim peak is reached when the policyholders are between 30 and 40 years old. Associated with the higher claims, the policyholders also pay higher premiums. However, in our case, the considered scenario is equal among all age groups; hence from a normative perspective, it is reasonable to suggest that age does not have a significant impact.

Similar to Zimmer et al. (2018), we examine the gender effect on the relative willingness to pay. Zimmer et al. (2018) do not find a significant impact for a low insured value and Schubert et al. (1999) identify a gender-specific risk attitude depending on the decision framework. For a loss domain, men tend to be more risk-averse than women. In line with economic theory, this implies that men tend to pay more for insurance than women, as a loss domain is present according to the insurance. As Case et al. (2005) demonstrate, increasing wealth leads to higher consumption. Consequently, we analyze the wealth effect on the relative willingness to pay. We extend the insights provided in Wakker et al. (1997) and determine whether policyholders strive for expected utility results, given probabilistic insurance and no default probability with different coverage levels.

In summary, we acquire empirical data from an online survey and use the data to investigate the impact of multiple parameters on the policyholders' relative willingness to pay. Our primary aim is to develop a deeper understanding of the key drivers of the relative willingness to pay for high insured values. Furthermore, Expected Utility Theory is used as a benchmark for different coverage levels and for comparing those results with our empirical findings.

2. LITERATURE REVIEW AND POSITIONING

We initially connect our paper to the existing body of literature, including the willingness to pay a premium against the background of a default probability, as well as under- and overinsurance. Furthermore, we explain how these different streams are related to our research. First, we consider the literature on the relationship between default probability and premium. Previous studies have documented a substantial decrease in the willingness to pay when the default probability increases [Wakker et al. (1997), Zimmer et al. (2009, 2018)].[4] Moreover, under certain circumstances, policyholders might even be insensitive to a small default risk [Gatzert and Kellner (2014), Eckert and Gatzert (2018), Klein and Schmeiser (2020)], and hence, do not necessarily reduce their willingness to pay if the default probability increases.[5] More specifically, a lack of default probability transparency might be why policyholders do not adapt their willingness to pay. However, since policyholders are directly confronted with the underlying default probabilities in the empirical research [Wakker et al. (1997), Zimmer et al. (2009, 2018)], it cannot be ignored. We extend the previous research by investigating how under- and overinsurance affect policyholders' willingness to pay if a default probability and no default probability exist. Subsequently, we provide an overview of the research on under- and overinsurance.

Second, there is a large body of knowledge regarding empirical studies based on hypothetical surveys or experimental studies in the context of insurance demand. A literature overview and the pros and cons of the different model setups are provided in Jaspersen (2016). Under- and overinsurance are comprehensively discussed in the insurance literature. Mossin (1968) analyzes insurance coverage under rational behavior for a given risk. In this context, it is not optimal to purchase full coverage if a premium higher than the fair premium is

[3] We consequently focus on a loss domain, as insurance is connected with losses and the avoidance of losses. Holt and Laury (2002) investigate a gain domain. However, as Kahneman and Tversky (1979) illustrate, changing the domain might also lead to changing behavior.
[4] For a comprehensive overview of the empirical research into the default probability and willingness to pay, see, e.g., Klein and Schmeiser (2019).
[5] This insensitivity is in line with the argument by Kahneman and Tversky (1979), where very unlikely events are overweighted or ignored.

in place. Nevertheless, Mossin (1968) also mentions that if policyholders act irrationally, they face either uncertainty or the probability distribution of the potential damage being overestimated. This might explain why policyholders would prefer full coverage rather than partial coverage.

Doherty (1977) analyzes the effect of stochastic dominance models on insurance coverage and Eeckhoudt et al. (1996) consider the impact of background risk on risk-taking behavior. Moreover, Schlesinger (1997) extends Mossin (1968) and determines the optimal insurance coverage without the Expected Utility Theory. In this regard, it might be optimal to take full coverage if the premium is higher than the actuarially fair price. Cutler et al. (2008) analyze insurance markets and the preference heterogeneity and suggest that against the background of market inefficiencies (induced by private information) overinsurance should be regarded as additional to underinsurance related to adverse selection models.

In the context of natural disasters, Kunreuther (1984) investigates the reasons for underinsurance. He argues that underinsurance is induced from the demand side when low probability events with a high impact are not considered (underestimated) by individuals or the potential loss is underestimated. More concretely, this implies that the premium, which has to be paid, is overestimated. Furthermore, the premium is widely denoted as a function of the insurance coverage [Smith (1968), Viauroux (2014)].

In this paper, we analyze how insurance coverage affects policyholders' maximum willingness to pay. In this regard, we extend the previous research in the field and provide empirical insights. More precisely, we measure whether underinsurance, full insurance, or overinsurance generate the best ratio between the maximum willingness to pay and expected indemnity payments from the insurer's perspective. In practice, overinsurance is typically forbidden, due to ex-ante and ex-post moral hazard.[6] In our setting, no effects from moral hazard occur. More precisely, we assume that the policyholder cannot influence the damage probabilities or the damage amounts.

3. HYPOTHESES, EXPECTED UTILITY THEORY, AND EMPIRICAL DESIGN

3.1 Hypotheses

Wakker et al. (1997) and Zimmer et al. (2009, 2018) find that it is reasonable to suggest that policyholders substantially decrease their willingness to pay for low default probabilities. In contrast to the previous research, we consider a default probability that is very small and analyze high insured values. Wakker et al. (1997) also investigates high insured values; however, only for circumstances where default probability is between 0 and 1 percent. Additionally, we focus on cases of under- and overinsurance. Derived from Kahneman and Tversky (1979), a certainty effect might exist, and hence, we derive the first hypothesis:

H1: Relative willingness to pay significantly decreases for (very) low default probabilities in relation to the non-default case

Previous research illustrates that under- or overinsurance preferences are influenced by the individual risk itself, the wrong estimation of the probability or loss functions, or missing information, which may result in uncertainty [Mossin (1968), Kunreuther (1984), Cutler et al. (2008)]. However, within our survey, such a reason does not exist. Moreover, we argue that the certainty effect, measured by Kahneman and Tversky (1979), directly refers to the default probability and not to the degree of insurance coverage. Smith (1968) and Viauroux (2014) emphasize that the premium increases with higher coverage. For a proportional relationship between coverage and the premium we would expect constant premium-coverage ratios. Consequently, we develop the second hypothesis:[7]

H2: Relative willingness to pay does not significantly deviate for varying insurance coverage values

We analyze financial literacy following the recommendations in Lusardi and Mitchell (2011). Previous research has demonstrated that individuals with high financial literacy tend to invest, to a higher degree, in stocks [Christelis et al.

[6] Overinsurance typically leads to moral hazard effects, since the inpayments of policyholders are greater than the damage. However, moral hazard effects are only possible if asymmetric information can be reached between the insurer and the policyholders. For instance, under asymmetric information and ex-ante moral hazard, the actual probability that a damage event occurs might be higher than what is expected by the insurer. For further research about moral hazards, see, e.g., Kihlstrom and Pauly (1971), Pauly (1974), and Holmström (1979).

[7] Note that H2 violates the Expected Utility Theory. The second order risk aversion implies that the relative willingness to pay will decrease with the coverage level [Segal and Spizak (1990)].

(2010), van Rooij et al. (2011)]. One reason for this might be a deeper understanding of risk diversification [Lusardi and Mitchell (2011)]. To the best of our knowledge, there has been no research undertaken, to date, that directly examines willingness to pay for insurance with high insured values. We argue that financial literacy affects policyholders' behavior. Individuals with higher financial literacy exhibit a higher ability to diversify their risks. Hence, it is intuitive that high financial literacy leads to a maximum willingness to pay that is closer to the expected indemnity payments (and hence lower than the willingness to pay of decisionmakers with a low financial literary).

H3: For individuals with high financial literacy, the average relative willingness to pay is closer to 1 (fair premium) compared to individuals with lower financial literacy

Following Holt and Laury (2002; 2005), we examine risk attitudes. Based on economic theory, risk aversion affects policyholders' wealth position preference function [Gatzert and Schmeiser (2012)]. Assuming preference equality between insurance and no insurance, we conclude that the premium increases with higher risk aversion [Klein and Schmeiser (2019)]. In other words, individuals with a higher degree of risk aversion accept a higher loading than those with a lower degree of risk aversion. Focus is placed on being protected against potential damage [Mossin (1968), Braun et al. (2015)].

H4: Relative willingness to pay increases with a higher degree of risk aversion

Hansen et al. (2016) analyzes house insurance claims in the Danish market. The authors find that average insurance claims reach their peak when the insured are between 30 and 40 years old. Hence, it is reasonable to assume that willingness to pay among this age group is higher than for older or younger policyholders. However, in our empirical framework, equal damage probabilities and damage quantities are presented. Hence, age should not influence policyholders' willingness to pay.

H5: Relative willingness to pay is not affected by policyholder age

Zimmer et al. (2018) analyze whether a significant gender difference exists with respect to willingness to pay for probabilistic insurance. The authors do not find significant results based on the willingness to pay. However, the majority of studies support the gender effect on risk aversion [Charness and Gneezy (2012), Fehr-Duda et al. (2006)]. Schubert et al. (1999) identify a gender-specific risk attitude depending on the decision framework. More precisely, men tend to be more risk-averse than women if a loss domain is present and vice versa. In line with the economic theory, as a loss domain is present in insurance, men tend to pay more for insurance than women. In contrast, Halek and Eisenhauer (2001) analyze the demography of risk aversion concerning life insurance. Although they investigate a loss domain, they find that women are significantly more risk-averse than men. Previous studies do not present unique results. As explained in section 1, the Zimmer et al. (2018) study is related to our survey.

H6: Relative willingness to pay is not affected by gender

A large number of theoretical research focuses on utility and the utility of wealth [Markowitz (1952), Pratt (1964), Arrow (1965)]. To the best of our knowledge, to date, wealth effects regarding willingness to pay for probabilistic insurance have not been measured. Previous studies have documented a positive correlation between wealth and consumption [Case et al. (2005)]. More precisely, when individuals exhibit higher wealth, they tend to spend more money. We transfer this insight to the insurance industry and argue that wealth positively affects willingness to pay for insurance. In other words, wealthy policyholders are willing to pay higher loadings than less wealthy policyholders to minimize the probability that an extreme event occurs that substantially decreases their wealth.[8]

H7: Relative willingness to pay increases with policyholder wealth

Expected Utility Theory provides concave preference functions when policyholders are risk-averse, convex preference functions if risk-seeking behavior is present, and a linear function under risk neutrality [Pratt (1964), Arrow (1965)].

[8] Note that H7 implies increasing the absolute risk aversion.

Wakker et al. (1997) show that the substantial decrease in willingness to pay for probabilistic insurance cannot be explained by risk aversion. Under Expected Utility Theory, even high risk-averse policyholders will pay substantially more than policyholders in the sample.

Concerning insurance decisions, Slovic et al. (1977) and Schoemaker and Kunreuther (1979) demonstrate that policyholders' behaviors deviate from Expected Utility Theory. In our questionnaire, the policyholders communicate their maximum willingness to pay for insurance policies with and without a default probability, as well as under- and overinsurance. More precisely, under Expected Utility Theory, the policyholders would exhibit exactly the willingness to pay for insurance policies that strive to achieve expected utility results among the different contracts. However, derived from the insights of Slovic et al. (1977), Schoemaker and Kunreuther (1979), and Wakker et al. (1997), we argue that this might not hold true:

H8: Policyholders do not act in line with the Expected Utility Theory

Expected utility equilibria between probabilistic insurance and no default probability with different coverage levels cannot be reached since the premiums vary significantly from the equilibria points.

Expected Utility Theory serves as a benchmark for interpreting the different levels of willingness to pay based on the empirical findings. We consider a utility function $U(W)$ with a constant relative risk aversion; this has also been analyzed in Holt and Laury (2002). In formal terms, we have:

$$U(W) = W^{1-a}, \quad (1)$$

where W determines the wealth of the policyholders and a is the risk attitude. For $0 < a < 1$, risk aversion exists, $a = 0$ stands for risk neutrality, and $0 > a > -1$ denotes risk affinity. We consider -1 (1) as the lower (upper) bound for the risk attitude.[9]

3.1.1 SCENARIO UNDER DEFAULT AND FULL COVERAGE

Policyholders' expected utility under the default probability and the underlying utility function is described as follows:

$$\begin{aligned} E(U_{DP}) &= E(U_{DP}(p)) + E(U_{DP}(1-p)) \\ &= p \cdot (max(W_0 - \pi_{DP} - D, 0)^{1-a} \cdot DP + (W_0 - \pi_{DP})^{1-a} \\ &\quad \cdot (1 - DP)) + (1-p) \cdot (W_0 - \pi_{DP})^{1-a}, \end{aligned} \quad (2)$$

where $W_0 \geq \pi_{DP}$, p stands for the probability that a damage event occurs, W_0 describes the initial wealth of the policyholder, D is the damage, π_{DP} is the maximum willingness to pay under the default probability, which, in our case, is equal to the premium, and DP is the default probability. If a default occurs, we assume that the insurer does not pay the policyholders' damage. Furthermore, as a policyholder's lowest wealth is 0 (in this case, the policyholder is insolvent), it results in a lower bound for the utility, which implies that for a low initial wealth, a higher default probability does not reduce the utility, as it does under high initial wealth.

3.1.2 SCENARIO UNDER NON-DEFAULT AND VARYING COVERAGE

If the insurance policy pays in each scenario, no default probability exists. In this context, we reach for the expected utility under no default:

$$\begin{aligned} E(U) &= E(U(p)) + E(U(1-p)) \\ &= p \cdot max(W_0 - \pi - D_c 0)^{1-a} + (1-p) \cdot (W_0 - \pi)^{1-a}, \end{aligned} \quad (3)$$

where $W_0 \geq \pi$ and π denotes the premium for an insurance policy without a default risk. Moreover, D_c is the share of the damage that is not paid by the insurer. More precisely, if $D_c > 0$, underinsurance results. For $D_c < 0$, we have overinsurance, and for $D_c = 0$, we have full coverage. A result that is in line with the Expected Utility Theory can be obtained between the default and non-default case. This is the case when $E(U_{DP})$ is equal to $E(U)$.

3.2 Study design

Initially, we present the key elements of the questionnaire to determine the policyholders' willingness to pay under certain circumstances. Afterwards, we explain the further specifications. We consider a fire insurance contract, where the initial scenario follows Wakker et al. (1997). Furthermore, we examine a non-default scenario, 0.1, and a 1 percent default probability for the insurer. We illustrate the non-default and 0.1 percent default probability case. In addition, we investigate different coverage levels (including underinsurance (U.S.$200,000; U.S.$240,000), full coverage, and overinsurance (U.S.$260,000)). For underinsurance, we discuss a scenario with U.S.$240,000. Following Wakker et al. (1997), the different default probabilities for the given coverage are transparent for the individuals. Moreover, we randomize the order of the different coverage levels to avoid response-order effects.

[9] A risk aversion of 1 implies that the individuals are insensitive to the wealth, since the exponent $1 - a$ is equal to 0.

Table 1: Five lottery-choice decisions with high losses (in U.S.$)

OPTION A	OPTION B	OPTION C	EXPECTED VALUE DIFFERENCE
10% 250,000; 90% 1000	15900	Indifferent	10000
10% 250,000; 90% 1000	20900	Indifferent	5000
10% 250,000; 90% 1000	25900	Indifferent	0
10% 250,000; 90% 1000	30900	Indifferent	-5000
10% 250,000; 90% 1000	35900	Indifferent	-10000

3.2.1 QUESTIONNAIRE

Imagine you own a small house. Assume that there is a risk of 5 in 1000 per year (i.e., 0.5%) that your house will be completely destroyed by fire. The value of the house is U.S.$250,000.

- What is the most you would be willing to pay per year for an insurance policy that will cover all damages due to fire?
- Imagine that you have been offered an insurance policy that does not pay you the damage in 1 of 1000 cases (i.e., 0.1%). What is the most you would be willing to pay (per year) for this insurance policy?
- What is the most you would be willing to pay (per year) for an insurance policy that will only cover U.S.$240,000 of your damage due to fire?
- Imagine that you have been offered an insurance policy which will only cover U.S.$240,000 of your damage due to fire. However, in 1 of 1000 cases (i.e., 0.1%), the insurance policy does not pay anything. What is the most you would be willing to pay (per year) for this insurance policy?
- What is the most you would be willing to pay (per year) for an insurance policy that will pay you U.S.$260,000 (damage + reconstruction aid) when your house burns down?
- Imagine that you have been offered an insurance policy that will pay you U.S.$260,000 (damage + reconstruction aid) when your house burns down. However, in 1 of 1000 cases (i.e., 0.1%), the insurance policy does not pay anything. What is the most you would be willing to pay (per year) for this insurance policy?

In a next step, we test for financial literacy by using the three questions introduced by Lusardi and Mitchell (2011) (see Appendix A).[10] Furthermore, we measure risk attitudes in a manner similar to Holt and Laury (2002, 2005). They consider lottery-choice decisions, where the individual must choose between two options. In total, the authors consider 10 lottery choices. Moreover, Holt and Laury (2002, 2005) focus on positive payoffs. In contrast, we analyze how the risk attitude is related to the different loss scenarios. Since we are interested in risk attitudes for high potential losses, such as when the owner's house burns down, we analyze the choice decisions against the background of high potential losses.

Holt and Laury (2002, 2005) determine risk attitudes for relatively low values. However, we argue that individuals who are risk-averse for high loss values might be indifferent to very low losses, since their (hypothetical) utility function is only marginally affected. In addition, Holt and Laury (2002; 2005) compare real and hypothetical incentives. The authors argue that under real incentives, the degree of risk aversion is higher than under hypothetical incentives. Since we consider very high potential losses, real incentives are, in our case, only possible if the values are downscaled. However, this implies that individuals are incentivized based on low payments. We actually want to measure behaviors in relation to high loss values.

In addition, as Kahneman and Tversky (1979) emphasize, when scenarios are investigated under a potential win or loss situation they can have a significant impact on the results. From our perspective, it is misleading to analyze a loss behavior, but incentivize with positive payments. Consequently, we analyze a hypothetical scenario and introduce five choice decisions to measure risk attitudes. Thus, we analyze broader risk attitude classes than Holt and Laury (2002, 2005).

Table 1 illustrates the different lottery-choice decisions. Option A denotes a probabilistic loss, where a high loss or a relatively small loss can result. The probability of the relatively small loss is substantially higher. Option B shows a certain loss. Furthermore, we enable the policyholders to be indifferent

[10] Lusardi and Mitchell (2011) define the four criteria (i.e., simplicity, brevity, relevance, and capacity to differentiate), and create their three questions to measure financial literacy based on these criteria.

Table 2: Risk preference classification

ANSWER DISTRIBUTION	RISK PREFERENCE CLASSIFICATION
5 times A	Very risk-seeking (1)
More A than B	Risk-seeking (2)
Balance between A and B	Risk-neutral (3)
More B than A	Risk-averse (4)
5 times B	Very risk-averse (5)

Table 3: Descriptive survey statistics

	QUANTITY	RELATIVE VALUE (%)
GENDER		
Men	178	50.57
Women	174	49.43
AGE (IN YEARS)		
< 30	34	9.66
30 – 45	83	23.58
46 – 60	78	22.16
> 60	157	44.60
FINANCIAL LITERACY		
0 correct answers	31	8.81
1 correct answer	74	21.02
2 correct answers	91	25.85
3 correct answers	156	44.32
RISK ATTITUDE		
Very risk-seeking	68	19.32
Risk-seeking	75	21.31
Risk-neutral	135	38.35
Risk-averse	51	14.49
Very risk-averse	23	6.53
WEALTH (IN U.S.$)		
≤ 250,000	136	38.64
> 250,000 - 500,000	65	18.46
> 500,000 - 750,000	31	8.81
> 750,000 - 1,000,000	31	8.81
> 1,000,000	48	13.63
Refused to answer	41	11.65

concerning the answers (Option C). The expected loss difference illustrates the expected value of Option A minus Option B. Table 2 presents the risk preference classification in order of the choices.

Kahneman and Tversky (1979) find that individuals are risk-seeking (loss aversion) if they have a choice between a probabilistic loss underlying a high loss probability and a certain loss with comparable expected values.[11] We also recognize that such certainty avoidance may not take place if the probability of the event is sufficiently low and the impact is sufficiently high. For instance, Kahneman and Tversky (1979) demonstrate that if individuals have the option to choose between a certain loss of 5 and a loss of 5000 with 0.1 percent, 83 percent prefer the certain loss. In our survey, we tendentially expect risk-averse behavior among the policyholders as we analyze high damage events. This is the main reason why the insurance business model works in real markets. Finally, we ask personal information about the individuals to analyze the deviations among the different groups.

4. RESULTS

We distributed the survey electronically via a specialized provider in the U.S. The individuals that completed the survey earned a fixed payment from the provider. In total, 500 individuals completed the study; 70.4 percent of respondents provided usable results. We eliminated all individuals who took 240 seconds to fill out the survey or less,[12] provided random results, or had extreme outliers (willingness to pay more than a factor of 50 of the fair premium). Table 3 illustrates the descriptive survey statistics. Age is cardinally scaled. In Table 3, we build the age groups to provide an overview.

Concerning the descriptive survey statistics, not in line with our expectations, the number of risk-seeking individuals is higher than the number of risk-averse participants. Hence, the policyholders prefer the probabilistic scenario with a substantially higher loss, instead of a certain loss.

Furthermore, Tables 4 and 5 show how the default probability and coverage level influence the mean willingness to pay, the ratio of the mean willingness to pay and the fair premium, and the ratio of the median willingness to pay and the fair premium. The ratio for the mean is substantially higher than

[11] For further research concerning loss aversion, see., e.g., Tversky and Kahneman (1992) and Thaler et al. (1997).
[12] Each pre-test subject needed more than 240 seconds.

Table 4: Willingness to pay for underinsurance (in U.S.$)

DEFAULT PROBABILITY (%)	0	0.1	1	0	0.1	1
COVERAGE	200,000	200,000	200,000	240,000	240,000	240,000
FAIR PREMIUM	1000	999	990	1200	1198.8	1188
MEAN	1182.04	807.83	800.09	1310.93	939.45	871.56
MEAN/FAIR PREMIUM	1.1820	0.8086	0.8082	1.0924	0.7837	0.7336
MEDIAN/FAIR PREMIUM	0.4000	0.2002	0.1843	0.4167	0.1877	0.1684
STANDARD DEVIATION	3113.74	2200.40	2338.10	3113.11	2554.74	2639.50

Table 5: Willingness to pay for full coverage and overinsurance (in U.S.$)

DEFAULT PROBABILITY (%)	0	0.1	1	0	0.1	1
COVERAGE	250,000	250,000	250,000	260,000	260,000	260,000
FAIR PREMIUM	1250	1248.75	1237.5	1300	1298.7	1287
MEAN	1690.17	1067.39	980.82	1962.91	1304.26	1061.24
MEAN/FAIR PREMIUM	1.3521	0.8548	0.7926	1.5099	1.0043	0.8245
MEDIAN/FAIR PREMIUM	0.4800	0.2002	0.1616	0.4615	0.2310	0.1904
STANDARD DEVIATION	4188.94	3200.39	3366.11	5542.25	3498.91	2973.90

for the median. Similar to the findings in Zimmer et al. (2018), the willingness to pay is skewed right. For each default probability level, the ratio of the mean and fair premium is higher, with an increased coverage starting at U.S.$240,000. Moreover, the coverage level of U.S.$200,000 leads to a higher ratio of a mean and fair premium than U.S.$240,000. Typically, insurance companies charge premiums that exceed the fair premium. However, given the results in Tables 4 and 5, a considerable number of the participants in this study are not prepared to pay above the fair premium.

Next, we run a multiple regression to measure which independent variables affect the relative willingness to pay in a significant way. The chosen independent variables do not exhibit strong correlations (see Appendix B).[13] As in Zimmer et al. (2018), we code the default probability levels as dummy variables. The different coverage levels are also coded as dummy variables. The case of full coverage and no default probability is denoted as the reference category. Financial literacy is a categorical variable. Between 0 and 3 correct answers for the financial literacy questions were obtained. Financial literacy increases with the number of correct answers. In addition, the degree of risk aversion is explained by five categories, where category 5 is very risk-averse and category 1 is very risk-seeking (see Table 2). As mentioned previously, age is cardinally scaled. Moreover, female is a binary variable, and wealth is subdivided into five categories. Wealth increases with a higher category (see Table 3). Table 6 illustrates the regression results.

The existence of a default probability substantially decreases the relative willingness to pay. Furthermore, coverage and financial literacy do not significantly influence relative willingness to pay. Based on financial literacy, we provide an additional analysis since we hypothesize that the average relative willingness to pay for high financial literacy is closer to 1 compared to individuals with a low financial literacy. Moreover, a higher degree of risk aversion positively affects the relative willingness to pay. Hence, our results are in line with economic theory. Surprisingly, age also provides strong significant results, with older individuals typically having a lower relative willingness to pay. While for the entire set of observations women pay less than men, when we exclude those who answered "refuse to answer" concerning wealth gender is found to have no relevant effect. In addition, an increase in wealth leads to a higher relative willingness to pay for the underlying insurance contracts.

[13] In addition to the correlations, we also checked for the variance inflation factor. Since the variance inflation factor is less than 1.501 for all variables smaller, no multicollinearity exists (greater than 10 indicates multicollinearity).

Table 6: Regression analysis for the relative willingness to pay

	(1)	(2)	(3)
CONSTANT	1.305[a]	3.515[a]	2.945[a]
	(0.000)	(0.000)	(0.000)
CONTRACT 1 (0.1% DP)	-0.421[a]	-0.421[a]	-0.402[a]
	(0.000)	(0.000)	(0.000)
CONTRACT 2 (1% DP)	-0.494[a]	-0.494[a]	-0.460[a]
	(0.000)	(0.000)	(0.000)
CONTRACT A (U.S.$200,000 COVERAGE)	-0.067	-0.067	-0.013
	(0.579)	(0.564)	(0.916)
CONTRACT B (U.S.$240,000 COVERAGE)	-0.130	-0.130	-0.083
	(0.282)	(0.262)	(0.485)
CONTRACT C (U.S.$260,000 COVERAGE)	0.113	0.113	0.132
	(0.349)	(0.329)	(0.266)
FINANCIAL LITERACY		-0.045	-0.082
		(0.316)	(0.073)
RISK AVERSION		0.131[a]	0.104[b]
		(0.000)	(0.005)
AGE		-0.038[a]	-0.039[a]
		(0.000)	(0.000)
FEMALE		-0.238[b]	-0.063
		(0.004)	(0.459)
WEALTH			0.209[a]
			(0.000)
OBSERVATIONS	4224	4224	3732
R^2	0.007	0.084	0.092

Note: We consider the following significance levels c ($0.01 \leq p < 0.05$), b ($0.001 \leq p < 0.01$), and a ($p < 0.001$). For each table element, we insert the regression coefficient and the p-value in brackets. According to (3), we eliminate all participants who are not interested in communicating their wealth ("refuse to answer"). In general, we cannot expect high values for R2, as we have only one cardinally scaled variable (age) and most variables are binary.

Table 7: Relative willingness to pay

FINANCIAL LITERACY GROUP	MEAN	STANDARD DEVIATION
0 correct answers	0.812	1.855
1 correct answer	1.791	4.582
2 correct answers	0.989	2.658
3 correct answers	0.621	1.498

We also investigate whether a higher degree of financial literacy leads to an average relative willingness to pay that is closer to 1. As Table 7 illustrates, the average relative willingness to pay increases between 0 correct answers and 1 correct answer, but decreases with a larger number of correct answers. Surprisingly, individuals with the highest financial literacy have the lowest average relative willingness to pay, which is substantially lower than 1. Furthermore, we use the t-test to investigate whether the means are equal or whether, based on the findings of Table 7, it results in a decision for the alternative hypothesis (see Table 8). The mean for one correct answer is significantly higher than for no correct answers. Moreover, the mean for two correct answers is significantly lower than for one correct answer. The same holds for three and two correct answers.

The group with two correct answers is close to the fair ratio of 1.

Based on the previous findings, we conduct a one-sample t-test to determine whether the policyholders' results significantly vary from Expected Utility Theory. We set the initial wealth *W0*, the risk aversion parameter *a*, and the

Table 8: Relative willingness to pay equality test

FINANCIAL LITERACY GROUP	P-VALUE	ALTERNATIVE HYPOTHESIS
0 correct answers versus 1 correct answer	0.000[a]	The mean for 1 correct answer is higher than for 0 correct answers
1 correct answer versus 2 correct answers	0.000[a]	The mean for 2 correct answers is lower than for 1 correct answer
2 correct answers versus 3 correct answers	0.000[a]	The mean for 3 correct answers is lower than for 2 correct answers

Note: If the p-value is smaller than 0.05, the alternative hypothesis is supported. We consider the following significance levels c ($0.01 \leq p < 0.05$), b ($0.001 \leq p < 0.01$), and a ($p < 0.001$).

average willingness to pay by the reference category as input parameters to calculate the premium πEQ that should be paid to reach the equilibrium point. Subsequently, we measure whether or not these premiums vary from the actually paid premiums (see Tables 4 and 5).

In addition, we run for two different initial wealth $W0$ (U.S.$150,000 and U.S.$250,000) results for the reference category of a 0.1 percent default probability and full coverage. For a coverage of U.S.$250,000 and U.S.$260,000, and independent of the considered levels of initial wealth and degree of risk aversion, we obtain strong significant results.[14] Hence, the policyholders do not strive for results given by the Expected Utility Theory. For U.S.$240,000 coverage, a deviation from the results provided by the Expected Utility Theory is not statistically supported. Concerning coverage of U.S.$200,000, we recognize weak significance. For low initial wealth and a high degree of risk-seeking behavior the results are not significant. When the reference category changes from a 0.1 percent default probability to a 1 percent default probability, the p-value decreases for all analyzed combinations. Consequently, the policyholders' willingness to pay varies even more from the equilibrium point, as under the lower default probability.[15] In the Appendix, we summarize the results of our study in relation to the existing publication in this area.

5. IMPLICATIONS

Our survey aims to enable a deeper understanding of what an insurance contract with a high insured value (fire insurance). Similar to Wakker et al. (1997), Zimmer et al. (2009), and Zimmer et al. (2018), we find that as long as the individuals are aware of a potential default probability, a no default probability leads to the highest relative willingness to pay ratio. Furthermore, as the coverage does not significantly affect the relative willingness to pay, striving for higher coverage results in higher premiums without decreasing the relative willingness to pay ratio. However, in practice, a moral hazard problem might exist if the indemnity payments are higher than the damage.

Since potential moral hazard avoidance is connected with costs, the insurer should offer full coverage to increase its profits, as long as the costs of moral hazard and moral hazard avoidance overcome the premium surplus of overinsurance. Surprisingly, the individuals with the highest financial literacy exhibit an average relative willingness to pay of 0.621, while potential policyholders with medium financial literacy are close to the "fair premium" 1. For an insurance company, a segmentation concerning financial literacy might be beneficial to maximize profits. Consistent with economic theory [Mossin (1968)], increasing degrees of risk aversion lead to higher relative willingness to pay. This insight is also important for the insurer to price the insurance contract appropriately.

Surprisingly, we find that older people tend to pay less for an insurance contract than younger people. This implies a perceived utility shift with increasing age. Our results also indicate that gender might be a driving factor for the relative willingness to pay. Furthermore, increasing wealth substantially increases the relative willingness to pay. In summary, our findings show that multiple parameters affect the relative willingness to pay significantly. Hence, those parameters are essential to better understand for the insurer to price insurance contracts and to comprehend the behavior of the policyholders.

In addition to providing insights about the key drivers of the policyholders' willingness to pay, we extend the findings by Wakker et al. (1997) concerning the Expected Utility Theory. We reach for full coverage and overinsurance, independent of initial wealth and risk attitudes, strongly indicating significance against the findings based on the Expected Utility Theory. For underinsurance, the results are less significant or not significant at all. Consequently, coverage affects whether or not policyholders' behavior significantly deviates from the Expected Utility Theory.

[14] If the p-value is smaller than 0.05, the mean of the willingness to pay significantly varies from the results derived from the Expected Utility Theory.
[15] More results on the Expected Utility Test are available on request from the authors.

Our analysis also exhibits some limitations. Consistent with Wakker et al. (1997), Zimmer et al. (2009), and Zimmer et al. (2018), we assume that the loss probability is known. However, in practice, theses probabilities are widely unknown for the policyholders. Moreover, although our willingness to pay analysis is important to recognize what drives policyholders' behavior, in practice, the market competition might affect the policyholders' behavior. Thus, for future research, we recommend analyzing competition-driven prices. For instance, a choice-based conjoint analysis can be used to enable a setting with different options.[16] Like many other studies in this field, we use hypothetical choices for the analysis. In such a setting, the subjects may offer erratic responses, since a baseline price is, in general, unknown to the participant. Hypothetical scenarios typically violate the Expected Utility Theory more than choices based on an experiment.[17] To account for these issues, participants should typically receive rewards depending on the outcomes of the experiment. Even though this aspect is well known, it is often hard to implement for many important research questions, like in our case of high insured values.

6. CONCLUSION

In this paper, we consider relative willingness to pay for insurance contracts with a high insured value. Our research is conducted from the insurer and regulator's perspectives. The analysis of the willingness to pay for high insured values is important for the insurer to recognize which policyholder groups exhibit a high willingness to pay and which do not cover the insurer's expected expenses. From a regulatory perspective, it is also relevant to understand which customer segment price regulations are useful to protect policyholders against potential discrimination. In this context, we develop a survey and collect empirical data. We then analyze whether or not the default probability, coverage, financial literacy, risk aversion, age, gender, and wealth are key drivers for the relative willingness to pay.

A multiple regression with dummy variables is used to determine the impact of the different independent variables. We also investigate whether higher financial literacy leads to an average relative willingness to pay which is closer to 1 compared to individuals with a low financial literacy. In addition, we examine whether policyholders strive for the expected utility results, given probabilistic insurance and no default probability with different coverage levels. We develop eight hypotheses that we test with the collected data. Those hypotheses are derived from previous empirical findings and the economic theory. Finally, we deduce the economic implications based on our findings.

Consistent with Wakker et al. (1997), Zimmer et al. (2009), and Zimmer et al. (2018), we find that the existence of a default probability significantly decreases the relative willingness to pay. Furthermore, the coverage does not significantly affect the relative willingness to pay. Hence, increasing coverage leads to higher profits for a positive premium loading. However, in practice, some moral hazard effects induce costs. The insurer should, therefore, strive for full coverage as long as the costs of moral hazard and moral hazard avoidance are greater than the premium surplus of overinsurance. In addition, we find the surprising outcome that the average relative willingness to pay for individuals with medium financial literacy is close to 1 (fair premium), but policyholders with the highest financial literacy pay substantially less (0.621).

Consistent with economic theory, we find that the relative willingness to pay significantly increases with a higher degree of risk aversion [Mossin (1968)]. Surprisingly, older age leads to a lower relative willingness to pay. We conclude that the perceived utility of the underlying insurance contract decreases with increasing age. The results for our overall sample partly deviate from Zimmer et al. (2018), since women pay less than men for insurance contracts. However, gender does not have a significant impact when we eliminate all the individuals who do not state their current wealth status. Furthermore, we extend previous research by finding that higher wealth implies an increasing relative willingness to pay. Hence, wealth is a key driver for insurance pricing. We also find that, for overinsurance and full coverage, policyholders significantly deviate from the results based on the Expected Utility Theory. These results are independent of the initial wealth and the degree of risk aversion. Concerning underinsurance, the deviation is less significant or not significant at all.

[16] A choice-based conjoint analysis concerning term life insurance is, for instance, conducted by Braun et al. (2016).
[17] See the literature review presented in Jaspersen (2016).

APPENDIX

Appendix A: Financial literacy

The full questionnaire is available upon request.

Suppose you had U.S.$100 in a savings account and the interest rate was 2% per year. After five years, how much do you think you would have in the account if you left the money to grow?

- More than U.S.$102
- Exactly U.S.$102
- Less than U.S.$102
- Do not know
- Refuse to answer

Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year.

After 1 year, how much would you be able to buy with the money in this account?

- More than today
- Exactly the same
- Less than today
- Do not know
- Refuse to answer

Please state whether or not this statement is true or false. "Buying a single company's stock usually provides a safer return than a stock mutual fund."

- True
- False
- Do not know
- Refuse to answer

Appendix B: Correlation coefficients among the independent variables

Table 9: Correlation table for the regression analysis (2)

	FINANCIAL LITERACY	RISK AVERSION	FEMALE	AGE
FINANCIAL LITERACY	1	-0.171[a] (0.000)	-0.113[a] (0.000)	0.334[a] (0.000)
RISK AVERSION	-0.171[a] (0.000)	1	-0.028 (0.066)	-0.030 (0.055)
FEMALE	-0.113[a] (0.000)	-0.028 (0.066)	1	-0.030[c] (0.048)
AGE	0.334[a] (0.000)	-0.030 (0.055)	-0.030* (0.048)	1

We consider the following significance levels c ($0.01 \leq p < 0.05$), *b* ($0.001 \leq p < 0.01$), and a ($p < 0.001$).

Table 10: Correlation table for the regression analysis (3)

	FINANCIAL LITERACY	RISK AVERSION	FEMALE	AGE	WEALTH
FINANCIAL LITERACY	1	-0.168[a] (0.000)	-0.100[a] (0.000)	0.341[a] (0.000)	0.182[a] (0.000)
RISK AVERSION	-0.168[a] (0.000)	1	-0.013 (0.445)	-0.014 (0.392)	0.026 (0.107)
FEMALE	-0.100[a] (0.000)	-0.013 (0.445)	1	-0.047[b] (0.004)	-0.137[a] (0.000)
AGE	0.341[a] (0.000)	-0.014 (0.392)	-0.047[b] (0.004)	1	0.227[a] (0.000)
WEALTH	0.182[a] (0.000)	0.026 (0.107)	-0.137[a] (0.000)	0.227[a] (0.000)	1

We consider the following significance levels c ($0.01 \leq p < 0.05$), b ($0.001 \leq p < 0.01$), and a ($p < 0.001$).

Appendix C: Summary

Table 11: Empirical results summary compared with the existing research

HYPOTHESES	MAIN RESULTS	EXISTING RESEARCH
H1: Default probability	The existence of default probabilities decreases the relative willingness to pay	Consistent with Wakker et al. (1997), Zimmer et al. (2009), and Zimmer et al. (2018)
H2: Coverage	No significant effect on the relative willingness to pay	No empirical research, to date; consistent with the theoretical research [see, e.g., Smith (1968)]
H3: Financial literacy	Medium financial literacy leads to an average relative willingness to pay that is close to 1; individuals with the highest financial literacy have a significantly lower average relative willingness to pay (0.621)	No empirical research, to date
H4: Risk aversion	Higher relative willingness to pay with higher risk aversion	Consistent with the economic theory [see, e.g., Mossin (1968)]
H5: Age	Lower relative willingness to pay with older age	No empirical research, to date
H6: Gender	Women exhibit a lower relative willingness to pay (overall sample); no significant results (partial sample)	Charness and Gneezy (2012) and Fehr-Duda et al. (2006) did find significance; Zimmer et al. (2018) did not find significance
H7: Wealth	Higher wealth increases the relative willingness to pay	No empirical research, to date. Consistent with research about consumption [see Case et al. (2005)]
H8: Expected utility	For full coverage and overinsurance, we reach, independent of the initial wealth and risk attitudes, strong significance against the Expected Utility Theory results; for underinsurance, the results are less significant or not significant at all	Extends the findings by Wakker et al. (1997)

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STRATEGIES FOR RESPONDING TO PANDEMIC RISK: REMOVAL AND/OR REDISTRIBUTION

PAULA JARZABKOWSKI | Professor of Strategic Management, University of Queensland and Bayes Business School, City, University of London

ELISABETH KRULL | Postdoctoral Research Fellow in Strategy, Bayes Business School, City, University of London

MUSTAFA KAVAS | Lecturer in Strategic Management, University of Sheffield

KONSTANTINOS CHALKIAS | Senior Lecturer, Department of Management, Birkbeck, University of London

ABSTRACT

The pandemic has an ongoing financial impact on the global economy, resulting in its uninsurability and ultimately an insurance protection gap. While solutions exist to address other protection gaps caused by large-scale disasters such as repeated flooding, earthquakes, and terrorism, pandemics differ and require novel solutions. This paper builds on Jarzabkowski et al.'s (2018) strategic response framework to large-scale, catastrophic disasters and applies it to the pandemic insurance protection gap. Set in the U.K. context, the research empirically studies various insurance solutions that are being proposed for pandemic risk and presents and evaluates four types of responses.

1. INTRODUCTION

The COVID-19 pandemic has, in addition to causing losses of lives and "social normality", severely affected the global economy and economic activity [Brammer et al. (2020)]. This was largely the result of measures taken to prevent the disease from spreading [OECD (2021)]. The OECD (2021) estimates that, in the U.K., one month of government restrictions costs businesses about U.S.$88 billion (~£64.14 billion). Normally, if they have a business interruption (BI) insurance policy, losses that affect organizations' ability to conduct business are covered by their insurance policies. However, given the severity and the systemic nature of the pandemic, a jarring protection gap has been exposed. Systemic risks, meaning losses of large scale that occur at the same time across many organizations, lines of business, and regions, are too big and concurrent to be insurable. The sheer number of losses caused by the pandemic would not be possible to cover by the insurance industry alone [Schanz et al. (2020)]. In addition, the novelty of the nature of COVID-19 led to uncertainties about whether or not existing BI insurance policies cover pandemic risk. For example, many business interruption policies have been proved to have ambiguous wording that is open to interpretation, or are linked to property, equipment damage, or inaccessibility [OECD (2021)] that are more relevant to other disasters, such as fire or flood, but not relevant to a pandemic. In addition, only a few businesses have policies in place that would cover these types of losses [OECD (2021)]. Going forward, given its systemic nature [Schanz et al. (2020)], insurance firms are likely to exclude insurance cover for pandemic risk [OECD (2021)]. Alternatively, if such insurance is made available, to cover the range and magnitude of potential losses it will likely be unaffordable for most businesses, thus resulting in an "insurance protection gap" [Jarzabkowski et al. (2018)].

Insurance protection gaps are often addressed by national government interventions into the insurance industry [Jarzabkowski et al. (2018)]. Examples of gaps include flooding risk in the U.K., earthquake risk in California, or commercial property terrorism risk in Australia. The government interventions, designed to ensure continuity of insurance in the face of extreme events [Jarzabkowski et al. (2019), McAneny et al. (2016)], are referred to as "protection

gap entities" (PGEs). PGEs are entities that "bring together different market and non-market stakeholders in an effort to address the protection gap by transforming uninsured risk into insurance-based products that can be transferred onto government balance sheets or into global financial markets in order to provide capital for recovery following a disaster" [Jarzabkowski et al. (2018)]. In the U.K., examples of PGEs include Pool Re and Flood Re, which are single-peril risk pools set up to support the private insurance market to provide commercial terrorism cover and residential flood insurance cover, respectively.

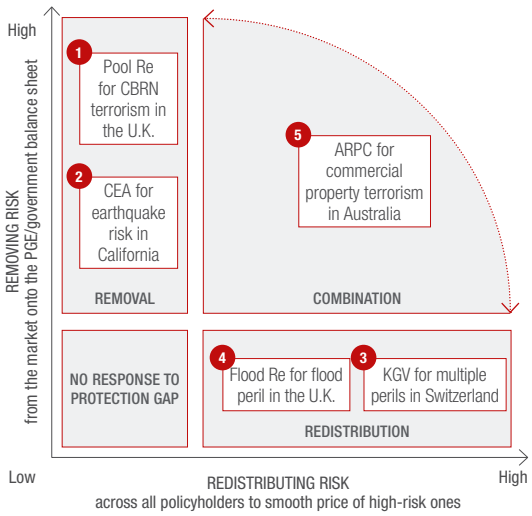
Globally, PGEs are growing, generating a range of different risk-sharing schemes that aim to address protection gaps for various large-scale disasters [Jarzabkowski et al. (2018)]. The goal of these schemes is broadly to transform uninsured risk into insurance products. These can then, at least partially, be further transferred to global reinsurance markets in order to provide capital for recovery following a disaster. Considered as "archetypical forms" of government involvement, PGEs, nevertheless, vary considerably in terms of their governance structures, the risks covered (e.g., single- or multi-peril), the type of risk solution (e.g., insurance versus reinsurance), and the funding model (e.g., policyholders' premiums, public or private levy). Despite these differences, PGEs have important common underlying principles in their strategic responses to protection gaps and how they share risk with market and non-market parties [Jarzabkowski et al. (2018)]. Specifically, they primarily respond to catastrophic risks by either removing risk from the market or redistributing risk across all policyholders [Jarzabkowski et al. (2018)].

In this paper, we first explain how existing protection gap entities address insurance protection gaps. We then consider some of the solutions to pandemic business interruption insurance proposed in the U.K., in order to evaluate whether and how protection gap entities can be adapted to address systemic risks such as pandemics.

2. A STRATEGIC RESPONSE FRAMEWORK FOR PANDEMIC RISK

This section introduces the strategic response framework to catastrophic risk developed by Jarzabkowski et al. (2018). These strategic responses can be categorized into various degrees of removing risk from the market and redistributing it across all policyholders to smooth the price of those at high risk (Figure 1).

Figure 1: Protection gap strategic response framework



Notes:

1. Remove all risk from the market to the PGE/government
2. Remove risk to the PGE and return only some to the market (e.g., through reinsurance or insurers' retention)
3. Redistribute all of the risk across all policyholders
4. Redistribute some of the risk across all policyholders
5. Remove risk from the market to the PGE/government AND redistribute across all policyholders

Source: Jarzabkowski et al. (2018)

2.1 Removal

Removing risk is a response that removes the risk from the (insurance) market onto the balance sheet of the protection gap entities, and potentially then to the government (vertical axis, Figure 1). This response is particularly likely for risk that is seen as too volatile or extreme for the market to take. Insurance companies may accept premiums from insureds, so ensuring that policies can still be issued and serviced, and then pass the entire premium associated with this risk to the protection gap entities. The PGE can provide the cover because it has access to a government guarantee (limited or unlimited) to pay for losses, as with the terrorism reinsurance scheme Pool Re in the U.K. Alternatively, it can generate its own reserves in the private market (e.g., reinsurance) to cover losses, as with the California Earthquake Authority (CEA).

The extreme position on this dimension is removing the risk fully from the market but responses may vary along the continuum, by removing only some of the most extreme risks. For example, a PGE might remove a "top layer" of risk as defined by market signals, such as withdrawal of insurance supply, while risk below a certain threshold is retained by insurers in the usual way.

2.2 Redistribution

Redistributing risk is a response that takes the risk of loss by a relatively small group of highly exposed policyholders and shares it across the wider pool of variably exposed policyholders through a subsidy (horizontal axis, Figure 1). Low-risk policyholders pay a slightly higher premium than they would normally have to based on their actual risk, which in turn is used to subsidize affordable premiums for high-risk policies. The protection gap entity, typically formed as an insurance or reinsurance pool, collects the premiums from all policyholders and uses the levy to smooth pricing across all participants in the risk pool.

Protection gap entities that adopt the strategic response of redistributing risk attempt to create a wide pool of insureds, in which the premiums of the many policyholders, widely distributed across possible exposures, can continue to cover the extreme losses of the few. However, they can only do so with some government legislation. Examples are the flood insurance scheme Flood Re in the U.K., where a government-enabled levy on lower-risk policyholders subsidizes higher-risk policyholders in order to offer them affordable insurance, or the KGV (Cantonal Building Insurance) in Switzerland, where a not-for-profit government monopoly makes insurance mandatory so that it can be offered at a fixed affordable price.

2.3 Combination

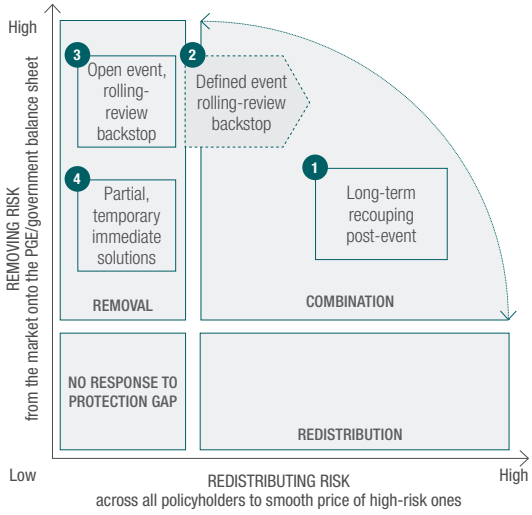
Removing and redistributing risk are not necessarily either/or responses. As demonstrated in Figure 1, PGEs can combine risk removal and risk redistribution, albeit not necessarily in equal measures. Rather, they may take an approach where they remove some elements of risk and redistribute others. Often, such changes occur in an evolutionary way. A protection gap entity may initially be established to solve, for example, the problem of lack of supply for a very volatile risk, such as earthquakes or terrorism, through a strategic removal response. Once supply begins to return, it might also employ some redistribution of risk through industry retentions that are spread across a pool of policyholders. For example, the Australian Reinsurance Pool Corporation (ARPC) continues to remove that proportion of the terrorism risk for which the global (re)insurance industry has neither appetite nor sufficient capital. At the same time, ARPC has progressively scaled down the level of risk removal and included some risk redistribution by pushing insurers to retain more of the terrorism risk losses on their own balance sheet to a specified threshold that is aggregated across the industry.

While these are more or less effective responses to the protection gaps caused by large-scale and catastrophic disasters such as earthquakes, floods, and terrorist attacks [Jarzabkowski et al. (2018)], pandemics differ [OECD (2021), Schanz et al. (2020), Schanz et al. (2021)]. Firstly, they are systemic in the sense that especially in the business interruption insurance arena, they contain "elements of uncontrollable aggregation and correlation which defy insurability" [Schanz et al. (2020)]. Secondly, it is complicated to know when a specific pandemic event ends; for example, are further waves of infection and lockdown part of a single event or are they separate events? Thirdly, the actual cause or trigger for the losses is not precise – it is not necessarily the specific contagion of a pandemic per se that causes the business interruption, but government decisions for lockdown as part of their public policy choices. These characteristics make pandemics more problematic to insure, exacerbating the "protection gap" issue [Lloyd's (2020), OECD (2021), Schanz et al. (2020)]. Nonetheless, useful lessons can be learned from these existing PGEs strategic responses in order to consider how to address insurance protection gaps for pandemics in the future. We, therefore, explain the principles underlying existing PGEs and apply them to evaluate some of the pandemic risk-sharing solutions currently proposed.

Our research identified four responses to the pandemic based on a series of interviews with insurers, reinsurers, government, and businesses; observations of key events, industry forums, and working groups over the period of 1.5 years; and documents including news articles, magazine articles, and government announcements. Based on the various solutions proposed during the period of our research, some of which were also acted upon, we now use the Protection Gap Strategic Response Framework to evaluate four potential types of responses to pandemic protection gaps (see Figure 2). The proposed typology reflects the proposed solutions in the U.K. but is also relevant for other jurisdictions.[1]

[1] An earlier version of this appeared in Schanz et al. (2021).

Figure 2: Four potential responses to the pandemic protection gap



Notes:

1. Remove risk to the insurance-led PGE and redistribute across all policyholders with government guarantee for default
2. Remove risk to the PGE/government and later may return some to the market (e.g., through reinsurance or insurer retention)
3. Remove all risk from the market
4. Remove risk partially and temporarily from the market

Source: Paula Jarzabkowski, adapted from Schanz et al. (2021)

Broadly, each of these responses intends to protect small- and medium-sized enterprises (SMEs) against business interruption from pandemics. However, they vary in terms of their design, time scale, scope, product type, and degree of industry capitalization [Schanz et al. (2021)]. The typology is not intended to reflect any specific solution, as these are currently evolving as the pandemic persists. Rather, the aim is to provide a framework for evaluating the range of solutions under development according to their key risk-sharing characteristics.

TYPE 1: LONG-TERM RECOUPING POST-EVENT (REDISTRIBUTION WITH SOME REMOVAL)

Type 1 aims to provide businesses with an immediate cash injection to support fast recovery. It is a post-event insurance product that is paid for over the long term. Backed by a government credit risk guarantee, it relies on both government capacity and insurance industry commitment.

Type 1 offers a flexible pricing mechanism where businesses can receive a payment immediately during a pandemic but must buy multi-year policy contracts from insurers. This allows insurers to recover upfront claims costs over the full policy term while ensuring the product remains affordable for customers by spreading the costs over time. The product, therefore, involves mandatory premium payments over a pre-agreed policy term (e.g., 10-15 years). In the event of premature policy cancellation, businesses face penalties to ensure insurers' claims costs are recovered. To mitigate the risk of payment defaults, governments would be required to guarantee policyholders' future premiums.

Given these characteristics, Type 1 is primarily a risk redistribution response with some element of risk removal. In the short term, the insurance industry covers the risk to pay claims without receiving the full premium. This initial industry subsidization of the premiums will be redistributed across the policyholders through recouping premiums over time via a multi-year insurance contract (see Figure 2). At the same time, the risk of default on long-term premiums is covered by a government guarantee that effectively moves the risk of default to the public sector.

This combination approach has two challenges. First, it can only work where policyholders are compelled to take out a multi-year product. Yet, even with a compulsory, long-term recoupment, some businesses may default as a result of other disruptions to their business model, cash flow, and overall survival. Hence, embedding a risk-removal mechanism in the form of a government backstop is required to guarantee the premiums in light of a possible default. Second, regardless of whether a guarantee is in place, moral hazard remains a problem. Businesses could take the upfront policy despite a high uncertainty about whether they will remain robust for the life of the policy. For example, many SMEs could be offered payments through a recoupment scheme even though they have declining or failing business models that will realistically not survive. This would require developing careful parameters in offering the product. Yet, although some of these businesses will fail and be unable to meet the long-term recoupment of premiums, the insurance acts as an economic stimulus. At the same time, insurers' own risks are minimized due to the government guarantee.

TYPE 2: DEFINED-EVENT, ROLLING-REVIEW BACKSTOP (REMOVAL WITH POTENTIAL FUTURE REDISTRIBUTION)

Type 2 is a large-scale, government-backed premium pool to reinsure pandemic-specific non-damage business interruption (NDBI) insurance cover. Typically formed as a public-private partnership (PPP), it is largely insurance industry-led in its execution but relies on the government as a financial backstop to cover any claims.

Under this scheme, insurance firms design and offer products specifically around pandemic-related NDBI and also collect the premiums. These premiums are then paid into a pool that acts as the designated reinsurer and provides payments to policyholders that are affected by a pandemic-related event as defined in the enabling agreement of the government. The government-defined event is critical because that will determine whether and when payments are triggered. While the insurance industry administers the scheme, it does not retain any of the risks. Instead, the designated reinsurance pool will pay all claims. The government provides a financial backstop of a limited or unlimited guarantee to step in if the assets in the pool are exhausted, as might occur due to a significant national lockdown or a series of medium-sized lockdowns.

As observed by Jarzabkowski et al. (2018), government-guaranteed pools tend to be designed with a (rolling) review period. This typically involves a government inquiry every three to five years to ascertain whether a government backstop is needed to ensure ongoing cover, or whether the private market can take more or all of the risk. These reviews provide an opportunity to increase retention of risk by the primary market and to increase the amount of commercial reinsurance cover that might trigger prior to the government backstop. Rolling reviews enable private market appetite and capacity to be reconsidered regularly, incentivizing the insurance industry to not simply rely on the government as "the insurer of last resort". The rolling review of Type 2 may, therefore, eventually involve some redistribution of risk across the insured population, as indicated by the arrow in Figure 2.

TYPE 3: OPEN EVENT, ROLLING-REVIEW BACKSTOP (REMOVAL)

While Types 1 and 2 aim to provide protection against pandemic risk, Type 3 takes a broader, multi-peril approach. It is designed for non-damage business interruption as a result of any future systemic events, such as a cyber event, or, potentially, the systemic effects of climate change.

In its design, this scheme has similarities to Type 2 but is not peril-specific. Type 3 is intended to be a catch-all for disasters that shock the system and hence the exact peril or the event that triggers a claim is not specified a priori. This scheme requires a full government backstop as the private market would not be able to operate the scheme given the open definition of both the peril and the event triggers, resulting in uncertainty. Yet, the scheme may be executed in the same way as Type 2, with premiums being collected against systemic risk and paid into a government-designated reinsurance pool that can provide a buffer for the government backstop.

Type 3 recognizes that, just as the COVID-19 pandemic was unanticipated, it is difficult to predict what the next systemic disaster will be. The scheme also counters current principles of insurance related to indices, models, pricing, and solvency requirements. As such, any premium charged would be difficult, if not impossible, to directly link to, or reflect the actual risk of a disaster. Hence, Type 3 might be operationalized as a form of levy upon insurance policies that would be passed directly to the government pool, rather than to a specified "systemic risk" insurance product that would be sold by insurers, with the premium then transferred to the government pool.

As with Type 2, this option would also operate as a risk removal scheme. In this scenario, the government would need to declare events as systemic, which would then trigger the backstop claims related to those declared events. Such systemic risk could be another pandemic, a widespread cyberattack, or even potentially widespread and unprecedented extreme weather disasters, such as the Australia-wide 2019-2020 bushfires, or even the recent 2021 European flooding, where Germany's government committed €30 bln for reconstruction alone [DW (2021)]. In this situation, the term systemic would need considerable definition. For example, if systemic means affecting the global economy, of widespread geographic and industrial spread, and concurrent, then pandemic fits the definition, but something like bushfires or flood may be less easy to define.

The main challenge for Type 3, therefore, is the problem of declaring the trigger for such an event. Knowledge about which risks are likely to be systemic is continuously evolving and risks that are not currently on the horizon at the time of designing the protection gap entities may be systemic in the future. We suggest that the pool of premium that is built up through a Type 3 scheme is partly reinvested to better understand which types of risks may be identified as systemic and to help mitigate against their effects. This could be built into a three-to-five year rolling review process, enabling it to

be responsive to emerging risks that are considered systemic. More fundamentally, Type 3 is an untested concept. Bundling different types of systemic risk, such as pandemic and cyber-attack, within a single protection gap entity response will present major challenges in terms of complexity and exposure.

TYPE 4: PARTIAL, TEMPORARY IMMEDIATE SOLUTIONS (REMOVAL)

Type 4 aims to resolve the lack of appetite from the private insurance market for offering insurance products to cover losses for specific business sectors. This includes government-backed solutions that partially and temporarily remove a specific risk from a business sector to the government balance sheet.

Since the beginning of the COVID-19 pandemic, the U.K. government has introduced three government-backed solutions to address sector-specific risk: (1) the Trade Credit Reinsurance Scheme, (2) the Film and Television Production Restart Scheme, and (3) the currently proposed Live Events Reinsurance Scheme. Each scheme was developed in close collaboration between the insurance industry and the U.K. government, with claims covered by the government, and designed to be temporary solutions rather than to remain in place after the COVID-19 crisis. We, therefore, label Type 4 as "partial, temporary immediate risk removal" solutions.

The Trade Credit Reinsurance Scheme was announced in June 2020 in response to the concerns of both insurance firms that offer trade credit insurance (TCI) and business associations that represent SMEs typically with supply chains [Ralph (2020)]. The scheme served as a state-backed reinsurance program by providing a guarantee of up to £10 bln for insurers to be able to continue to offer TCI [ABI (2021)]. Under the scheme, the government agreed to reinsure 90% of insurance claims and, in exchange, take 90% of the premiums up to a total insurer loss ceiling of £3 bln, and 100% of claims between £3 bln and £10 bln [BEIS (2020)]. Consequently, despite the increased risk of non-payment due to the ongoing pandemic, the scheme enabled the provision of trade credit insurance to U.K. businesses that allowed them to continue trading on credit terms. This provided financial liquidity and cash flow but also boosted confidence, ensuring ongoing economic activity. Initially set up to run for six months, the scheme was extended to the end of June 2021 and has since ceased [ABI (2021)]. Yet, there are ongoing concerns that insurers may continue to have little appetite to insure businesses that rely on face-to-face contact such as retail shops, hospitality, and events [Smith and Arnold (2021)].

The Film and Television Production Restart Scheme was launched by the U.K. government in July 2020 to assist in the restart of productions that have been suspended or postponed due to the withdrawal of the private insurance market for COVID-19 related risks. The government allocated £500 mln to the scheme to offer insurance for productions against losses arising from COVID-19 interruptions, including filming delays and cast and crew illnesses. Production companies that meet the eligibility criteria can obtain cover directly from the government up to a cap of £5 mln per production for a fee of 1% of the production budget. To date, the scheme has supported numerous productions and helped save many jobs in the film and TV industry [DCMS (2021a)]. The scheme, which was initially launched to run for six months has been extended until December 2021 in order to cover the summer shooting schedule.

The Live Events Reinsurance Scheme was launched in the U.K. in September 2021 [DCMS (2021b)] after a lengthy period of lobbying from the live events and entertainment industry. The scheme allows event organizers to buy insurance directly from insurance firms [Payne and Thomas (2021)] and the government commits more than £750 mln to costs incurred in the event of cancellations due to COVID-19 restrictions legally enforced by the U.K. government [DCMS (2021b)]. The scheme was initially launched in September 2021 with provision to run until September 2022.

Type 4 provides rapid, temporary, government-backed (re)-insurance solutions to mitigate the consequences of the unavailability of (re)insurance arising from pandemic risk. These solutions, however, are partial as they aim to cover only specific risks, such as trade credit, or particular sectors, such as film and TV production or live events. The positive aspect of such solutions is that they can be instated rapidly at the instigation of the government, without needing to go through policy changes or legislation and so can address immediate demand. However, the downside is that they are, in turn, partial, which means that only a few business sectors can be covered according to government decisions about what discrete sectors are in critical need. Moreover, their temporary nature assumes that the private market will have an appetite to re-assume such risk at the end of the current pandemic. As that is yet untested, such solutions may eventually need to be legislated to become more permanent.

In conclusion, for each of the four types presented, there are three key considerations. First, whether the cover is mandatory or voluntary. This will determine the size of the risk pool and the scope for risk redistribution. Second, each of

these options necessitates government involvement to varying degrees, either through legislation to support redistribution or through a government guarantee or backstop. Third, questions of fairness arise. For example, the government will support those who have been risk-averse and proactive in taking out pandemic insurance, yet it will also have to prop up those without insurance. Furthermore, in Type 4 some specified risks and sectors receive support while others do not. In light of this, a mandatory approach might be most appropriate for systemic risks, particularly for Types 2 and 3, where the cover involves a full government guarantee.

Despite being based largely on risk removal by the government, each of the types proposed indicates a valuable role for the insurance industry to play in acting as professional distributors of the insurance policies that will be backed by the government, as claims managers, and as experts in risk mitigation and prevention. Effective communication and exchange between the government and the insurance industry are, therefore, vital. In the short- to medium-term, redistribution of such risk (Figure 2) is likely to be difficult to achieve; that is, pandemic risk or other systemic risks cannot easily be spread amongst a large pool of policyholders without government backing.

3. CONCLUSION

The purpose of this article is to outline the solutions currently being proposed to address the pandemic insurance protection gap and provide a framework for evaluating them. As our Strategic Response Framework clarifies, a government backdrop for risk removal will need to be involved when addressing a risk of such magnitude. The schemes that have successfully been launched (Type 4) are all temporary, with the aim of a return to the private market, which may not be possible in the short- or even medium-term. We, therefore, recommend ongoing dialogue and collaboration between the government and the insurance industry in bringing any of these proposed solutions (Types 1 to 3) to fruition as working insurance products that can ensure continuity of pandemic insurance for businesses. Furthermore, as businesses are the biggest carriers of these risks, it is important to include their needs and experiences in developing these solutions.

Our Protection Gap Strategic Response Framework and its application to pandemic risk also have implications for other burgeoning systemic risks. While the pandemic is a significant event that has hit economies around the world hard, other, longer-term risks also need to be addressed to minimize insurance protection gaps. Rising global temperatures have caused a climate crisis in which extreme weather events such as flooding, droughts, cyclones, and bushfires have almost doubled to 6,681 events over the past 20 years, costing U.S.$4.07 trillion in global economic losses [UNDRR (2020)]. As much of this risk is underinsured, the burden of paying for such losses falls on governments and the affected communities and individuals. The problem is that the global insurance and reinsurance market that pays for such losses [Jarzabkowski et al. (2015)] will break down under the impact of climate change. If temperatures do rise by 1.5C by the end of the century, annual costs incurred by damages as a result of climate change could reach €71 bln compared to €22.9 bln in 1981 [Smith and Arnold (2021)]. Yet, the relatively long-term impact of climate change forestalls a sense of urgency and can delay change [Slawinski and Bansal (2015)]. By contrast, sudden systemic shocks, such as the current pandemic, provide opportunities for learning about how to respond to the protection gap on other systemic risks. While climate risk differs considerably from pandemic risk in terms of the speed at which risks become uninsurable [Rosenthal et al. (2001)], nonetheless, urgent strategic responses to climate risk are needed. We, therefore, hope that this article provides grounds for considering some options through which governments and the insurance industry, alongside those policyholders who are increasingly affected, can plan their strategic responses in advance of a crisis or collapse of insurance.

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PANDEMIC INSURANCE: A PORTFOLIO MANAGEMENT APPROACH

ALEXIS LOUAAS | Postdoctoral Researcher, CREST-Ecole Polytechnique
PIERRE PICARD | Professor of Economics, CREST-Ecole Polytechnique

ABSTRACT

The COVID-19 crisis has highlighted the deficiencies of business interruption insurance when the economic activity is deeply impacted by a worldwide pandemic. Pandemics have a systemic nature, which distinguishes them from other catastrophic risks such as natural disasters or large-scale industrial accidents. This specificity makes it impossible to mutualize the pandemic risk through insurance or reinsurance. In facing this challenge, capitalization-based insurance mechanisms – so far limited to life insurance – offer a renewed perspective on corporate risk management and provide new opportunities to the insurance industry. In this perspective, we explore the reasons why business interruption insurance should be backed by a specific portfolio-management strategy, and how such a combination would allow insurers to offer coverage against pandemic risk.

1. THE SYSTEMIC DIMENSION OF THE PANDEMIC RISK

In many countries, COVID-19 has inflicted dramatic losses on a large number of businesses. Workers, customers, and entrepreneurs were prevented from conducting their activities normally because of social distancing, lockdowns, and limits to transport of goods and people. Huge losses have resulted from this unprecedented health crisis. As a result, many firms turned to their insurers, in the hope of receiving coverage through their business interruption policies. Unfortunately, most of these hopes were dashed. Indeed, such a coverage is typically included as part of a company's commercial property insurance policy, and is triggered when there is direct physical damage to insured property due, for instance, to a fire or a natural disaster like a flood. Many insurers have thus denied coverage, contending that claims do not meet the "direct physical loss" requirement contained within standard business interruption policies. Although many legal actions are still underway, and without expressing a view on the validity of the arguments made by firms and insurers, it is clear that corporate insurance had not been conceived by insurance companies to protect firms from such a pandemic risk. Hence, if one keeps in mind the risk of new pandemics in the future, the design of an efficient business interruption cover remains an open question for the insurance industry.[1]

It is well known that insurance is based on two pillars: mutualization and capitalization. Mutualization works through risk-pooling when risk exposures are independently distributed. It is based on the law of large numbers, which allows policyholders to be covered through non-participating contracts after paying a fixed premium. In brief, through mutualization, the misfortunes suffered by a few policyholders are compensated by the contributions of all the others. In contrast, capitalization refers to mechanisms through which policyholders cover their own risks (either directly, or more usually through a financial intermediary) by purchasing

[1] See OECD (2021) on the economic disruptions caused by the COVID-19 in countries around the world, and on how business interruption against pandemic risk could be provided with support from governments.

financial assets and they are protected against risks through a portfolio management strategy. It is usually considered that mutualization and capitalization are relevant in areas that are clearly separate from one another: P&C lines and health insurance are based on mutualization, while life insurance works through capitalization.[2]

So far, the business interruption risk exposure has been considered by insurers as an indirect loss induced by property damage, with the implicit consequence that it could be covered through the same mutualization mechanisms. More recently, the emergence of cyber risk has meant that many have started questioning whether mutualization of business interruption risk could be undermined by common factors affecting the whole economy. COVID-19 has also led to similar concerns, but on a much larger scale and with far-reaching consequences for the design of insurance contracts. Although from the perspective of the insured firm there is no difference between business interruption losses being caused by property damage or health issues, mutualization is possible in the case of the former but not in the latter.

There are important differences between pandemic risk and other catastrophic risks that need to be taken into account when considering the types of exposure coverage available. Catastrophic risks are low-probability high-severity risks with correlation between individual exposures, which reduces the efficiency of mutualization as a risk-sharing mechanism.[3] In particular, property damages resulting from natural or industrial disasters are correlated at a local level, hence the mutualization within a portfolio of insurance contracts has to be complemented either by mutualization at a higher level (i.e., between portfolios) or by the transfer of risks to financial markets. This is mainly done through reinsurance, which acts as a worldwide risk-spreading mechanism. From this standpoint, the increase in the number and cost of insured catastrophic risks has certainly played a role in the consolidation of the reinsurance sector during the last decades. This complement to mutualization may also be provided by specific financial instruments, such as cat-bonds, industry loss warranties (ILWs), or other forms of alternative risk transfer mechanisms, with the purpose of transferring risk to dedicated investors, outside the sphere of the insurance and reinsurance industry.

Pandemic risk, on the other hand, increases the correlation issue at the global level, because all countries are simultaneously affected, which reduces the benefit of using reinsurance as a risk spreading instrument. It also differs from catastrophic P&C risk exposures (such as large-scale natural disasters) because of its systemic nature. This is a crucial point. Cummins & Weiss (2013) describe as systemic "the risk that an event will trigger a loss of economic value or confidence in a substantial segment of the financial system that is serious enough to have significant adverse effects on the real economy with a high probability." In this definition, the transmission chain starts with an economic event that destabilizes the financial sector and thereby causes a severe decline in the real-sector activity. The bursting of the U.S. housing bubble that peaked in 2006 – a major contributor to the global credit crunch of 2007-2008, which resulted in huge losses on global stock markets, which in turn created a worldwide downturn in economic activity – is a typical example of such a sequence of events that begins with the financial markets and is transmitted to the real economy. In the case of COVID-19, the causality chain is reversed: the triggering event (i.e., the health crisis and its consequences on social distancing and limits to mobility) is in the real sphere. It spreads worldwide in the global economy, and is ultimately transmitted to the financial markets. Whatever the direction of causality, in both cases the risk is systemic because it affects the real and financial spheres of the global economy, and not only a limited number of victims. Natural disasters and industrial catastrophes, unlike the pandemic risk, and irrespective of their severity, do not have this systemic dimension.

2. TOWARDS A CAPITALIZATION-BASED CORPORATE INSURANCE MECHANISM

Because of the high degree of correlation and the low-probability high-severity nature of pandemic risk, looking for a mutualization-based pandemic insurance is probably not the way to go. It seems more appropriate to think in terms of capitalization. To put the matter differently, so far mutualization and capitalization have been relevant in areas that are clearly separate from one another: a Chinese wall separates non-life and life insurance, with mutualization on one side of the wall, and capitalization on the other. We think that this dichotomy

[2] Some insurance contracts may be based simultaneously on mutualization and capitalization, as for example in the case of P&C participating contracts offered by mutual insurers.

[3] See Louaas and Picard (2021a) on the insurability of low-probability catastrophic risks.

has to be abandoned in the case of corporate pandemic insurance, since the coverage of business interruption is a key line of business for P&C insurers, yet it cannot be mutualized in the event of pandemics.[4]

A superficial approach to this issue might suggest that the capitalization channel conflicts with the systemic nature of pandemic risk. In simple terms, protecting firms affected by business interruption through risk-sharing mechanisms is all the more difficult because pandemic events coincide with severe macroeconomic downturns and financial crises. While this concomitance is obviously a challenge to capitalization-based insurance mechanisms, a closer inspection reveals the specificity of the financial effects of pandemic events.

Firstly, as documented by Dingel and Neiman (2020), Hensvik et al. (2020), and Koren and Petö (2020), pandemics affect different sectors of the economy differently, depending on the effects of social distancing constraints, lockdowns, and mobility restrictions on their activities. Some, as we have seen, have in fact benefited from the crisis. Accommodation and food services, transport and distribution, manufacturing and crafts, the entertainment, retail and luxury industries, and all industries reliant on an international supply chain have been severely impacted by COVID-19, while pharmaceutical and biotech industries, online B2B and B2C platforms, and high-tech industries have benefited from the increase in demand for healthcare, from changes in consumption patterns, or from the propensity of firms to digitize their activities. Pagano et al. (2021) have highlighted how this differentiated exposure to the pandemic risk is reflected in stock returns during the COVID-19 crisis.

Secondly, as in any period of financial instability, and particularly from late March to December 2020 – which Pagano et al. (2021) refer to as the "post-fever" period – fund managers have reallocated their portfolio choices toward assets perceived as more defensive, either because of their low correlation with the market return (small beta) or because factor models have highlighted their intrinsic quality. While distinguishing cyclical and defensive sectors is the usual practice of financial analysts and portfolio managers, considering the effects of social distancing and mobility restrictions on stock performances is quite a new perspective.

In a recent paper [Louaas and Picard (2021b)], we explored how a capitalization-based insurance scheme could be built, specifically through exploiting this differentiated exposure to pandemic risk. More specifically, we analyzed the performance of a portfolio of stock options and/or long-short positions, including call options and/or long positions for stocks whose returns are expected to be fostered by a pandemic event, and put options and/or short positions for stocks expected to be strongly penalized by such an event. Such a portfolio allows the owner (say, a firm seeking coverage through a capitalization-based self-insurance mechanism) to reduce their non-pandemic risk through a mixture of call-put or long-short positions, as in a straddle portfolio management strategy, while allowing them to achieve a strong capital appreciation should a new pandemic occur.

This approach is based on the premise that pandemics have differentiated structural effects on the economy, according to the vulnerability to social distancing in different sectors of activity, and that this uneven vulnerability is reflected in stock returns during a pandemic event. Taking long positions and/or purchasing call options on stocks more resilient to a pandemic shock, and simultaneously going short and/or purchasing put options on less resilient stocks allows the policyholder to be covered against the risk of a new pandemic, while hedging non-pandemic risks.

3. STRUCTURAL FINANCIAL EFFECT OF A PANDEMIC SHOCK: THE COVID-19 CASE

To give more substance to these premises, we may consider how good or bad news on the spread of the COVID-19 pandemic has been reflected in changes in stock returns. To do so, we use French data on the daily number of new hospitalizations due to COVID-19, and we check whether this information correlates with stock returns on the French stock exchange. This allows us to classify stocks in three groups, with positive and negative correlation in groups 1 and 2, and without significant correlation in the residual

[4] We have deliberately ignored the role that governments may play, either by acting as reinsurers of last resort or by promoting a legal framework for insurance. In particular, arguments in favor of an insurance regime in which the government would provide the upper layer of coverage often confuse their ex-ante role in making an insurance scheme viable and effective with the ex-post assistance and financial aid they provide to victims once a catastrophe has occurred. Governments have an important role to play in both cases, but distinguishing between them is of utmost importance in clarifying the issues at stake. For instance, in the U.S., the National Flood Insurance Program (NFIP) is one of the instruments of the Federal Emergency Management Agency for the coverage of flood insurance, which fundamentally differs from the financial aid to victims and local governments that the government may provide after a Presidential Disaster Declaration.

group. We restrict our sample to the largest stocks listed on the French stock exchange, included either in the CAC40 or in the CAC Next20.[5] We may evaluate whether good or bad news on the pandemic front, measured by the daily number of new hospitalizations, affects the performance of a stock in comparison with the average market return. This leads us to the following regressions:

$$r_{it} - r_{mt} = \alpha + \beta_1 h_t + \beta_2 h_{t-1} + \varepsilon_{it}$$

where *i*, *m*, and *t* refer to the specific stock under consideration, to the stock market, and to the date (on a daily basis), respectively.[6,7] We denote *r* and *h* as the daily stock return and rate of change of hospitalizations related to COVID-19. Hence, we test whether the return on stock *i* in excess of the stock market return has been affected by changes in hospitalization, possibly with one-day lag. The regressions (one for each stock in the sample) are performed over the period March 18, 2020 to May 18, 2020.[8]

Table 1 includes the results of these regressions for stocks, such that the estimate of coefficient β_1 is significantly different from zero. When groups 1 and 2 are selected through the sign of this estimate, eight stocks are included in group 1 and nineteen stocks are in group 2. Taking a closer look at the list of companies in each group allows us to determine, in an intuitive way, why some are more negatively impacted by the spread of the pandemic than others. Group 1 includes stocks in sectors that have been boosted by the pandemic for various reasons (biotech, pharmaceuticals, business services, and videogames), were intrinsically defensive (alcohol, luxury goods), or were relatively sheltered from fluctuations in consumer demand (chemicals, oil and gas). In group 2, the stocks were in sectors whose activities are strongly impacted by the decrease in household demand (automobile, real estate, consumer demand), reliant on governmental investment decisions (aerospace/defense, engineering/construction, railway), or whose services were required by other firms (steel, chemicals, electrical equipment). Banks and insurance reflect the general state of the economy, and they are negatively impacted by bad news about the spread of the pandemic.

Table 1: Results of the regression analysis

NAME	β_1	P-VALUE	SECTOR
GROUP 1			
Air Liquide	0.0630	0.00	Chemicals, healthcare
Biomerieux	0.2529	0.00	Biotechnology
LVMH	0.0668	0.00	Luxury goods
Pernod-Ricard	0.0392	0.00	Alcoholic beverage
Sanofi	0.0516	0.02	Pharmaceuticals
Total Energies	0.0999	0.00	Oil, gas
Ubisoft	0.0838	0.00	Videogames
Worldline	0.0978	0.00	Business services
GROUP 2			
Alstom	-0.0769	0.00	Railway
Arcelor Mittal	-0.1328	0.01	Steel
Arkema	-0.1463	0.00	Chemicals (specialties)
AXA	-0.0637	0.01	Insurance
BNP Paribas	-0.0880	0.00	Bank
Bureau Veritas	-0.0325	0.00	Business services
Dassault Systemes	-0.0878	0.01	Aerospace/defense
Eiffage	-0.0926	0.02	Engineering/ construction
Engie	-0.0698	0.06	Gas (distribution)
Gencina	-0.0886	0.02	R.E.I.T.
Essilorluxottica	-0.1208	0.00	Household product
Klepierre	-0.0504	0.07	R.E.I.T.
Legrand	-0.0495	0.07	Electrical equipment
Peugeot	-0.1119	0.00	Automobile
Safran	-0.1629	0.08	Aerospace/defense
Saint Gobain	-0.0518	0.00	Chemicals
Société Générale	-0.0753	0.00	Bank
Solvay	-0.0732	0.00	Chemicals (specialties)
Teleperformance	-0.1812	0.00	Technology

[5] The CAC40 index is a capitalization-weighted measure of the 40 largest stocks listed on the Euronext Paris. We have extended our sample of stocks to the CAC NEXT20, i.e., the 20 stocks next in line, because the two sets are separated by a very porous frontier: stocks may move between CAC40 and CAC NEXT20 from one year to the next, according to changes in their capitalization.

[6] Omission of the lagged variable h_{t-1} would create an omission variable bias since the series h_t is auto-correlated.

[7] The daily hospitalizations are taken from the French government website data.gouv.fr.

[8] It was not possible to include the period before March 18, 2020 in the sample because of the lack of daily data on hospitalization related to COVID-19. Extending the sample beyond May 18, 2020 has no significant impact on our conclusions.

4. CONCLUSION

Although this is only a sketchy analysis, the results highlight the specificity of pandemics in comparison to other systemic shocks. By its very nature, a pandemic affects activities severely, according to their exposure to social distancing and to the rise or fall in demand for specific products. In addition, the macroeconomic dimension of a large-scale pandemic like COVID-19 encourages a shift toward defensive sectors in portfolio management. The effects of a pandemic event on stock returns result from the interaction between these two mechanisms, with timings that may not coincide. It is, therefore, difficult for insurers to build portfolios of assets and financial positions that will provide the best coverage, should a new pandemic occur, while hedging usual market risks as long as there is no pandemic. In this non-pandemic period (or, if we may say so, while the asset owner is waiting for the next pandemic), we may interpret the difference between the expected return of such a pandemic-insurance portfolio and the return of a portfolio that would be optimal if the pandemic risk was ignored, as an insurance premium. Insurance is often viewed as a mechanism that allows the policyholder to substitute wealth from no-loss states to loss states, and using a capitalization approach to pandemic insurance achieves just that. This requires using financial instruments that are not part of the usual toolkit of insurers, but with new uses for them in the management of catastrophic risk, and also new business opportunities.

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USING RISK ANALYTICS TO PREVENT ACCIDENTS BEFORE THEY OCCUR – THE FUTURE OF INSURANCE[1]

MONTSERRAT GUILLEN | Full Professor, Director of the Riskcenter, Universitat de Barcelona
ALBERTO CEVOLINI | Associate Professor, Department of Political and Social Sciences, University of Bologna

ABSTRACT

While insurance was originally devised as a safety net that steps in to compensate for financial losses after an accident has occurred, the information generated by sensors and digital devices now offers insurance companies the opportunity to transform their business by considering prevention. We discuss a new form of risk analytics based on big data and algorithmic prediction in the insurance sector to determine whether accidents could indeed be prevented before they occur, as some now claim is possible. We will use the example of motor insurance where risk analytics is more advanced. Finally, we draw conclusions about insurance's new preventive role and the effect it may have on the policyholders' behavior.

1. INTRODUCTION

We are in a new era. We have measurement sensors that can capture data without interruption, we have huge storage capacities, and we have created algorithms that allow for the analysis of information with unprecedented speed. All this promises to transform the insurance business, with consequences that many observers have no hesitation in defining as "disruptive".

The insurance industry has always been eager for information, predominantly because it is through processing of information that the industry can assess future risks. While it is obvious that no one can predict with absolute certainty what might happen in the future, good information combined with suitable mathematical models can make it possible to construct expectations about what might happen. It is on the reliability of these expectations that the insurance industry bases its business model.

However, the transformation that is taking place within the insurance sector as a consequence of the enormous potential of information processing made possible by digital technologies and the algorithmic techniques of data mining is not simply an improvement in the reliability of the loss expectations on which prices of insurance policies depend. The change actually has more to do with the kind of expectations that can be constructed and how they impact on the social role of insurance.

While insurance was originally devised as a safety net that steps in to compensate for financial losses after an accident has occurred, the information generated by sensors and digital devices now offers insurance companies the chance to step in before that accident occurs. As a result, the function of insurance becomes increasingly proactive. This means that the premium paid by the policyholder contributes not only to the compensation of losses in the pool to which the policyholder belongs, but also to risk prevention; to maintaining early-

[1] This work was supported by the European Research Council (ERC) under Advanced Research Project PREDICT no. 833749, and Fundacion BBVA grants for big data and the Spanish Ministry of Science PID2019-105986GB-C21.

warning signals pertaining to the risk being insured. The question is not, therefore, only how much information do we have, but also how information can help us improve safety and prevent accidents from happening – and how this can be managed actuarially by insurance companies when they feed this information back to policyholders.

In this paper, we will analyze how the perspective of traditional insurance changes in an IoT-based (internet of things) society and how this will affect the development of the sector in future. We shall start with some general observations about the development of a new form of risk analytics based on big data and algorithmic predictions in the insurance sector and then focus on one branch of insurance in particular – that of motor insurance – where risk analytics is more advanced, in terms of both technical experimentation and of insurance practice. Finally, we shall draw conclusions about insurance's new preventive role and the effect it may have on the behavior of policyholders.

2. RISK ANALYTICS WITH BIG DATA

The availability of huge data flows provided by current technologies has given rise to a new discipline known as "risk analytics", which allows data science and big data to be combined with risk analysis.

Risk analysis is a well-established discipline, which investigates the occurrence of adverse phenomena that do not take place frequently but that can have devastating consequences for all humans directly or indirectly. For example, storms, floods, and earthquakes do not only cause loss of life and destruction, but they can also have enormous impacts on communities and their future generations. Risk analysis builds upon solid methodological principles that have much in common with the foundations of insurance. Accidents, whose coverage is included in an insurance contract, are rare phenomena and when a contract is underwritten it is unclear whether they will or will not occur. Insurance is based on a treaty of honor, such that the insurer will compensate the insured not for the peril, but for the occurrence of an adverse event.

When analyzing risks in general, not just insurance, the main concern is how to find the causes of accidents and how to mitigate hazards. The paucity of data is the main stumbling block in risk analysis. As adverse events are occasional, there is not a sufficient statistical mass of data to apply traditional mathematical instruments to that can guide decision-making. A classic example is the law of large numbers, which relies on repeatedly observing a phenomenon and allowing for the extrapolation of its expected behavior into the future. For this main reason, risk analysis has developed its own methodology over the years, adapted to the scarcity of data.

With the greater availability of information, the challenges for risk analysis are different from the traditional ones. Risk analytics is about discovering which part of the data can inform and anticipate the occurrence of a claim, and how to find this value. Most of the data is, in fact, uninformative or repetitive, so that there is no indication of any anomalous behavior. However, a small part of the data stream, and especially the segment immediately before an accident, can offer the opportunity to discover a warning indicator that may be useful in the future to foresee that an accident is about to occur. Those few seconds may be essential to saving lives and enhancing protection.

2.1 Low-frequency phenomena in insurance

Insurance is intended to compensate for losses caused by events that are unlikely to occur, but which can cause serious damage. So, in general, insurance provides protection to organizations and individuals by allowing them to overcome the financial consequences of accidents.

In the case of car insurance, for example, liability insurance is mandatory to prevent a driver who causes damage to third parties from being unable to face the losses caused to others. In automobile insurance, the annual accident frequency for each policy does not usually exceed 10% in developed economies, a level that is much lower if only the frequency of at-fault accidents is considered. For this reason, if an observer selects a surveillance window for a group of drivers lasting less than one year, then the vast majority do not experience any accidents. This characteristic, known as "low frequency", makes analysis difficult because the event of interest is not observed. No occurrence, despite massive data being intensively collected, means no information revealing patterns of accident occurrence.

However, new algorithms in risk analytics are aimed at handling these cases, something known technically as "rarity", which means that the usual focus of machine learning is changed from looking at the most frequent data values to

the less frequent measurements. The most difficult part of dealing with rare data is how to be certain about the absence of measurement error in the analysis of event occurrence. For example, a traditional puzzle for automobile insurance is to distinguish between drivers that have no accidents because they do not use the car and those who are exceptionally good drivers.

2.2 How does intensive data collection impact on insurance?

In recent years, the increasing use of sensors and digital devices has paved the way for an intense collection of data that insurance companies can process, using suitable algorithmic techniques, to enhance risk analysis [Bohn (2018)]. Yet, it would be misleading to assert that big data leads to data-driven insurance, since insurance has always been data-driven, as actuarial mathematicians know only too well. What has changed, then, is not the presence of data, but the quantity of data available and, even more importantly, the nature of the data with which the insurance industry can work.

The specificity of risk analytics is to be found, we believe, in the fact that it not only allows risk assessment itself to be improved, but that it also allows risks to be assessed differently. This is because digital data offer insurance companies the unprecedented opportunity of profiling their clients, while traditional statistics had to make do with defining the "average customer". Although such a profile does not completely replace the average, it certainly contributes to redefining the classical pricing procedures used by insurance companies, especially when the available data is behavioral data.

That is why the insurance industry has been talking about UBI (usage-based insurance) for several years now. UBI is a form of insurance whose price depends on the individual user's behavior, as in the case of telematics third-party liability motor insurance, which we shall discuss shortly. The aim here is to manage to set a price that is no longer based on the statistical properties of a given segment of policyholders, but on the real behavior of the individual who belongs to that given segment of policyholders. In this way, the aforementioned "low frequency" problem is partly compensated for by an increasingly personalized prediction of risk exposure.

Yet, if the way we predict the future changes, the way we insure also changes, and that could have more far-reaching social consequences that still remain largely unexplored [Cevolini and Esposito (2020)]. Before proceeding to illustrate telematics motor insurance in greater detail, we would like to give brief consideration to two crucial issues on which the impact of UBI could be more disruptive: adverse selection and information asymmetry.

2.2.1 ADVERSE SELECTION

Adverse selection is a classical problem for the insurance industry. And, although extremely complex mathematical techniques have been developed to tackle the problem, it has remained unsolved and is quite possibly unsolvable. The problem for insurance companies is that they have to predict which individuals, among all those who apply to take out insurance coverage, will lodge a claim that causes the company to make the kind of loss that could be far greater than the premium received. In this respect, the paradox underlying the question of adverse selection is that the insurance company would prefer to insure only those customers who do not need any insurance. Since exactly who they are is a question that the company can only answer with the wisdom of hindsight, insurance is a risky business.

The possibility of getting to know their policyholders better, using the profiles that can be drawn up for each of them, offers insurance companies the opportunity of implementing what is known in the insurance jargon as "cream skimming" [Cather (2018)]: the company can discriminate between its more and its less virtuous clients, offering the former proportionately more attractive premiums. This could improve the efficiency of the insurance business, i.e., the company's loss ratio, but it also raises several thorny issues.

Policyholders who are more exposed to given risks, regardless of their own intentions, may find themselves facing insurance premiums that they cannot afford. The result is that they might have to go without insurance coverage, losing out on the social, as well as economic, opportunities offered by that coverage.

There is also the fear that the data that is in the possession of the insurance company could be used for the purposes of price optimization, i.e., to increase the premiums paid by those clients who are prepared to pay more than their risk demands. In that case, the increase in the premium would not correspond to a real increase in the policyholder's exposure to risk, and the price of the policy could be considered unfair.

2.2.2 INFORMATION ASYMMETRY

Information asymmetry is another area where digital data could have a disruptive impact. This, too, is a classic problem for the insurance industry: policyholders typically have access to plenty of information that they have no interest in disclosing to their insurance companies, since it might lead to an increase in their premiums or even to the companies refusing to offer them insurance coverage. When this information is missing, it increases the uncertainty that the companies have to manage.

The pervasiveness of digital technologies promises to revolutionize this situation completely. The continuous stream of digital traces that we leave when we use our mobile telephones or when surfing the web generates an impressive amount of data, which can help insurance companies learn a lot about their customers. To these digital traces we can also add the behavioral data that wearable devices like a FitBit watch or a black box installed in a car can transmit in real time, which an insurance company can process to get a better-focused idea of the individual it is dealing with.

There would appear to be multiple advantages from having access to such data. Firstly, insurance companies can make a more accurate estimate of the risks they run when they decide to sell a policy to a given individual. Secondly, they can use the information available to them to mitigate their moral hazard. Customers who know that they are being monitored or tracked are dissuaded from behaving imprudently. Finally, the data transmitted by digital devices and generated by online activity can improve a company's capacity for fraud detection.

These benefits, however, do not come without costs. The idea of being constantly monitored and traced immediately raises a whole host of concerns about individual privacy. The sensation that we are living in a regime of "dataveillance" is very strong, but our fears are often mitigated by the incentives that accompany it. If, for example, an insurance company offers the policyholder who is prepared to transmit their data a not so insignificant discount on the price of their policy, they might be more willing to being monitored (we shall return to this issue later in the paper).

The fear remains, however, that such data might end up having some unexpected penalizing strings attached. If the data, once processed, lead to pessimistic predictions the premium may go up when the policy comes up for renewal. If the policyholder wants to avoid running this risk they can opt to not disclose their data, although that would mean losing out on the incentives. When it comes to it, privacy comes at a cost.

We should also add that the policyholder typically does not have access to the mathematical procedures used to process the data they have transmitted to their insurance company. Algorithms are notoriously opaque and their implementation is automated. Since policyholders have the right to know how their risk exposure is evaluated, a legal guarantee of a certain degree of algorithmic accountability is considered indispensable.[2] However, how that accountability can actually be implemented, by whom, and with what consequences remains unclear. Overturning the information asymmetry thus still remains an open problem that demands further investigation.

3. MOTOR INSURANCE TELEMATICS RATEMAKING

After these rather general considerations, we now want to tackle a particular case of usage-based insurance: third-party liability motor insurance based on telematics data.[3] In our opinion, this is an extremely interesting branch of insurance, since this approach to insurance can associate the more abstract theoretical considerations with empirical research based on tangible practices. In the next section, we shall provide a brief overview of the developments of telematics motor insurance and present the leading telematics solutions available on the insurance market today.

3.1 A brief history of pay-as-you-drive and pay-how-you-drive insurance

The first interesting thing to mention is that the technology of telematics was not developed for insurance purposes, but that it was the insurance industry that – with a certain delay – discovered the technology's potential for improving the insurance business. The same applies to all the other digital technologies that are used in one way or another these days in the insurance industry value chain. It could be said, then, that the insurance industry has co-opted technologies that were originally intended for other purposes, and that could explain – at least in part – why the insurance industry was relatively late in setting its own digitalization in motion.

It has always been known that telematics data furnish vital information for evaluating driver behavior, however, it was not until the 1990s that the hypothesis that this information can

[2] GDPR (General Data Protection Regulation, E.U. n. 2016/679), art. 22.
[3] Telematics allow for real-time information collection about vehicle location, safety metrics, and engine diagnostics.

also be used for insurance purposes first surfaced in actuarial literature. And it is only since the beginning of this century that some insurance companies have started offering third-party liability motor insurance policies based on telematics data to calibrate the insurance premium to the actual usage of the vehicle by the driver. In short, these were policies of the pay-per-mile type: when the policy came up for renewal, the driver was allocated a discount based quite simply on the number of kilometres driven [Litman (2005)].

At a later stage, insurance companies experimented with a variety of technological solutions for increasing both the volume and the variety of the data to be used for understanding driving behavior and establishing a probabilistic model of how it relates to future claims. Three technologies have been used in the course of the last twenty years: the black box installed in the vehicle, OBD (on-board diagnostic) systems, and the pairing of mobile phones with a smart tag attached to the windscreen. The first and the last of these are the ones that have had the greatest bearing on the development of usage-based motor insurance policies.

In the first case, the insurance company asks the policyholder to allow a black box to be installed in their vehicle. By coupling its readings with a GPS tracker system, the black box transmits very accurate data about driving behavior, such as speeding, cornering, braking, swerving, tailgating, lane-changing, road type, and time of driving. The company then builds these data into its actuarial procedures for the purpose of better explaining variance, i.e,. the fact that, within a given pool of policyholders with identical statistical properties, some individuals perform better than average, while others perform worse.

It is only in the last few years that the mobile phone has become an alternative to the black box, launching the concept of "mobile telematics". Instead of installing a black box in the vehicle, the driver downloads an app to their smartphone, which is paired with a smart tag attached to the windscreen. This enables multiple sensors – an accelerometer, a gyroscope, the GPS, a magnetometer, and a barometer – to be combined together, whose data are reprocessed to establish the policyholder's driving behavior.

One major advantage of mobile telematics is that it can feed all the information about each individual trip back to the driver, through the app. In this way, the driver can view the roads they have driven along, the number of kilometers driven, and the precise points where any critical events occurred (e.g., a forbidden U-turn, breaking the speed limit, or a dangerous lane change).

On the basis of these technologies, insurance companies have developed two different usage-based insurance solutions: pay-as-you-drive (PAYD) and pay-how-you-drive (PHYD) insurance policies. In the first case, when the policy comes up for renewal, the premium is calibrated to the number of kilometers actually driven, the type of road, and the time spent driving. Those who only use their cars at the weekend, on rural roads, and returning home before it gets dark are less exposed to the risk of accidents than a sales representative who drives hundreds of kilometers every day on urban roads and motorways and returns home late in the evening – so the argument goes.

In the second case, that of PHYD, the telematics data are used to define the policyholder's driving style. To do this, the driver's behavior is rated using a points system. Those who break the speed limit, drive at night, change direction suddenly, or break without warning are penalized.

Insurance companies normally distinguish between three clusters: "evolved" (those who are very prudent), "intermediate", and "reckless" drivers. For their part, policyholders receive feedback in the form of a score: a very high score is a sign of prudence; a very low one a sign of imprudence. The discount that will be applied when the policy comes up for renewal depends on this score, as does access to such incentives as vouchers for buying goods and services, or a cashback when filling up with fuel. Pay-how-you-drive policies obviously also take the amount of kilometers driven into account, so are implicitly pay-as-you-drive policies.

3.2 Insurers' innovations: Current challenges to creating usage-based insurance

Insurers are convinced that the collection of telematics data provides them with information about their policyholders that is both valuable and useful, and this seems to be the case. Recent studies [Gao et al. (2019), Guillen et al. (2019), Wüthrich (2017)] confirm that telematics data perfectly substitute traditional pricing factors, namely, the indicators that were traditionally recorded when underwriting an insurance contract (age, address, type of vehicle, and so on). In addition, some studies [Barry and Charpentier (2020), Geyer et al. (2020)] have found that with just a few weeks of monitoring drivers with telematics devices it is relatively simple to classify drivers.

For these reasons, although with great prudence, it is expected that insurers will gradually include driving style indicators in motor insurance rates. That will allow prices to be adapted and

personalized. Competition between insurers means that each of them will use their own tools, and the predictive capacity of each of these telemetry-based pricing factors will typically not be revealed to competitors. Some kind of regulation for this "algorithmic competition" will also be required.

There are multiple challenges to usage-based insurance, however. Firstly, how would you incorporate personalized insurance pricing into rental vehicle platforms, where the provision of the service includes insurance and could be adapted to the user's driving style. Secondly, how would you communicate new ways of adapting prices, also considering real-time pricing.

Recent studies [Guillen et al. (2021)] propose that the insurance be made up of two blocks: i) a base premium that depends on some general characteristics of the vehicle and the driving area, and ii) a variable premium based on the distance traveled and the driving style. A recent research innovation in insurance allows for the recording of "near-misses", i.e., events such as sudden braking or acceleration that may indicate the presence of an imminent danger, even if it did not end in an accident. In this case, the challenge is to decide whether these events should be penalized or how their absence should be rewarded.

The main challenge for the insurance companies, however, seems to be related to moving from pure compensation for what has already happened to a service provision, giving feedback to drivers on how they improve their style at the wheel. We will cover this issue below.

3.3 Customers' perspectives

So far, we have considered the novelty implicit in user-based insurance in general, and in telematics motor insurance in particular. The question that also needs to be addresses is how policyholders view the fact that their behaviors are being evaluated by their insurance companies. Furthermore, how does the social role of insurance change as a consequence when behavioral tariffs start to play a leading role in pricing?

3.3.1 PRIVACY

As we mentioned above, the inversion of information asymmetry might further aggravate the issue of privacy. If we consider the case of telematics motor insurance policies, the situation appears to be somewhat different from the one typically discussed in ethical or legal debates, and in a certain sense also far less critical than would appear to be the case.[4]

Let us start with a rather prosaic observation: the fact that there are millions of connected vehicles in the world today with which a pay-as-you-drive (PAYD) or a pay-how-you-drive (PHYD) policy is associated demonstrates that substantial numbers of policyholders have no problem transmitting the data about their driving behavior. It would appear, then, that the incentives play a decisive role here.

Drivers who give their consent to installing a black box in their vehicles get an immediate discount (known as the "flat discount") when they buy the policy, a discount that can go as high as 25% of the insurance premium. To this should also be added the other incentives we already mentioned (vouchers or cash-back), together with a further discount when the policy comes up for renewal, calculated on the basis of the score accumulated by the policyholder during the previous period. All these incentives increase policyholders' motivation to share their data.

Privacy nevertheless remains an issue, since the data are used to produce predictions that could be penalizing in fields that have no direct relationship with the data. One classic example of such a case in motor insurance is the use of credit scoring. Policyholders who are some months behind on their mortgage payments may find themselves paying an increased third-party motor insurance premium without anything changing in their actual driving behavior. This is because credit scoring functions very well as a variable proxy for predicting the risk of car accidents. In order to avoid questions of this kind arising, many insurance companies that sell PAYD or PHYD policies guarantee their clients that their behavioral data will not be passed on to data brokers, but will be used exclusively to calculate the cost of the motor insurance policy.

3.3.2 COACHING

Another new feature introduced to insurance by behavior-based tariffs is the possibility to provide policyholders with feedback, information that ought to help them understand whether and when their behavior exposes them to risks that they would do better to avoid. When discussing this, the latest literature talks about "coaching". It would be ideal if policyholders could be trained to become increasingly prudent, thus reducing not only the rate of accidents, but also their insurance premiums.

[4] This is also the emerging result of an ongoing empirical research on third-party liability motor insurance based on telematics data that is carried out by one of the authors of this article (Alberto Cevolini) and Elena Esposito, PI of the ERC PREDICT (ERC-2018-ADG, n. 833749) research project on "The future of prediction: the social consequences of algorithmic forecast in insurance, medicine and policing."

From a strictly operational standpoint, the problem is that it is very hard to find indicators capable of giving a reliable reading about whether and to what extent this feedback affects drivers' behavior. Once a driver is set in their way of driving, it is not very easy for them to change it. And if they do, it is hard to pinpoint the exact reason – have they learned their lesson, or are they doing this just to pay less premium, or even whether this is just a temporary change.

One thing is certain: the most complete benefit can be had from the potential of pay-how-you-drive policies, especially those associated with an app installed on the driver's mobile phone, but only if the insurance companies manage to implement proactivity, which depends on their ability to achieve an effective coaching process with their policyholders. This is certainly one of the most important aims of behavior-based policies.

4. RISK MITIGATION AND PREVENTION WITH RISK ANALYTICS

Risk mitigation and prevention is one of the main functions of risk analytics: allowing insurance companies to identify which risk indicators are relevant and preparing high-dimensional risk maps in which the probability of occurrence can be presented through more than one component. The abundance of data enables risk to be measured through different dimensions.

For example, a moving vehicle's speed can be recorded together with the distance between it and the vehicle in front, the time elapsed since the start of the journey, instantaneous acceleration or deceleration, and even fuel consumption and the turning angle of the wheels. All these components provide information about the vehicle's condition and the driver's behavior and habits. The use of the mobile phone can be recorded as well, since it has been proven to be a major cause of distraction and is associated with greater accident rates. Consequently, the most recent methodological advances seek to combine both individual traits and cross effects, showing the combination of several risk components.

4.1 Intensive data analysis to find early-warning indicators

Interdependence between the factors that provide data flows makes it difficult to find synthetic indicators that serve as early warnings of accident risk. As suggested recently, intensive data analysis methods, combined with predictive risk techniques, may lead to new risk measures. A good example is the use of quantile and distributional regressions, which make it possible to calculate assessments, a figure from 0 to 100, for each driver, by placing drivers at their risk level in real time while considering observational circumstances simultaneously. For example, it is not the same to exceed the speed limit for about 10 kilometres for someone who drives 200 kilometres a day as for someone who drives an average of 25 kilometres a day. In both cases, the type of driving area or the experience of the driver can also be taken into account. The search for reliable early-warning indicators is, however, of the outmost importance for achieving effective loss prevention and, in this respect, risk analytics plays a crucial role.

4.2 Defining the benefits of preventing losses

In the preceding sections, we mentioned that the task of insurance companies has always been to ensure a correct transfer of risk, that is to say that the premiums paid by policyholders are sufficient to cover compensation for accidents. However, current risk analytics go beyond premium calculations (drivers who are statistically proven to have a greater risk of having an accident pay more) and a radical change is needed for insurance.

In years to come, we will see a new way of approaching insurance, which apart from being a risk transfer mechanism will also provide safekeeping services. For this reason, more research is needed to evaluate how much a policyholder is willing to pay for prevention and security. In such an equation, it is obvious that insurers will seek profit margins equal to, or greater than, those obtained by the actuarial balance provided in a traditional insurance pricing-coverage system. In addition, researchers should be able to design methods to evaluate the absence of presence, which means that no accident occurs.

That service, accident prevention, should be profitable for both consumers and insurers. As yet, there are not many studies that help in this direction and they will be extremely necessary [Eling and Kraft (2020)]. How much are citizens willing to pay to prevent their houses from burning? How much will drivers pay to obtain elements of judgment that can modify driving behaviors to improve and reduce the probability of suffering an accident? Is there room for considering the cost of traffic accidents and whether this is also a matter of public health and economic policy?

The latter, if it were true, would open the door to subsidizing preventive assessments. In fact, our hypothesis is that a cost-benefit analysis considering i) costs of gathering detailed telematics data, and ii) the benefit of saving lives and diminishing traffic accidents, is an urgent matter. The

experience of using radar and cameras to detect speeding drivers and to deter all others is an example of how new technologies have an enormous impact on the reduction of accident rates [Cohn et al. (2020)].

5. CONCLUSION

The aforementioned considerations about the preventive role played by insurance in the future have an implication that we find intriguing, one that is evident especially, though not only, in telematics motor insurance (another case is health insurance based on the use of wearables). As we know, insurance was not invented to reduce our exposure to risks. Precautionary measures, such as wearing a seat belt or avoiding the use of the car completely for getting around, are more useful for this purpose. Instead, the original function of insurance has always been to free policyholders from worrying about the financial consequences of any possible future damage. This form of relief is particularly useful, because it encourages individuals to venture and profit from opportunities that would otherwise be unavailable. In this sense, insurance was born, paradoxically, to multiply risks, not to reduce them.

Behavior-based policies and their proactive vocation are bringing profound changes to this social function of insurance. Individuals are now being asked to keep their behavior under control, so as to avoid potential future damage. In an extreme scenario, the ideal of a moral hazard reduced to zero would lead to a form of self-imposed inhibition: in order to avoid any unpleasant events, individuals would give up doing anything at all (in our specific case, using the car). But that would mean that there would no longer be any need for insurance coverage.

In fact, adapting the policy in proportion to the driver's exposure to risks actually avoids an extreme scenario of this kind. Nevertheless, behavioral tariffs are based on the principle that the premium depends on the decisions made by policyholders – and policyholders are aware of this. Their decisions, in turn, depend on their readiness to pay an insurance premium that might be substantially higher than what they would pay (or not pay) if they were to forego decisions that expose them to certain dangers.

This leaves several questions unanswered: what will change in the social role of insurance in the future when it implements proactive functions alongside the usual financial compensation for unpredictable claims? What restrictions will be imposed on policyholders and what opportunities will open up to them when they interact with insurance companies and provide data not only to reduce the classical information asymmetry, but also to make the activity of prevention possible? Lastly, how will actuarial calculations change when the historical data about claims is integrated with the historical data about prevention and the number of claims is reduced, as is to be expected? For actuarial mathematics and the socioeconomic sciences, there is evidently still a great deal of research to be done.

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ECONOMIC POLICY IN A WORLD WHERE INFLATION, PRODUCTION, AND PRODUCTIVITY ARE MISMEASURED AND MISLEADING, AND WHERE MACRO-MODELS CANNOT WORK EFFECTIVELY

STEVEN W. KOHLHAGEN | Former Professor of Economics, University of California, Berkeley
D. SYKES WILFORD | W. Frank Hipp Distinguished Chair in Business Administration, The Citadel

ABSTRACT

Mismeasured GDP is now the norm. In a period when policy implications for inflation, new structures in monetary and fiscal policies, and the efficacy of historical models of policy are being argued, with hyperbole, it is time to move away from the narrow, typical GDP-centered economic analysis to look holistically at the measurement problem. The COVID-19 shock has led to multiple mini-shocks and numerous policy actions while at the same time the Third (and maybe Fourth via AI) Industrial Revolution is taking place. Responses to shocks are often driven by historical measures of GDP and the ancillary issues of inflation, productivity, and economic wellbeing. Unfortunately, they are likely based upon incorrect, badly measured data. This paper discusses these measures, the problems associated with them, and the implications arising from mismeasurement. It points out that while macroeconomic models are calculus-based and can, thus, be used effectively to analyze and predict what will happen to, say, GDP if there is a small change in an independent variable, they are absolutely ineffective in predicting what will happen if there is a massive pandemic or a series of massive exogenous government actions. It further suggests that the actual real economic output being experienced in the United States and the advanced economies is terribly underestimated and concludes with policy and forecasting dilemmas created by the lack of reliable measures for output, inflation, productivity, the actual state of the economy and the ineffective forecasting ability of macroeconomic models in a period of massive shocks.

1. INTRODUCTION

We believe that current economic data – such as inflation, the size of the economy, and productivity growth – are materially mismeasured. Additionally, while current calculus-based macroeconomic models were developed to forecast the effects of small changes in independent variables on the economy, the exogenous shocks we have witnessed since February 2020 have been massive, and, accordingly, do not lend themselves to forecasting with current economic models. Not surprisingly, we believe that the implications for current policy debates are very significant. We are not alone in this belief. There are other economists and government statisticians who are also concerned about the public policy ramifications of these miscalculations, but sadly it is not as yet part of the public discussion or knowledge base.

What are the implications for government monetary and fiscal policy if actual inflation is materially lower than is being reported? If the actual values of production and consumption

and productivity growth are greater than is being measured? If the actual debt to properly measured and adjusted GDP is not at its highest level ever, but actually at levels that were considered normal a generation ago? If macroeconomic models are not effective for economic forecasting?

Before we try to answer these questions, let us return to the beginning:

In the 15th Century, the rulers, kings, emperors, etc. had created systems where governments took whatever they wanted from their people in exchange for protecting them from their fellow citizens and "the other" rulers, kings, and emperors. There was no official economic data. The rulers did not need to know what GDP or inflation was in order to determine public policy. They just took what they wanted until they no longer could – taxes in the form of money were just one example of what they took.

Fast forward 500 years through countless economic and technological innovations, wars, massacres, plunders, pandemics, plagues, different forms of financial and economic systems, governments, and rulers to, say, 1945. The U.S. had been created and evolved into the largest, most powerful country in history. Founded on principles of democracy, regulated capitalism, and no taxation without representation, it had weathered a horrendous civil war, continuous episodes of other wars, a great depression, and several financial panics. It created and financed the most powerful army in the world. It financed this and other government activities through income and consumption taxes, and, inevitably, borrowing, following the British model of the Napoleonic Wars, all with at least the tacit approval of its citizens.

And economists had now developed ways of measuring the economic benefits from the relatively free market, regulated capitalist system that had evolved. The staggering results of two industrial revolutions created the goods we consumed and used to make other goods, and in this world, economists set up a system for counting and measuring output, GDP. With these measures, economic policies designed to meet the needs of "the people" could be managed by "the rulers", now the government.

Adam Smith (1776) would have been proud that the world had adopted a measurement of a wealth generation system that fit nicely with his view of the world, recognizing what the actual "wealth of nations" was and was not. And, of course, due to the Enlightenment and the subsequent Industrial Revolution, economists could measure how much new production of goods and services was being created in a fairly efficient manner. Yes, there would be the inability to measure the output of some activities, for example "stay-at-home moms" or the "underground economy", however, it was felt that these could be considered constants or only analyzed periodically. As long as there were markets to observe transactions then Price times Quantity (PQ) could be observed and counted, documented, and measured. Governments, thanks to professional economists, now had the tools they needed to determine effective policies, including taxation and many others.

> *"Something is happening here, and you don't know what it is, do you Mr. Jones?* – BOB DYLAN"

Largely ignored in all this was what the creators of the measure of GDP had originally cautioned about, that the "welfare of a nation can scarcely be inferred from a measurement of national income as defined (by the GDP)" [Kuznets (1934)]. Like all tools, economic data, to be effective, had to be defined, measured, and used responsibly and with care.

Governments today provide a vast array of social services to their citizens, including national defense, infrastructure development and maintenance, healthcare, social welfare, the aforementioned economic data, education, housing support, etc. A similarly vast array of taxes and, of course, borrowing is used to finance these activities. In the fifty years after 1945, the world economies grew at what had come to be considered, with the usual variances of ups and downs, a "normal" pace. This was accompanied with what came to be accepted as normal productivity growth, normal tax rates, normal budget deficits, etc. For the measurement of economic output, PQ, GDP seemed certainly adequate, if not perfect. And with our ability to observe price movements, one could observe the growth of Q, recognizing that having Q (quantity of goods and services) grow was a major, if not a main consideration. And as Q grew, it was clear that, on average, we were becoming wealthier, which could be observed by looking at measured real GDP growth rates (where real denotes adjusted for measured inflation). Between 1945 and 1995, U.S. real GDP grew four and a half times, a 3.1% annual rate of growth. And on a per capita basis, it grew a little more than two and a half times, nearly 1.8% a year.

But in the 1970s, we entered the Third Industrial Revolution, the computer age, with a vengeance. Change began to happen much faster (if not always adequately measured). The world now enjoys staggering increases in productivity that we will argue are not being correctly measured (as "the other" Marx, Groucho, famously asked, unintentionally playing the role of government economist: "Are you going to believe me or your lying eyes?"). Consumer benefits in the form of improvements in product quality, innovation, and new products expanded rapidly, increasing the wellbeing of citizens that is simply not being fully measured and reported.

We are now well into that Third Industrial Revolution and perhaps just entering the Fourth if that is where AI takes us. One of the public goods that governments should and do provide is economic data. Presumably accurate data. But, as Robert Solow noted as early as 1987, "You can see the computer age everywhere but in the productivity statistics." Increasingly, it is clear that some of the data the government is providing, and that policy-makers and forecasters are relying on, is quite clearly wrong. And much other data is very misleading. This is not because of any malfeasance or lack of professional good intentions, but because it is hard to accurately measure what is happening. And happening so fast.

The fault for a lack of public understanding does not lie completely with government statisticians and bureaucrats. Only a small part of the economics profession is aware of this problem, and, with a few unheralded exceptions, they are not calling it out. Most private citizens and some public policymakers are operating under the delusion that the data they are seeing continue to give an accurate description of our economy. But they don't.

Thus, current "rulers" are making policy decisions partially blind. They are being forced to try to manage production, inflation, and social and economic progress without even knowing what the current levels are, let alone how their policies will affect actual future levels. Needless to say, forecasters are also in the dark, making guesses about data that are incorrect when reported. So, what is one actually forecasting when arguing that real GDP will rise by X? The number reported will be inaccurate.

2. MEASURED INFLATION IS BEING OVERSTATED

The easiest place to begin analyzing these issues is to look at the difference between actual inflation and the inflation that is measured (and reported). Actual inflation, to be properly measured and useful, needs to be adjusted to reflect quality changes and the introduction of new products. This is very hard to do, and, as a result, actual inflation is lower than what is being measured and reported.

As early as 1996, the Boskin Commission reported that actual inflation had historically been lower than what had been reported by 1.3% per annum, and that it was, to highlight it, still 1.1% in 1996 [Boskin et. al (1996)]. Subsequent literature mostly agrees that it is high by close to 1.0% per annum Moulton (2018) made several suggestions to the Bureau of Labor Statistics (BLS) and Bureau of Economic Analysis (BEA) on how to best deal with the continuing problems going forward. He cited in particular a need for better accounting for globalization and, still, a way to deal more effectively with measuring new and outdated products. We believe that the greater and faster innovation and new product development are, the more reported inflation will overstate actual inflation, as statisticians and economists struggle to keep up.

Measured U.S. inflation has been stubbornly and surprisingly low since the early 1980s, certainly relative to the expectations of many, if not most, economists, market forecasters, and central banks. The long-term downward trend in interest rates reflects this despite the fact that many experts and policymakers were forecasting the opposite for much of the forty-year period. Among the explanations for this continuous forecasting error are the mismeasurements of inflation and production due to the pace of product innovation, the growing mismeasurement of economic wellbeing (including consumer surplus), and the openness of the economy.

It should be stated that it is easy to measure a manufactured good's sale price, the price of a typical food basket, the number of cars, the number of phones sold, the accounts of electrical or phone connections, or the money spent on utilities. It is very easy to measure items if the only change is price. Significant measurement difficulty is introduced with quality improvements and new products. We know cars are better; we know medicine/healthcare is better; we do not know if education is better; we know that clothes are more plentiful, but better?

As a simple comparison, one product the author purchased 10 years ago for approximately $1,000 is now available for about half the cost – replacement product is the same – and should show up as a negative in calculations for inflation. However, the newer updated version, which is much more efficient and does a better job, costs, yes, about $1,000. So, for that service in general no change in the price is likely registered. The quality improvement is large.

It is simply very difficult to measure the benefit of a better product. Over the past 20 to 30 years, greater proportions of what we use comes from technology. In 1975, the price of long-distance calls was not zero. Today, thanks to technology, per capita long-distance calls, at a price of zero, are multiple times as frequent as before. We do not measure that increase in Q (quantity of goods and services) or in the Consumer Price Index (CPI) for the simple reason that its price became zero. And, of course, this challenge is increasing at a faster and faster pace with the advent of the digital economy, smart phones, and the internet. As is, therefore, the over-measurement of inflation.

One of the interesting results of this overstatement is that consumers, investors, and public policymakers, expecting interest rates to keep pace with measured inflation, remain puzzled about why interest rates stay so stubbornly low. Many remain convinced they will go much higher. But most likely, the market has this right – interest rates are not too low. They are where they should be with properly measured, actual inflation being lower than what is being reported. The level of interest rates reflects real rates of return that seem sensible when one realizes that reported data overstate actual inflation.

3. PRODUCTION, PRODUCTIVITY GROWTH, AND CONSUMPTION ARE GREATER THAN REPORTED

In all industrial revolutions, production, innovation, and both new consumption products and new production input products grow much more than long-term historical averages. The ability of economists to keep up with how to measure the value of these newly created, produced, and consumed new products, and, especially, the value of the associated quality changes, has been understandably inadequate. This has been especially difficult in this Third Industrial Revolution, the newly developing digital economy, where so many products are free to the consumer. This inability is not because economists are not capable and/or not trying, but because it is very hard, possibly impossible, to fully measure these phenomena. Moulton (2018) urged more work in these very areas at the Bureau of Labor Statistics (BLS) and the Bureau of Economic Analysis (BEA) to get a more accurate measure of actual inflation. But the problem exists in measuring the size of the economy as well.

As a result, we believe that reported, measured production and consumption levels and real growth rates are lower than actual values. And even lower still than the value to individuals and society. That is, our current measures understate both the growth and health of the economy as a whole. This is especially apparent when examining the growth in value to consumers, both individually and collectively. In fact, as we will discuss, we believe that the underestimation, non-recognition, and non-reporting of consumer welfare is by far the most mismeasured of economic data. It is, arguably, not measured at all.

The best place to start may be that we know, as a profession, that productivity is being mis-measured; it is much higher than reported. And, whereas there is an increasing amount of academic work on this, its existence is not yet fully visible in the public sector [see work by Erik Brynjolfsson and Oh (2012), Groshen et al. (2017)].

The simplest way to see this (but it is only one of a number of contributing factors) is to start from the fact that productivity is defined to be GDP/hours worked. As mentioned earlier, GDP, as it was designed to do, measures only total purchased output in an economy. It is increasingly not an appropriate measure of the total benefits of production or the wellbeingness of an economy, especially in the digital age with many valuable products available for free. Accordingly, going forward we will call GDP* the appropriate, currently unmeasured, more complete size/benefits of the economy (with apologies to Brynjolfsson et. al. at the Stanford Digital Economy Lab who are making great progress analyzing and measuring individual examples of the concept, calling it “GDP-B”).

Thus, using GDP rather than GDP* in the numerator of measured productivity significantly understates actual productivity in the economy. No thoughtful observer believes that U.S. productivity is on the order of the 0.7% that is being measured.

It is close to preposterous to claim, for example, that Google workers, because much of their product sells for nothing,

have zero, or close to zero, in the numerator of their measure of productivity, and are, thus, essentially measured as unproductive workers in our economic data. This reduces the overall measured and reported productivity in the economy relative to actual productivity. And thus, with just this one illustrative example, we know that productivity is materially much higher than is being measured. And increasingly so. (NOTE: the careful reader may ask at this point, but what of the real value to consumers and the economy/society of goods sold for close to or actually zero? Precisely. Now we begin to see the dimensions of the issue.)

Search costs have collapsed. How does one easily count the value of reduced search costs? Time searching for information has typically not been estimated and except for the creation of the printing press and the massive roll out of libraries little has changed for long periods of time. In this new era, however, a radical change has occurred and needs to somehow be measured. To be fair, government statisticians, while understandably always chasing technological change from behind, are working to catch up. They do recognize the issue. In the case of Google, for example, they are striving to use advertising revenue and profits as proxies for correctly measured GDP*. It seems to us that, while credible and important, these efforts are likely to continue to understate actual GDP*.

Additionally, to this mismeasured value discussion, note that Google has become a word. It connotes little search time and cheap access to information. Search time in an economy is a real cost, but often measured in theory more than reality. With respect to information, search time has collapsed, not just fallen. How do we measure this value to the consumer? We do not. How do we count this value in GDP? We do not.

If you Google a problem and repair it yourself, there is no measure of the benefit. If you hire a plumber or electrician to repair the problem then there is a measure of output measured in GDP. These inconsistencies and information cost collapses are increasingly important, and at faster and faster rates. Search cost collapses can be seen in more practical ways. As a current example, due to the internet and the digital universe, many skilled workers have been able to weather the COVID-19 shutdowns simply by working from home.

Zoom is a perfect example of how something basically free, or not fully measured, is changing the economy. Is the use of Zoom a productivity enhancement? Again, if P (price) is zero, then so is PQ. Our standard measurements simply do not work for the digital economy proportion of our total economy. We should add here that it is obviously difficult to measure Q if there is no P to observe (as noted previously, economists wrestled with this for decades with the existence of stay-at-home, unpaid moms. Zero production? Zero productivity? Really?).

What would the search cost for a new job have been if the pandemic shutdown and new products did not allow for many individuals to continue to work remotely? What would the level of unemployment have been without these digital aids? The answers are obvious in direction, but, importantly, not in magnitude. And not measured adequately by economists or policymakers. Interestingly, it seems that the recession in the U.S. in 2020 lasted only two months; adjustments due to better technology and lower costs of information allowed what could have been catastrophic effects on the economy to be short-lived. Even with all the negatively impacted segments of the economy reeling, the overall economy adjusted and began to recover quickly.

Consumers may not need to pay the plumber as often, and also do not have to work through the files or the paper manuals at a library to find the key to fixing the problem. Time has economic value that should be measured. Due to such unmeasured reduced search costs, actual productivity has risen by more than measured productivity. Lower search costs generate better resource allocation and investment efficiency, benefits not fully capturable in GDP data. The recent COVID-19-driven recession is just one example of the speed of adjustment possible with low search costs due to technological advances.

Additionally, these mismeasurements of real GDP growth and productivity gains leave us with a measure of the deflator that is too high. Thus, reinforcing the belief that measured inflation is higher than actual inflation. Asked how long before we can expect to get a usefully more correct measure of productivity given ongoing work by both academic and government economists, Goshen alarmingly replied “twenty years.”

4. CONSUMER SURPLUS

The incomplete picture painted by overstated inflation and understated production and productivity growth is only the start. The economic concept of consumer surplus also informs our knowledge of the wellbeingness of the economy compared to measured GDP. Yet, economists do not use it in

analyzing our economy. Consumer surplus is the benefit to a consumer of buying something whose price is less than the consumer would have been willing to pay. Without going into it technically, as a group, consumers in a society clearly derive very large unmeasured benefits from buying products at less than some of them would have been willing to pay. Consumer surplus may not be precisely measurable, but we know a great deal about it directionally.

The ongoing work on valuing society's benefits from free consumer goods is very helpful here [again, see the work of Brynjolfsson (2018) and his Stanford Digital Economy Lab among others], since almost all consumers pay much less for goods than what they actually are willing to pay. What would they be willing to pay for free goods? But most importantly, we know that the extremely wealthy, the merely wealthy, and the merely well off all get more satisfaction than do subsistence level consumers from being able to buy goods at prices considerably below what they would be willing to pay. We do not need to know how much Bill Gates, Warren Buffett, or even we would pay for an iPhone or an iPad or even a cheeseburger to know our derived benefits are much greater than those for the purchaser paying their just barely affordable amount.

In a society where everybody had identical income and wealth, consumer surplus would largely measure differences in consumer preferences. Chocoholics, for example, because the market price would be less than they were willing to pay for a chocolate bar, would get more satisfaction from it than those who were only willing to pay the market price. In a more inegalitarian society, however, consumer surplus is considerably higher. The very wealthy or merely wealthy can derive multiples more consumer satisfaction from their consumption than the poorer members of their society. The previous examples of iPads and iPhones are very illustrative. Many citizens cannot afford them at all, while many would be willing to pay multiples of the market value.

How do we get our arms around the magnitude of consumer surplus of new technological products as it relates to information and consumption? Since there is currently such a massive change in relative costs of both delivered products and information, the answer is: not easily. And isn't one of the reasons to get inflation and GDP calculations correct to be able to better consider consumer surplus?

5. FIRST ATTEMPT AT ESTIMATING MAGNITUDE: THE VELOCITY CONUNDRUM

There are many ways that the public dialogue among policymakers, many journalists, economists, and the public is being misled by the understandably reasonable assumption that inflation and production are being measured correctly. Analyses of the reported dramatic decline in the velocity

of money is a great case in point and leads directly to our attempted approximation of the magnitude of GDP* mismeasurements. As put to one of the authors recently, "when will the velocity of money once again be normal?"

The velocity of money is the rate at which money is exchanged in an economy. It is the size of the total economy divided by the amount of money in the system, the number of times that money moves from one entity to another, or how much a unit of currency is used in a given period of time. Simply put, it is the rate at which consumers and businesses in an economy collectively spend money.

Shooting in the dark to try to understand why the velocity of money seems to be declining so rapidly while assuming that both inflation and GDP* are being measured correctly, has led to long discussions about how money is used, what substitutes there are, etc. While those discussions may be interesting, in our opinion they do not lead to the real, revealing answer.

If we are mismeasuring the size of the economy because we mismeasure both price changes and quantity changes, could this explain the decline in velocity? Could the observation of declining velocity thus be spurious? Perhaps velocity is not declining so rapidly. Perhaps it is not declining at all. Perhaps the measurement is merely the result of calculating velocity with mismeasured P and Q. Perhaps declining velocity is, at least partly, "fake news".

First, consider M1[1] velocity, which reportedly has fallen off a cliff during the recent past. From a high of 10.6 in 2008 it fell to 1.22 in Q4-2020. A cleaner comparison for our purposes would be to eliminate the unknown temporary effect of COVID-19, and only include the period to Q1-2020 when it had only fallen in half, to 5.25. We should note, however, that what drove it so low by the end of 2020 is at least partly the phenomenon that we believe is contributing to the mismeasurement of GDP. Buying habits are changing dramatically and the digital economy roared during a period when much of the rest was so negatively impacted.

Anderson et al. (2017) provide a discussion and a picture of the debates on changes in velocity. Using their M2[2] measure of money, velocity of money was relatively stable, bouncing up and down between 1.8 and 1.9 till 1990 when it began to rise, hitting a high of 2.1+ in the mid-1990s. From that point it has been on a downward trajectory, falling to 1.4 before the recent collapse to just above 1.

But, what are the implications if we assume that, with correctly measured inflation and GDP*, actual velocity, rather than declining as calculated, was constant from 1995 to now? If that was the case, what is the resulting implied mismeasurement of GDP*? Examining the data closely, assuming a constant velocity of money and a, say, 1% per annum overmeasurement of inflation, we believe that the magnitude of error for estimating GDP* growth to be somewhere between 50 and 100% since 1995 (between 1.6% and 2.8% per annum).

The implications of this view of velocity generate an interesting starting point for determining the possible mismeasurement of GDP*. And note, if we chose M1 velocity the results would be even larger. In short, we believe it is partly mismeasured inflation and largely mismeasured GDP* that is leading us to wrongly conclude that the velocity of money is falling dramatically.

6. REINFORCING OBSERVATIONS

What has happened to calculated velocity in other countries reinforces our view that we are not measuring actual output or inflation correctly. M3[3] velocity for the U.K. fell from well over

[1] "Before May 2020, M1 consists of (1) currency outside the U.S. Treasury, Federal Reserve Banks, and the vaults of depository institutions; (2) demand deposits at commercial banks (excluding those amounts held by depository institutions, the U.S. government, and foreign banks and official institutions) less cash items in the process of collection and Federal Reserve float; and (3) other checkable deposits (OCDs), consisting of negotiable order of withdrawal, or NOW, and automatic transfer service, or ATS, accounts at depository institutions, share draft accounts at credit unions, and demand deposits at thrift institutions. Beginning May 2020, M1 consists of (1) currency outside the U.S. Treasury, Federal Reserve Banks, and the vaults of depository institutions; (2) demand deposits at commercial banks (excluding those amounts held by depository institutions, the U.S. government, and foreign banks and official institutions) less cash items in the process of collection and Federal Reserve float; and (3) other liquid deposits, consisting of OCDs and savings deposits (including money market deposit accounts). Seasonally adjusted M1 is constructed by summing currency, demand deposits, and OCDs (before May 2020) or other liquid deposits (beginning May 2020), each seasonally adjusted separately." The Board of Governors of the Federal Reserve System, https://bit.ly/37oQU8Y

[2] "Before May 2020, M2 consists of M1 plus (1) savings deposits (including money market deposit accounts); (2) small-denomination time deposits (time deposits in amounts of less than $100,000) less individual retirement account (IRA) and Keogh balances at depository institutions; and (3) balances in retail money market funds (MMFs) less IRA and Keogh balances at MMFs. Beginning May 2020, M2 consists of M1 plus (1) small-denomination time deposits (time deposits in amounts of less than $100,000) less IRA and Keogh balances at depository institutions; and (2) balances in retail MMFs less IRA and Keogh balances at MMFs." The Board of Governors of the Federal Reserve System, https://bit.ly/37oQU8Y

[3] "M3, called the "broad money" is the sum of M1 (currency in circulation and overnight deposits), M2 (M1 plus deposits with maturity of maximum two years and deposits redeemable at notice of maximum three months) and marketable instruments issued by Monetary Financial Institutions such as repurchase instruments or money market fund units." Statista, https://bit.ly/3rRl3aJ

2 in the 90s to 0.7 in 2018. In the eurozone, M3 velocity has fallen since 2000 by 50%, the Australian decline in velocity has been material but less, and we know that M2 velocity for Japan has collapsed. We believe these phenomena in the advanced economies are largely explained by underestimates of GDP*. In the case of Japan, a declining workforce has been held up as an answer to the deflationary factors impacting the economy and it also does fit and support our narrative here.

To close the velocity conundrum, we can use the average of these calculated velocity declines in the advanced economies (40-50% since 1995). We can then use this average to estimate our undermeasurement of actual output and overmeasurement of inflation. Similar to the U.S. estimate, this implies that the real economies could be 100% or more larger since 1995 than is being measured (2.8% p.a. or more). Though perhaps a radical statement of the size of real economic output, it highlights the fundamental problem of underestimation of GDP*.

One additional note on the mismeasurement of inflation. Our sense from the earlier discussion is that it is overestimated in the U.S. by on the order of 1% p.a. Anything greater would, of course, be suggestive that U.S. actual inflation has been approaching zero or negative. Initial, comparable, estimates for Japan and the eurozone (even more so in the more advanced eurozone countries) definitely suggest negative actual inflation rates.

Current markets, which seem to perplex many observers, seem to be holding a non-perplexing view to us. First, consider interest rates. The 10-year Treasury interest rate has fallen from 8% in 1990 to an average of 2% over the past decade. In Germany, a similar story with rates falling from just under 8% in 1990 to zero in 2015 and now below zero. The story in Japan is even more illustrative. The bond markets seem to be agreeing with us that near zero interest rates are consistent with lower than measured inflation and a real rate of return on the order of 3%. Basically, interest rates are telling us that our measures of inflation are wrong. Indeed, the interest rate story is even more likely to be correct if, as we are asserting, we are underestimating actual real GDP growth by some 2 to 3 percent. A long-term real rate of return of some 3 to 4%, as would be implied by today's Treasuries, is, on average, consistent with other periods of rapid growth.

In this context, it is noteworthy that during the age of English industrial dominance and expansion, consoles yielding 3 to 4% were the norm, while average inflation was bouncing up and down around zero. Taking this as a gauge of real returns during periods of strong industrial growth, the possibility of a 4% actual rate of return today is consistent with our contention of a 2 to 3% p.a. GDP undermeasurement – the story of an industrial revolution, properly measured.

Finally, also consistent with our velocity view, equity markets appear to be reflecting the reality of undermeasured growth. The stock market has been behaving as if it is seeing the total wellbeingness of the economy as 2-3% p.a. higher than is being measured and reported. This is even true through all the ups and downs of the tech bust, the Asian contagion, Russian default, 9/11, the 2008-09 financial crisis, the PIIGS crisis, and more recently COVID-19. That is, the market is not inconsistent with what we think are actual growth and inflation. It is our government's reported measures of real output, inflation, productivity, and consumption that are mismeasured!

7. ONE EXAMPLE OF A PUBLIC POLICY CHALLENGE WITH GDP MISMEASUREMENT

The measurement problem is not new. Economists are aware of at least some of this, but until recently they have not even begun to develop a substitute definition or measure of national output to measure GDP*. And the profession has not communicated the issue very well to the public and maybe not to all policymakers. The effect is that policymakers and the general public have no idea what the general wellbeing of the economy is, or how it is changing over time. Measured GDP is all they have and know.

A perfect example of this problem is the currently important public debate about the sudden rise in the measured debt/GDP ratio. The measured public debt to GDP ratio of the U.S. has grown from 30% in the mid-1960s to 65% in 1995 and as high as 130% during the pandemic. Many politicians, journalists, and economists have sounded the alarm about impending inflation or, even, doom as a result of this "unsustainable" development. How sustainable is the current level comparable to, say, 1945? 1995? Clearly, using only measured GDP data in the denominator materially misstates the problem. What if the debt to correctly measured GDP* ratio is at historically reasonable levels?

When we use our approximation from the velocity analysis above to estimate the debt/GDP* ratio, as opposed to the measured debt/GDP ratio, we get an interesting result. If we take the midpoint of our 50%-100% potential range for GDP mismeasurement since 1995, we find that the debt/GDP* ratio has risen from 65%, not to 130%, but to a much more reasonable 74%. Essentially, to the mismeasured level

of 2009 debt/GDP ratio. It is important to note that we do not present this as an empirically accurate data point. It is an approximation. In fact, had we started estimating GDP* in, say, 1960 (or 1945), our estimated ratio would be lower. But, whereas we believe this approximation adds value to the debate, like all economists, journalists, politicians, and policymakers, we, too, are handicapped by the blindness resulting from our mismeasured inflation and production data. But, we believe this to be a constructive start.

8. NEXT STEPS, PAYING FOR PUBLIC POLICY

Let us begin with the proposition that policy in our "enlightened age" (unlike, say, in the 1400s) should be designed to increase the wellbeing of the society and its members, including their consumer surplus. For many policymakers and economists, GDP has become the de facto approximation for that concept of wellbeing. However, as we have discussed, this is emphatically inappropriate because it is increasingly mismeasured and, even when measured correctly, it does not include significant amounts of society's total welfare (e.g., consumer surplus).

Thus, importantly, in contrast to the perception from GDP's general usage, it has become, silently, a rapidly decreasingly useful tool for evaluating public policy choices. If GDP is mismeasured, as we contend, then examining how to measure GDP correctly is a useful first step in the direction of better public policy decision-making. Then, secondly, once we have a correctly measured GDP, how do we use that as a basis for developing a better measure, say GDP*, that will respond responsibly to the challenge of creating a measure that does come close to measuring the wellbeingness of an economy. Which, again, GDP was never intended to do and emphatically does not.

It is important for many reasons that the economics profession work with policymakers to achieve this goal. Most public policy debates are impacted by the mismeasurement of GDP*, as well as the expected impact of changing policy on potentially mismeasured GDP* growth. To name a few: should we raise taxes to deal with rapidly rising expenditures by the Federal authorities; are zero interest rates too high; is the stock market "obviously" overvalued (irrational exuberance); and, of course, there is the Fed or Old Lady, the BOJ, or the ECB trying to figure out what the best combination of interest rate and monetary policies in general are needed to promote real growth (presumably of GDP*).

Many of these policy issues are thorny. Perhaps the thorniest of all is appropriate tax policy. We began this discussion by stating that in 1500 it was simple. I am powerful and I will take what I want. It is not so simple in a "free" society, a Keynesian world, an open economy world envisioned by Mundell, a supply side economics world, a rational expectations world, or even in a classical economics world of say, Patinkin, where optimal tax policy is not easily defined.

Nobody wants to be taxed. Everybody would prefer that their neighbors pay for the public goods they enjoy: defense, economic data, infrastructure, the justice system, the resulting thriving economy, etc. For each individual from time immemorial the ideal tax system has been clear: I pay zero and everybody else pays for all the valuable public services we share. Economists even have an appropriate term for this, the free rider problem.

What are some accepted elements of the appropriate tax system for a society? Should we tax publicly non-preferred activities like smoking or drinking or gambling? Tax by how much? Who knows? Economists do agree that corporations and citizens should be taxed by the difference between the private costs of their activities and the public costs of those activities (e.g., pollution) and subsidized for the difference between the private benefits and social benefits of their activities (e.g., charitable contributions).

The problem is that tax revenues from these two sources, setting aside the difficulty of calculating the second source, are a very small proportion of government spending. They simply are not sufficient to fund the activities of modern governments.

How about taxing your work? For each individual? Taxing your savings? Certain classes of investments? There is no economic rationale for such taxes, except to force individuals to contribute to the general welfare they are receiving from government services and the resulting economy. However, it is impossible to measure the individual's benefits, so there is no way of knowing whether individuals are paying more or less than their share. There is little, if any, alignment between benefits from government activity and tax contributions. Almost nothing in public debate is more counterintuitive than for a country to be taxing their citizen's work. Governments appropriately generate program after program to guide and enhance work. But taxing work? There is no possible rationale for it, except for the fact that it is relatively easy to measure and implement.

The same can be said, with nuances, about taxing savings, certain classes of investments, and certain classes of assets. There is simply no alignment between benefits received and taxes required for each individual.

An argument has evolved that it is fair to tax those with the highest income, the most assets, etc. But would fair not involve a better attempt to align benefits received and benefits paid for? And it might be true that those with the highest income and the most assets do benefit the most from government activity, but we have never seen such a case developed. It might be true. We just do not know.

Nevertheless, it is worth another step backward. Whether justifiable or not, would the average citizen, wealthy or poor, feel that our current taxation system and rationale is an improvement over those that existed in the 16th Century? Whereas we feel the answer in modern capitalistic democracies is probably yes, it does not mean that the current systems or rationales cannot be improved upon.

Since the origination of the corporate structure, it is a given that corporations pay taxes in return for the benefits they get from a society that grants them protection under the rule of law and protection from enemies, both foreign and domestic. It is now popularly accepted that corporations should be there for their workers and their owners, and should also pay for the benefits they receive from society, rather than retaining 100% of the benefits for their owners. Absent an acceptable way to calculate each corporation's individual benefits, and given the difficult choice of whether to tax each corporation the same lump sum amount, or according to their number of employees, their total revenues, their total net revenues, or their market value, societies have generally evolved into taxing them on their net revenues. Again, with no notion at all of aligning benefits and contributions either among corporations or between individuals and corporations. This also is probably an improvement over how kings and emperors taxed organizations five hundred years ago. Probably.

In all cases, however, one begins with some measure of real GDP and inflation and argue from there. If our measures of inflation and real output are different than actual inflation and output, then what are the correct tax policies, assuming one wants to pay for government services at all? Indeed, if actual economic output and/or consumer surpluses are much higher than we think, then is there a need to raise taxes (one group of economists will clearly like this outcome, but which one?). If the actual debt to GDP ratio is low, should we not issue more debt, assuming it is put to productive uses (and again one can debate these uses), just as a private firm may use debt to grow? If we do not really know what actual Q is how are we to be confident about any particular tax policy?

As we discussed earlier with our velocity-based approximate GDP* estimate, the economy may be some 20 to 50 percent larger than is currently being measured, with a corresponding lower ratio of debt to GDP*. This would have important implications for all macroeconomic policy discussions. Does recent fiscal authority profligacy require immediate tax hikes? Do planned spending bills threaten to push the debt to GDP* ratio over the tipping point? Is a Fed targeted inflation of 2% or 0% or 3% relevant in a world where we do not know actual growth of inflation rates and when an increasing number of our consumer products are free (or at least only approximated in real output)? Why are we seeing creation of government debt held at the monetary authority without a serious rise in average inflation – could it merely be that we are relying on mismeasured inflation and economic growth rates?

Since we really do not know what the actual level of GDP* is and how it is growing in this period of rapid transition, these public policy debates, where GDP is a centerpiece, may, and almost certainly will, lead us to many misleading and inappropriate policy solutions.

9. CONSUMER SURPLUS AND PERSONAL INCOME TAX

This brings us back to the rapid changes of the last decades. We admittedly have no way of measuring each citizen's and each corporation's benefits from government actions. Consequently, we have no way of allocating the tax burden in proportion to those unmeasurable benefits. However, if we bring consumer surplus and digital products into a discussion of how to better align benefits received and benefits paid for, we can grossly define 1) which segments do we know that benefit far above what they pay for their bundle of consumption goods and 2) which segments do we know benefit closer to what they actually pay for their bundle of consumption goods.

Whereas we have not seen this question asked by economists, policymakers, or laymen, the answer seems fairly obvious. Perhaps trivially so. Theoretically, empirically, and intuitively, those consuming at a subsistence level are benefiting close to what they pay for their bundle of goods. And without putting too fine a point on it, consumer surplus informs us that the wealthiest, say 5% of consumers, are benefitting far above

what they need to pay for their bundle of goods. And, of course, so are the wealthiest 10%, 20%, etc. The nature of consumer surplus leads us to conclude that the wealthier you are, the more likely, in general, you are benefitting from your consumption more than those who are also wealthy but less wealthy than you.

This leads to the all but obvious conclusion that a thoughtfully crafted graduated income tax, with all its flaws, will tax increasingly those who are getting the most unpaid for value from their consumption. A graduated income tax has generally, anecdotally, and popularly been considered as the fair way to design and implement an income tax. But, consideration of consumer surplus shows rigorously that, whether "fair" or not, it is one, if not perfect by any means, way to achieve a goal of taxing those benefitting the most from their consumption.

10. ECONOMIC FORECASTING IN A WORLD OF MASSIVE EXOGENOUS SHOCKS

In a world where innovation is so high and growth and product changes so rapid that measured data materially misrepresents what is actually happening, it is very difficult to make a living forecasting the future economy. If you do not know actual inflation, productivity, the size of the economy, or actual economic growth today, how can you reasonably forecast what is actually coming as opposed to what is going to be measured?

To compound this problem for forecasters and policymakers, macroeconomic models are calculus-based. They are designed to analyze and predict what will happen, say, to GDP if there is a small change in, say, government spending. They are absolutely not designed to predict what will happen to GDP or inflation if there is a massive exogenous shock to the economy from, say, a pandemic and the human responses to it. Not to mention if there are a series of massive exogenous government interventions in response.

Accurate economic forecasts are simply not possible in an environment where both reported data are wrong and there are such large exogenous shocks.

But, what of relative price movements in the face of these exogenous shocks? It is reasonable to expect unusually large movements in relative prices as different sectors are hit by different, and possibly opposite, shocks and associated distortions. One is reminded of the consumer price index of the U.K. from the 18th and 19th centuries. Prices rose during war periods then fell back to a long run norm of zero inflation. War, like other exogenous shocks, will cause overall prices to rise as trade is interrupted, regulations imposed, and general demand for labor increased. Some of the changes are temporary, some lasting, as stressed markets seek new equilibria. Examples abound of stress in various markets: shipping rates, timber, wood pulp and paper, copper, steel, groceries, etc.

Many of these relative price changes will be interpreted by some as inflation or deflation, while, in fact they are often to-be-expected market adjustments. Much of the reporting of changing individual prices will be noise, much like the politicians' statements of blame, rather than inflation data. As new data rolls out, economists and policymakers are forced (if they so choose) to expound on possible average outcomes, variance and unevenness in different sectors, the possible length and duration of shortages and eye-popping sudden price changes, the many possibilities in changing asset prices, and the effects of these on inflationary expectations and Fed policy, etc. Not possible.

As we are increasingly seeing, many, if not all, markets are in disequilibrium and adjusting as fast as they can (including, it must be pointed out, many, if not all, labor markets). Generalizing and/or forecasting from such out of equilibrium data points is, rather than may be, hazardous to one's health.

Rutledge (2021) makes the case with characteristic inability to get his tongue out of his cheek: "Sadly, I learned today that 231 economists have been hospitalized with neck and spine injuries sustained when they suddenly and without warning flipped from worrying about deflation to worrying about inflation when the Labor Department reported the CPI was up 4.2% in April ('21). When questioned, the head of orthopedic surgery at Boston General explained, 'The damage appears to be concentrated between cervical vertebrae C1 and C2, used when a person suddenly changes their mind… In this case, the movement was just too quick, damaging the connective tissue, made worse by the fact that many of the sufferers had never actually changed their minds before.' The good news is that the patients are all economists, not plumbers or carpenters, so there should be no negative impact on GDP."

Unable to put it any better ourselves, we make no forecasts in this paper. And we recommend that others' forecasts be taken with more than the usual number of grains of salt until sufficient time has passed for measured data and economic models to catch up to the rapid changes of the past 25 years and the shocks of 2020-1.

11. CONCLUDING COMMENTS AND POLICY IMPLICATIONS

Unbeknownst to the general public, many economic analysts, and, possibly many policymakers, much of our reported U.S. macroeconomic data is materially mismeasured. Most importantly, measured GDP, the universally used policy target, is increasingly understating the size of the economy. This is especially true with respect to the wellbeing of the economy. And this is only partly because of mismeasurements.

The dramatic increase in innovation and product change associated with the current Third Industrial Revolution has led reported inflation numbers to be overstated by the order of 1% per annum or more. Utilizing a constant velocity of money assertion, we develop an approximation that shows productivity, GDP, and consumption have been understated since 1995 by as much as 3% per annum (even if half as much, this is huge). This would suggest that appropriate measures of our economy have grown by as much as two times what our measured data are showing. We discuss the fact that these observations are the same or greater in other developed countries. As an example of the implications for public policy debates, we show that this implies that the U.S. debt/GDP ratio is much lower than is currently being debated. This a very important, but not very surprising, conclusion in a very important policy debate.

We note the implications for fiscal and monetary policy of ignorance about actual inflation and GDP numbers, that is, of conducting economic policy without known data points. In that vein, we note that if a better measure of the total wellbeingness of the economy is used, rather than mismeasured GDP, there is a strong argument to be made, on purely economic grounds, for a progressive income tax in a world where policy perfection is not possible.

Lastly, we observe that calculus-based macroeconomic models are not designed to work in periods of very large exogenous shocks. In point of fact, they simply will not effectively forecast future economic changes in a world where the shocks are of a magnitude experienced after February 2020.

To put it bluntly, economic policymaking is being made in the dark with mismeasured data and ineffective models. And this is not being acknowledged by either the bulk of the economics profession or our policymakers. It is possible that a large number of policymakers are unaware of this. It is also possible that many economists are equally unaware. But certainly not all.

It is time for the economics profession and policymakers to invest in correctly measuring GDP, inflation, productivity, and a newly created measure of economic production and national wellbeing that is more useful for public policy than even a correctly measured GDP. Perhaps the American Economic Association (AEA) or the Royal Economic Society (RES) can push for and achieve a national government-associated task force on these issues.

Public economic policy made in the dark, with known misleading underpinning data, can only be in the interest of our economy and society by accident. By luck.

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TECHNOLOGY

INNOVATION AS A COMPETITIVE ADVANTAGE – EXPERIENCES AND INSIGHTS FROM BALOISE

ALEXANDER BOCKELMANN | Group Chief Technology Officer, Baloise Group

ABSTRACT

The ability to innovate is key for any company to survive and prosper over time, independent of its industry. Digital transformation has significantly accelerated the innovation cycles and led to the megatrends that are groundbreaking for the insurance industry. With its corporate strategy Simply Safe, the Swiss insurer Baloise is facing the challenges of continuously evolving itself. This article shows how an insurance company can structure the innovation process in a way that the strategic focus is not lost and explains why the corporate culture plays a decisive role in this.

1. INTRODUCTION

All businesses follow a lifecycle influenced by the balance of market forces and the demand for, or substitution of, the products or services they offer. The lifecycle of a business is often described in five stages, from initial development of the product or service to market entry, growth, stagnation, and then decline. Depending on the circumstances, the need for adjustments or innovation to sustain an existing offering, or to develop a new offering, might vary based on the competitive forces in the particular market or industry. Ultimately, however, innovation is crucial to all successful business models.

Numerous studies have highlighted the strategic importance of innovation for business, for example, in the form of disruptive innovation, with its potential to exploit niche segments and then mass markets over time.[1] It has also long been known that innovation needs to be managed on an ongoing basis so that its positive impact does not wane over time, as described by Everett Rogers with his S-curve theory of innovation.[2]

Although the challenge is well understood, the implementation of an effective innovation strategy is very difficult. Successful innovation models vary from industry to industry and, in some cases, also by region and market. Baloise is a financial services company based in Western Europe offering insurance, asset management, and banking. We have made innovation part of our group's Simply Safe strategy and identified and employed multiple levers for the effective and ongoing management of innovation. Reflecting on our approach will hopefully offer you some insights into the pros and cons of different options for your business and innovation strategy.

2. MEGATRENDS ARE SHORTENING INNOVATION CYCLES

Baloise has a proud history, stretching back over almost 160 years, of meeting the financial and insurance needs of its customers. Although efforts to innovate were undoubtedly made down the years, the pressure to differentiate and diversify our products, processes, and business model appears to have grown steadily over time, until innovation became a core focus of our business strategy.

More recently, the pressure to innovate has been increasing due to the megatrends influencing our lives at all levels – from societies to business to individuals. To illustrate this point, we have highlighted some key trends that are progressively changing the landscape for our financial services business models and pushing the adjustment and innovation process towards ever shorter cycles.

[1] Christensen, C. M., 1997, The innovator's dilemma: when new technologies cause great firms to fail, Harvard Business Review Press
[2] Rogers, E. M., 1962, Diffusion of innovations, Free Press

2.1 Digitalization

Digital technologies are increasingly present in our daily lives, and this means that people now expect to be able to engage with us across multiple channels. This is driving the need for innovation at the level of operating models and technology in order to meet and exceed the changing expectations of customers and business partners. Digitalization, however, also lowers entry barriers for new business models and makes the entry of new competitors and the transfer of business models into new markets faster and cheaper.

2.2 Personalization

Customers' expectation of personalized advice, offers, and services, coupled with the trend towards digitalization, creates a need for innovation in products, processes, and technologies – to name but a few areas – and for pushing the envelope on the availability, quality, and analysis of data, often in real time as part of a digital customer journey. Whereas in the past customer expectations generally differed depending on the sector, the expectation of personalization appears to be ubiquitous across industries.

2.3 Connectivity

The growing connectedness of business models and information sources changes how businesses position themselves and act in markets by allowing for new network processes and services. Modern supply chains and new and coupled service offerings from business partners require growing levels of data and process integration. Coupled with the trends of digitalization and personalization, this also enables the creation of new service ecosystems, with multiple businesses creating one customer experience and/or product offering where in the past it had only been possible to offer products individually and independently of one another.

2.4 New work

Traditional career paths are dissolving, while purpose and individual empowerment are becoming more important for today's workforce. This puts pressure on businesses to be more innovative when it comes to their operating models. The provision of new employee experiences is becoming critical in the hunt for talent and in providing work environments that are both effective and competitive. New ways of working focused on incremental improvements (agile working) are also improving the integration of customer feedback and flexibility. However, the development and establishment of these new methods requires a shift in culture and modus operandi on a scale equivalent to past industrial revolutions.

2.5 Transport

The world of transport is changing rapidly as populations grow and urbanize, and we shift to more efficient and sustainable formats. The notion of triple zero, i.e., zero emissions, zero accidents, and zero ownership, and the work that is being done on this, will not only change the way we get from A to B but also shake the foundations of the traditional motor insurance business, as risks shift from drivers to the algorithms driving the autonomous car. This will transform the product and demand landscape for non-life insurance companies operating in the traditional motor insurance segment.

2.6 Security

Security is a megatrend at both a geopolitical and individual level. For businesses, the megatrends of digitalization and connectivity are driving innovation pressure as new cybersecurity risks are emerging and new data and digitally enabled offerings and services create new security needs and approaches. For insurance companies, these newly emerging risks also present a new market opportunity in helping to mitigate the risk for individuals and businesses.

Of course, other megatrends, as well as new trends in traditional and local markets, are also changing the competitive landscape. And these are some of the key trends that influenced our Simply Safe strategy and innovation strategy at Baloise.

3. CULTURE AS A CRITICAL ENABLER FOR INNOVATION

For some industries, such as pharmaceuticals, ongoing innovation is part of the business model's DNA. In these industries, a systematic innovation process and roles and responsibilities are well established and have proven their worth over time.

For Baloise as a player in the financial services industry, the competitive pressures for fast and potentially transformative innovation were not as strong. Hence, we needed to make a conscious effort and decision to develop our innovation capabilities and view an effective system of innovation management as a competitive advantage.

This step was taken in 2016 with the launch of our Simply Safe strategy. The strategy was based on the concept that happy and engaged employees lead to satisfied and loyal customers, which in turn leads to commercial success. Together with the focus on employee engagement and empowerment in the organization through more agile ways of working, the

agenda at senior management level included a special focus on innovation as a lever for strategic success, which created room, resources, and recognition for innovation activities. On the execution side, establishing an open innovation culture was a critical factor in helping to challenge our internal beliefs and enhance our innovation capabilities.

It is often recommended to relocate innovation activities to a lab or remote environment outside of the core business in order to create a set of greenfield conditions with fewer cultural and bureaucratic legacy effects. This can be an advantage for the incubation of new and self-sustaining innovations or future stand-alone businesses. We followed this approach with our digital insurance and insurtech spin-off FRIDAY[3] in Germany. This business started with a "garage team" to provide the maximum degree of freedom to rethink insurance for the 21st century.

However, if transformation of the core business is the intention, separation of the innovation activities creates distance and cultural differences that often make it hard to bring innovations back into this core business. Hence, if the objective is to change the core business, the core of the culture needs to change too.

At Baloise, we wanted to create a spirit of ownership, entrepreneurship, and innovation throughout the company, consequently, we made innovation a focal point for the core organization as well. Challenging the status quo has become part of our strategic transformation and we try to include employee-driven innovation on our journey by imbuing the workforce with a spirit of entrepreneurship and ownership. This is facilitated by granting decision-making authority to the employee experts who are closest to the work. These experts generally have the best understanding of the daily challenges and often have great ideas for how to improve and innovate incrementally over time.

To also challenge ourselves on a bigger scale, including through potentially more transformational innovations, our process integrated partners, peers, academics, and external experts right from the outset. It is an approach we call open innovation. The assumption was that although we are strong in our core business areas, we want to leverage the expertise from outside the company to get new ideas, new perspectives, and new solutions for our innovation activities.

This gave us new scope to come up with fresh solutions, and many ideas were generated in the early phases of the journey. We opened the ideation diamond wide and experimented and learned a great deal. In hindsight, this period might have not been as focused as we would have liked, but it did allow for many learning experiences and a broad range of innovation activities. At a later stage in the journey, we closed the ideation diamond again and sharpened the focus by defining target areas and topics for our innovation activities. This called for rigor, as good ideas might pop up everywhere but focus was required for us to improve the traction in the strategic target areas.

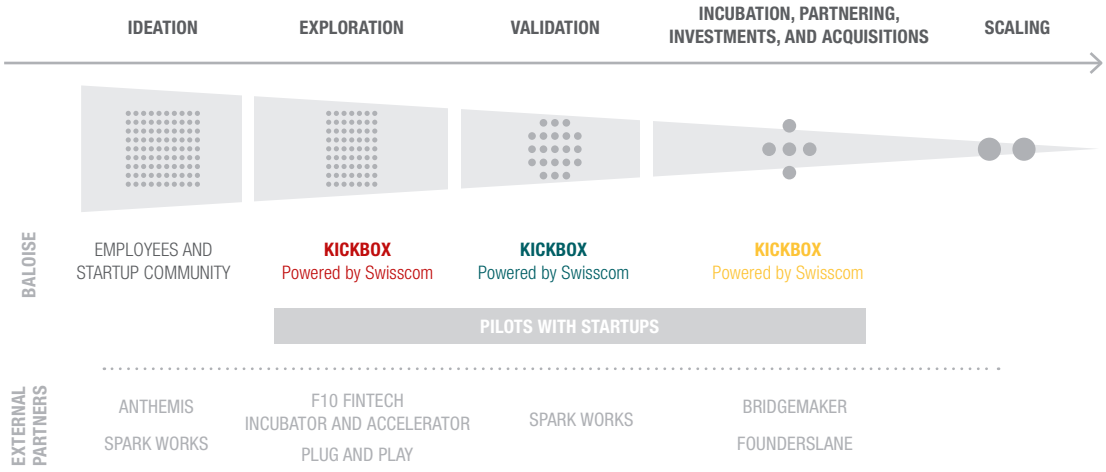
An innovation culture should allow for the possibility of failing fast, and often, in a safe and learning-oriented environment. Mistakes should be reviewed and the lessons learned should influence future activities and iterations. A healthy culture of failing forward also means expecting competence and innovation approaches that are driven by valid hypotheses. What do we want to try, what do we intend to learn, and how do we measure success? All of these issues need to be defined from the outset. To ensure an efficient and effective innovation culture, failures caused by incompetence should have different consequences and not necessarily be tolerated. There needs to be an underlying hypothesis driving the innovation and some idea of the parameters for judging a successful outcome.

4. THE PORTFOLIO APPROACH TO INNOVATION

Unsurprisingly, Baloise also follows a portfolio approach to innovation, as shown in Figure 1. In this approach, the innovation process is segmented into different stages with specific steps for evaluating success and interim decision points. This approach is able to generate a great deal of ideas with a high degree of freedom in respect of the form of innovation while maintaining a strong focus on objectives. At each stage of the process, most ideas are dropped, with only a select few progressing to the next stage, in which they obtain additional resources for their further development and growth. The type of innovation targeted in this approach is mostly focused on reimagining the current business model and processes or diversifying of the business and innovating new market opportunities. It is less about sustaining innovation of existing processes. This is generally managed via a continuous process improvement approach in the respective business areas.

[3] https://www.friday.de/

Figure 1: Portfolio approach to innovation



A key challenge of this portfolio approach is maintaining a balance between the amount of ideas generated and the capability of the organization to nurture and execute them. Particularly when the ideas come from employees, who can become frustrated if they have to wait too long for a decision on their idea or there is a lack of resources to efficiently move the idea to the next phase of the innovation process. Another pitfall to avoid is concentrating only on individual parts of a process. In a garden hose, the section where the diameter is smallest ultimately determines the overall efficiency. And it is no different for a chain of processes. Introducing an innovation to only one process or part of a process runs the risk of losing sight of the overall end goal and can lead to bottlenecks.

This is a typical challenge faced, for example, when building new and optimized digital customer touchpoints and sales processes. If the related back-office processes are not automated as well – perhaps once the touchpoint has been piloted in the market – these slower processes will lead to growing backlogs in your operational departments from the new digital sales channels. Your new digital customers might have to wait an unacceptably long time for their enquiry or order to be processed and your back-office staff might become overwhelmed.

It is, therefore, advisable to be aware of the implications of new ideas and to address them accordingly as the idea is nurtured and moved along the innovation pipeline. At Baloise, we address this problem by leveraging a cross-functional innovation board that challenges the ideas and tries to identify unintended consequences of a new approach or solution for different parts of the business.

A general challenge is the scale of innovation and the financial commitment required to bring the ideas in your portfolio to fruition. This is especially true if you aspire to invest in, or acquire, new or more established companies with the intention of growing and scaling their ideas.

If you are a small or medium-sized enterprise, the annual budget for such activities might be limited. As you do not know which idea will prove successful in the long run, you need to invest in multiple ideas. This dilutes your investments but is essential for building a portfolio of ideas. Over time, the ideas will ideally mature and require additional capital. Business-to-consumer ideas eat up a particularly large amount of cash because the costs of acquiring the product or service and brand are not known at the outset. Hence, at a particular point in time, your innovation budget might not stretch far enough to fund the number of maturing ideas or even your most promising ideas. More capital is needed, and this is when you might need to consider bringing additional partners and investors on board to fund the next steps.

The innovation portfolio approach, therefore, often also requires a degree of upskilling in startup financing and venture capital, and not just when it comes to the innovation management processes. You may also need to include a strategic review on which companies or ideas you want to control or where you want to become a minority stakeholder or even withdraw entirely.

5. IDEATION – THE STARTING POINT OF INNOVATION

At Baloise, we utilize multiple input channels for our ideation processes. As part of our efforts to foster an entrepreneurial corporate culture, we are running innovation campaigns on specific topics and strategic areas in order to leverage the ideas and expertise of our staff. But particularly in established industries such as financial services, whose business models remain more or less unchanged for long periods of time, generating transformative ideas can be a challenge. It is simply not in our DNA. This is why, at Baloise, we strongly advocate for an open innovation approach that also includes external partners and stakeholders. This brings new perspectives, experiences, and capabilities to the innovation and ideation process.

One way of getting the outside-in view is to set up a startup scouting community and to work with startup networks, accelerators, and incubators, such as the Plug and Play Tech Center. Exposure to the dynamic world of startups might prove overwhelming if you are in the early stages of creating an innovation process. And for all the many great ideas that are produced, only a handful are ever successfully incorporated into the core business. There could be many reasons for this: cultural challenges, a lack of expertise in how to work with startups, competing priorities, a lack of technical and data integration capabilities, etc. After a period of going out into the world and looking for interesting ideas, we have shifted our approach to identifying internal needs and action areas and then looking for potential solutions in the startup space. The advantage of this new approach is stronger internal buy-in and alignment with priorities. The disadvantage might be that the more transformational ideas may be missed if the search parameters are too focused. Regardless, we have seen a huge return on establishing a permanent team, including IT experts, who specialize in working with startups, since it also helps to bridge the gap between their expectations and workstyles and the more traditional core business areas. This approach is demonstrably adding value for both sides of the new partnerships.

In recent years, the growth of fintechs and insurtechs has generated substantial momentum that is also influencing our innovation and ideation activities. In Anthemis, a global leader in startup investments and development, Baloise has a strategic partner and a joint corporate venture capital vehicle for identifying, investing in, and developing mainly early-stage startups in segments such as fintech, insurtech, and sustainability. The strategic objectives are to analyze emerging and developing local or global trends, to identify potential new business partnerships or ideas, and to scope out the financial returns from future exits as the startups grow and access fresh rounds of funding. For the ideation process, analytical studies of the startup market are providing food for thought, while the investment business models are an opportunity to work on innovations with others.

Further ideation input originates from partnerships with innovation management consultancies such as Spark Works. We worked with Spark Works to compile a report called "The future of mobility",[4] for example, which identifies and describes the drivers for change in the transport space as well as possible scenarios for driving forward our internal campaign focused on transport innovation and future transport services.

6. EXPLORATION – THE FIRST STEPS IN SHAPING A NEW IDEA

Developing and realizing an idea is the first and often hardest stage of the journey. A helpful tool we are employing for employee-driven innovation is the Kickbox approach.[5] This was invented by Adobe and refined by Swisscom, a Swiss telecommunication company, and is now used by many companies to structure and support an idea throughout its lifecycle. In the first step, with the red Kickbox, the employee is given support in analyzing their idea, validating it, and presenting it to potential sponsors. The Kickbox journey then continues with blue and finally gold boxes, with more resources and expert support being provided in the later stages of the innovation process.

Baloise is also using startup accelerator programs to explore ideas. Emerging ideas and their owners have the opportunity to become part of a dedicated program such as the one offered by F10, a leading startup accelerator in Switzerland. An additional advantage is the cross-pollination with other entrepreneurs and with the wider startup community. In general, we have seen accelerator programs as more beneficial if an idea has already matured somewhat and is closer to the validation stage, in which a first minimum viable product might already be in field tests with customers. The "cultural exchange" that

[4] Wirth, P., and A. Bockelmann, 2020, "The future of mobility: imagining the world in 2040," Baloise, February 13, https://bit.ly/2XvS6Gs
[5] https://www.kickbox.org/

working with such startup communities offers adds a great deal of value, turning employees into catalysts of change who can champion new ways of working and new methods of collaboration.

At Baloise, we also experiment with our own startup accelerator programs to explore emerging ideas in specific strategic areas and to potentially identify interesting ideas for future validation. An example of this is our Baloise Mobility Accelerator,[6] implemented in tandem with our partner Spark Works, and its spinoff Sparkademy. This accelerator is our invitation to European transport startups to get support in further exploring their ideas and evaluating the potential for future collaboration with Baloise. The approach is the latest addition to our innovation process and its impact is still to be assessed.

7. VALIDATION AND WAYS OF GROWING AN IDEA

Employee-driven ideas follow the Kickbox process with stage gates and pitches to a cross-functional decision-making panel. If successful, the ideas are progressed to the blue and ultimately gold stages of the Kickbox process. This is when the employees can flesh out their idea and market test it with customers. The final outcome may even be the creation of a new business. From a Kickbox campaign in 2019, we had our first employee-driven and employee-owned spin-off in 2021 in the shape of a new company offering transport services.

On the external partner side, we follow a systematic innovation process, in which we can partner with other companies to create joint customer offers and experiences. We also incubate our own companies, such as the aforementioned digital insurer FRIDAY or the mobility platform Mobly in Belgium.

To build a network of related service companies, for example, in our focus areas of home and mobility, we also invest in or acquire strategic startups. We often do so with other strategic investors who can bring additional capabilities and collaborations to the table to help grow and expand the nascent business.

Another key factor in our success is how we differentiate between the intention to buy and sell an investment versus the intention to strategically work with and develop a business or service offering. The former might lead to an investment via our corporate venture capital arm. Where the intention is to maintain a strategic longer-term business interest, the investment is managed outside of the corporate venture capital vehicle and closer to the core business. This separation is extremely helpful in avoiding strategic confusion and mitigating potential conflicts of interest originating from a mid-term disinvestment goal.

8. CONCLUSION

The ability to innovate in ever faster cycles is a competitive advantage that is growing in importance. Forces and megatrends outside the direct business segment or industry are reshaping customer expectations and often require significant changes to business models and processes to be addressed appropriately. These trends, however, also present new opportunities to develop and market new offerings to customers, potentially in partnership with other firms.

To address the challenges and to reap the benefits from such opportunities, companies need to establish an effective and efficient innovation management process. At Baloise, we manage innovation through a portfolio approach and are building up various new internal capabilities to address the topic. At the core of this approach are our efforts to establish a new corporate culture that instils ownership and entrepreneurial spirit in the workforce, and incorporates innovation as a key component. This in turn is proving to be a fruitful and enduring source of innovation ideas. As part of an open innovation approach, this is complemented by the inputs and capabilities of partners, who also form part of the Baloise innovation network.

Particularly in financial services, the innovative capabilities of the growing fintech and insurtech communities need to be integrated into a holistic process as well. At Baloise, this is addressed through a corporate venture capital approach and by partnering with, investing in, acquiring, and incubating startup ventures as part of the “build out of new” service networks.

Simply Safe Season 2 launches in 2022, and it will see Baloise targeting a combined annual portfolio valuation of its innovation activities of CHF 1 billion by 2025.

[6] https://bit.ly/2XmMXQL

ARTIFICIAL INTELLIGENCE AND DIGITAL TRANSFORMATION OF INSURANCE MARKETS[1]

CHRISTOPHER P. HOLLAND | Professor of Information Management, Head of Data Analytics, and Co-Director of TECHNGI, Loughborough University

ANIL S. KAVURI | Research Associate and Visiting Lecturer, Loughborough University

ABSTRACT

Artificial intelligence (AI) is recognized as a strategically important technology because it has the potential to exploit human-like intelligence at machine scale and speed. However, the hype surrounding its business use masks the AI phenomenon and makes it difficult to analyze and evaluate in a systematic manner. Current approaches to defining AI tend to focus on its technical aspects and neglect the business, ethical, legal, and regulatory context. To remedy this deficiency, an AI systems approach is taken that defines AI within a broader systems framework. This is important because it provides a richer set of concepts that relate AI technology to business processes, business models, ethical considerations, and the legal and regulatory environment. A new framework of digital transformation is proposed, which is based on a synthesis of a new AI systems definition and business model concepts. The digital transformation model is illustrated with two global leaders in insurance markets, Ping An and Tesla insurance. In both cases, a similar causal model of digital transformation, continuous innovation, and rapid growth is identified that exploits the AI digital flywheel effect. The managerial and regulatory implications of the case study analyses and conclusions are described, and future research opportunities are outlined.

1. INTRODUCTION

Digital technology is transforming all types of businesses and markets [Schwab (2017, 2018), Brynjolfsson and Mcafee (2016)] and these changes are having a profound effect on the insurance markets and the broader financial services [Naylor (2017), Alt et al. (2018)]. Digital technology is defined as the set of technologies that are used to process, analyze, store, move, and interpret data, which includes cloud computing, enterprise systems, data networks, computer hardware, software, social networks, mobile systems, and internet of things (IoT). The rate of improvement in the performance of digital technology is reflected in new artificial intelligence (AI) technology and business applications, and radically new business models [Holland (2019)], in what has been termed more generally as "Industry 4.0" [Schwab (2017)].

2. ARTIFICIAL INTELLIGENCE DEFINITION

A sample of recent AI definitions is provided to position the scope of this paper with relation to the insurance market.

"Artificial intelligence (AI) refers to systems that display intelligent behavior by analyzing their environment and taking actions – with some degree of autonomy – to achieve specific goals. AI-based systems can be purely software-based, acting in the virtual world (e.g., voice assistants, image analysis software, search engines, speech and face recognition systems) or AI can be embedded in hardware devices (e.g., advanced robots, autonomous cars, drones or Internet of Things applications)" [EC (2018)].

[1] This research is an output of the Technology and Next Generation Insurance Services TECHNGI project (www.techngi.uk) funded by Innovate UK and the Economic and Social Science Research Council (grant reference ES/S010416/1) as part of the £20 million Next Generation Services Research Challenge.

The European Commission [EC (2018)] has identified several important characteristics and properties of the AI system. The key point is that AI systems display "human-like" behavior, but unlike humans can be embedded into software, as well as the physical environment such as an autonomous car.

The Financial Stability Board (FSB) gives a very practical and high-level definition in their discussion paper on AI [FSB (2017)].

"AI is the theory and development of computer systems able to perform tasks that traditionally have required human intelligence. AI is a broad field, of which 'machine learning' is a sub-category. Machine learning may be defined as a method of designing a sequence of actions to solve a problem, known as algorithms, which optimize automatically through experience and with limited or no human intervention. These techniques can be used to find patterns in large amounts of data (big data analytics) from increasingly diverse and innovative sources" [FSB (2017)].

The key ideas that emerge from just this short sample of definitions is that an AI system can perform tasks that replace human intelligence and that the algorithms adapt in the light of new data, i.e., experience. The FSB also relates the definition to big data, and the interdependency of AI with big data is crucial in almost all application areas, including insurance, where an AI algorithm needs to be "trained" with a large volume of what is termed big data [Gandomi and Haider (2015)].

The Bank of England and the Financial Conduct Authority (FCA) define machine learning with a focus on the purpose of the model to identify patterns and to make predictions, and also highlight the fact that it can yield benefits for both businesses and their customers [Jung et al. (2019)].

"Machine learning (ML) is the development of models for prediction and pattern recognition from data, with limited human intervention. In the financial services industry, the application of ML methods has the potential to improve outcomes for both businesses and consumers" [Jung et al. (2019)].

These definitions have some important commonalities and omissions.

- They focus on the technical dimensions of AI, especially the algorithm and the use of big data to train algorithms.
- Machine learning is commonly identified as an important element of the algorithmic dimension of AI systems.
- Human-like behavior is taken as the key characteristic that defines AI systems, with no reference to other, new forms of intelligence that could exist, and which are unique to machines.
- The capabilities of AI systems are expressed in a limited manner, e.g., with respect to optimization and pattern matching, which is a narrow conception of human intelligence.
- There are no references to the business context of the AI application nor to its organizational scope, e.g., business application, functional area, and whether it relates to individual, group, or organization-wide systems, which are a crucial part of defining earlier generations of technologies, such as management information systems (MIS), including enterprise resource planning (ERP) systems that cover the whole organization and decision support systems (DSS) that are focused on the individual/group.
- There are no references to the ethical and regulatory contexts, which have become significant in market sectors such as health, insurance, banking, and e-commerce, where privacy, confidentiality, and data protection regulation are important factors in the design, use, and evaluation of AI systems.
- The notion of value is touched upon but is not described in any meaningful manner, for example to distinguish between simple cost savings from improved automation and strategic advantages from advanced data analytics and improved business models.

2.1 Technical properties of AI

The technical properties and attributes of AI systems are important to distinguish AI technology from existing management information systems. The emphasis on machine learning is relevant here because the capability to learn from data and, therefore, adapt is the crucial point. The current set of AI systems in business are termed "narrow" AI, which means that they have very limited intelligence that is applied to a single area or problem. There is an active debate in the literature about more general AI intelligence [Tegmark (2017), Bostrom (2017)], where the machine displays superior intelligence to a human [Penrose (1989)]. Taking this a step further, the singularity concept asserts that it is simply a matter of time, and continued exponential increases in computing power, when we will reach a singularity where machines overtake human intelligence and then continue to evolve into super-intelligent beings in their own right, e.g.,

Prometheus [Tegmark (2017)]. The idea of strong AI or general AI presupposes that intelligence is a function of algorithmic complexity and processing power, which is strongly disputed because it does not actually address the core definition of intelligence and the related philosophical and scientific models of consciousness [Penrose (1989)].

The concept of intelligent capabilities, whether they are very limited in their scope or attempt to have more general intelligence, leads onto the ability of AI to perform human-like behavior [Turing (1950)], i.e., to do tasks that would normally require humans to perform, such as complex classifications of data, predictions, assist in an online application process, optimize pricing, and voice/image recognition. Note that there is no effort here to define intelligence, but the approach is simply to state that the machine can perform tasks that previously required humans. This emphasis on humans in most of the definitions of AI raises an important question, which is that there may be other forms of machine intelligence that are not directly comparable to human behavior. The implicit assumption in these definitions is that the ultimate aim for AI is to emulate humans, rather than build a different form of intelligence. The point here is that there may be different forms of intelligence, and by concentrating on human-like capabilities we may miss other important development opportunities.

2.2 Business, ethical, regulatory, and legal context

The broader context is relevant when AI is considered from a managerial perspective, because it situates the technology within an organizational setting, with a business purpose or framework. For example, to assist someone in an online application, to identify a fraudulent claim, to estimate risk, or to organize policy documents. The key dimensions here are redesigned individual business processes that take advantage of AI and big data, new kinds of products and insurance services such as behavioral insurance and parametric insurance services, and the emergence of new types of insurance business models that are underpinned by AI processes and products. The use of sensitive personal data and the importance of insurance from a societal perspective create difficult ethical issues that are now receiving careful attention from regulatory bodies [Wood-Harper et al. (1985)]. The legal and regulatory context is crucial because it potentially affects all aspects of AI systems in insurance from their design principles, method of implementation, rate of adoption, and consumer rights over data, and appeal over automated decision-making.

3. PROPOSED DEFINITION OF AI INSURANCE SYSTEMS

In an insurance context, it is necessary to place these rather general AI definitions into a specific business or application context, which adds meaning to its relevance and helps in understanding the contentious strategic, ethical, social, and legal issues related to the implementation of AI systems in insurance. A socio-technical approach to AI systems is a concept that places the AI algorithms and machine learning technology into a broader business context [Wood-Harper et al. (1985)], which encompasses the digital technology of core insurance systems (data capture, GPS, cloud computing, internet of things, and software), big data, the insurance business processes or activities, people, and business models that are involved in a particular insurance product-market business example [Wood-Harper et al. (1985), Data Ethics Commission (2018)].

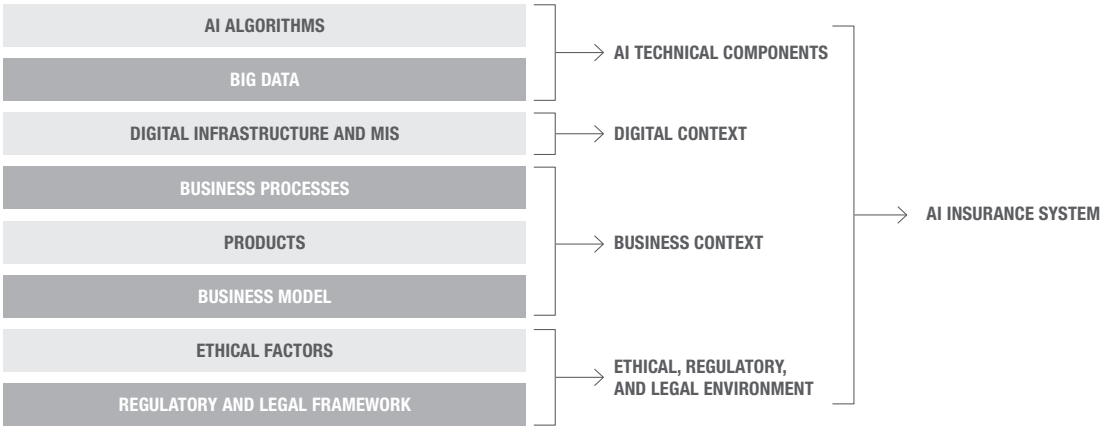
An AI insurance system is defined by the authors as:

"A set of inter-related elements of AI algorithms, big data, digital infrastructure and Management Information Systems (MIS), and the business context that encompasses business processes, products, and the business model of the firm, within an ethical, regulatory, and legal environment."

For example, in a behavioral AI automotive insurance system, GPS and digital technology in mobile devices and/or the car itself capture telemetry big data that is shared with the insurance company. The data could be combined with other data types – e.g., historical loss data, weather patterns, route map information that contains speed limits, and data from other drivers – and analyzed using machine learning algorithms to derive a driving score, which is then used as an indicator of the risk of an accident and used to price the insurance premium. This approach is a fundamentally different approach to using what was historically used to model risk in car insurance, which was the demographic information about the driver, the value and type of car being insured, and the driver's history, in particular previous claims and convictions. A behavioral approach shifts the use of data from a periodic, typically annual exchange of summary data between the insurance firm and the customer, to a continuous exchange of real-time driving data, where risk is modeled on a continuous basis and is used to inform the insurance premium on a dynamic basis.

Expanding on this verbal definition and extending the systems approach by formalizing the identification of individual system elements, a revised model is developed in Figure 1. An AI

Figure 1: A framework definition of AI



insurance system perspective shows the inter-relationships between the technical components of the AI system – i.e., the algorithm, big data, digital platforms, core legacy systems, sensors, GPS, and other digital technology – and separates them from the business context, which includes the business processes, insurance product, business model, and insurance value chain [Data Ethics Commission (2018)]. This setting of the AI technical components within the broader business context is similar in concept to a socio-technical approach to systems design [Wood-Harper et al. (1985)]. The legal and regulatory context is then concerned with issues such as transparency, explainable AI, fairness, and ethical considerations. Regulatory issues are applicable to all types of AI and have particular relevance in those sectors where there are additional privacy, confidentiality, and data protection rules, such as in health, insurance, banking, and e-commerce.

The key feature of a systems approach to AI definition is that it allows a holistic approach and the consideration of each element separately, their relationships to each other, the natural groupings of the elements or components, and an appreciation of the overall structure of an AI system.

3.1 AI technical components

The natural starting point is the AI algorithm, because this is what distinguishes AI technology from MIS. In a traditional ERP system, the algorithm for managing the production and accounting systems is fixed and applied to a set of data to generate meaningful insights, information, and statistics. In an AI system, the algorithm has the potential to change, adapt, and "learn" as new information becomes available – it is this dynamic ability to adapt that is probably the most important characteristic of AI that sets it apart from earlier digital technologies and systems. Some researchers and commentators emphasize the ability to make predictions as a key characteristic of AI, for example, to classify information, or to identify a pattern or anomaly, or to predict the likely probability of an outcome. While this is useful, it could be argued that many types of management information systems that have no claim to be AI systems, make predictions; for example, a weather forecasting system will predict tomorrow's weather based on a causal model of weather patterns, a sales forecasting system will predict next week's sales based on a simple regression model and prior information of historical sales, level of promotion, competitor reactions, and market confidence. An ERP system will predict the optimal time for ordering parts from suppliers based on a fixed material requirements planning system.

Big data is an integral technical component to all AI systems and is vital for the initial training of the algorithm, and then for its ongoing operations, evolution, and maintenance. Commercial AI systems are rarely standalone systems because they need to access new forms of big data and relate these to existing data in legacy MIS, such as enterprise and policy management systems. In insurance, new forms of big data are often related to physical and behavioral phenomena related to insured assets, such as data from health trackers, telemetry, IoT in buildings, and smart sensors. The inclusions of digital infrastructure as a general class of technology to capture, communicate, store, and analyze is, therefore, important.

3.2 Digital context

The digital infrastructure and management information systems link the AI applications to the broader organizational enterprise systems. In an insurance company, these include functional business areas such as HR, marketing, finance and

policy management, as well as regulatory compliance, and risk management. Almost all current AI applications in insurance are designed to support existing business processes within a functional area, typically following the customer lifecycle: digital marketing to acquire new customers and retain existing ones, AI behavioral risk assessment, smart policy management, ChatBots and online tools to facilitate e-service, voice recognition and natural language processing (NLP) to automate call center operations, a/b testing of new customer interface designs, and automated claims management from image recognition and machine learning to estimate the cost of claims. This means that the digital infrastructure and MIS remain as the core systems in an insurance company and that AI systems are in effect a smart wrapper to existing organizational blueprints defined by the existing enterprise systems and business processes.

3.3 Business context

The business context is described in terms of changes to business processes, products, and insurance value chains and business models. The digital transformation process can be analyzed by considering the interactions and causal effects of AI technology and applications on business processes, which are the basis for product innovation, value creation, and the emergence of radically new business models in insurance.

3.4 Ethical, regulatory, and legal environment

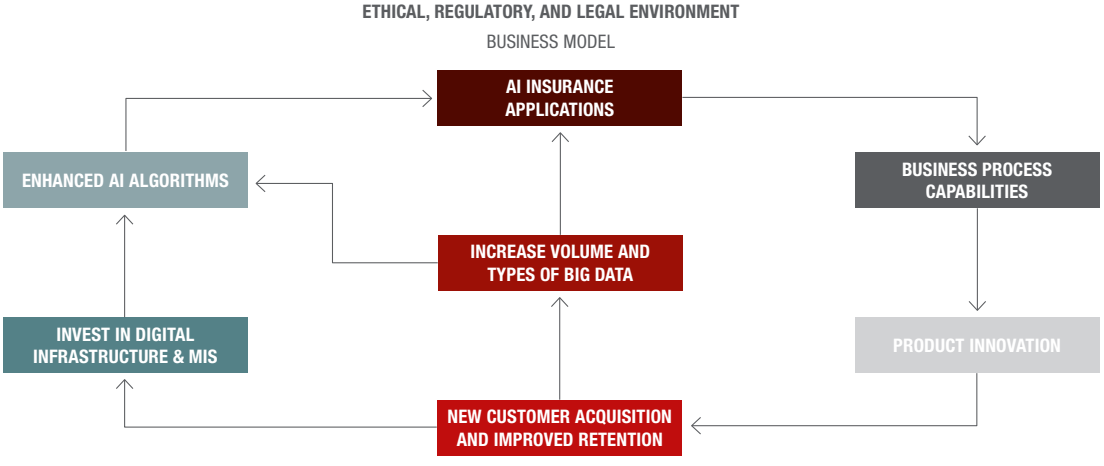
Beyond the boundary of the insurance firm, the regulatory and legal environment is particularly important in areas such as transparency and explainability of AI systems, and ethical issues associated with its implementation. Regulatory [EIOPA (2019)], governmental [EC (2019)], and consumer organizations [BEUC (2020)] all agree that there needs to be oversight and regulation so that insurance firms abide by relevant legislation and more generally protect consumer rights. There is also a more general argument that societal norms and ethical considerations should also be considered. In addition, the regulatory environment must also be balanced against maintaining the need for innovation [Keller et al. (2018)] and to enable profitable and sustainable insurance companies. There are significant benefits to consumers from AI systems in insurance, including ease of use, extending insurance to previously non-insured groups through improved targeting, new products such as cyber risk, reduced premiums from administrative lower cost insurance operations, consumer analytics to mitigate and reduce risks, learning systems from the behavior of large networks of consumers, and early warning systems [Keller (2020)].

4. A STRATEGIC MODEL OF TRANSFORMATION IN INSURANCE MARKETS

The framework definition in Figure 1 identifies the elements of an AI insurance system and this is used as the basis for developing a causal model of AI transformation in insurance markets, which is shown in Figure 2.

This is a simplified description of the mechanisms of digital transformation from the novel application of AI and digital technologies. Starting with customer acquisition, new customers generate increased levels of big data that is used to personalize the AI insurance applications and to train and enhance the existing AI algorithms. New customers create revenue, which is invested in digital infrastructure and MIS, which links the AI systems into the organization's enterprise systems. AI-enabled insurance applications create high-performance business process capabilities in areas such as

Figure 2: AI and digital transformation in insurance markets



customer interaction, risk assessment, claims handling, and digital marketing. These business process capabilities are the direct result of a set of narrow AI applications, and provide the basis for product innovation, which is used to attract new customers and improve the retention of existing ones. A virtuous circle is created that leads to increased data and customer growth, which is termed the AI data flywheel effect.

4.1 AI insurance systems focused on individual business processes

Business and technology examples of contemporary AI systems are used to illustrate the digital transformation model. All the AI examples given in this section have the common feature of focusing on a single business process, and this is termed "narrow" AI. This is a characteristic of almost all current business examples of AI systems and is a result of the current state of maturity of AI technology, which can handle narrowly defined problems, based on extensive training of the algorithm to solve a very specific and tightly defined problem. Conversely, the machine learning technology that provides the mathematical algorithms for today's AI applications is poorly equipped to handle more general problems, where the organizational scope and/or the number of parameters and interdependencies between different aspects of the problem domain are significantly higher.

Starting with big data, which is at the center of the model, a recent survey report by European Insurance and Occupational Pensions Authority [EIOPA (2019)] identified a clear transition in the use of data to assess and evaluate risk, which is a core part of all insurance markets. The data transition is from the use of traditional data sources to new forms of big data that are enabled by digital strategies that embrace and encourage customer involvement in the value creation process. Traditional data sources to assess risk include demographic, exposure, loss, hazard, and medical data. Big data sources include behavioral data, IoT, images, personal data from smart watches, and genetics data.

Taking risk assessment in motor insurance as an example, insurance carriers are utilizing telematics technology from technology partners to fundamentally redesign the risk assessment process, which enables the development of new kinds of innovative insurance products, such as personalized behavioral insurance, pay per use, dynamic risk assessment and pricing, and to create customer value with new services such as data analytics on driving performance, risk mitigation, and driver advice based on a large network of other insured drivers. Behavioral insurance has been adopted quickly by market leaders in the U.K. (Aviva), Germany (HUK-COBURG), the U.S. (Geico), and China (Ping An). What emerges from these examples is that the innovation process and changes to the business model do not stop at risk measurement based on driver behavior. The data collected to assess driver behavior is also used to create additional services such as analytics and driver performance dashboards, dynamic pricing, and risk mitigation.

Relating behavioral motor insurance to Figure 2, new forms of big data are used to develop AI driver apps that monitor and evaluate driving behavior, which generates new risk processes that enable product innovation to create personalized driving insurance pricing. This improves new customer acquisition and retention, which supports further investment into digital infrastructure and related MIS, and crucially generates a larger big dataset of driving behavior. The combination of better digital technology and larger datasets make it possible to enhance and refine AI algorithms, which is reflected in more effective AI behavioral insurance apps. This is a dynamic model and is a typical example of the data flywheel concept in action, where a growth in customers results in better data and AI systems, which creates a virtuous circle that is focused on the commercial use of more relevant data. A similar logic applies to health behavioral insurance, which uses personal data such as weight, physical activity, exercise, heart rate, and blood sugar levels.

Continuing with a focus on the business process as the unit of analysis, AI systems can be mapped onto a customer lifecycle model, starting with sophisticated a/b testing to score new website designs, machine learning for the automated evaluation of digital marketing campaigns, the use of virtual assistants to facilitate the sign-on process for new customers and also in e-service, AI for image recognition and claims handling, and machine learning techniques for market segmentation based on statistical clustering techniques using search and buying behavior through online channels.

4.2 Ping An – an ecosystems and technology-driven business model

4.2.1 AI TECHNICAL COMPONENTS AND DIGITAL CONTEXT

The Ping An group started as a traditional insurance firm and has expanded into four main ecosystems: (1) "Finance +", (2) healthcare, (3) automotive services, and (4) smart cities. In 2020, the company had 598 million online users across its platforms, and four apps with at least 100 million users. The focus of this case vignette is on its telematics insurance app because this illustrates Ping An's use of AI and

technology strategy to automate internal and customer-facing business processes, within a broader business model context [Larsen (2019)].

The AI algorithms that form the basis of its AI applications are developed in-house and are part of a technology-driven strategy that uses digital technology to improve all aspects of business performance. The origin of its technology strategy was to use digital technology to improve existing products and services and then expand the digitalization process into ecosystems for specific product markets such as finance, and invest in connecting with economic partners that play important roles in that market. The company realized that to avoid the legacy systems problems associated with long-established banks and insurance firms, it should build technology platforms that have inherent flexibility and scalability, and continually invest in new technology. Four technology pillars underpin its digital strategy, which are AI, cloud computing, security, and emerging digital technologies such as blockchain and internet of things (IoT).

Customer growth and behavior generates huge amounts of big data, and this is tracked to capture salient characteristics and properties, which is then used to improve customer understanding, cross-sell services, and to inform product innovation. Important technologies that cut across all ecosystems are customer identity, CRM data, cloud infrastructure, AI knowledge and expertise, and security. Investment into AI, digital infrastructure and MIS, therefore, benefits from huge economies of scale and scope.

4.2.2 BUSINESS CONTEXT

AI and digital technology are used to automate business processes in a comprehensive digitalization program. For example, to automate customer-facing business processes, especially to enhance the user experience in areas such as new customer acquisition, policy e-service, and online claims management, and internal processes such as risk management, digital marketing for cross-selling within and across ecosystems, and coordinating B2B relationships with economic partners such as automotive dealers and workshops. In automotive claims, 70% of claims involve superficial damage, and the insurance app uses a picture to estimate the damage and offer an immediate settlement into the e-wallet of the customer.

The business model of Ping An is hugely complex but can be described in a meta-model and then by a series of more detailed sub-models for each ecosystem. The meta-model is to treat data as the core element in the creation of value, and most business activities generate vast amounts of big data, e.g., search and buying behavior, customer profiles, telematics data, responsiveness to advertising, and customer financial profiles. Long-term capital is invested to exploit the big data resources from each ecosystem, and continuous investments are made into talent and the generation of patents, or more generally, intellectual property (IP). At the level of an individual product, the business model for the telematics insurance app is described.

4.2.3 PING AN'S TELEMATICS APP

In 2019, the telematics application had 9.5 million monthly active users, and captured detailed driving behavior in the form of physical behavior, such as acceleration, deceleration, cornering speed, centripetal force, and use of phone while driving. An AI algorithm combines the driving and customer big data to create a unique customer profile, which is used to automate the assessment of crucial insurance business processes, personalized risk, and pricing. The insurance service benefits from the general AI applications to support standard customer lifecycle business processes such as new customer acquisition, security, customer identification, policy management, customer renewal, and cross-selling. Insurance-specific AI applications are also used to support claims management.

The MIS and digital infrastructure connects the AI technical components with other services, including links to thousands of dealerships, automotive workshops for repairing vehicles, and garages for maintenance.

4.2.4 ETHICAL, REGULATORY, AND LEGAL ENVIRONMENT

Although not the focus of this case, it is relevant to note that Ping An has benefited enormously from the historical legal framework in China, because it invested early in ensuring that it had a comprehensive range of business licenses to operate in a range of financial markets as a non-government insurance and banking organization. In addition, it could be argued that the Chinese market has been less restrictive in the use and exploitation of personal data in AI applications such as facial recognition, customer identity, and customer profiling across different served markets, when compared with the U.S. and especially with European GDPR legislation [Allen and Masters (2020)] and ethical frameworks [EIOPA (2021)].

4.2.5 PING AN CASE DISCUSSION

The telematics app is primarily an insurance app, which is part of the Finance + ecosystem [Economist (2020)], but also incorporates important aspects of the automotive ecosystem.

It is, therefore, an example of synergies across ecosystems in areas such as cross-selling of insurance to customer buying vehicles, and cross-selling of vehicle repair services to insurance customers.

Ping An has built a range of digital platforms for specific products and services that host a set of narrow AI systems. These platforms form the basis of the four broad ecosystems of customers, Ping An services, and economic partners of Ping An, for financial services, health, automotive, and smart cities [Ngai (2018)]. Each ecosystem has a close focus on the customer so that it can cross-sell products within the ecosystem, e.g., insurance to a bank customer or vice versa, and across ecosystems, e.g., insurance to an automotive customer based on brand affinity, customer value, and ease-of-use.

The key individual, "narrow" AI applications follow the customer lifecycle model from AI robots in market surveys, AI agents to sell products, service policies through automated e-service robots, and claims management. The company claims that 82% of total service interactions with customers were managed by AI systems, which represents an impressive level of e-service automation and significantly reduces the cost to serve customers [Ping An (2021)]. AI robots are being used for inbound and outbound calls and sales. In claims management, automated AI systems account for 83% of all consumer claims. There may be a law of diminishing returns here, and human oversight to handle exceptional or unusual cases will always be needed. However, the norm is already that customer interaction takes place via AI systems.

Ping An's strategy starts with a technology-driven business model for AI insurance, which generates an AI data flywheel effect and leads to rapid customer growth. The huge amount of customer behavior data is used to train AI algorithms and improve business processes, which in turn lead to further product innovation and improved customer acquisition and retention. This creates economic and data scale, which is then exploited further by expanding from insurance into insurance-related activities in what it terms an ecosystem that includes economic partners such as automotive repair workshops and sales outlets [Catlin et al. (2018)]. The ecosystem strategy creates significant barriers to entry for new competitors, e.g., the database of customer behavior and associated insurance knowledge, sophisticated AI systems, and relationships with economic partners that may be difficult to replicate. In addition, economic scale confers further advantages because there are clear technology economies of scale in the development of AI systems that can be shared across ecosystems – such as security and digital marketing, and the hosting of the technology infrastructure and MIS on data platforms – and significant marketing economies of scale, particularly in reducing the unit cost of acquiring new customers.

4.3 Tesla – behavioral insurance in practice

4.3.1 AI TECHNICAL COMPONENTS AND DIGITAL CONTEXT

Tesla is a market pioneer and leader in electric vehicles and autonomous driving. AI algorithms, big data, and digital technology are in its core DNA, so it makes sense to enter a related market, which is fundamentally about handling data and in particular risk assessment. The shift from traditional sources of data to behavioral risk assessment is a market discontinuity and, therefore, creates an opportunity or opening for new entrants [EIOPA (2019)].

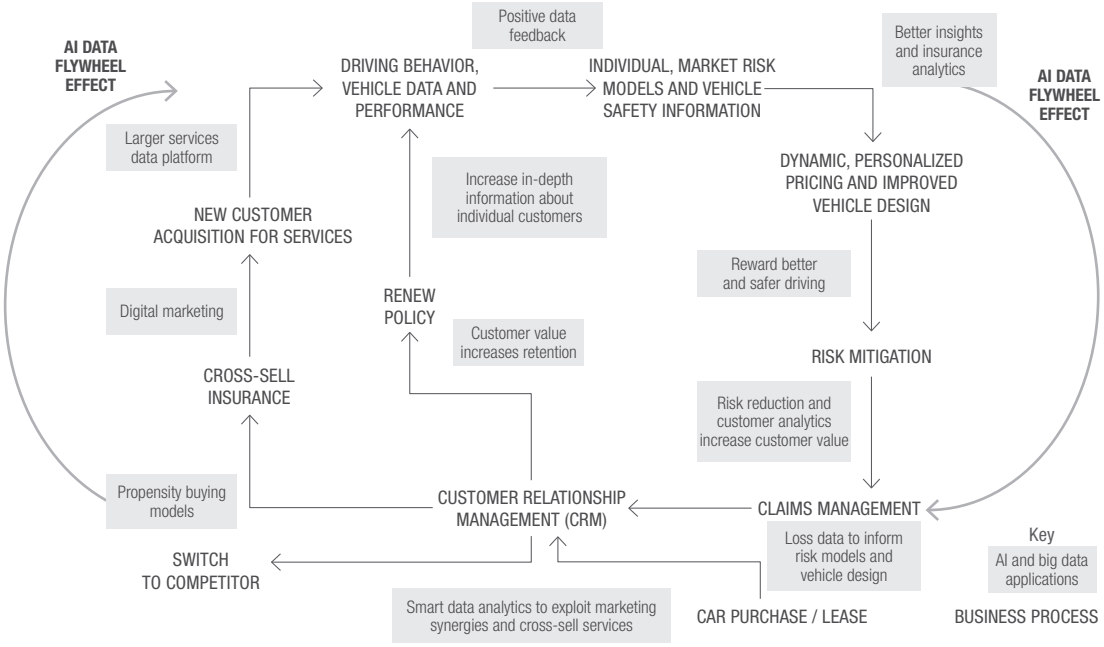
In existing, traditional insurance markets, established insurance carriers use their historical datasets, digital infrastructure and MIS, and knowledge of risk and claims as significant barriers to entry – knowledge and data effectively block or at least impede the launch and growth of new entrants. However, these datasets are based on traditional demographic information, and legacy digital infrastructure and MIS, which have much less value, perhaps even negligible value, in a behavioral risk market. The new digital technology, especially vehicle telematics, vehicle safety, accident data, and claims losses for electric vehicles are all brand new, which means that the behavioral insurance market for e-vehicles has the characteristics of a new technology market rather than an established, mature, insurance market.

4.3.2 BUSINESS CONTEXT

The brand advantage and market position of insurance carriers, especially in distribution, operations, compliance, and access to secondary markets for capital and risk, are extremely valuable. However, Tesla will exploit its global brand strength and particularly strong affinity with its customers to cross-sell insurance services, in much the same way that technology companies such as Apple sell services and software in addition to the phone and computing hardware. It will also take a digital first approach in designing operational systems and e-service capabilities, which may have significant advantages over insurance carriers' legacy systems. Tesla's scale and access to capital funding mean that the financial barriers to entry into insurance markets are not a significant consideration.

An expanded version of the simplified business model concept from Figure 2 is used to illustrate Tesla's use of AI technology

Figure 3: Tesla's insurance business model and use of AI technology



to create a disruptive insurance business model – see Figure 3. Starting with a new car sale or lease, data analytics are used to create cross-selling opportunities for insurance services, typically based on propensity buying models. Tesla has adopted a typical new entrant strategy by offering high-value insurance services, claiming to undercut competitors by 20-30%. Their initial efforts were assisted by the fact that established insurance carriers had very little knowledge and data on which to base the potential exposure resulting from claims to fix e-vehicles. New insurance customers increase the volume of data and improve the accuracy of risk assessment from driving behavior. There is also a network effect because insights about road safety, routes, and safe driving can be shared across the community of Tesla drivers.

The telematics data from the car provides insights into both the performance of the driver and the vehicle, which can then be related to geographic location, weather information, driver profile, and road position and layout. The potential for generating rich insights to mitigate risk, improve driver behavior, reduce future claims, and offer personalized pricing that rewards better and safer driving, adds significant value to customer interactions and is likely to improve customer retention. The overall effect is to create a positive growth cycle where growth in data improves AI applications and business performance, which in turn attracts new customers and continues to increase the volume and range of big data. This has been termed the "data flywheel" effect [de Véricourt and Gurkan (2020)] and is shown in the diagram as a positive direction of change, which stimulates a continuous growth cycle.

4.3.3 ETHICAL, REGULATORY, AND LEGAL ENVIRONMENT

Insurance firms in Europe and U.S. need to ensure that their data management practices and privacy policies conform to the strict data protection regulations in both countries. In Europe, the General Data Protection Regulation (GDPR) regulations require firms to protect privacy and personal data of all E.U. citizens. GDPR defines personal data as any "information relating to a person who can be identified, directly or indirectly" [Keller et al. (2018)]. Consequently, any data that enables identification of an individual is subject to strict GDPR rules.

Lawyers have argued that big data analytics are in many cases incompatible with GDPR, e.g. Zarsky (2017). However, insurance firms must somehow balance innovation with regulatory compliance, which is difficult at the cutting edge of practice, e.g., Tesla's leadership in autonomous driving and personalized services for individual customers. For example, Tesla Model 3 cameras monitor the surrounding environment and record vandalism, which has come under scrutiny by the

State Commissioner for Data Protection because it may be an infringement of GDPR [Andernach (2021)]. Tesla's use of customer data to personalize its insurance products in the U.S. has also received attention and is subject to individual U.S. state laws [Bellon (2019)].

Under the regulatory patchwork model in the U.S., each of the 50 states have different definitions of personal data, which is likely to lead to high compliance costs [Bayley (2020)]. The situation in China is also changing and the Personal Information Protection Law (PIPL) will come into force in 2021. KPMG's analysis shows that it has similarities with Europe's GDPR and is likely to lead to a stricter regulatory environment in China concerning the use of big data and AI systems [KPMG (2020)].

4.3.4 TESLA CASE DISCUSSION

By entering the behavioral insurance market early, Tesla gains several distinctive advantages: it builds skills and knowledge associated with the new telematics technology and associated data analytics problems, it places the company in a favorable position as behavioral insurance becomes mainstream, and it gives the company important insights into new forms of risk differentiation, and an associated understanding of how to actively reduce claims and accidents. The data from the insurance business could also be used to improved vehicle safety and is likely to influence the design of future vehicles.

5. CONCLUSION

A framework definition of AI is proposed in Figure 1 that captures the key technical dimensions of an AI system and places these in a broader business and regulatory context. This approach is important because it provides a more nuanced perspective on how to analyze and evaluate AI technology by relating AI to business and regulatory themes, i.e., a socio-technical or business system. Big data is already recognized as a crucial input for the design and operation of AI technology, and it is shown that links to the existing MIS and digital infrastructure are also crucial in the successful deployment of AI systems.

Most AI systems in insurance are focused on individual business processes, which are the basis for product and service innovation. The combination of AI business process capabilities and product innovation have significant effects on the overall business model, whether this is to improve its performance through reduced costs and improved service, or to radically change the nature of the offering, which then creates a brand-new business model that has the potential to disrupt the market, e.g., behavioral insurance. AI technology should, therefore, be viewed in a broader digital and business context to make sense of how AI technical components and the business context influence, and are influenced by each other, in a reflexive relationship.

There are some important common characteristics to both Tesla and Ping An. Both companies have developed a technology and data-driven business model approach, where digitalization and big data are taken as the starting point for the design of business processes, product innovation, and customer interaction. In the late 1990s, at the height of the internet boom, Charles Schwab described itself as a technology company in the brokerage business. This is also true of Tesla and Ping An – they are technology companies in the insurance market. Both companies still enjoy the enormous benefits of the internet for distribution to support new sales, delivery of the insurance service, and to offer e-services to existing customers. The key difference between today's AI systems and the digital leaders of the 1990s are network effects in marketing, which are combined with rapid data growth and evolution of AI technology from improved training, which has been termed the AI data flywheel effect [de Véricourt and Gurkan (2020)].

Their strategies and business models resemble those of fintech companies rather than an automotive company and an established insurance carrier. The technology strategies of the two firms follow a digital first approach because it is viewed as the natural way of improving business models, by adopting AI and achieving improvements in business performance through digital transformation. Technology is developed in-house, and emphasis is placed on fast prototype development and evolution of systems that are built on modern technology platforms that can exploit open technology and embrace new advances in areas such as image recognition, machine learning, security, data analysis methods, and computing innovations generally. The strong funding of both companies through shareholder investments mean that they can adopt a long-term approach to technology investment where the focus is on building market share and data scale rather than short-term profitability concerns, again, a feature of fintech markets rather than a mature insurance market.

The Tesla business model diagram in Figure 3 is a clear illustration of the causal model of digital transformation and it shows the roles and effects of individual AI applications on business processes, product innovation, customer value

and experience, and business benefits. Big data is essential for AI systems because it is required to train and improve algorithms, and to offer personalized services based on individual customer data. In parallel, customer growth is important because it funds continuing investments into the broader digital and MIS infrastructure that links individual AI applications together to form an insurance enterprise system.

Tesla has exploited the market discontinuity in the transition from traditional risk models to behavioral risk and its natural advantage regarding access to personal and vehicle behavioral data. It has then extended its offering to include vehicle repair, which in turn, provides important insights into future design improvements. Ping An has followed a similar path by exploiting its data analytics capabilities and access to a large number of customers to offer a behavioral driving app, and has extended beyond insurance services to offer an enhanced claim and repair service through close B2B relationships with automotive dealers and repair workshops.

Some parallels exist with the implementation of ERP systems in the 1990s and a brief comparison with Cisco, a widely recognized digital leader of that era, illustrates the point. Cisco's digital strategy was to build business capability by embracing digital technology throughout its operations and it focused on closing the loop on all its business processes. Cisco focused on automating all business transactions to create a common information blueprint for its enterprise, which then gave it strategic advantages, in particular the ability to integrate newly acquired companies extremely quickly.

The key difference between Cisco's ERP system and today's AI technology are that Tesla and Ping An are building intelligent business processes that increase the scope of automation to activities that required human intelligence in the past. The second-order implications of these AI systems are that AI leaders are enjoying data scale effects, which accelerate business growth, and big data in a symbiotic manner. They may also create new economies of scope by enabling companies to diversify beyond what were traditional market boundaries, such as automotive and insurance, or insurance and banking.

The insurance industry is evolving and developing novel and sometimes radically different business processes, products, and business models that take advantage of new technologies, in particular big data and AI systems [Naylor (2017), Holland (2019)]. Innovation in the insurance market has the potential to create significant benefits and structural changes to individual firms and insurance value chains, as well as changing the nature of relationships between insurance firms and their customers. While these innovations should be encouraged, a laissez-faire approach to the regulation of AI technology would be a mistake because the risks associated with AI systems in insurance – e.g., unfair discrimination, exclusion, loss of privacy, and unfair distribution of benefits from innovation – are too important to neglect or ignore.

The regulation of AI systems should distinguish between legal norms such as GDPR, social justice and fairness [Rawls (1999)], which is of particular relevance regarding the distribution of the benefits from AI systems [Schwab (2018)], and ethical and regulatory frameworks. A risk-adapted approach is vital to ensure that regulation is focused on those areas that matter most to each stakeholder. In an AI context, the problems of opacity and lack of explanations on how AI systems operate mean that there are significant risks to consumer confidence and the regulation of insurance markets. Time is, therefore, of the essence in designing suitable approaches to manage this new wave of business models and AI insurance products that considers the different and sometimes competing needs and requirements of insurance firms and their customers, and regulatory and government bodies.

Future research opportunities include the analysis of the interactions between AI systems and business models and to explore the topic in different organization and market contexts. There are two broad trajectories for AI systems in insurance over the next decade: (1) better narrow algorithms and (2) broader algorithmic scope. Improved algorithms are almost inevitable with the growth of big data and access to cloud computing. The managerial question is how quickly will these improvements be realized and what are the limitations of these technologies? The other avenue to be explored is broader algorithmic scope, and it seems likely that if AI technology follows MIS theory, then it will evolve into an organization-wide technology and extend into the insurance value chain.

The regulatory aspects of AI need to be balanced with the need for innovation, otherwise customers may not reap the rewards of AI technology or gain trust in its use in insurance. The role of AI startups also deserves closer attention because they play a crucial role in facilitating incumbent insurance firms to implement novel AI solutions and as new entrants into the insurance market with disruptor business models.

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THE CHANGING FACE OF INSURANCE

JOHN PYALL | Senior Product and Wordings Manager, Great Lakes Insurance SE, Munich Re

ABSTRACT

COVID-19 has had a profound impact on the insurance industry, not only on the results of the business lines but also on the way customers, regulators, and the insurers themselves look at how the business operates. This article looks at the challenges that insurers have faced over the last few years, the potential issues insurers need to address in order to keep themselves relevant, and how they can take the necessary steps to adapt to the dynamic market situation they find themselves in.

1. INTRODUCTION

The COVID-19 pandemic has had a profound impact on our world, and there have been few, if any, that have not been touched in some way by it. The insurance industry, like all other businesses, has also been enormously and profoundly impacted. There has been a substantial shift within the industry to match customer requirements and the industry itself has had to change in order to manage the demands that have been put upon it by the many stakeholders it has to interact with.

The customer model is changing, with over 50% of customers fully prepared to purchase insurance from non-traditional players,[1] with most customers worldwide researching, if not purchasing, the product they intend to purchase via digital channels. Insurance companies have had to react, not only to the changing face of customer demand, but also to the increased regulatory burdens and the significant internal cultural challenges of the last couple of years. This article looks at the issues and challenges insurers have faced and what they may need to overcome them.

2. THE CHANGE IN THE CUSTOMER VALUE CHAIN

Digital technology is changing what risks insurers cover and how they underwrite, distribute, and administer policies and manage claims (Figure 1). Insurance is becoming more customer-centric due to the perceived enhanced benefits and the need to respond to regulatory and legal requirements.

Insurance was already facing disruption from the wave of insurtech companies coming into the market, developing new products, new distribution models, or evolving the insurance process, and the impact of COVID-19 has been to markedly move this digital evolution into a revolution as insurance companies and brokers have had to allocate substantially more resources to the development of digitalization of the value chain.

The use of third-party resources is not new within the insurance sector, however the development of technology, and its possible use within the value chain, has led to growth in the ways in which third-parties have been integrated into the processes.

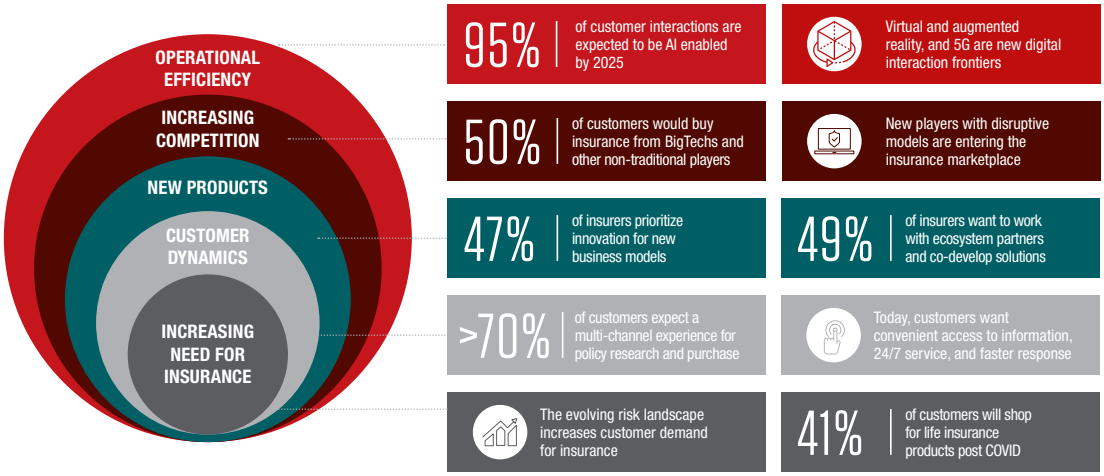
While the initial wave of insurtechs were looking to disrupt the existing insurance market, such as Lemonade, recent insurtech developments have more often looked to work in cooperation with the existing players.

[1] https://bit.ly/3kSiymH

Insurers are beginning to learn the hard lessons already learnt in other industries, such as mobile phone technology, that building everything in-house is not the most practical solution and partnering with relevant firms can give them more flexibility within the value chain. According to CB Insights,[3] as of May 2019 there were 45 innovation hubs created by insurers investing in widely different areas, from improving customer service with new digital tools to investing in blockchain and virtual reality technology. These partnerships are all looking at ways in which insurers can develop a more effective way of managing the customer relationship.

The goal is to create a seamless journey throughout the process, allowing flexibility to the insurers and their partners whilst creating the transparency that the stakeholders require. The problem is that insurers have concentrated resources

Figure 1: Changing business dynamics means distribution channels have to deliver more



Sources: Capgemini Financial Services Analysis, 2021; Capgemini Voice of Customer Survey, 2021 and 2020; Capgemini Research Institute, Consumer Behavior Survey; CRI Transformation Agenda post-COVID 19, May-June 2020; ITPRO, "AI will empower 95% of customer interactions by 2025" March 9, 2017; Medici, "Use cases of AR-VR in financial Services," July 16, 2020.

Figure 2: Insurance value chain

PRODUCT DESIGN AND DEVELOPMENT	PRICING AND UNDERWRITING	SALES AND DISTRIBUTION	POST-SALE SERVICES AND ASSISTANCE	CLAIMS MANAGEMENT
• Usage-based insurance products • Tailor-made products and services • New products (e.g., cyber insurance • Predictive modeling of disease development patterns	• Enhances risk assessments • New rating factors • New claims drivers and predictive models • Price optimization practices • Churn models	• Automated advice • Disintermediation of sales processes • Sophisticated customer relationship (CRM) systems • Increased frequency and customer interaction: "next best action"	• Smartphone applications • 24/7service, accessible from any location • Chatbots • Safety warnings in case of flood, storm, hail, etc. based on geolocation data	• Enhanced fraud analytics • Optical character recognition (OCR) to estimate repair costs from images and videos • Automated segmentation of claims by type and complexity • Automated invoice verification and payment process

Source: EIOPA (2020)[2]

[2] https://bit.ly/2ZywlX6
[3] https://bit.ly/3CVxO8n

on legacy systems in order to mine the data from these systems. Whilst this can be a real benefit, what is perhaps needed is a cultural shift from looking inwards at our own requirements towards putting the customer at the heart of the insurance journey.

3. WINNING BACK THE CUSTOMER

It is difficult for insurers to obtain a positive perception of insurance from customers. This is because customers associate insurance with negative events and the interaction with insurance tends to be at stressful times, when they need to make a claim on their insurance.

Customers tend to relate buying their insurance to purchasing other goods and services they require. The "Amazonification" of the insurance industry is occurring as insurers attempt to catch up with customer expectations. Given the cultural shift in purchasing patterns that has occurred due to the COVID-19 epidemic, the need to match this expectation has become even more pronounced. In a PWC survey from June 2020, 41% of the respondents said that they are likely, or more likely, to switch providers due to a lack of digital capabilities.[4]

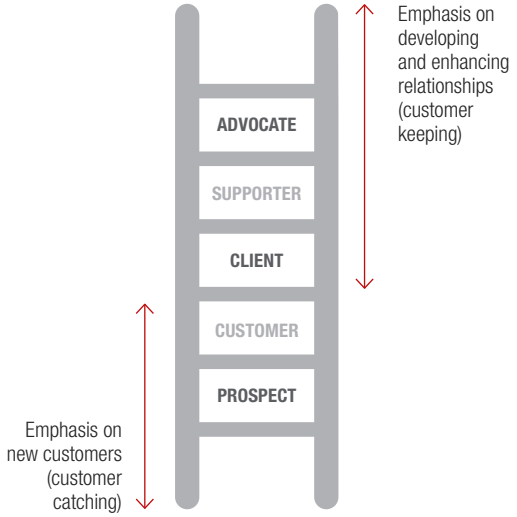
Customers expect the following from their insurers:

- **Customer simplicity:** customers expect a simple purchase journey. Whilst this is relatively easy for firm such as Amazon, the regulated nature of the insurance industry makes it much more complex, as there are necessary legal steps that must be undertaken. However, the learning from Amazon is that their customer journey is intuitive and does not ask unnecessary questions, making the process relatively pain-free for the customer and one they will want to repeat.
- **Clear communication:** communication should be in the format that customers can readily access and in media that they chose to use. Insurers need to design their products accordingly. Positive touchpoints with customers enhances the relationship, especially at times when the customer is not in a stressful situation, i.e., during a claim.
- **Transparency:** steps customers take along the process, both from a product and a claims perspective, need to be clear and visible to them. After purchasing a product through Amazon, customers can track their product through until receipt. Insurers should be able to do this with a claim, so that a customer understands where they are in any step of the process.
- **Effective processes:** the customer needs to be core to the decision-making process rather than an add-on. They need to be allowed to make decisions easily and in a time-efficient manner. Insurance providers have often been driven by what they need to provide internally to their systems and lose sight of the customer perspective.

Insurers have recognized that they must change their customer experience, through the development of apps to provide more interaction around their products, creating more support for customers, and additional positive touchpoints with the brand. The aim for insurers is to bring customers in and develop loyalty to the brand. The obvious point behind this is that retaining customers is cheaper and more efficient than gaining customers, and that people are more likely to consider purchasing goods and services from a brand that either they or their friends and relatives have already had a good experience with.

The idea is to promote customers up through the loyalty ladder (Figure 3),[5] by providing good service and experience to them. The best brands rely on their customers to promote the brand, which is ever more important in a digital world where people can share both good and bad experiences through social media.

Figure 3: The loyalty ladder



Source: Christopher et al. (1991)

[4] https://pwc.to/3igxZTG
[5] Christopher, M., A. F. T. Payne, and D. Ballantyne, 1991, Relationship marketing: bringing quality, customer service and marketing together, Butterworth Heinemann/CIM

The problem with insurance is that, while customers understand the need for insurance, until recently the only interaction they would have had was to either pay their premiums or to deal with claims, neither of which engenders the most positive of experiences. Consider the Amazon experience, with Amazon you are looking to purchase something you want or need, and it comes in (generally) a tangible form in the next few days. With insurance, you purchase a promise that if something happens that falls within the terms and conditions of the policy they will indemnify you, i.e., put you back in the same position. The whole point of insurance is that customers do not benefit (except for peace of mind), they just break even.

A good example is the issue of business interruption, the lack of clarity around business interruption coverage has led to a U.K. Supreme Court ruling (Financial Conduct Authority (FCA) versus Arch Insurance (Arch) Ltd. and others)[6] substantially in favor of the policyholders. In the U.S., according to the COVID Coverage Litigation Tracker of Penn Law, as of July 19, 2021 there were just short of 2000 cases filed on business interruption.[7] In France and Germany, there have been well publicized decisions. Paris' commercial court ordered AXA SA unit, Axa France IARD S.A., to pay €45,000 to restaurant group Maison Rostang SAS over the closure of one of its restaurants and in Germany, Versicherungskammer Bayern had to pay €1.01 million to the operator of the Augustinerkeller beer garden. Regardless of the outcomes, the costs of dealing with these claims may have been saved by having greater customer transparency around the wording. The customer journey should always be reviewed to avoid similar expensive outcomes, and the greater use of information across the various departments of the company would ensure this.

Insurance companies have begun to realize that in order to improve the customer experience, they need to provide more positive engagement with the brand. Companies have moved from insurance to assurance, looking at ways in which they can positively assist customers.

Vitality, a company founded in South Africa, with operations in the U.K., Asia, and the U.S., has developed a health insurance model that encourages and rewards members for pursuing a healthier lifestyle. Members can access a range of benefits as part of their plan, as well as earn rewards points that can be converted into gifts or services that they can use.[8] Aviva launched their smartphone dash cam in the U.K. in 2018, which was available regardless of whether people had an Aviva policy or not.[9]

For Pet insurance, BBM launched free access to FirstVet video consultations with qualified veterinarians through the FirstVet app.[10] Customers could even have the first contact with a managed veterinarian response through the app.

All these examples provide a positive customer experience and could help reduce claims, create fitter people, and improve driving, which creates a positive brand image around caring for customers.

Emerging from the pandemic, insurers must develop different growth opportunities, looking at new partnerships or segments where other insurers may have withdrawn from. Innovation of existing insurance using such ideas as parametric triggers can create unique selling points and differentiate brands. Insurers need to understand that customers' buying habits have changed and must adapt accordingly. Customers are not willing to read through forty-page documents on their mobile phones, hence simpler and easier to understand formats that are purpose built for the customers' preferred means of communication should be the norm.

What appears clear from these and other examples is that the more that insurance companies interact with customers outside of stressful situations the better their customers' perceptions become, although, insurers' responses during claims situations is still the vital ingredient of the product. Customers demand greater support in general and a rapid response when they need it most, the question for insurers is whether they can match the demands of their customers with the timeframes and flexibility they require.

4. THE DEMAND FROM REGULATORS

Concerns regarding the coverage available in the wake of the pandemic have been raised by regulators. In the U.K., the Chair of the U.K. House of Commons Treasury Select Committee wrote to the Association of British Insurers requesting information on the approach that insurers have taken to ensure continuing customer support during the pandemic. Various states in the U.S. have proposed

[6] https://bit.ly/3zRmlPN
[7] https://bit.ly/3kUYDDD
[8] https://bit.ly/3zUdwKs
[9] https://bit.ly/2Y0YvJA
[10] https://bit.ly/3F6aHde
[11] https://bit.ly/3F6avuw

amendments to their legislation to require insurers to pay business interruption claims.[11] However, these proposals have only received a lukewarm reception, with fears over the impact retroactively opening up contracts would have on future risks and the longer-term concerns around policyholder protection and insurance companies' financial stability. The recent FCA v Arch case was an example of the regulator stepping in to provide clarity for customers in an insurance field.

Ombudsman services also are increasing pressure. Which magazine found that in in 94% of cases, the FOS (Financial Ombudsman Service) ruled in the customer's favor, stating that: "While it's right insurers consider the policy terms and whether any exclusions apply, we still expect insurers to take into account unprecedented situations, such as the one created by COVID-19, when deciding whether to rely on an exclusion."[12]

What is clear is that there has been and will continue to be a greater degree of intervention by regulators in the insurance sector over the next few years. This focus will revolve around two key areas, sustainability of the firms within the industry and ensuring that the firms are treating customers fairly.

The initial steps from regulators revolved around ensuring that insurance companies could provide continuity of services. Some governments included insurance in the list of "essential" services, such as New Zealand, whilst others monitored the implementation of business continuity plans or provided specific guidance on doing so, as well as attempted to reduce the administrative burden of regulatory and supervisory functions. What they were seeking was an understanding that insurance companies could implement business continuity plans to maintain the delivery of essential insurance functions, including but not limited to digital service delivery. The European Insurance and Occupational Pensions Authority (EIOPA) issued a press release recommending that business continuity plans be implemented and that insurers adopt the steps necessary to maintain services to their clients and ensure business continuity.[13]

Hand in hand with this approach was the need from the regulators to ensure that the insurance sector was able to survive the chaotic changes. Certain portfolios, such as hospitality and event insurance, were facing overwhelming payouts that were not encountered previously or even considered, while other portfolios, such as travel, either came to a practical standstill because of the government lockdowns or substantially reduced, such as motor, due to lack of customer mobility. At the same time, insurers' invested assets in equity and bond markets could have been impacted by the pandemic. The collapse of the financial markets combined with increased claims and reduced premium revenues could have led to substantial insolvencies and the inability of insurers to respond to customer needs. This, however, does not seem to have materialized. Whilst there has been some restructuring in the insurance markets, and some withdrawal from certain product lines, in general the insurance market has managed the situation relatively well.

The regulators, however, still have concerns and there have been repeated requests for qualitative and quantitative data on the impact of COVID-19. Regulators have looked for information on investment risk, data on invested assets (Belgium, Czech Republic, and Spain), and/or additional data on asset classes of particular concern (such as equities in Hong Kong, China or corporate bonds in the Netherlands or various types of impacted asset classes in Korea). Government regulators have also in some cases requested insurers to consider the impact of various scenarios on their liquidity. For example, in China insurers have been asked to conduct stress tests and in Sweden they have been asked for an assessment of the impact of a further decline in equity markets.

Several regulators have requested information on potential claims exposure across different lines of business (Belgium, Bermuda, Chile, Czech Republic, Lithuania, and Spain) or actual claims submitted (Costa Rica, South Africa, and Texas for workers compensation). The Australian Prudential Regulation Authority has contacted intermediaries to seek their views on potential large losses[14].

Whilst being careful to understand the impact of the pandemic on the viability of the industry, regulators have also focused heavily on the response by insurers to the needs of policyholders. Regulators have been more willing to provide guidance on coverage and exclusions related to COVID-19 losses, either across all relevant lines of business (Australia, Colombia, France, and Portugal) or for certain lines of business, such as life and sickness in Bulgaria. The New York Department of Financial Services required all insurance companies "to provide certain information regarding the

[12] https://bit.ly/39QIwIm
[13] https://bit.ly/2Wq9Fat
[14] https://bit.ly/2XZQsNk

commercial property insurance it has written in New York and details on the business interruption coverage provided in the types of policies for which it has ongoing exposure."[15] As already mentioned, the FCA in the U.K. invested in a Supreme Court decision to clarify some points in respect to business interruption coverage and the Swiss Ombudsman of Private Insurance commissioned Law Professor Dr. Walter Fellmann to issue a legal opinion regarding selected epidemic insurance wordings[16].

In addition, there has been a substantial increase in demands for feedback to regulators in relation to customer performance in the insurance industry. The General Insurance Pricing Practices[17] in the U.K. requires firms to ensure that their renewing customers pay no more than the new equivalent business price, that firms implement processes ensuring fair prices for products, and ensuring customers wishing to cancel auto-renewal have easy options to do so. In this regard, the FCA has implemented reporting requirements to ensure the ongoing supervision of firms that participate in the home and motor insurance market. In Europe, EIOPA Pillar 3 of the Solvency II regime has potentially led to the situation where regulatory reporting is even more complex, requesting numerous quantitative reporting templates that will require voluminous data that may have to be collected using legacy systems.

If the European insurance industry follows in the footsteps of the European banking sector, then the next step could be real time reporting. In Austria, banks have teamed up with the regulator to use new technologies to create a new regulatory value chain. Austrian Reporting Services GmbH (AuRep), which is co-owned by seven of the largest Austrian banking groups and represents 87% of the market, works as the central interface between the banks and the OeNB (Oesterreichische Nationalbank). Granular bank datasets are captured automatically for supervisors to interrogate in whichever way they want, while the banks retain control over their commercially sensitive data, maintaining only the so-called "passive data interface" on the AuRep platform.[18]

The issue that insurers face is that while trying to build up a transactional customer facing system that enables the companies to become customer centric, the information that is required from the regulators is analytical, dealing with risk, assets, finance, and actuarial models. The need to provide the level of granularity in reports and dashboards for this information could have an adverse impact on the actual customer experience the insurer is looking to develop. An example may be that the insurer must raise questions in the customer journey, not because they need the information to enable them to provide an offer for the client but to provide the data to the regulator, or for considerations internally. When developing their requirements, insurers need to balance the business needs with the governance framework.

In addition, insurers are living with legacy systems that make getting hold of such necessary data either difficult or impossible. This is because it was never requested in the first place or that they do not have the necessary internal models to interrogate the system to obtain the correct data from it. Insurers need to build in processes that take account of the changing requirements for data, not only from regulators but also as a result of system enhancements, developing business needs, and changing market environments. COVID-19 has taught us that there is a need for even more flexibility internally to effectively manage such pressures in the future from both the regulators and the market.

5. THE INSURANCE CULTURAL ISSUE

Insurance companies have developed over 300 years into broadly similar beasts. They have had hierarchical structures where people understood their functions. There was a focus on structure and compartmentalization with clear delineation of departments and roles and responsibilities. What this enabled insurers to do was to develop individuals with a depth of expertise in a specific line of business or area and develop a core unique selling proposition around this expertise.

Whilst this was beneficial, it engrained within the proposition an almost risk averse culture. The employees were not empowered to take decisions or calculate risks outside of their own remit. Innovation was stifled as companies audited performance against set benchmarks and any deviation would be noted adversely. The silo mentality of the culture did not allow insurance companies to take advantage of new opportunities outside of the core areas of the business and made them vulnerable to new and more innovative firms that could act faster and more innovatively to developing trends within the industry.

[15] https://bit.ly/2Y3J0AN
[16] https://bit.ly/3ijFV6Q
[17] https://bit.ly/3ol2FY0
[18] https://bit.ly/3mftVED

However, all that has been forced to change, and thanks partly to the COVID-19 situation, hybrid workforces have become the norm. A recent Deloitte survey[19] has highlighted the impact COVID-19 has had on the industry, with 60% of the responding firms indicating that they had furloughs or layoffs and 50% seeing either compensation reductions or raises and bonus limitations or promotion freezes. Working from home impacted employees substantially, with issues around ergonomic space and personal responsibilities such as childcare. While companies responded quickly to the software and hardware requirements around the new hybrid working patterns, many have not been able to adapt so quickly to the new work environment, although some such as Nationwide in the U.S. have embraced it.[20]

To function in this new, modern digital environment, where a customer driven approach must be matched with analytics that support a quick and flexible underwriting of new opportunities and the need to supply the reporting frameworks required by internal and external stakeholders, insurers have had to adapt to survive. Employees are now developing cross-functional expertise, companies are promoting a more flexible approach to risk taking, and developing processes that consider that cross-functional requirements. The original concept of having it 100% right before implementation has shifted to move quickly and adjust during a pilot phase.

The problem insurance companies have is to develop the new cultural mentality and embed it within the organization. There is no "one size fits all" and each company will have its own slant on what makes a successful culture. However, there are certain common themes that run through winning cultures:

- **It starts at the top:** the mission statement should come from the board of management and be embraced by them. This should create both value and purpose and manage expectation within the company. With a clear understanding of what the cultural of the organization is all about, or endeavoring to be, it is able to attract individuals who are drawn to this type of culture and creates an advantage when seeking talent.
- **It must be seen:** the outcomes must be clear and measurable against stakeholder expectations, such as customers, regulators, and your value chain. Its impact on the business must be understood and successful outcomes need to be fed back to the stakeholders so that they can understand the benefits.
- **Employees must buy into the culture:** without the active engagement of the key stakeholders any developments are doomed to failure. Active engagement, good communication, and positive rewards for embracing the culture all allow it to grow.
- **Empowerment of the individuals:** allowing employees to have their say regarding the culture, challenging preconceptions, and encouraging innovation and development are essential for success. Ensuring that the employees are brought with the management along the journey, rather than pushed into it, will allow for a smooth transition into a new culture and avoids the risk of falling back into old ways.
- **Continuation of the process:** the environment is constantly changing, and so insurance companies need to adapt. The culture should continually develop to consider new angles, whether social, economic or political (environmental, diversity, talent flight all being potential examples that could impact companies, departments and regions differently).

The link between the high-level aspirations of the company in regard to culture and the customer outcomes must be linked through performance objectives and incentives. It needs to be built into everyday practices until it is embedded and second nature. Identify the peer leaders in your organization, engage them, and actively bring them into to the change mechanism. If they can become advocates for the new culture then they will motivate the change in others.

Employees need to be enthused by the new culture, seeing the opportunities that it creates rather than fearful of the potential issues that change may bring. Training can help, but a nurturing and mentoring environment is a greater benefit.

6. CONCLUSION

Insurers have faced greater challenges in the last two years than at any time in the last five decades. There have been substantial changes imposed on companies, largely from external sources, that have meant that most companies are having to upgrade and develop solutions far more rapidly than ever before. As a result, their workforce has had to adapt and change into a more flexible, agile, empowered staff in an environment where the traditional face to face support is not there. The fact that insurers have managed the changes so

[19] https://bit.ly/3maBr3F
[20] https://bit.ly/3ogRBuZ

well speak volumes of their management and their robustness, however emerging into the new environment they will need to be even more dynamic to take on the new opportunities that are being presented by the changing customer environment.

To do this, the following needs to be considered:

- There has to be a customer-centric approach. All new products and services must be developed from the perspective of the needs of the customer. Rapid response to customers, in the communication format that they prefer, touchpoints that add benefit to the customer journey, and an outcome-based approach that satisfies the customer to an extent they become an advocate for the insurer's products. Look to offer non-traditional advice and services to create a unique selling point and differentiate your brand.
- Identify new growth opportunities, whether this is in different market segments or by innovating existing products so that they appeal to the customers' needs. Enable a culture where staff are challenged to bring about positive customer experience.
- Use new technology effectively to drive your customer-centric approach, engaging in partnerships to ensure lean processes while maintaining operational resilience.
- Engage with the regulators to understand their increasing demands and seek the best ways to coordinate responses to provide analytical data from your systems. Offer positive feedback to enhance the relationship and to ensure that regulatory requirements do not negatively impact on your customer experience.
- Futureproof your company by ensuring you have a flexible agile workforce that understands the dynamic market environment in which you are working and can respond rapidly to the need for change.

With increasing digitalization within the market and a consumer-led demand for a broader, technology enabled (although not entirely) approach, insurers are having to deal with a revolution rather than the previously slower moving evolution in the insurance sector. And, the rate of change has not yet slowed down and is unlikely to in the near future. In order to survive companies must move with the pace of the change. The mantra is adapt and thrive, remain still and you will not survive.

HOW TO DELIVER THE BENEFITS OF DIGITALIZATION AS AN INCUMBENT IN THE INSURANCE INDUSTRY?

BARBARA LIEBICH-STEINER | Chief Digital Officer and Head of Digital Strategy & Solutions, UNIQA Insurance Group

ABSTRACT

This article highlights the transformational journey of the author, the Chief Digital Officer of UNIQA Insurance Group, one of the major players in the insurance industry in Austria and CEE, during the implementation of UNIQA´s digital strategy and transformation of the way the company does business in order to stay relevant in the digital world.

The four essential dimensions of digital transformation and their impact on the current hybrid work environment will also be addressed.

1. INTRODUCTION

The message is clear for anyone who cares to listen: "The pace of change has never been this fast yet will never be this slow again!"[1] The exponential growth of technological possibilities versus the logarithmic development of large organizations is a huge challenge for stagnating and traditional industries such as banking and insurance.

A recurring theme I have observed while driving transformation and building state-of-the-art digital solutions for the past 20+ years in the financial services industry is that technology – even the best and most innovative – always acts a (powerful) enabler but is not the driver of real transformation, and that change based solely on technology only takes you so far. When building the first corporate customer portal for a major banking group with headquarters in Vienna, Austria and 18+ subsidiaries in CEE (Central and Eastern Europe), I was in charge of the development of a state-of-the-art technical platform. We included exciting and innovative features such as straight through electronic transfers, video chats, and online conferences, etc., which were groundbreaking in 2001. However, the really remarkable and sustainable achievement was that we completely transformed the way the bank approached and communicated with its customers.

Now, as the Chief Digital Officer at UNIQA Insurance Group, one of the major players in the insurance industry in Austria and CEE, I have the mission to develop and execute a digital strategy, and in 2016 led the effort to completely transform and digitalize the way we do business in order to stay relevant in the digital world.

This article highlights the process we went through to achieve our objectives of digitally transform UNIQA.

[1] Justin Trudeau, the Prime Minister of Canada, made this statement in his 2019 World Economic Forum Speech.

2. ACHIEVING TRANSFORMATIONAL CHANGE

The replacement of outdated legacy technology was only part of this endeavor. Technology only works as an igniter of change; real transformation starts with cultural change. UNIQA planted the "digital seed" right within the core of the company. In summer of 2016, we launched a new digital team within the existing organizational structures, endowing them with excellent talent, enough resources, and the guidance of our Group CEO and the Head of Group IT. We started the transformation from within. This was a risky path as the new, young, and innovative team had to face the forces of inertia head on.

There were two options for how to move forward with this new digital team:

- Placing the team outside of the traditional business and aim to develop innovative services very quickly, adding new digital products and services as an additional stream of income to the existing business model, or
- Transform and reinvent the business from within.

The first option promised faster results and probably more innovative solutions. The second one had the potential for a profound and sustainable cultural change and a deep-rooted transformation across the entire organization. Back in 2016, the clear message was: we want to transform our business from its core.

The advantage of driving digitalization from the inside was that UNIQA was able to develop in all digital dimensions:

- **Customer centricity:** understanding customer needs and being able to address their changing and growing demands – a crucial factor for sustainable revenue growth and acquiring new customers.
- **Automation:** achieving simpler, cost efficient, and high-quality processes by providing much greater levels of integration, transparency, and IT/business collaboration.
- **Corporate culture:** empowering employees through new ways of working, fostering a new team spirit, and collaboration. Working in cross functional and autonomous teams was vital to break up silos.
- **Innovation:** fulfilling innovation challenges in a large organization by encouraging a "startup" mentality.

The starting point was to deliver an exceptional customer experience that satisfies and even exceeds customer needs through the development of digital touchpoints. We placed the interaction with our customers at the heart of our customer facing applications. The possibility of gaining deep data-driven insights enables us now to identify patterns, make predictions, and respond to important moments in our customers' lives. Our online touchpoints – the myUNIQA app and customer portal – are constantly tailored to the needs of the users. MyUNIQA provides context-sensitive information and services and will be extended by the integration of third-party services. Direct communication channels, such as secure messaging and video chat, enable high contact availability and help to translate the high quality of customer experience established through our local sales agents into digital channels.

As the automation and improvements of existing processes is incremental to a high-quality customer experience, the next step was to digitalize and simplify the most important customer journeys. This is an ongoing endeavor that is only made possible through close collaboration between business and IT. As a necessary precondition, a new work style was homegrown based on agile principles but tailored to the needs of UNIQA. The goal was to significantly enhance our digital capabilities and foster business agility. Starting with the top management, these new ways of working were spread out through the organisation. A "garage" format was set up to explore new topics and business models, encouraging participants from different parts of the company to join and become part of the new movement.

With the growing digital mindset, cross-functional collaboration, and the usage of new technology, UNIQA was able to promote innovation, improve efficiency and time to market. The startup mentality of small autonomous teams within the company facilitates fast paced innovation cycles and the possibility of proposing new approaches and testing them right away.

3. THE COVID-19 STIMULUS

The COVID-19 pandemic has increased the level of complexity and at the same time accelerated UNIQA's path to become a digital and agile organization. As 95% of the complete workforce started to work from home within days of the first lockdown in Austria in March 2020, there was no time for training and preparation. This was a true test of the corporate

culture change initiated back in 2016. UNIQA's employees adapted quickly to the new rhythm and conditions of remote working. Internal surveys show that all groups of UNIQA employees report high job satisfaction levels in home office settings.

The next major challenge we had to face after the strict lockdowns were the "new normal" ways of working. With an ever-increasing number of vaccinated or frequently tested employees, the possibility of onsite work was back on the table. The motivation was manyfold: better office infrastructure, more social contacts, easier face-to-face communication, and a change in scenery. On the other hand, there were colleagues who did not want to come back to the office due to various equally understandable reasons. As a consequence, we progressively faced the situation where part of our (agile) teams was at home, while the other part of the team was at the office, creating the "new normal" hybrid work set-up.

The new challenge was to determine how could we apply what we had learned throughout the lockdown, and leverage our successful approaches to this new hybrid set-up throughout the organization, to further ensure the high job satisfaction and productivity that we are so proud of?

The answer is to start with the right mindset. Courage, commitment, openness, focus, and respect are the five agile values that are key for the successful digitization of the company culture of UNIQA and perfectly summarize the key values that are important to create a successful work environment. Scaling a work environment to "hybrid" is no exception to this. It was the trust in our colleagues, the honest but respectful feedback, as well as openness and courage to break new ground and trying out new ways of working, that allowed us to celebrate successes.

As a result, one might be spoilt for choice when choosing the right set-up for meetings and the desired mode of collaboration in the future. Be it physically onsite, remotely, or hybrid, each set-up has its advantages and disadvantages. To select the most productive set-up, our philosophy is to always start with why. What is the aim of the meeting? Depending on the goal the suitable meeting set-up will change. When carefully examining the approaches of our teams across the organization, we found that creative or idea finding processes, involving a lot of discussion, are best done in a physical set-up. Examples for this are collaboratively developing a new design for our group webpage or discussing entirely new features for the myUNIQA app to foster digital self-service for our customers. In contrast, meetings where interactions between team members are limited, e.g., a presentation or team jour fixes are suited for a remote set-up. While they take a lot of preparation, the hybrid set-up offers a valuable compromise. A hybrid set-up can combine the benefits of meaningful in-person conversation with the organizational flexibility of remote meetings. We continuously applied this method during user interviews even before the pandemic. Our researcher would sit together with a customer trying out our new information architecture on the webpage, while on the other side of the live stream our developers would gain direct feedback to their work and were able to relate better to real clients.

However, an absolute precondition to having this choice is enabling digital collaboration tools. This encompasses suitable hardware as much as the fitting software. Concerning the fitting software solutions, the company-wide streamlining of MS Teams as a communication tool and SharePoint to facilitate remote work environments also paved the way for the hybrid set-up in many ways. Following this, our remote team members were able to collaborate with onsite teams on shared documents during workshops or visualize input on the whiteboard feature, projecting said input on large screens in a meeting room for everyone to see. Regarding the suitable hardware, among other things, we are currently experimenting in training set-ups with 360° cameras, which display the entire room with all participants and automatically follow and focus on the moderators' movements. Here, financial investments really do make the difference.

We find the most significant point of leverage to enable a productive use of the hybrid set-up is the training of the team members. Especially, our engaged agile coaches and HR employees are the important facilitators of this transformation. As with every cultural change, it takes time, patience, and practice to foster an open-minded approach and the needed courage to try new methods and technologies after years of a different modus operandi. Encouraging and enabling UNIQA employees is an effort that is spread throughout all organizational levels. From special trainings for the executive management these efforts spread all the way to video tutorials for employees who might be challenged by a hybrid set-up, explaining how to best set up your remote workspace and how to best collaborate in this new environment.

4. CONCLUSION

In conclusion, technology alone is not sufficient to deliver the benefits of digitization to a company. For the UNIQA Insurance group, a deep-rooted cultural change from within the company, altering how we collaborate as employees and communicate with customers, was able to transform and reinvent the business sustainably. Understanding customer's needs, achieving cost-efficient high-quality processes, driving innovation, and empowering employees were the four pillars that helped make this change happen. Initiated by an incumbent from within the company, we were able to cope with the sudden changes to the work environment during the pandemic. And now, in the aftermath of the pandemic, the organization continues to benefit from those sustainable changes, paving the way for the "new normal" hybrid working.

Through fostering the right digital mindset, supporting with agile methods, and enabling through state-of-the-art technology we will continue to transform our culture to prepare UNIQA for the next challenges to come.

HOW IoT CAN DISRUPT CLAIMS PROCESSES

JÖRG TOBIAS HINTERTHÜR | Former Head of Smart Home Innovation Lab, Zurich Insurance

ABSTRACT

Internet of things (IoT) devices already provide an infinite treasure trove of data that is often overlooked among insurance companies. Using the example of how data from a water detector can fundamentally change the claims process of an insurer, this article will examine in more detail how IoT can help insurers improve the efficiency and effectiveness of their services and create entirely new customer experiences.

1. INTRODUCTION

In the insurance industry, innovations are still often only associated with new business. Many fintechs, insurtechs, and others concentrate on the application/closing process and new customer acquisition.

However, only a few deal with existing processes and innovations have a shadowy existence in the claims area.

As internet of things proliferates across society, even within people's homes, it is important to get a better understanding of the possibilities it creates, both for policyholders and insurance companies. In this article, we will use the example of a normal single-family homeowner to describe the possibilities that IoT provides, opportunities that tend to be overlooked by most insurance companies as of today.

2. THE CONNECTED HOME AND THE INSURANCE PROVIDER

While the introduction of new technologies and capabilities within people's homes have been gradual, the resulting environment has been nothing short of revolutionary, something that people living in the 1980s would not have even been able to imagine. People are now able to communicate with their homes and within their homes with their appliances. And I am not only referring to gadgets, or to put it more precisely, digital assistants, such as Amazon's Alexa. We can open the house door remotely, make sure it's locked remotely, turn the heater on or off from our offices, or even check who is at our door from thousands of miles away. All of these technological innovations have allowed our homes to become smart and as a consequence have created both challenges and opportunities for the insurance industry. These are opportunities that insurance companies are only now beginning to recognize and have yet to fully develop ideas on how to benefit from them.

The smartness of our homes is not restricted to ease of use, many homes now have devices that can even help prevent damage. Examples include the GROHE Sense Guard and Pontos from Hansgrohe. Both devices offer very good protection against tap water damage. They can detect micro leaks and they can also immediately interrupt the water supply in the event of a burst pipe.

In addition to these functionalities, a lot of data is generated that is becoming increasingly interesting for insurers. The devices, intended for the user, provide consumption and system values via an app. This information could be used at some point by insurance companies to generate premium prices. For example, an algorithm of flow rate and temperature in connection with the type of pipe can be used to predict when and what type of damage is to be expected. System temperatures can also be relevant when it comes to avoiding frost damage.

All of this will have a positive influence on the frequency and amount of damage in households, as well as in the home insurance sector. In terms of process, however, I still see great additional potential.

3. AUTOMATING CLAIMS

Despite all the advancements made in technology in recent years, cases of damages are still reported to most insurers by phone or email, be it directly or through an intermediary. The policyholder must then fill out various forms regarding the cause and the extent of the damage. Some insurers, though by no means all, do allow these forms to be filled in online, but many still struggle in terms of being user-friendly. On the insurer's side, the processes are also still traditional: the claim is recorded by the clerk and a claim is created in the claims system. If necessary, an expert is then commissioned manually. Only then do the claims service providers come into play, once again after manual commissioning, and the claim is fixed and settled.

From the customer's perspective, this is an extremely lengthy and time-consuming process. And it certainly is not in line with the online experience of new insurance business or other online services they purchase. The question is, therefore, why do we not use the data from the IoT to remedy this?

4. IoT AND THE INSURER

When discussing the water damage prevention technologies, I described how customers' homes can be protected from small leaks and bursting pipes using IoT technology. The alarm message of a water burst water pipe that the customer receives from the water monitor on their smartphone can also create a number of opportunities for insurers.

The alarm can automatically create a claim file in real time via a suitable interface with the claims system. Since the contract and customer numbers are known by the water monitor via the user profile, there is a direct assignment of damage to customer. The water monitor also transmits other important information. It is known where the damage occurred (basement, ground floor, etc.) and what happened, e.g., how many liters of water leaked. This allows a damage profile to be created based on some empirical values.

With this virtual damage pattern, the so-called "first notice of loss" is almost fulfilled. With this in mind, the claims process can be further automated. Using artificial intelligence (AI), the insurer can determine whether or not an expert should be called in. It can also notify the suppliers needed in such circumstances.

> *"The process costs on the insurer's side are greatly reduced since manual activities are significantly reduced."*

Thus, the process chain of standard tap water damage can be significantly automated. There is an immense gain in time, which not only reduces process costs but also follow-up costs. The earlier that the damage is discovered and mitigation actions are initiated, the lower the subsequent damage will be. The process costs on the insurer's side are greatly reduced since manual activities are significantly reduced. Highly specialized claims handlers can now concentrate on difficult cases and be relieved of standard activities.

The customer experience is also not to be underestimated; the rectification and settlement starts immediately with the loss event. Customers can be informed about the status of the processing directly via the water monitor app and, if necessary, provide additional information (availability for the service provider, etc.).

But how can these ideas be implemented? From my point of view, very few claims management systems are able to be controlled directly via an application programming interface (API) and many subsystems, e.g., for commissioning service providers, are not always linked to these systems or have cloud-based architecture.

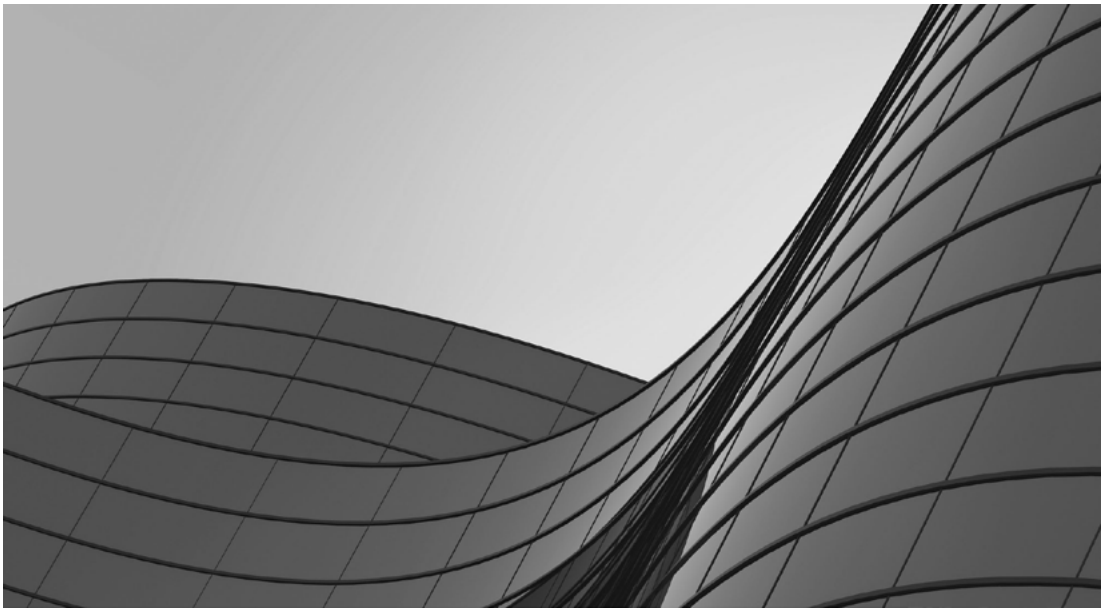
Hence, a layer is needed that brings the cloud information from the water monitor into the insurer's core systems. This creates new opportunities for insurtechs to expand their portfolio and to cooperate with insurers. In my opinion, those who have quick solutions ready have a real competitive advantage, because the cost pressure from manual processes is still there and claims processes will increasingly come into focus here.

Insurers are currently focusing on motor vehicle damage, which will revolutionize claims processing with access to telematics data – I see the same potential with IoT data from houses and apartments.

Apart from these technical options, it is still essential that process innovations receive the type of attention they deserve.

Too often innovations are all about new product ideas. From my point of view, a major, if not the major, lever for savings and simultaneous service improvement lies in the procedural issues. Many manual processes are still taken for granted, but these very often have a high potential for automation or digitization. It is important to pay more attention to this in the company.

To take up the question of implementation again: here, too, the classic way of looking at the entire process chain and involving the people who oversee this process on a daily basis still applies. They know best what is cumbersome and time consuming. These time wasters must then be examined to see whether data can be used as a trigger for automation.



5. CONCLUSION

I am firmly convinced that IoT with the corresponding data flows will lead to unexpected process improvements. We have to take the existing data from the IoT into account much more aggressively when trying to automate our processes. We also need to engage in greater dialogue with manufacturers of IoT regarding whether and, if so, which data can be additionally provided and how. It is at that stage that the combination of IoT and insurance will open up completely new possibilities for both the insurers and their policyholders. This leads me to think that perhaps a better title for this article might have been: "How IoT *will* disrupt claims processes".

LLOYD'S BLUEPRINT TWO – THE BUILDING BLOCKS FOR INDUSTRIALIZING AI IN INSURANCE

ALVIN TAN | Principal Consultant, Capco

ABSTRACT

This paper examines industry conditions within the context of Blueprint Two (BP2), sets out the details and plan to deliver the second phase of the Future at Lloyd's, and considers the wider challenges of industrializing artificial intelligence (AI). It sets out why conditions are ripe for insurers to engage in enterprise AI, and provides an overview of the key challenges that insurers face in doing so.

1. INTRODUCTION

Artificial intelligence is the application of non-biological computational processes to mimic the outcomes of human cognition, learning, and problem solving. It has existed as a concept since the dawn of the computing age and today, AI has come of age due to a confluence of use cases, supporting technologies and the vision to bring to life the opportunities presented by AI.

The field of AI encompasses a fast-evolving collection of tools and techniques that fulfill a range of operations from process workflow to decision-making analysis. Some of the key concepts include:

- **Machine learning (ML):** a field of algorithmic computation where the algorithms themselves automatically improve through iteration. ML models are said to "learn" by training through repeated exposure to different sets of data. ML enables the automation of complex, multivariate decision making and non-deterministic processing of large volumes of data that human beings cannot handle. By doing so, ML enables significant additional capacity for leveraging the value hidden in the data that an organization has access to.
- **Deep learning:** a subset of machine learning that focuses on building large neural networks that can be used to solve problems in vision, language, and more. Neural networks have the advantage over classical decision trees and regression algorithms by being able to better represent what is really happening. Deep learning algorithms are especially useful for facial recognition and speech analytics.
- **Natural language processing (NLP):** a machine learning technique that provides the ability for human speech and text to be interpreted by computers/AI. It enables unstructured data sources such as telephone calls, free text fields, etc. to be structured for efficient computerized processing, enabling significant opportunities for data mining and operational efficiency.

These techniques are now having a deeply disruptive impact on traditional business models, not least in the global insurance industry. From data quality to governance, strategically harnessing AI poses challenges for insurers not only across product lines and propositions, but also across operating models and decision-making processes.

2. THE IMPACT OF AI ON INSURANCE

The implications of AI on insurance are already being felt in some areas and insurers are having to learn quickly how to deal with them. Some examples of how AI is changing the game in the insurance industry include:

- **Integration of AI into underwriting decisions:** AI unlocks value by enabling transformation across the entire underwriting process from broker engagement to settlement. Using algorithms to evaluate and price risk enables the real-time decision making needed to support process digitalization. To leverage pricing automation, insurers need to use AI to automate the broker experience and deliver real-time customer interactions to refine price and coverage. AI-driven customer processes result in significantly reduced transaction times, at the same time as delivering easily accessible decision-making transparency for both management and regulators. A high-profile example of such an approach in the London insurance market (LM) is Ki Insurance: an AI-enabled "follow only" syndicate created in collaboration between Brit Insurance and Google Cloud. Using algorithmic principles that have been successfully exploited in other sectors of the financial markets for some time, AI enables Ki to be a data-led syndicate.
- **Building intelligent claims management processes:** the ability of AI to solve complex problems at speed, using machine and deep learning models, is a key enabler of intelligent claims management. AI automates the handling of multiple data sources that inform complex claims management processes, such as the analysis of unstructured data (images, voice, etc.) or the integration of external data sources (market metrics, weather data, ad hoc policyholder data, etc.) into the claims assessment process. The AI-driven system means that the process continually learns from every new claim processed. This insight can be immediately leveraged in the risk model as well as driving ongoing process efficiency and delivering further automation and cost reduction.
- **Accelerating digital transformation:** building the most advanced insurance marketplace is founded on achieving seamless end-to-end processes. This is underpinned by digital transformation to enable processing of the vast amounts of structured and unstructured data needed across placement, endorsements, renewals, claims, accounting, and reporting. By embedding AI into digital processes, insurers can accelerate the removal of manual and time-consuming processes that can otherwise hold up or stall digital transformation.

> *"Lloyd's Blueprint Two (BP2) reflects the wider market recognition that data foundations are critical not only to AI, but to digitalization in general."*

3. WHY THE TIME IS RIGHT FOR THE LLOYD'S MARKET TO EMBRACE AI

An AI Forum survey identified that two-thirds of respondents reported the use or active testing of AI solutions for a wide range of commercial use cases, with a similar proportion expecting their AI budgets to increase by at least 25% by 2022 [AI Forum (2020)].

Technology firms such as Amazon, Facebook, and Google have led the way for many years in the use of AI across many areas of their businesses. The usage of AI in recommendation engines by firms such as Netflix and Amazon to enable personalized marketing, improved customer retention, and increased sales, is well documented. These companies have long been mature in their ability to harness AI at scale to reduce customer churn, understand their preferences, and innovate in their product offerings.

While the financial services industry continues to play catch up, regulations, such as BCBS 239, have forced banks to mature the ways in which their data is captured, stored, provisioned, consumed, and managed. This is providing a strong foundation from which banks are increasingly leveraging AI, for example, to find patterns and identify risks in KYC processes.

As these and other sectors have shown, advanced analytics and AI is at the core of any digitalization road map – it is a significant enabler to offering new services to customers and embedding digital workflows at scale. For the Lloyd's Market (LM) there are certainly lessons to be learned from other industries to ensure that AI strategies, roadmaps, and deployment models are best placed to address the challenges of AI adoption at scale.

One such challenge is in building robust data foundations upon which successful AI implementations depend. Lloyd's Blueprint Two (BP2) reflects the wider market recognition that data foundations are critical not only to AI, but to digitalization in general. BP2 signifies a significant opportunity for the

market to create the building blocks necessary to deploy AI at scale, by:

- Embedding data-driven workflows
- Leveraging the standardized data driven by the Core Data Record (CDR)
- Reducing the risk and control cost of managing data on legacy infrastructure
- Enabling data to flow frictionlessly from transaction through to reporting.

Through BP2, Lloyd's effectively articulates a data-driven vision of how the LM will operate in the digital era. It sets out a strategy to accelerate digital transformation and innovation across the market, enabling growth and operational efficiency: "The transformation envisaged by this blueprint is only possible if complete, accurate and timely data is available to support and connect digital processes. It is the quality of this data that makes the difference between an automated process that happens immediately and a manual process that routinely takes days today" [Lloyds (2020), Chap 9].

BP2 is about going back to basics on the mechanics of capturing good quality data from the market. The CDR facilitates collaboration with brokers and managing agents, standardizing the way data is submitted into the Lloyd's ecosystem. This is the start of addressing the inconsistencies, incompleteness, and inaccuracies that plague data currently shared across the market.

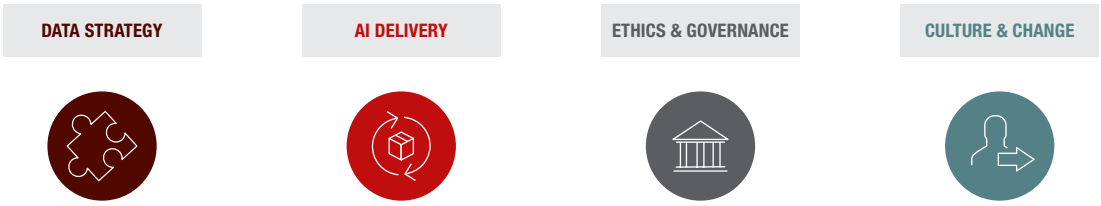
Being able to leverage this transformation depends on the LM participants having a good degree of data maturity to facilitate the timely provision of good quality and conformed data. With the strong competition incentive that BP2 offers, this is a significant shift in the sense that participants will have to improve their data architectures and data management processes to adhere to the standards.

In conjunction with BP2 adoption, however, there are several additional factors that are converging to place the LM in a good position for accelerating and scaling AI adoption:

- **Specialty insurance is a business of advanced analytics**
  Insurers have long had a deep familiarity and natural affinity for advanced analytics involving prediction and modeling, particularly within actuarial and underwriting capabilities. For the sector, with clearly stated digital and data driven objectives, AI is a logical next step, not a leap into the unknown.
- **Data platform and technology advances**
  The timing of BP2 is ideally aligned to modern data architectures that are being enabled by innovative technologies, real-time data, and virtually unlimited cloud processing power. Movement to cloud and digitalization of business processes provides the opportunity to integrate data and processes to leverage AI across the value chain. For the first time, insurers have the opportunity to deploy AI at scale and not just deploy limited value single use cases.
- **Process transformation**
  Innovation applies not only to products, but also to the ways in which organizations remove costs. As insurers seek to improve their operating ratios in a commoditized market, applying AI to streamline and automate processes can help insurers gain a comparative advantage over their competitors. For example, the application and improvement of NLP and chatbot technology to handle increasingly complex questions and call handling decisions, is helping insurers progressively reduce operating expenditures in their call centers.
- **Modernization in the middle and back office**
  AI offers a critical opportunity for insurers looking to overcome operational limitations and inefficiencies imposed by legacy data and architectures. While AI will not fix data issues at source, AI-enabled real-time data validation, data reconciliation, matching and exception reporting, enables downstream processing to operate efficiently without the need to fix upstream data issues. This enables the replacement of legacy architectures to be further decoupled from the business-as-usual operation of the insurer.

In summary, with BP2 as a cornerstone, insurers can use internal and market forces as a springboard from which higher quality business outcomes can be achieved by the strategic application of enterprise AI.

However, the strong data foundations being pushed by BP2 will not be all that is required to deploy AI at scale. While by its nature AI depends on data, it is more than just a tool or system. AI is an enterprise capability founded on a combination of technology, data, and (human) competences. Furthermore, new risks brought about by increasingly ubiquitous and automated decision making will only heighten concern with the regulator and in the court of public opinion.



4. FOUNDATIONS FOR SUCCESS

As insurers increasingly move beyond isolated AI use cases towards scaling AI deployments, it has become clear that significant challenges exist in leveraging AI appropriately and successfully. Indeed, it is estimated that half of all AI projects currently fail [McCormick (2020)] because of the complex interplay of a multitude of issues from inadequate data foundations to failure to address the challenges of integration with existing operating models.

To mitigate the risk of failure and realize returns on investment, it is necessary to understand how AI projects need to be integrated into the operational environment of a modern organization. In contrast with traditional analytics, AI projects have specific challenges that require changes not only in delivery mindset and governance, but also in the way in which business users consume and utilize AI outcomes.

Strategically harnessing AI correctly and appropriately involves more than just hiring people with the right skills and increasing the number of CPUs available. From data quality to AI governance, the disruptive impact of AI means that the decision-making culture and data management habits of the organization will need to be shifted, and operating models and processes will need to adapt. The key strategic pillars that require consideration for industrializing AI include:

- **Data strategy: Providing trusted data at scale**
  Many insurers are operating with evolved legacy architectures that have had historically weak focus on good data management and governance practice. This causes pervasive data quality issues and highly manual data processes, hampering efforts to digitalize. However, AI applications can only ever be as effective as the quality, representativeness, and appropriateness of the data upon which they are built. Adopting a scalable approach to storing, provisioning, and managing data is, therefore, key. Insurers need to minimize the marginal costs of both data consumption, and data management and governance. Getting on top of bad data is not simply about remediating data quality issues as they appear – it is also about systematically detecting, making known, and managing the presence of bad data in the first instance, and being able to do so at scale.
- **AI delivery: Applying the right approach to deliver the best outcomes**
  Unlike traditional IT projects where executable code is developed and deployed to a production environment, an AI application is data and code. AI deliveries, therefore, have additional considerations in relation to the way in which these must be considered in the development lifecycle. The knowledge and experience required to understand and deliver value from AI is still relatively rare and true expertise is at a premium.
- **Ethics and governance: Ensuring AI outcomes have ownership and are transparent and ethical**
  AI outcomes are unpredictable by nature and have additional governance considerations to standard IT governance. Not only is governance required to manage model drift and retain traceability, explainability, and repeatability of outcomes, but there are significant ethical risks in AI adoption. The most significant concerns in this regard lie in the unintended consequences of AI feature design. Data required for these features may not be ethically risky on the surface, but may have hidden proxies to risky data, e.g., life expectancy as a proxy of gender. Pending E.U. regulations, that in a similar manner to GDPR could result in significant fines, highlight the need

for AI applications to be adequately risk assessed and emphasizes the need for adequate governance and risk management to mitigate the dangers of AI being utilized in ethically inappropriate, biased, or non-transparent ways.

- **Culture and change: Adopting and integrating AI into the business**
  Augmenting and automating decision-making processes requires a wholesale mindset change and culture shift in the business community. One of the biggest challenges, and where many organizations get it wrong, is in delivering the "last mile". Even if benefits can be identified, many organizations are just not setup to integrate AI into their processes in efficient and effective ways to realize them. They become insight-rich but outcome-poor as a result, leading to loss of confidence (and investment) in the ability of AI to deliver meaningful change.

5. CONCLUSION

Data and AI are important to the evolution of the London insurance market. The scope of opportunity open to insurers is broad and deep, and critical to their continued success. Successfully integrating and implementing data and AI strategies will enable insurers to benefit from enhanced customer and risk insight, increased revenues, operational efficiencies, and meet head-on the challenges from the insurtech sector. To realize these benefits, insurers' AI strategies will need to consider not only the data foundations upon which AI is built, but also the way in which AI is delivered, governed, trained, and integrated.

The key lesson already learned by other industries is that to optimize the value of AI, firms must focus on economies of scale. Not doing so embeds high cost into meeting any AI objective; and delivery, governance, data, and adoption roadblocks are not strategically resolved for wider implementation. Firms that have focused on reducing the marginal cost of AI implementations have had the most success realizing the wider value from AI.

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HOW DIGITAL CAPABILITIES CAN DRIVE INNOVATION IN LIFE INSURANCE AND ANNUITIES

PAULA NELSON | Co-Head of Individual Markets, Global Atlantic Financial Group

ABSTRACT

New insurance technologies and digital tools can help financial professionals integrate insurance into a client's holistic wealth management plan with ease and transparency. This space is rapidly evolving and transforming how financial professionals conduct business on a daily basis. This evolution brings operational efficiency and simplifies business not only for financial professionals with insurance product expertise, but also for the many other financial professionals who lack adequate knowledge and understanding of how life insurance and annuities can be used to provide a complete wealth management experience. By clearly demonstrating the products' potential within the context of their client's overall strategy, even less experienced professionals can confidently offer these solutions to their aging clients. These new wealthtech tools can also help professionals comply with regulatory and administrative requirements embedded in the legacy business practices of the industry. We believe that by leveraging existing digital capabilities, as well as supporting the development and standardization of new technologies that are under development today, we can drive innovation in the areas of new product development, user experience, and sales access for life insurance and annuities. This paper discusses how technology can make it easier for professionals to incorporate annuities, life insurance. and other insurance-based solutions alongside traditional stock and bond portfolios. The paper also discusses specific technology tools that we believe can make an impact.

1. INTRODUCTION: WHY WE NEED INNOVATION

Technology can play a key role in enabling financial professionals to bring sophisticated financial products to their clients, complementing their overall investment strategy and meeting needs related to income and protection. New innovations can also help professionals comply with regulatory and administrative requirements to develop more holistic outcome-based financial planning strategies for clients.

From a digital experience standpoint, life and annuities (L&A) have trailed property and casualty (P&C), homeowners, and even health insurance. Old legacy systems have made it difficult for L&A to go digital. The necessary paperwork can be time-consuming, and electronic forms have not done a whole lot to help the industry.

P&C faces regulatory challenges that are in some ways similar, but it is predominantly regulated by state insurance laws. The L&A space, on the other hand, is governed by federal law in addition to state law. At the federal level, some of these products are governed by the Securities and Exchange Commission (SEC) and Financial Industry Regulatory Authority (FINRA), due to the use of equity or securities in the structure of the product. As a result, the insurance companies need to be able to deliver a consistent experience with other securities products offered by those financial professionals.

In the past, some financial professionals felt that managing all of the complex paperwork was part of their value proposition. However, this mindset began changing, particularly as technology has become more integrated in our daily lives. The shift was then accelerated as many found themselves working remotely during the pandemic. With social distancing

mandates and lockdowns in place, many Americans have been less interested in meeting face-to-face. Financial professionals have generally learned to meet with clients and prospects virtually, through video conferences and webinars.

LIMRA and Boston Consulting Group (BCG) surveyed 4,000 Americans between July and August 2020 about the experience of buying life insurance [Sims et al. (2020)]. The survey found that 4 in 10 consumers purchased life insurance through a hybrid approach (online and consulting with a financial professional), a significant increase from before the pandemic. This has accelerated the digital transformation that had already been taking place in the industry.

At the same time, insurance companies have faced tighter margins and pressure to become more efficient and scalable. Carriers have begun adopting more digital capabilities, such as electronic forms and electronic underwriting.

There are a number of examples to illustrate technology driving growth in financial services. In the 1980s, a technology transformation allowed mutual funds to become mainstream and easy for retail investors to use in their portfolios. A more recent example on a smaller scale is what has transpired with structured notes over the last five years. Structured notes use technology to enhance both the user experience and the construction of products and make them available to a wider market. These technology enhancements create efficiencies that have led to lower minimums needed to purchase a structured note, enabling real-time quotes, and reducing the time to issue from days to hours. All of this resulted in an increase in annual sales. Data from Structured Products Weekly of Prospect News [Liu (2021)] shows that in 2020, more than U.S.$72 billion worth of structured notes were issued in the U.S., an increase of 36% from the previous year. Wealthtech, albeit still in the early stages, is enabling a similar evolution for insurance products.

One industry-specific example is online marketplace Policygenius. Policygenius allows consumers to compare and purchase life, home, auto and other types of insurance. According to its website, the company has served over 30 million shoppers and placed over U.S.$120 billion of insurance, including over U.S.$90 billion of life insurance. In addition to using innovative technology, Policygenius employs licensed insurance brokers to assist customers. All of this shows that digital innovation can improve the experience of buying life and annuities, making it faster and easier while educating the end-user on personal finance and insurance.

2. AVAILABLE TECHNOLOGIES

Today, there are a number of tools that can help financial professionals be more holistic and efficient in how they manage client portfolios. These tools include: technology platforms, financial planning software, wealth management platforms, annuity product stores, annuity planning tools, and outsourced insurance desks. Detailed below are some of the more interesting offerings:

- **Technology platforms:** a leading technology platform is Fiduciary Exchange LLC (FIDx), a network that provides connectivity with carriers and financial professionals to offer annuities and insurance solutions. FIDx was designed to make it easier for financial professionals to conduct business electronically across solution providers rather than have to use carrier-specific experiences.
- **Wealth management platforms:** financial professionals use wealth management platforms (WMPs) to help them track their clients' investment portfolios. This technology can either be outsourced to one of the vendors, such as Envestnet, or custom built in-house as done by some of the larger firms (e.g., Morgan Stanley).
  - Envestnet launched the Envestnet Insurance Exchange as part of the company's popular wealth management platform in 2019 to integrate insurance-based solutions into the financial planning process [Envestnet (2019)]. The goal is to deliver a unified insurance and annuity experience within financial professionals' existing workflows. Envestnet also offers MoneyGuidePro, a suite of web-based financial planning and retirement planning software, for wealth management firms.
- **Annuity product stores:** annuity product stores are "storefront" interfaces that provide financial professionals with access to a variety of annuity products in a single location. These include the capability to run multiple scenarios for case design including risk tolerance and performance back-testing. Some are connected to platforms like FIDx.
  - In 2020, FIDx announced a partnership with Halo's protective investing platform, an independent marketplace for annuities [FIDx (2020)]. In the press release, the companies said that the integration would "elevate the availability and distribution of annuities to users of the Halo platform."

Digital technology can help financial professionals better understand life and annuity products. Professionals frequently ask, "If I'm going to use a product, how do I pick one and recommend it to my client?" The technology described above can help with that smart learning. The professionals enter data about their clients' financial situations, and the technology provides recommendations on what products should be used and how they should be actively managed within a portfolio. There are also AI-powered tools like the The RightBRIDGE annuity wizard, which is a tool that can financial professionals determine suitability of a product. Ultimately, technology can help find products to be used as part of the clients' broader wealth management strategies.

3. WHAT THESE CAPABILITIES CAN DO FOR THE FINANCIAL SERVICES INDUSTRY

The financial services industry can benefit in many ways from these new and improved capabilities. I believe that these benefits fall into three categories: development, experience, and distribution access for life insurance and annuities.

3.1 Product development

Digitization allows insurance companies to leverage unique investment strategies that improve client outcomes and offer educational tools to improve product transparency for financial professionals and their clients. Two product types that exemplify this are indexed-linked annuities and registered index-linked annuities (RILAs). Platforms like HALO, Simon, and Luma have enabled innovation for structured notes, and I believe that they are doing the same for annuities.

The innovation is well-received. In a recent article about the best annuities on the market today, Hube (2020) has called RILAs "the industry's newest innovation" and attributed their growth to "a compelling trade-off that they offer to investors who are risk-averse but need growth – some protection on the downside in exchange for a cap on a linked stock index's performance."

3.2 Experience

By leveraging existing digital capabilities and developing new ones, we can improve the experience that financial professionals and consumers have with buying life insurance, understanding existing policies, and submitting claims. As Sims et al. (2020) stated in their recent report, "If technology can help make life insurance easier to understand, less trouble to apply for, and quicker to get, it will be a dramatically better experience for customers."

- **Transparency:** consumers and financial professionals should be able to use online portals to review documentation and check the status of insurance-related items such as applications, withdrawals, and claims, without having to make phone calls. They should also be able to access information about their policies online, any time they choose, without any difficulty.
- **Speed:** the process of filling out paper applications, obtaining signatures, faxing or mailing in applications, and waiting for carriers to receive and process them is manual, time-consuming, and inefficient. This weeks-long application process can and should be replaced with turnarounds in as little as 24 hours, resulting in higher transaction volumes and increased client satisfaction. An added benefit is that the claims process can then also be much faster.
- **Quality and accuracy:** we currently rely on people to manually enter information into multiple forms. This introduces the chance for human error into a process that can be automated. Information provided by clients should be checked for accuracy, entered once, then automatically cascaded through both internal and external systems.

3.3 Distribution access

Customer and agent expectations are evolving, and rightly so. A recent Edward Jones survey of more than 1,200 investors found that almost all (95%) would like their financial professionals to use the latest technology tools [Edward Jones (2021)]. While many clients do not seem to want technology to replace financial professionals, there are tools that can provide greater operational efficiency, thereby freeing up time to meet with clients and manage their business.

Technology can also give registered investment advisors (RIAs) broadened access to insurance products. This is especially helpful for RIAs who may want to incorporate insurance strategies into their practice. Digital platforms offer several alternatives to support RIAs either through advice planning tools, digital business submission embedded into their operating platform, and licensed insurance or brokerage professional product recommendation and execution.

Digital capabilities will continue to improve the overall process and experience of delivering comprehensive wealth management services to consumers.

3.4 Digitalization of the industry

The life insurance industry is moving away from a traditional, paper-based and manual underwriting process to a more modern experience. Digital underwriting with the use of data improves speed, accuracy, and consistency of decisions.

Today, there are several well-established third-party underwriting rules engines including Swiss Re's Magnum, Munich Re's ALLFINANZ, and Hanover Re's ReFlex. These engines help automate underwriting decisions by using dynamic online questionnaires and evaluating responses in real time. Some underwriting decisions are made by the engines, while others are referred to an underwriter for further review. With automated underwriting, customers can sometimes get same-day or even instant decisions instead of having to wait weeks or months.

Other tools available to carriers allow them to access data that they can use for underwriting. This includes the electronic delivery of consumer data, as well as medical data such as pharmacy history, laboratory test results, and medical claims. This combination of digital data allows carriers to predict a person's health profile and whether they qualify for insurance coverage without further evaluation.

The industry also uses several innovative technology platforms that serve as storefronts where financial professionals can compare products and submit electronic applications. Two examples of vendors offering these platforms include iPipeline and FireLight. These tools can help deliver a more modern insurance buying experience for financial professionals and customers.

4. CONCLUSION: WHAT THE LIFE AND ANNUITY SPACE CAN LOOK LIKE WITH INNOVATION

With Baby Boomers aging and younger generations losing access to defined benefit retirement plans, their financial needs are becoming more complex and they need more help than ever before. We are excited about the innovation that we are seeing that will enable professionals to provide that help in a holistic manner.

Digital advancements provide a significant opportunity for financial professionals to seamlessly incorporate insurance strategies into their wealth management practices. Financial professionals who are interested in learning more may contact their firm's sales technology resource lead.

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BRIDGING THE GAP BETWEEN MEDICINE AND INSURANCE: HOW TO LEVERAGE DATA, ARTIFICIAL INTELLIGENCE, AND NEUROINFORMATICS FOR INSURANCE AND FINANCIAL RISK MANAGEMENT

ANITHA RAO | CEO and Founder, Neurocern, and Board-Certified Geriatric Neurologist, Department of Neurology, University of Toledo College of Medicine

MARK WEINDLING | Chief Technology Officer, Neurocern

PAUL RIDGEWAY | Strategy, Chief Financial Officer, Neurocern

LIZ KENNEDY | Project Manager, Neurocern

HARRIS A. EYRE | Chief Medical Officer, PRODEO, and Co-Lead, Neuroscience-inspired Policy Initiative, OECD

PAULO PINHO | Vice President and Medical Director of Innovation, Diameter Health

ABSTRACT

As the global population ages, neurological diseases such as Alzheimer's disease, stroke, and epilepsy will represent a top data attribute in disability and mortality predictive modeling. Clinical shortages of geriatric specialists globally have led to missed diagnoses and delays in care leading to untoward clinical and financial outcomes. Research has demonstrated a clear trickle-down impact in underwriting, latent mortality risk, and reserving for the aging population.

Advances in technology and artificial intelligence have given rise to innovative analytical modeling that have benefited both insurance and overall population health. This paper will discuss the application of a neurologically trained artificial intelligence data engine and case studies to provide understanding on how AI-enriched data insights can improve the quality, costs, and context of care.

1. CONNECTING THE DOTS: NEUROINFORMATICS, FINANCE, AND INSURANCE

The use of artificial intelligence (AI) has become pervasive in today's world, with new use cases and problems solved in nearly every discipline. Medicine is no different – the applications of AI in medicine have expanded significantly in the 21st century. For instance, application of computational methods to large datasets on human genomics have allowed researchers to better understand and trend data impacting diseases and genes [Obermeyer and Emanuel (2016)]. While much work has been done already, with applications out, clinicians and researchers alike are only beginning to understand AI's benefits and pitfalls.

The subject of our discussion for this article will be centered around one subtype of AI, an expert system. In its simplest form, an expert system emulates the decision-making capability of a human "expert", generally through a rule-

based process and primarily using "if-then" predicate logic. "Medical" expert systems are computer programs that guide clinicians and doctors in evaluating, triaging, diagnosing, and treating patients [Pac et al. (2021)].

Expert systems in medicine are especially impactful in reducing the time to diagnosis and in clinical instances where experts are needed for accurate diagnosis and treatment of niche diseases where availability of specialists and clinical acumen may be in short supply. While these expert systems use "human expert knowledge" to compute results, their use should never replace the value-add of seasoned medical experts who are constantly keeping current in their medical knowledge and possess the ability to apply qualitative reasoning based on deeper experience and understanding. This knowledge upkeep and ability to reason provides an additional layer of nuance to a diagnosis or understanding that an algorithm, with its limited inputs and fundamentally restricted logical description, is unable to match. Thus, a human being is an essential component of ensuring appropriate results and functioning [Pac et al. (2021)].

1.1 Population aging and considerations for insurance and financial services

The increased life expectancy and reduced fertility rates globally have shaped the demographics of society into a predominantly older and increasingly aging population [Rao and Eaton (2021)]. With a rise in population age comes a rise in the prevalence of neurological and cognitive conditions such as dementia, stroke, and epilepsy. Neurological diseases are the leading cause of disability globally [Alzheimer's Disease International (2020)] and the second leading cause of death [Alzheimer's Association (2020)]. Life reinsurance mortality analyses include neurological conditions in the top three paradigms in their financial and actuarial modeling with a clear trickle-down impact in underwriting, latent mortality risk, and reserving for the aging population. For instance, clinical severity and residua of a stroke will dictate the length of disability of an individual. This, in combination with other comorbidities, will impact mortality modeling.

With increasing population age, older adults will be also required to stay productive beyond traditional retirement age to sustain national and global economy viability [Smith et al. (2021)]. Neurological diseases can impact the productivity of older adults, thereby challenging economic security. Retirement and pension funding will undoubtedly be impacted by later retirement age, morbidity, and mortality from neurologic diseases [Smith et al. (2021), OECD (2021)].

Chronic neurological conditions can even influence the fraction of the GDP spent on healthcare and long-term care (care homes and nursing homes) and private sector pension funds [Bohk-Ewald and Rau (2017)]. For example, neurological conditions such as Alzheimer's and related dementias (ADRD) represent a sizable global public health conundrum in both developing and developed countries. There are approximately 50 million people living with dementia globally, and this number is expected to triple by 2050. The annual global total direct and indirect cost of dementia was estimated at U.S.$1 trillion in 2018, a figure expected to double by 2030 [Prince et al. (2015)]. To provide context and scale, if the global cost of dementia care represented the economy of a country, it would represent the 18th largest global economy – currently Saudi Arabia [Prince et al. (2015)].

1.2 Predictive analytics and claims modeling in the aging population

The insurance industry is only beginning to connect the dots between insurance and medicine. For example, while with respect to long-term care insurance (LTCI), neurological diseases constitute a plurality of total claims incidence, accurate data inputs are not in place to appropriately model morbidity. In a study funded by the Society of Actuaries, researchers from Neurocern and Milliman found that traditional parameters (gender, claim duration, and age) used by insurance actuaries to assess cost and utilization in LTCI did not actually predict variability in claim incidence across geographic areas [Rao and Eaton (2021)]. These findings impact modeling for other product lines that rely on these attributes for cost calculation and reserving assumptions, like retirement, pension, annuity, and life insurance. These same researchers identified other critical data elements that predicted claims incidence more accurately. For example, the study showed a modest correlation of 38% between clinical neurological specialist shortages and historical incidence of LTCI claims from years 2000 to 2017, highlighting how medical workforce shortages have trickle-down effects on the financial and insurance industries [Rao and Eaton (2021)]. Better data can help insurance companies stratify utilization risk, predict cause of claim, and estimate the duration of claims more accurately than the status quo.

1.3 Financial modeling and risk management

Underwriting based on incorrectly estimated mortality assumptions in older populations can result in premature benefit payout and longer duration [Bohk-Ewald and Rau (2021)]. The same applies to critical illness, where incorrectly underestimating the risk of certain conditions in older

age policyholders results in paying out benefits to more policyholders than initially budgeted for. Moreover, gaps in clinical documentation and clinician shortages can lead to misdiagnosis or lack of diagnosis; even the most detailed underwriters will miss conditions that are poorly documented in the electronic medical record. According to the Alzheimer's Association, at least 50% of cognitive impairment cases are undiagnosed or undocumented [Alzheimer's Association (2016)]. Furthermore, the severity of cognitive impairment (often used as a benefit eligibility trigger) may ultimately impact adjudication for critical illness and LTCI riders.

2. A NEED FOR MULTI-MODAL DATA PROCESSING AND NEUROLOGY-BASED AI-EXPERT SYSTEM

Digital technologies are employing biomarkers for neurologic conditions; wearables can detect gait cadence changes and identify Parkinson's disease and eye-tracking devices can identify early cognitive impairment [Kourtis et al. (2019)]. These technologies are experimental, albeit rapidly evolving. Currently, no one data element is the holy grail in this space and instead, should be acquired in multivariate fashion for decision support, risk stratification, and early diagnosis use cases. An overreliance on one data source risks a higher number of false positives and false negatives, whereas a multi-modal data processing technique using an expert-AI system can achieve higher accuracy and reproducibility in computation, financial modeling, and analytics.

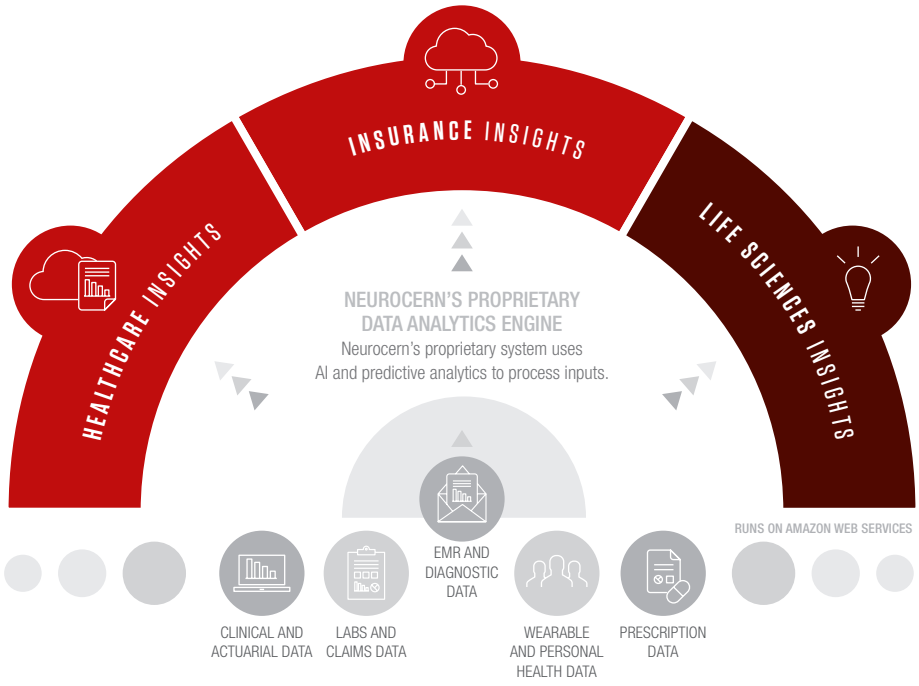
This paper will focus on the application of an expert system developed by Neurocern capable of leveraging data insights for financial and health outcomes to a specialty where clinician shortages abound. Despite increasing prevalence of neurological conditions in the aging population, the supply of neurologists and other geriatric mental health specialists is sparse [Dall et al. (2013)] and the supply is challenged to meet the demand [Rao and Eaton (2021)]. Patients often face challenges in accessing neurological care due to long wait times and lack of available experts in their area [Freeman et al. (2013)].

Data sources such as claims, prescriptions, health, and lifestyle data can be used in multivariate fashion to generate probabilistic risk scores, which can help insurance carriers identify risks in their populations and influence contextual care more easily and timelier (Figure 1).

2.1 The application of predictive analytics, AI, and informatics for financial outcomes

Making data-informed decisions in medicine can mean the difference between early diagnosis and treatment. By extension, data-driven decisions in insurance can translate

Figure 1: Expert AI-system for neurology and cognition



to mitigating risk and forecasting population outcomes more accurately. Sadly, both clinical medicine and insurance have datasets that are siloed and, therefore, not always optimized to glean insights.

Applying Neurocern's expert system that has been trained with clinical data to insurance and financial decisions can unlock meaningful population-level insights for organizations. Neurocern benefits from millions of claims data elements and a robust research reference dataset to generate data enrichment. This process can predict neurological conditions that are associated with high cost and utilization.

Not all analytics are created equal. Some predictive analytics vendors only scratch the surface, querying only known medical data to calculate financial risk. Sophisticated predictive analytics can go beyond this to find undiagnosed cases (second level analytics) that may result in additional financial benefit. Going a level further (third level analytics) allows for the accurate prediction of the total cost of care for an individual and a population.

We have laid out the following case studies to provide understanding on how data insights can improve the quality and context of care.

Case study 1: Cost of care – a new treatment for Alzheimer's disease

In 2021, pharmaceutical giant Biogen, announced the first ever treatment for Alzheimer's disease, a common neurological condition impacting over 50 million patients globally. This medication, Adacanumab, currently costs more than U.S.$50,000 per person per year. With varying life expectancy among Alzheimer's patients, projecting the financial cost of care can be challenging. Complicating the cost determination is the fact that Aducanumab is weight based and assumptions are based on a 74 kg average weight. Given global trends in obesity, U.S.$50,000 may underestimate the true financial burden of Adacanumab.

Cost is also driven by disease prevalence. Clinically, diagnostic sensitivity (premised on true positives in a particular population) for identifying mild cognitive impairment, and by proxy early dementia, among general medicine practitioners ranges from 14-61% [Van den Dungen et al. (2012)]. The same applies to false negatives [Bradford et al. (2009), Valcour et al. (2000)]. Given the narrow clinical indications for Adacanumab, over- and underdiagnosis may adversely impact cost assumptions.

Alzheimer's treatment cost of care implications for insurance and financial modeling

For the public and private sector in insurance, understanding disease prevalence, severity, and predicted life expectancy of those with clinical indications for treatment may help more accurately forecast reserves and allocate treatment costs to those patients that truly qualify for treatment.

To showcase the value of applying an AI expert system, Neurocern's Aducanumab Eligibility Analytics Model was applied to claims data to identify individuals truly eligible for treatment.

We provide two scenarios to illustrate the value (Table 1). In Scenario #1, traditional clinical workflow fraught with a high degree of false positives and false negatives and void of triaging of claim applications is modeled. In this scenario, 85% of claims are approved, resulting in a cost of care of U.S.$1.3 billion over five years for >30,000 potential claims in dataset. Scenario #2 showcases Neurocern's AI expert system's ability to enhance diagnostic accuracy. A triage score is computed to validate the veracity of the claims in terms of true positives, true negatives, false positives, and false negatives – this is

Table 1: 5-year savings model with artificial intelligence

	SCENARIO #1	SCENARIO #2 (with Neurocern AI)
Total cost of Aducanumab treatment per person per year*	U.S.$50,000	U.S.$50,000
Duration of treatment+	5 years	5 years
ABC Insurance Company cost per person per year (20% of total cost of treatment)¥	U.S.$10,000	U.S.$10,000
Percent of patients with cognitive concerns that meet eligibility criteria	85%	60%
Total eligible claims	30,572	30,572
Total cost over 5 years	U.S.$1.3B	U.S.$929M
Total savings over 5 years	--	**> $350M**

* Assumed average cost of $50,000 per person per year
\+ Assumed mean duration of treatment of 5 years
¥ Assumed estimated cost to ABC Insurance Company was 20% of the total cost of the drug

Figure 2: Delirium risk score and dashboard

premised on clinical data from an academic database (which also included brain autopsy findings), the current gold standard in diagnosis of Alzheimer's.

This research demonstrated Neurocern's ability to triage cognitive impairment more accurately, timely, and effectively than a general physician [Rao and Naryanaswamy (2018)]. With diagnostic accuracy, a truer eligibility rate of 60% for Aducanumab was derived after filtering out the false positive and false negatives. The five-year cost savings, as compared to standard of care, of employing the expert system exceeded U.S.$350 million – which represents a savings of approximately 33%.

As drug treatments emerge, their costs will dictate the importance of diagnostic accuracy; insurance carriers will want to identify those members truly eligible, both in terms of incidence and prevalence.

Case study 2: Digital claims transformation – life insurance with critical illness riders and long-term care riders

Delirium is an acute change in thinking, memory, and attention that develops over a short period of time and can be "reversible" with appropriate treatment in specific clinical scenarios [Tripathi and Vibha (2009)]. Diagnostic accuracy is important to carriers that offer critical illness riders and long-term care insurance to insureds suffering from irreversible cognitive impairment. When delirium occurs in patients with underlying Alzheimer's dementia or normal aging, the severity of the cognitive impairment appears worse. This results in false positive eligibility for benefit payout – a common occurrence in claims workflows. Moreover, patients with delirium have a two-fold increase in mortality, a 15-fold increase in walking dependence, and five-fold increase in nursing home placement according to published studies [Morandi et al (2014)]. This increase in both mortality and disability becomes especially relevant to life insurance carriers with critical illness riders, disability riders, and long-term insurance riders.

In 2020, Neurocern developed proprietary predictive analytics as part of their AI expert platform. In a digital claims processing pilot, Neurocern partnered with insurance carriers who cover over 1 million lives and have more than U.S.$50 billion in claims exposure. Claims for irreversible cognitive impairment were targeted with this AI expert system and compared against traditional claims processing workflows.

A claims triage risk score and a delirium risk score were computed using the expert system (Figure 2). To prevent sway and ascertain case-control accuracy, insurance third-party administrators (TPA) were blinded to the risk scores. Additionally, an independent medical advisory team reviewed the results from Neurocern's analytics. Neurocern showed a sensitivity of 94.7% (finding true positives) and specificity of 100% (finding true negatives) in this population. Both TPAs and insurance carriers failed to identify delirium in 28% of claims leading to the incorrect label of irreversible cognitive impairment in these claimants and downstream financial implications for patients through increased insurance premiums or inaccurate reserving.

To illustrate the cost impact of this tool (Table 2), if ABC long-term care insurance sees 1,000 cognitive impairment claims per month in their LTCI rider product and a payout of U.S.$6,500 per month is paid out as a benefit, accurately identifying cases of delirium in 28% of claimants by an expert system, could lead to over U.S.$1.7 million in savings per month.

Table 2: Savings from identifying claims accurately with artificial intelligence

DELIRIUM RISK SCORE	
Number of claims per month	1000
Claims with delirium	28%
Total claims with possible delirium per month	280
Total claims identified by Neurocern's AI-delirium model	265
Average monthly payout per insured	U.S.$6500
Potential savings per month of identifying delirium with Neurocern's AI platform	**U.S.$1.72 M**

3. CONCLUSION

Neurological diseases are one of the top three reasons for disability and represent a top condition in mortality assumptions globally. They are routinely diagnosed incorrectly, and this can lead to untoward clinical and financial outcomes. The COVID-19 pandemic has also spurred the incidence of neurological symptoms in at-risk conditions and may add to the overall cost of care [Taquet et al. (2021)]. Comprehensive data mining, contextually appropriate datasets, and multi-modal data processing with advanced analytics allows enterprise clients to find new insights that quantifiably improve clinical and financial outcomes. As illustrated in these case examples, neurological diseases can significantly impact reserving and outcomes for the aging population. Given new biopharmaceutical treatments on the horizon for neurological diseases, insurance carriers and financial risk managers will face new challenges. Employing predictive analytics and AI to understand cost drivers and overall morbidity and mortality for a block of business could prove to be a game-changer.

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THE FUTURE OF INSURANCE COMPANIES: PROSPECTS FROM AN INTERVIEW STUDY

CLAUDIA LEHMANN | Professor, Digital Innovation in Service Industries, and Executive Director, Center for Leading Innovation and Cooperation (CLIC), HHL Leipzig Graduate School of Management

THOMAS ZWACK | Partner, Capco Germany

SIMON MEIER | Innovation Scout, ERGO Group AG

TIM MOSIG | Research Associate, Center for Leading Innovation and Cooperation (CLIC), HHL Leipzig Graduate School of Management

ABSTRACT

Like other traditional industries, the insurance industry is faced with the challenge of mastering the effects of digitization and digital transformation as well as other trends. To investigate the question of which business models will dominate the German insurance sector in the future, a total of 32 semi-structured interviews were conducted with representatives from the middle and upper management of German insurance companies. As a result, five business models, such as peer-to-peer approaches, could be identified, which the experts evaluated according to criteria such as complexity, risk, and radicalism.

1. INTRODUCTION

The insurance industry, like other industries, faces the challenge of mastering the effects of digitization and digital transformation, which has implications for various aspects of the value chain, including customer interaction, sales, claims, as well as the insurance products themselves. From a more holistic perspective, just like the implications of what happens on the financial markets and the changing demographic structure of customers, among others, digitization and digital transformation have implications for the entire business models of insurance companies. Yet, despite these ramifications, business model innovation in the insurance sector has received little attention in academic literature.

In fact, there is no consistent definition of the term "business model innovation", or "business model" for that matter, in the literature to date. The considerations presented in this article are based on the definition by Zott and Amit (2009).[1]

A business model innovation occurs when there are (a) changes in the content of business activities, (b) innovations in the way in which these activities are linked to one another, and/or (c) changes in responsibilities. One example is the outsourcing or commissioning of services for the realization of business activities that were previously implemented internally in the company. Business model innovation is also subject to a wide variety of influences that can either hinder or promote its realization. These can come from inside or outside the company.

In order to add to our understanding of digitization and digital transformation in the insurance industry, we undertook the following study. We conducted a total of 32 semi-structured interviews with representatives from middle and senior management of German insurance companies. The questions put to them included: 1) What types of business models currently exist in the industry and which are seen as most promising in the future? 2) What are the success factors for

[1] Zott, C., and R. Amit, 2009, "The business model as the engine of network-based strategies," in Kleindorfer P. R., and Y. J. Wind (eds.), The network challenge, Wharton School Publishing

business model innovation in the insurance industry? and 3) What are the potential barriers to achieving business model transformation?

The interviews were recorded, the data transcribed and anonymized, and then categorized, i.e., analyzed, using a coding procedure.

2. TRANSFORMATION AND POTENTIAL FUTURE BUSINESS MODELS OF INSURANCE COMPANIES

Looking at the core of the value chain, it can be stated that all elements – including product development, underwriting, operations/claims, marketing/CRM, distribution (channels) – are in a process of change. Another finding of the study is that the elements of the value chain are changing together. This reflects the close connection between the individual elements of the value chain. Furthermore, all interviewees confirmed the thesis that the importance of partnerships for the insurance industry will increase.

The importance of five potential business models has been evaluated in the interviews and these have been assessed against predefined criteria.

Provided below are short descriptions of the possible future business models:

- **IoT and prevention:** damage prevention generally with the use of internet of things (IoT).
- **Make more of it:** using a company's core competencies to exploit new business models, outside of the core business.
- **Orchestrator:** reduction of the value chain to a few core functions, collaboration with many external partners.
- **Peer-to-peer (P2P):** modified collective formation often with promise of repayment if no damage/claims are incurred, the role of the classic insurer recedes.
- **Caretaker:** insurers not only provide compensation in the event of a claim, but also support the customer in related matters, usually with services.

The legend used for evaluation criteria were:

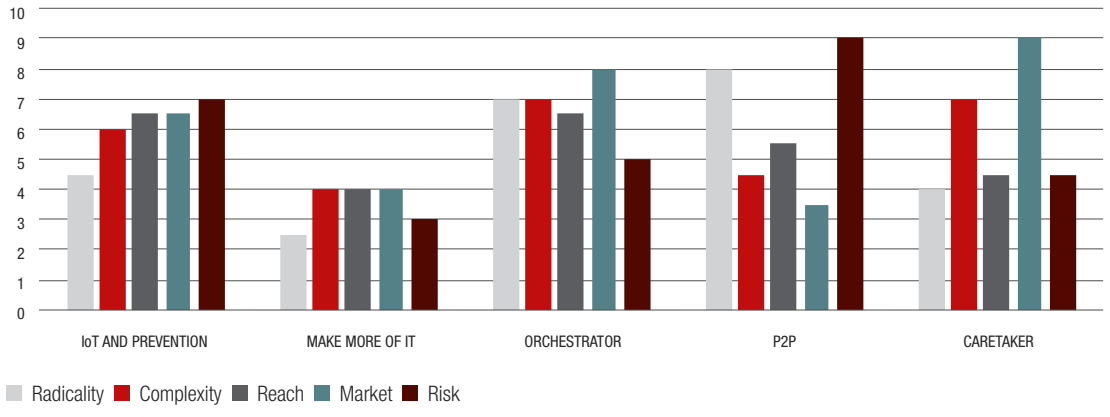
- **Radicality:** 1 is incremental, 10 is disruptive
- **Complexity (number of elements of the business model that are changed):** 1 is few, 10 is all
- **Reach:** 1 is new to the company, 10 is new to the world
- **Market:** 1 is niche market, 10 is mass market
- **Risk:** 1 is low risk, 10 is high risk of failure

The results of the interviews are summarized in Figure 1 and were as follows:

IoT and prevention is rated as having a high risk (7) but also with a potential for the mass market (6.5). In addition, IoT and prevention is seen as a topic that has a high degree of novelty (6.5), not only for the company itself, but also beyond the company. The interviewees agreed on the potential of IoT and prevention, but stated at the same time that it can be a challenge when participants outside the insurance industry want to participate.

The evaluation of **"make more of it"** is relatively low in terms of radicality (2.5) and low risk (3) compared to the other business models. The "it", meaning which core competencies can an insurer use to offer further services in addition to its core insurance business, certainly needs to be defined on a case-by-case basis.

Figure 1: Interview responses regarding possible future business models



The **orchestrator** is rated the second highest in terms of radicality (7) among the five business models. A common thread running through all of the interviews was that the discussion of the governance structure, in the sense of "who performs which task for the company?" is highly relevant. The orchestrator is a radical governance structure in which most of the value chain is outsourced. The orchestrator is certainly not transferable one-to-one to large existing insurance companies, but it represents a great opportunity for newly founded insurance companies.

The **P2P** business model is rated as both the most radical (8) and the riskiest (9). However, the fact that the model is only associated with a small market works against it. Almost all interviewees felt that they could not see much potential in the P2P business model.

The insurer as **caretaker** is considered not very radical (rated 4), but as being suitable for the mass market (9). Most interviewees agreed that the business model of the insurer as caretaker is relevant. Since many insurers already offer assistance services that go beyond the transfer of risk itself, this business model is possibly the closest to the current structure of the insurance industry.

3. FACTORS OF SUCCESS FOR BUSINESS MODEL INNOVATIONS IN THE INSURANCE INDUSTRY

Four of the seven success factors identified in this study for business model innovation in the insurance industry are related to human resources (Table 1). This is a strong indicator that human resources are essential for business model innovation in this industry.

Table 1: Factors of success for business model innovations

FACTORS OF SUCCESS	
HUMAN RESOURCES	MISCELLANEOUS
The right people are needed for business model innovation	Technology is a success factor for business model innovation
The ability to adapt is essential for the organization	Capital enables business model innovation
The mindset of people is important	To answer the question "make, buy or partner" is a success factor
New competencies of employees are necessary	

Insurance companies are not manufacturing companies, in addition to capital and IT, sales partners, employees, executives, and the board of directors are the most important resources they have. Hence, it is not surprising that human resources related topics are given such a high priority. It is, however, not clear whether the human resources related aspects receive the level of attention that other issues, such as creation of business cases, market research, selection of technology, etc., receive.

It was discussed in the orchestrator conversation that the topic of "make, buy, or partner" is a success factor for business model innovation. In an age when the world's most valuable companies are primarily technology-driven, it is not surprising that technology was cited as a success factor, along with the need for capital.

4. BARRIERS TO SUCCESSFUL BUSINESS MODEL INNOVATION

Three major categories of barriers to business model innovation in the insurance sector were identified.

1. Regulation is already widely regarded as a hinderance to the insurance business; however, the interviews highlighted another aspect that should not be underestimated. Until now, regulation has been seen as an external problem, but internal regulations usually bind the company's activities even more so in order to ensure that no external regulation is violated with the consequence of possible penalties. However, this results in a vicious circle if the external regulator uses internal company regulations as a basis for future decrees, making them even stricter.

2. Industry identity is a hinderance for several reasons. First, there is an organizational cumbersomeness in many companies that resists innovation continuously, both from inside and outside. The phenomena described in science as "the not-invented-here syndrome" and "resistance-to-change" are still frequently found in the insurance business. However, it is also important to note that there are already numerous promising trends that indicate that these structures are effectively being broken down. Second, hierarchies that are strongly developed are often a barrier when it comes to flexible and fast decision-making capabilities. From an innovation perspective, flatter hierarchical structures would be advantageous. Third, there is still a strong risk aversion in many companies.

3. Competition is another factor that hinders the development of new business models, especially among the large insurers. This relates to the widespread assumption among companies that insurtechs could become a competitive threat en-masse. They should rather be understood as potential cooperation partners offering promising, future-oriented solutions.

5. CONCLUSION

The results of the interviews on the topic of business model innovation undertaken in this study can help us derive new ideas that can serve as food for thought, but they cannot cover the respective topics in their entirety. The findings lead to the following conclusions.

1. IoT as an aid to risk prevention: prevention should be considered across all product categories in insurance entities. IoT is an important driver of new prevention solutions. It is important for insurance companies to develop their own competencies in order to be able to evaluate new opportunities and not be misled by false promises.

2. Examine own governance structure: one advantage of globalization is that companies and customers alike can access services and products worldwide. Digitalization ensures that solutions can be implemented across continents using remote technology. This increases the likelihood that there will always be a provider who can perform a task better than the insurance company itself. The results from the interviews underline that partnerships will become increasingly important. It, therefore, makes sense for an insurance company to establish partnerships with service providers, companies from outside the industry, or startups in order to offer insurance customers new services, optimize its own value chain, or develop new business models.

3. Using technology: the influence of digitalization cannot be overestimated, as the interviews have confirmed. The traditional areas, such as damage or underwriting, should work hand in hand with IT. This makes it easier to find new, innovative solutions that serve the organization, sales partners, and customers in a more meaningful way. New technologies are a major driver of innovation regardless of the insurance sector and therefore require individual responses in each case. Insurance companies should be able to evaluate the new technologies in order to determine what they actually mean for their own business model. Cooperation with start-ups is one way in which insurance companies can benefit from new technologies.

4. Reassess the potential of people in insurance companies: human resources should be permanently strengthened in insurance companies and redefined as a success factor for business model innovation and beyond. Insurance companies should realize that people are the most important resource they have. People either buy the right technology solution or fall for false promises. People either come to work every day motivated and give their best, or they spend the whole day waiting for the end of the day. People are enthusiastic when talking to potential cooperation partners about a new business model, or they are more defensive when talking to partners because they don't believe in their own company. New competencies are needed at all levels of the hierarchy to meet future challenges. The key words in this context are technological competencies, a mindset that welcomes change, knowledge of modern (agile) working methods, and the willingness to constantly improve one's skills in order to be better prepared to master the challenges of tomorrow. Insurance companies should shape framework conditions, but it is at the same time just as important for each individual to consider how their current area of responsibilities will change in the future.

OPEN INNOVATION – ENABLING INSURERS TO ADAPT AND THRIVE

MATT CONNOLLY | CEO, Sønr
MATT FERGUSON | Managing Partner, Sønr

ABSTRACT

The insurance landscape has changed and continues to evolve at pace. Fueled by record levels of startup investment, new market entrants encroaching, and BigTech circling how should insurers respond? How can they balance the pressure of near-term commercial requirements and effectively manage resources today while simultaneously driving innovation to ensure they are still relevant tomorrow? Indeed, is this even possible? What is for certain is that this cannot be achieved with an incremental approach to transformation alone. This paper explores the critical role that "open innovation" – the partnering with external innovation – will play in enabling incumbents to adapt and thrive in this rapidly changing market.

1. INTRODUCTION

As the world slowly adapts to a "new normal", there is a creeping realization that for most, if not all, incremental transformation will soon not be enough to ensure longer-term relevancy.

The market has changed and will continue to do so at an even greater pace. New competitors are entering and the success stories of tomorrow lie simply with those that can offer a range of innovative and flexible products to customers in a way that interests them.

360% | THE INCREASE IN INSURTECH INVESTMENTS, GLOBALLY SINCE 2015

The advantages of big business have slowly crumbled away. Companies now need to look further ahead. They need to move beyond "agile" and become "predictive". To be comfortable being uncomfortable. To embrace risk, become experimental, and potentially significantly reimagine their businesses.

Over the coming years, new entrants from BigTech (e.g., Amazon) and others from outside of the industry (e.g., Tesla) will fundamentally change the construct of insurance as we know it.

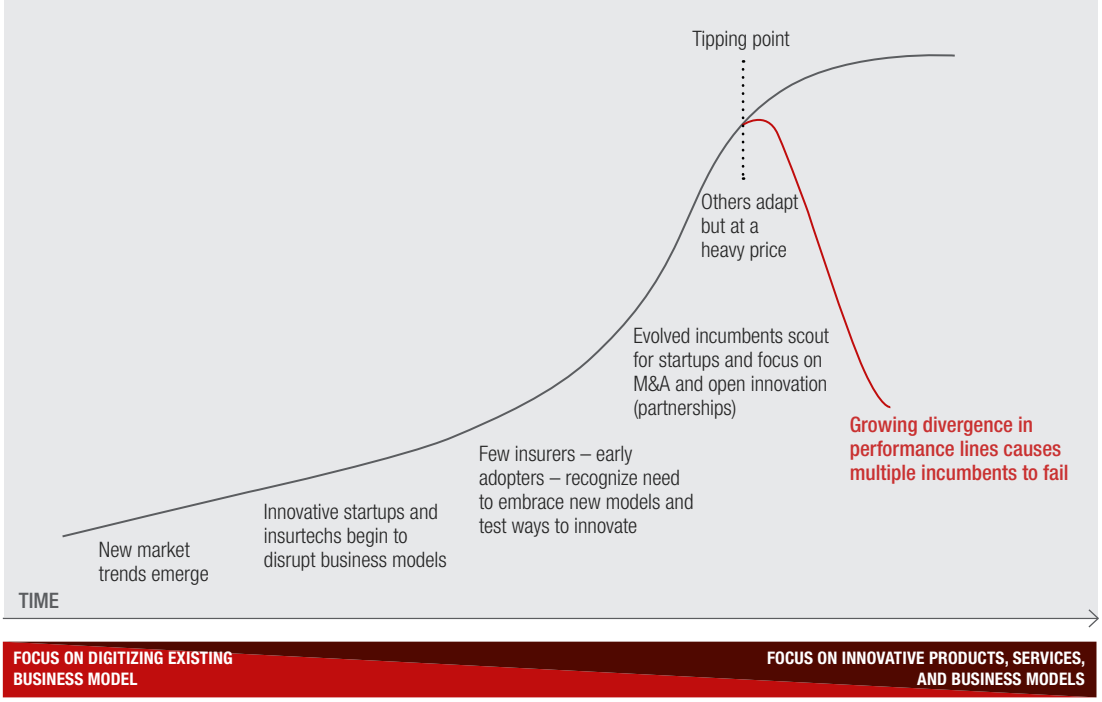
This paper explores the critical role that "open innovation" – the partnering with external innovation – will play in enabling incumbents to adapt and thrive in this rapidly changing market.

2. WHAT IS OPEN INNOVATION?

Open innovation is the term used when a company does not just rely on their internal capabilities for innovation. Rather, they use one or multiple external sources to drive innovation. Most commonly, it is used to reference the partnering with external insurtechs.

It is well recognized that insurance has barely changed in the past 100+ years. It is easy to attribute this to an inability to innovate, but in truth most companies have not seen the strategic imperative to change. Most are incentivized on performance no further than three to five years out. It is almost an inevitability that near-term commercial pressures take priority.

Figure 1: The changing insurance landscape



Whilst the past couple of years have accelerated the digitization of the industry, companies now need to think beyond moving their operations online and start to focus on new innovative products, services, and business models.

Over the coming five to ten years the industry will see more change than ever before. Maintaining the status quo, doubling down on digitization, and transformation, and not innovating, is now simply not an option.

The market will continue to evolve, and it will reach the point that when – not if – there is sufficient strategic imperative to respond, it will be too late for the incumbents. Either the resources will not be there, or the innovation capability will be too immature to respond appropriately. And so that leaves us with an industry with little experience in transformative innovation and yet one that needs to deploy radical change seemingly overnight.

The good news is it can be done. And it can be done primarily through open innovation.

3. THE BUY VERSUS PARTNER VERSUS BUILD CONUNDRUM

There are some well-known fundamentals that need to be in place for successful innovation: an appropriate culture and a forward-thinking CEO being two of the most important. But the actual innovation toolset is not particularly complicated. The options are to build it yourself, to buy it in, or to partner with external innovators. On paper, there is always a good argument to build it internally. And it is often a preferred route.

Companies already have the ideas, talent, assets, competencies, capital, and, most importantly, the customers. Combined with familiarity of the internal operations, it means that it should be easier to develop, produce, and ultimately sell what has been created, whilst maintaining IP and any trade secrets.

At the same time, it is important to also recognize that most companies tend to be inward looking and lack market orientation. They have processes, structure, and culture that tends to be complex, risk-averse, and siloed, and higher-risk projects will often be deprioritized.

What we have seen is that internal innovation rarely works out. Businesses struggle to create the right environments for ideas to incubate, let alone scale. Governance models, budgets, and controls throttle the opportunity for success.

Those that have experimented with building internal capability – whether it is the setting up of innovation labs or teams dedicated to R&D – have indeed now mostly closed those units and shifted focus to working with the external innovation ecosystem.

And so that leaves us with "buy" or "partner".

Mergers and acquisitions provide almost immediate access to resources, capabilities, revenue, or even clients. From a time to impact perspective, it is a highly attractive option. Whilst the difficulties of integrating new acquisitions into an existing business are well documented, they are not insurmountable. The greater barrier is the frequency and scale this can be done at, especially when the application of strategic experimentation must exist. With experimentation comes failure. For mergers and acquisitions, there is a very real and significant cost to failure.

Whilst we are likely to see continued growth in mergers and acquisitions, the number one route to successful, rapid, and effective innovation is through partnering with insurtechs, or as it is also known, open innovation.

Open innovation provides access to technology and businesses that are already built, have validated traction, and established market fit. The financial commitment will be significantly lower and the likelihood of success greatly increased.

To best capitalize on the opportunity open innovation brings, companies must align potential partners to where the greatest need and opportunity lie. They must look beyond the near-term, understand the trends that will be impacting the industry over the next five to ten years, and start scouting external innovation opportunities that can help them adapt and thrive. Once this becomes a regular and distributed capability across organizations, it will not be long before open innovation will become the most important weapon in the innovation armory.

In the first half of 2021, we tracked more than 200 new partnerships across insurers looking to bolster service provision with data analytics, AI, and machine learning, as well as those looking for distribution. This currently represents a year-on-year open innovation growth of around 40%.

4. THE ROLE OF INSURTECH IN OPEN INNOVATION

Insurtech, as a term, has been around for the past five years. For some it is insuretech, for others InsurTech. However it is written, the label provides a catch-all for the technological innovations impacting the world of insurance.

When publishing our recent Insurtech 100 – a list of the leading insurtechs globally – we analyzed close to 200,000 startups and scaleups that have a material impact on the insurance industry. What is most interesting when analyzing these insurtechs is that most now actively position themselves as "enablers" to the industry as opposed to a once commonly held perception of "disruptors".

To date, only a very few full-stack insurtechs have "disrupted" insurance. Most have failed to realize sufficient traction and scale to be considered genuine competition to the established players.

The vast majority are companies designed to work with incumbents to improve or evolve their offering. When considering the number of insurtechs out there, the maturing of the market, and the mutual need to work together, it is no wonder that open innovation is here to stay.

No longer is the rhetoric "death by a thousand papercuts", rather it is a more sophisticated and nuanced journey of ecosystem collaboration and experimentation. Where this becomes even more exciting is when considering the future of insurtechs.

Every year, an increasing amount of is poured into insurtechs – both emergent and more established. Since early 2020, we have also seen a rise in investors from outside the industry entering insurance, in addition to the private equity entering the earlier markets, both adding more capital to the glut already available.

$84.5bn | TOTAL GLOBAL INSURTECH INVESTMENT IN 2021 (Q1-3)

45% | OF ALL INSURTECH DEALS WERE EARLY STAGE INVESTMENTS

So far this year we have tracked over U.S.$45 billion of investments across 914 deals – more than any comparative time period. Most interesting, when considering the future of the industry, nearly 45% of all the deals went into early stage insurtechs – Series A and below.

At the other end of the spectrum, we have also seen a growing spate in IPOs. Whilst this indicates a maturing market, the media interest surrounding the multi-billion dollar valuations acts like a magnet attracting new entrepreneurs from within and outside of insurance. Plus, the IPOs also release capital back to their early investors to redeploy into new innovation.

All in all, the future for insurtech looks bright. As does the opportunity for incumbents to work with these businesses to jointly develop new futures, assuming, of course, they can realize the value these conditions might represent.

5. DEVELOPING OPEN INNOVATION CAPABILITY

Open innovation will become a critical enabler in delivering both short- and long-term innovation success. Developing robust processes for scouting, tracking, and partnering with insurtechs will be critical to developing the products, services, and business models of the future. However, as with any form of innovation, there must be buy-in to it from leadership. And ultimately the knowledge of how to scout for and work with external innovators must be disseminated across the individuals working in the business. This in itself can take time and why we stress the importance of engaging with this topic early.

Of those incumbents that have developed successful open innovation processes, almost all now make use of Insurtech Scouting platforms – Sønr being one of the examples of this in today's market. By tracking millions of companies around the world, Sønr is able to provide data-led insight on the latest market trends – both in the short and long term. Additionally, the platform provides detailed information on the startups and scaleups reshaping insurance, as well as key strategic intelligence on how other incumbents are innovating.

When Sønr is applied across a business, individuals are able to get an external lens on the art of the possible, a better understanding of the trends that will be impacting their area of expertise, and the ability to shine a spotlight on the individual companies that can help accelerate their transformation or innovation roadmaps.

Additionally, with built-in open innovation tools, knowledge and best practice can be shared across the business and ensure teams are working as efficiently and effectively as possible.

But an insurtech scouting platform is just the first step to successful open innovation.

Incumbents need to reach out and connect with the insurtech ecosystem. They need to be considered and selective as to whom they engage. Relying on inbound enquiries from startups is not recommended – you need a proactive approach to identifying and engaging those of greatest potential value to your business.

This is a critical step to ensure that your efforts are aligned to a need or opportunity. This has proven time and again to be the single most effective route to making a partnership translate into value for both parties – a fundamental requirement after all. It will result in the teams who have to work on the project recognize the value it brings; the leaders signing off resource and budget recognize the cost savings and expedited time to value.

Then comes the process by which one engages a startup or scaleup. Depending on the nature of the opportunity this will, of course, vary, but there are processes that can be applied to validate opportunities within a matter of weeks, with minimal financial commitment and resource interruption.

Finally, it is worth pointing out that this must not be a one off. A single successful partnership, and even an innovation award off the back of it, does not mean you have cracked it. Innovation needs to be continuous, and open innovation, in particular, woven into the day-to-day planning and execution.

6. NOW IS THE TIME FOR OPEN INNOVATION

In ten years' time, people will not buy insurance the same way as they do today. Nor will the construct of insurance be the same.

Let us consider just one trend set to change the market – embedded insurance – the ability to get coverage at the same time as a product or service is bought.

There is no question that over the next decade, the e-commerce and BigTech giants such as Amazon and Alibaba will dominate the embedded space. They already have control of the customer journey, as they hold the transaction data, device data, plus customer profiles, trust, and communication.

By embedding insurance, these tech players get to leverage their hard-earned brands into additional high margin revenue streams and create a deeper, longer relationship with their users.

It is also worth pointing out that consumers are increasingly willing and able to make very high value or complex purchases – such as cars – online. In short, society's accelerated consumption of digital services will create a similar acceleration towards embedding insurance in the digital world.

So where does that leave the insurer of today? Or the broker?

Over the past few years, there have been a handful of companies that have experimented with innovation seriously. Whilst there has been plenty of money spent and much criticism on what has and has not worked out, these companies now know what tools they need to innovate and have refined and embedded the processes enabling them to deliver meaningful results.

This is a huge advantage for them. They have put themselves in a position where they can continue to shape their own future, respond and adapt to external threats with speed, and be open to whatever change the industry sees over the coming years.

If this is not true for your company, it is not irrecoverable ... as long as you act quickly.

The long and short of it is the market is moving fast and will continue to accelerate. To be part of that future, continuous innovation will be critical. And the quickest, low-risk, greatest upside route to innovation? That's right, open innovation.

Those that embrace open innovation will build the capabilities required to adapt and thrive. Those that do not, face the very real danger of becoming irrelevant. Maybe not in the next three to five years, but quite possibly in the next ten.

7. CONCLUSION

Todays' insurance landscape is set to change significantly over the coming years and open innovation will play an increasingly critical role in enabling companies to predict, adapt, and remain relevant.

Companies must develop their capability to track and monitor the market; no longer is it sufficient to analyze the activity of your traditional competitors. Companies must keep across the trends impacting the industry, predict and understand the risk of new entrants from outside insurance, and become intimately knowledgeable on the startups and scaleups that best align to their needs and opportunities.

Once market intelligence is rooted and distributed across the business, it is then time to create both the culture and environment for open innovation to succeed, as well as the processes to scout, test, and scale new products and services.

If there is one new addition to your 2022 planning, it is open innovation. You cannot and should not wait to better understand the market and start experimenting and creating new futures for your business.

REGULATION

INSURANCE AND THE JOURNEY TOWARDS CARBON NET-ZERO[1]

RICHARD ROBERTS | Investment Director – Global Insurance, abrdn

ABSTRACT

In this article, we consider current sustainability practices, future objectives, and the views of key decision-makers from a wide range of European insurers. Given their long-term investment horizons, risk-management capabilities, and stringent regulatory framework, insurance companies are both highly exposed to ESG (environmental, social, and governance) challenges and, potentially, well equipped to turn some of those risks into opportunities. We discuss the key themes that arose from our research, including an overwhelming focus on environmental factors driven by risk management considerations and regulation. We go further to assess the practical challenges associated with developing and adopting decarbonization targets for insurers' investment portfolios. These challenges are not insurmountable, but they will require insurers, asset managers, policymakers, and regulators to work together to find practical and scalable solutions.

1. INTRODUCTION

In late-2020, abrdn commissioned a survey in partnership with Indefi. This involved more than 60 chief investment officers and heads of sustainable investment across Europe's five largest insurance markets: U.K., Germany, France, Italy, and Switzerland. The insurance sectors covered were property and casualty, life insurance, and reinsurance. At abrdn, we manage £221 billion of assets under management for insurers globally.[2] The aim of our research was to investigate how insurance investors are responding to environmental, social and governance (ESG) challenges, and their plans for the future. In this article, I will summarize the themes emerging from this research and also some of the practical challenges for our clients in moving towards carbon net-zero investment portfolios.

Insurers are becoming increasingly aware of the risks that climate change poses to their business in terms of assets and liabilities. As part of their efforts to consider and act on climate-change risks, the insurance industry is increasingly committing to net-zero targets for their own operations and their investment portfolios and strategies. There is an increasing recognition within the sector of the risks that climate change will bring for insurers, both directly but also through their investments. Increasingly, regulators require insurers to assess the potential climate risks to which they are exposed. These regulations do not require net-zero targets to be set for insurers, however, similar to other businesses, insurers are under increasing pressure from their own shareholders, customers, employees, non-profit organizations, and policymakers to commit to net-zero targets. Consequently, net-zero commitments have been made by many insurers

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[2] As at June 30, 2021

and pension funds. Given the uncertainty of the regulatory landscape, that will be essential to help move to a net-zero world. Membership of the Net Zero Asset Owners Alliance (NZAOA) now covers around U.S.$6.6 trillion of assets and is growing constantly.

2. CURRENT PERSPECTIVE ON THE EUROPEAN INSURANCE INDUSTRY

While our recent ESG research focused on the five largest European markets, we have frequently observed the same themes emerging to varying degrees from clients in North America and Asia.

Our research highlighted five main emerging themes:

2.1 Theme 1: Climate change a driver of innovation

In terms of the concrete ESG portfolio objectives set by insurance companies, almost all focus on climate change. These include carbon-footprint reduction, allocation to green assets, and net-zero commitments. This focus is driven by regulation, which has emphasized climate change as central to sustainable finance. Regulators have also facilitated climate action by providing investors with the necessary tools to measure risk and their contribution to the energy transition.

This emphasis has yielded an array of increasingly sophisticated analytical tools and methodologies. It demonstrates the industry's innovative capabilities and its vast potential to address the rest of the United Nations' Sustainable Development Goals (UN SDG) in the same way.

2.2 Theme 2: Drivers for adopting ESG

While there are a number of reasons for adopting ESG strategies – including values, ethics, and regulation – risk management was the main driver. Around 81% of respondents cited this as the main reason why they were considering ESG in their investment strategies. Only 33% of respondents saw ESG as a business or marketing opportunity, which emphasizes that ESG integration is seen as a risk mitigator rather than a value creator.

It was also apparent that insurers with longer-term investment horizons, primarily life and pensions insurers, saw this as a key reason to consider climate-related risks.

2.3 Theme 3: Evolving the tools and techniques to support ESG integration

Innovations in ESG practices will come predominantly from two groups of market participants. Firstly, there are the pioneers of sustainable investment (chiefly large firms). These

Table 1: Main drivers of sustainable investment in insurance

MAIN DRIVERS OF SUSTAINABLE INVESTMENT IN INSURANCE BY COUNTRY					
	U.K.	GERMANY	SWITZERLAND	ITALY	FRANCE
Values and ethics	●	●	●	●	●
Risk management	●	●	●	●	●
Stakeholder management	●	●	●	●	●
Regulation	●	●	●	●	●
Investment opportunities	●	●	●	●	●
Business opportunities	●	●	●	●	●
MAIN DRIVERS OF SUSTAINABLE INVESTMENT IN INSURANCE BY BUSINESS LINE					
	LIFE	P&C	REINSURANCE		
Values and ethics	●	●	●		
Risk management	●	●	●		
Stakeholder management	●	●	●		
Regulation	●	●	●		
Investment opportunities	●	●	●		
Business opportunities	●	●	●		

Notes: ● (<25%), ● (25%-50%), ● (50%-75%), ● (>75%)

companies were the first to adopt ESG practices and remain at the forefront. Secondly, there are the potential innovators or "leap-froggers". These are typically smaller firms that have only recently adopted ESG, but their late entry leaves them poised to exploit the maturity of the market. They innovate through new strategies or climate frameworks, and they are not constrained by processes that are embedded but potentially outdated.

Respondents highlighted that while some of the factors that impeded ESG integration a few years ago (such as the lack of reliable data) are now diminishing, more structural constraints persist. These include the search for yield to support investment-income requirements and constraints on the investable universe because of the need to meet capital requirements. This indicates that we are likely to see innovation in ESG-related investment solutions, such as measurement, stress-testing, and optimization tools in the future.

2.4 Theme 4: Juggling E, S, and G

The sustainable practices adopted by European insurance companies fall into four broad categories with significant overlap. These are exclusion, ESG integration, stewardship and impact, and thematic investing.

Although most respondents consider ESG as a single factor, nearly all recognize the drawbacks of this broad-brush approach. So far, the E in ESG has been by far the dominant factor. This is because it is the most quantifiable and material of the three elements in ESG. Environmental issues have attracted the overwhelming majority of attention from insurers, who employ all the elements in the ESG patchwork to address these issues (from coal exclusions, to engaging with companies on climate risk, to investing in climate solutions).

Undoubtedly the COVID-19 pandemic has led to a growing focus on social issues, particularly in the context of economic recovery and safeguarding jobs. But the S in ESG is seen as less material than environmental issues, and there is no consensus on how social issues should be measured. Nor is there any consensus as to how social indicators should be integrated into investment strategies. These issues are largely a result of poor reporting on social factors and a lack of consistency that comes with social reporting. But until they are addressed, we expect they will continue to impede government strategies that are using the longer-term investment capital of insurers and pension schemes to support post-COVID investment programs.

2.5 Theme 5: The role of asset managers

Most European insurance companies extend their ESG policies to outsourced assets and place ESG at the core of their discussions with asset managers. Asset managers have a pivotal role to play in the transition to a sustainable investment model. Lagging asset owners will look towards their managers for tools and support in navigating the sustainable investment landscape. Simultaneously, leading insurers will increasingly scrutinize managers in an effort to curb "greenwashing" and to find effective integration.

The rapid development of sustainable investment in the European insurance landscape presents a clear opportunity for asset managers to extend their role beyond asset management. They can help their clients manage extra-financial risks, contribute to SDGs (sustainable development goals) solutions, and warn that there is a risk of losing assets if managers fail to innovate with solutions to support their clients. One of the challenges is that the SDGs were set up by government and civil society to address world problems. They are not very investor-friendly and the transfer to companies/investments is proving challenging.

2.6 COVID-19 and insurers' responses

While COVID-19 was not a specific focus of our survey, many respondents gave their thoughts on the impact of the pandemic on their approach to ESG. Only a few respondents saw the pandemic as an opportunity to start considering ESG, particularly in light of the strong performance of ESG products in the first half of 2020. In contrast, more advanced ESG players saw the pandemic as an opportunity to invest in social products and to increase their efforts towards sustainable investment.

3. SO WHAT NEXT? THE CASE FOR, AND THE CHALLENGES WITH, INTERIM TARGETS FOR NET-ZERO

Our research highlighted that while the target is to be carbon net-zero by 2050 or, in some cases, 2040, the magnitude of the issue and actions required warrant immediate attention. But there is significant uncertainty when looking over a 20-to-30-year horizon because of a lack of certainty as to how governments will regulate on climate change. This is particularly the case when the focus is on an area that could be exposed to significant policy changes and technological developments.

3.1 The practical challenges associated with adopting interim net-zero targets for insurers' investment portfolios

Insurers are not required by regulation to set or disclose interim net-zero targets, although NZAOA (Net Zero Asset Owners Alliance) requires members to set interim targets within one year of joining. Indeed, often corporate-level commitments are made externally ahead of insurers determining the detail of how to achieve the ultimate goals. One area of increasing focus is breaking down the target into manageable chunks, such as setting interim targets for the next 5-10 years, so that progress towards the long-term 2050 (or sooner) goal can be demonstrated.

Interim targets in themselves are not straightforward to set, but the focus is increasing on this area and progress is being made. NZAOA has published guidance on how firms should develop and set these targets. It says that emissions need to be reduced by 16-29% by 2025 to ensure a pathway to net-zero. These figures are informed by work from the Intergovernmental Panel on Climate Change (IPCC).

While insurers are not currently required to set net-zero targets, they are increasingly required by regulators to assess the climate risks to which they may be exposed. This assessment is typically embedded in requirements that relate to risk management and governance for an insurer. Many regulators globally have introduced requirements for insurers to develop scenario-testing to assess the impact on their portfolio of differing climate transition pathways. Insurers will, therefore, become increasingly familiar with climate-scenario testing. This is useful for a range of reasons, including net-zero target setting and the development of investment approaches to achieve the targets set.

But the reality is that each firm that commits to net-zero and sets interim progress targets will have a unique set of circumstances to consider. They also need an actionable investment strategy and there is no easy solution to this challenge. Some of the considerations for insurers include their investment management framework, new business growth, customer redemptions and claims across the medium-to-long term, different liability characteristics and related limitations, and the corporate appetite to adopt ESG practices for their funds and policyholders. The reality of committing to interim targets could necessitate changes to current practice.

We have recently assisted insurance clients in assessing how they can achieve their net-zero targets and we have found a two-step approach to be useful. In one instance, we applied this approach to an existing £4 billion global multi-asset portfolio, with a diversity of investment management styles. We worked with the insurer's investment management team to consider the practical implications of implementing specific net-zero interim targets:

- **Step 1:** Assessing the expected decarbonization trajectories of a benchmark (existing) portfolio: what is the trajectory for the market? For example, the carbon intensity of the FTSE 100 is likely to be lower in five years than it is today. Consequently, even a passive portfolio will exhibit a level of natural decarbonization because of the changing market. Assessing this is not straightforward. For a start, which climate transition pathway is assumed? Various pathways have been published by expert agencies, but placing undue reliance on any one example may not be prudent. There are different assumptions about policy uniformity across regions and sectors that consequently weaken their usefulness for investment integration. At abrdn, our climate-scenario approach tries to overcome this issue by considering a range of bespoke and off-the-shelf scenarios. We apply our judgment to assess the probability of each scenario occurring. We look at the economic shocks expected under a probability-weighted scenario on a stock-by-stock basis, rather than by sector or asset class. We can then aggregate for any given benchmark or fund. We recently published a white paper "Climate-scenario analysis: a rigorous framework for managing climate financial risks and opportunities" that sets out in detail our approach to climate-scenario analysis in our asset-management activities. A practical example of this involved working with a client where we estimated equity indices to reduce their carbon intensity by about 44% by 2030. Against their own target of a 55-66% reduction over that timeframe, this helped them assess how much further their portfolios must go to achieve that extra 11-22% reduction.
- **Step 2:** Assessing how much further your portfolio must go: once the reduction estimate is known, asset owners can have a good view of the expected level of decarbonization they will need to achieve through more active means. There are a whole host of approaches to consider, but two have proved popular with our clients:

- Identify how we can adjust the current portfolios to further decarbonize while being aware of the pre-existing mandate requirements. For example, we can try to minimize turnover, changes to tracking error, or volatility. Some have chosen to do this through allocations to climate-friendly passive funds. But the challenge here is that different funds will have different approaches and ways of measuring a low-carbon future.
- At the portfolio level, consider how climate considerations can be embedded within the strategic asset allocation process without losing sight of the traditional objectives of risk. This could be focused on investment return targets, solvency capital ratios, and asset-liability matching requirements. This approach also considers whether climate-tilted benchmarks are appropriate in the context of the overall investment objectives. It also assesses the cost of transitioning to these more climate-focused strategies.

3.2 Considerations beyond the target

The most significant aspect of our work with clients is currently on target setting and climate-scenario stress testing. But there are other considerations for insurers' investment teams and boards that are equally complex to address and solve:

- A scalable and consistent ESG measurement framework, as many insurers use a combination of internal and external asset-management teams. In the absence of industry-wide taxonomies and measurement methodologies, many insurers are developing and designing their own climate and impact-measurement frameworks. These can then be applied across their portfolios. This is a challenging exercise to design and implement, and it also requires continuous improvement and evolution over time.
- ESG integration and whether to take a common approach across all business lines. In our survey, we identified that 41% of life-insurance companies are trying to ensure a minimum standard of investment solutions are available to their clients. Mostly, insurance companies try to ensure that the unit-linked products they offer do not violate sustainability objectives pursued by general-account assets. But a potential exception is an insurer's approach to engagement with the underlying investment universe and whether this should differ between funds or business lines. How do you quantify and report the impact of this engagement to the relevant stakeholders in a meaningful and relevant way?
- When, and to what extent, do E, S, or G factors become the priority outcome before investment risk and return?

- Exclusions – should stock- or sector-specific exclusions in the investment universe also extend to exclusions in customer groups, underwriting, or other business interests?
- How quickly are portfolios to be transitioned and who should bear the transition cost? We have seen insurers contemplate this, particularly with regard to the life and pensions sector where policyholder engagement levels are traditionally low and policyholder consent is often problematic to attain.
- Product innovation – does ESG integration present business growth opportunities through new investment solutions or target markets, particularly for the life and pensions sector?

4. CONCLUSION

In conclusion, there are challenges to be overcome for insurers to progress ESG investment themes, particularly for climate-related investments. But the opportunity for the insurance investment industry to shape and influence how ESG goals are achieved in domestic and global economies is significant. This is because of the size and scale of insurers' investment portfolios. These challenges are not insurmountable, but they will require insurers, asset managers, policymakers, and regulators to work together to find practical and scalable solutions.

All insurance participants in this sector – life and pensions, property and casualty, and reinsurers – have a role to play. They have the ability, through the design and implementation of ESG-focused investment strategies, to make a meaningful contribution to achieving net-zero targets. But they also have the ability to influence the future of impact investing.

REGULATING INSURTECH IN THE EUROPEAN UNION

PIERPAOLO MARANO | Professor of Insurance Law, Catholic University of the Sacred Heart, Milan, Italy, and University of Latvia, Riga, Latvia
MICHELE SIRI | Jean Monnet Professor of European Union Financial and Insurance Markets Regulation, Department of Law, University of Genoa, Italy

ABSTRACT

The European Union (E.U.) is one of the leading financial and insurance markets in the world. Fintech and insurtech have also developed in the E.U. The European Commission has taken numerous steps to fully comprehend and evaluate the challenges of applying new technologies to the financial services sector. This study provides an overview of the E.U. approach to insurtech from a regulatory point of view. Thus, risk governance within the E.U. Solvency II regime, including the role of the actuarial and risk management functions when dealing with this risk, will be illustrated. This analysis outlines the need for fair treatment of clients, as protecting policyholders is the main objective of E.U. regulations and supervision in insurance.

1. THE EUROPEAN UNION APPROACH TO FINTECH

The European Commission has taken numerous steps to fully comprehend and evaluate the fintech phenomenon and its implications for the financial services sector over the last three years. To this end, one of the most relevant papers issued by the European Commission is the FinTech Action Plan [E.C. (2018)], in which the E.U. acknowledged that fintech presents both opportunities and challenges for regulatory compliance and supervision. There was also a recognition that Europe's regulatory and supervisory frameworks should allow firms operating in the E.U. Single Market to benefit from financial innovation to safely provide their customers with the most suitable and accessible products. Moreover, such frameworks should also ensure a high level of consumer and investor protection and ensure the resilience and integrity of the financial system.

The European Commission clearly stated that technological neutrality is one of the guiding principles of the Commission's policies. This principle aims to repeal legal provisions that are outdated, unnecessary, or excessive about changing business models and/or the "digital" environment. Thus, one can achieve the underlying public policy objectives without a barrier to the development of fintech.

The FinTech Action Plan outlined (i) how specific E.U. rules that predate the emergence of innovative technologies may, in practice, not always be technology-neutral, (ii) that the benefits of technological innovation were already at the heart of the revisions to the Payment Services Directive [E.U. (2015)] and of the Directive and Regulation on Markets in Financial Instruments [E.U. (2014a)], and (iii) that new financial services do not always fall entirely under the existing E.U. regulatory framework; this is the case of the crowd and peer-to-peer activities for startups and scale-up companies. On the other hand, the Insurance Distribution Directive (IDD) [E.U. (2016)], as well as the Solvency II Directive [E.U. (2009a)] have not been adopted with technological neutrality at heart.

The European Commission, therefore, proposed that the European Supervisory Authorities (ESAs) should systematically take fintech into due consideration in all their activities.[1] This

decision is undoubtedly relevant for the insurance sector, as European legislation – IDD and Solvency II – has not been formally developed based on technological developments. Accordingly, the European Insurance and Occupational Pensions Authority's (EIOPA) Board of Supervisors confirmed EIOPA's commitment to insurtech and agreed to establish a multidisciplinary insurtech taskforce whose mandate was delivered in January 2019 [EIOPA (2019a)]. At the initial stages, and considering the European Commission's FinTech Action Plan, the taskforce will perform the following tasks.

Firstly, a thematic review on the use of big data by (re-) insurance undertakings and intermediaries (both incumbents and startups), including the mapping on an ongoing basis of the innovation facilitators set up by the different jurisdictions in the area of insurtech, to establish efficient and effective supervisory practices in the form of best practices, and, where appropriate, issue guidelines; the mapping of the current authorizing and licensing requirements and assessing how the principle of proportionality is being applied in practice, specifically in the area of financial innovation (e.g., regarding insurtech startups such as peer-to-peer insurers); and the assessment of National Competent Authorities (hereinafter NCAs) supervisory practices and expectations on outsourcing to cloud service providers and exploring the need to issue guidelines.

At a later stage and subject to EIOPA's work program, the taskforce will also undertake the following tasks: (i) convergence on supervision of algorithms; (ii) scrutiny of the (re-)insurance value chain and new business models arising from insurtech to propose remedies to the supervisory challenges arising from the new business models and the possible fragmentation of the (re-)insurance value chain as a result of new technologies and actors entering the insurance market; (iii) development of a European Insurance Innovation Hub, where EIOPA would cooperate with NCAs and insurtech firms (regardless of their size) to promote financial innovation in the European insurance and pensions market; (iv) assessment of the impact of insurtech in the context of regulatory monitoring, reporting, and compliance by (re-) insurance undertakings and intermediaries; and (v) exploring the benefits and risks arising from the use of blockchain and smart contracts for (re-)insurance undertakings and consumers, including assessing possible regulatory barriers preventing the deployment of this innovation.

Concerning potential barriers to insurtech, the methodology for the assessment of each barrier should include the following steps: identifying the public policy objectives sought by the relevant applicable provisions, analyzing why such provisions might represent a barrier to insurtech, and suggesting balanced solutions where the original public policy objectives are achieved without giving place to potential barriers to innovation.

Insurance Europe, the European (re-)insurance federation, shared with EIOPA's insurtech taskforce a list of examples of obstacles created by existing legislation and recommendations on how to address them.[2] However, most of the recommendations ultimately seem to demand considering the principle of proportionality for obligations deemed unjustifiable rather than relate to technology neutrality. The examples listed by Insurance Europe, which are connected to technology neutrality, mainly consist of paper requirements by default. One of the main factors for technologically driven cost efficiency is processing data digitally throughout the entire process. The Insurance Distribution Directive that applies to all insurance distributors, including automated advisory tools, sets out a default paper requirement and should, therefore, be appropriately modified (see Article 23). Similarly, Article 14 of the Packaged Retail and Insurance-based Investment Products Regulation (PRIIPS)[3] should be adapted to be more reflective of digital innovation. The paper-driven nature of these information disclosures conditions will hinder digital innovation.

However, as was mentioned, most of the other examples refer to the principle of proportionality rather than technological neutrality. This is the case, for instance, with the unnecessary reporting requirements. All providers, such as incumbents and new insurtech startups, would benefit from the reduced complexity of supervisory provisions. Rules that have proven unnecessary or overly burdensome need to be identified and revoked. One example of excessively burdensome provisions is that of the excessive reporting requirements as stipulated under Solvency II. It is also the case with the overly strict requirements in the case of outsourcing of functions/insurance activities and with the access to data and information sharing.

EIOPA (2019a) reported that the E.U. insurtech market is at an early stage but evolving based on the evidence. Most NCAs have limited experience with insurtech companies or do not differentiate those with "digital" business models. However,

[1] https://bit.ly/2UVHT53
[2] https://bit.ly/3fdoAuD
[3] https://bit.ly/3fbzRMc

both NCAs and external stakeholders highlighted the need for a level playing field, proportionality, and technological neutrality. EIOPA also believes that regulation and supervision must be technology-neutral and ensure a level playing field.

Following these principles and technological neutrality, EIOPA stated that facilitating innovation is not about deregulation. If an insurtech company offers the same services and products as an established insurance provider and is exposed to the same risk portfolio, it should be subject to the same legislation and supervision regarding the services and products in question. The preference for technological neutrality leads EIOPA to hold that there seems to be no need for further regulatory steps regarding licensing requirements, apart from some peer-to-peer insurance business models. As a best practice, EIOPA suggests that a member state that applies provisions regulating insurance in addition to those set out in E.U. law should ensure that the administrative burden stemming from those provisions is proportionate about consumer protection and financial stability and remains limited and technology-neutral.

Concerning peer-to-peer insurance, a regulatory issue could be identified when the business model consists of purely technical service providers/platforms acting as administrators for the risk-sharing groups without an underlying insurance carrier. Since the platform acts purely as an administrator for the risk-sharing groups (e.g., it might leverage blockchain and smart contracts and facilitate users coming together and creating their own "pools"), these platforms will not be easy to qualify under current regulation. Thus, it is a matter of evaluating concrete business models, and the outcome can be that a given business model falls under insurance regulation, or outside of it, as well as, say, under the regulations applicable to payments services. In addition, many do not believe that peer-to-peer insurance carried out by brokers, which is the most common type available in the market, can circumvent the standards of Solvency II [Marano (2019)].

2. TRANSFORMATION OF THE E.U. INSURANCE REGULATION

The rationale behind the use of the principle of technological neutrality is to evaluate if existing legal provisions are still up to date and/or necessary and appropriate in the context of changing business models and/or the digital environment. This assessment has been performed by identifying the public policy objectives sought by the provisions concerned, analyzing why such provisions might represent a barrier to insurtech and suggesting balanced solutions where the original public policy objectives are attained without causing any obstacles to technological development and integration.

However, the technology-driven innovations applicable to the business cycle of insurance and insurance intermediation activities may lead to gaps other than those listed by authorities: technological neutrality does not mean that the technology is neutral. Technology can affect the phenomena that have been regulated since the dawn of insurance. Insurance has now begun to develop in the environment of digital technology, which poses different challenges compared to those incurred in the "traditional" environment in which insurance has evolved.

As many have already observed [Eling and Lehmann (2018)], digital transformation can affect all components of the insurer's value chain. At the production side of an insurer, the benefits of technology (artificial intelligence) are still in development. Artificial intelligence (AI) solutions are likely to improve insurance offerings, especially customer segmentation. However, the outcome is not irrelevant for social welfare and – consequently – for insurance regulation. If AI were to be used to better assess customer risk profiles and optimize pricing systems, social welfare would be enhanced. It seems reasonable to predict that insurance products are likely to become more personalized and usage-based because of the availability of the client's data on a real-time basis. More in-depth information dataset and real-time analytics allow insurance pricing based on usage and behavior of the customers.

The role of AI and big data within the (re-)insurance sector has been specifically reviewed by EIOPA to assess the current trends and plan accordingly [EIOPA (2019b)]. The study underlined how, so far, AI and big data have been introduced alongside traditional means of data gathering and processing and thus have not replaced them. Not only has this combination generated benefits in terms of efficiency, but it has also brought about changes to the actual structure of the (re-)insurance market. In particular, EIOPA noted how this greater and much more accurate availability of data had fostered the identification of more numerous and smaller risk pools, based on new ratings strictly tailored on the customers' risk exposure.[4]

[4] As well as, potentially, the development of use-based insurance products and due to the impact of technologies, such as the Internet of Things and the 5G network.

A similar task has also been undertaken by the E.U.-U.S. Insurance Dialogue Project's Big Data Working Group.[5] The Dialogue Project carried out a joint E.U.-U.S. analysis of the impact of said technologies on the (re-)insurance sector and subsequently identified a series of areas of future study and/or intervention, such as the further development of AI principles in the U.S. and E.U., including the ethical issues; a regulatory review of predictive models, including, but not limited to, assessing transparency and explainability issues arising from the use of machine learning algorithms; the industry use of big data for fraud detection and claims settlement; and the continued monitoring of developments on third-party vendors and consumer disclosure issues [EIOPA (2020a)].

While technological developments, as underlined by the EIOPA (2019b), do not present any systemic issues at this point (e.g., concerning consumer protection), one can note that they have been causing concerns from an ethical standpoint, particularly regarding the fairness and transparency of data and AI analysis (as well as machine learning). To that end, EIOPA has given the mandate to an ad hoc working group to analyze the ethical aspects of these phenomena.

This research [EIOPA (2021a)] underlined that, as is often the case with new technologies, AI may bring some inclusion concerns to vulnerable customers and it may cause issues considering the impact mentioned above on ratings. AI should not be bent to the realization of prices and claims structured to bring customers to underwrite a contract that is unfavorable and/or unnecessary compared to the current standard.

Consistent with the technological neutrality principle, these issues should be faced through a cautious systematic application of the existing applicable framework, with particular care for proportionality. While (re-)insurance firms shall be required to have in place sound and prudent governance structures – also considering the introduction of AI in their value chain – regulation should tailor these requirements to not excessively hinder technological development.

Technology can transform the client relationship in the distribution chain, especially in increasing customer autonomy. Mobile and online customized channels can substitute traditional marketing tools. Conventional distribution channels can be replaced or supplemented by online distribution as well as by insurtech startups. First and foremost, the ambition of many insurtech startups is to automate the underwriting and intermediation of customers and the detection of claims and fraud.

Insurtech will transform insurance regulation because it will be necessary to update the framework to regulate the insurance business as a part of an integrated environment with the technology/data companies at the center of the ecosystem. Secondly, the scope of the supervision should include the "technology company" given that these "quasi-insurers" will be the source of almost all the data that the insurance industry will use. The traditional insurer will remain on the market as a risk carrier. However, technology-driven companies will be the providers of data and algorithms without being regulated in how they affect the insurance business model.

EIOPA remarked that one of the significant risks related to the mainstreaming of AI and big data within the (re-)insurance sector is that of excessive fragmentation and the possible ensuing regulatory gaps. To that end, EIOPA has opened a public consultation aimed at assessing the impact of such technologies on the value chain of (re-)insurance services to identify the appropriate regulatory measures (if any) [EIOPA (2020b)]. Technology has not only impacted how "traditional" services are provided (i.e., data gathering and processing), it has also given birth to platforms and services that are not easily qualified under existing categories (as mentioned above regarding peer-to-peer insurance models). These services may represent autonomous problems when included in the traditional (re-)insurance value chain (i.e., outsourcing). From the perspective of the regulatory authorities, they can cause a dangerous regulatory fragmentation, bringing phases of the provision of such services – which would typically fall within the scope of the applicable regulations – outside of its purview because of the new format in which they are provided.

Such risks are closely monitored by EIOPA, not only for the sake of legal certainty but also, and most importantly, because of the material risk that it may loosen the "supervisory grip" of the authority over service providers. Consequently, EIOPA has set out to identify the regulatory needs and appropriate measures that will need to be put in place in accordance with a technologically neutral approach (as per above).

[5] A project shared by the U.S. Treasury and the E.U. institutions aimed at supervisory and regulatory convergence.

Furthermore, EIOPA, under its mandate within the more general scope of the FinTech Action Plan, has been tackling other urgent areas of intervention and has carried out a careful assessment of the possible appropriate actions to take. Although EIOPA has only addressed some of the following summarized topics, one can expect that these developments in insurance regulation will be driven by the findings and studies undertaken by EIOPA.

Such is the case, for instance, with distributed ledger technologies (DLT), the so-called blockchain. This issue has been on the E.U. political agenda for a number of years now, resulting in the publication of a proposal for a Markets in Crypto-Assets Regulation (MiCAR) [E.C. (2020a)]. However, it is only in recent years that the topic has been raised regarding the insurance sector – in which, so far, this type of technology has yet to be widely implemented and experimented with (as opposed to securities trading).

EIOPA has set out a preliminary review of the state of play through an open consultation [EIOPA (2021b)] to gauge the potential of blockchain to be applied to (re-)insurance services. The EIOPA has discussed how such a tool could be implemented in all steps of the insurance value chain. The insurance value chain would benefit from the use of blockchain through the reduction of the duplication of processes, increased process automation, reduction of costs, increased efficiency, enhanced customer experiences, and improved data quality, collection, and analytics. The potential impact, however, would not be limited to improvements in existing processes, as it is deemed that blockchain could also encourage the introduction of new types of services, such as decentralized peer-to-peer insurance models, as well as parametric insurance products.

Having said that, all of these potential benefits of blockchain could potentially be problematic for EIOPA. The fact is that blockchain-based products (such as cryptocurrencies) entail new and, so far, unclear risk profiles, which would need to be considered should these products be streamlined in the insurance sector, particularly regarding consumers. Moreover, although the existing regulatory framework is generally effective when it comes to addressing emerging technologies and risks, blockchain is still shrouded in a layer of legal uncertainty for some particular aspects of these technologies: from the legal qualification of certain types of crypto assets[6] to the legal status of smart contracts, including all of the privacy and data protection concerns related to the latter. Thus, EIOPA calls for a harmonized approach to blockchain across the E.U. and cooperation among NCAs to that end. In addition, EIOPA is encouraging growth in this field.

Among the potential benefits of blockchain, according to the EIOPA, is its possible use for supervisory purposes (so-called suptech). For example, the implementation of smart-contracts could help automate regulatory reporting, thus increasing efficiency and transparency of supervision, improve data consistency across firms, as well as enabling real-time regulatory monitoring.

Fintech could be a useful tool for supervisory purposes. To that end, EIOPA has adopted a strategy to include these tools in its processes and develop the regulatory background to ensure consistency in the use of said technologies across the E.U. Moreover, suptech has been introduced in EIOPA's Annual Supervisory Convergence Plan [EIOPA (2021c)], hence, it will be pursued and developed, together with the other objectives of EIOPA, through its specific regulatory tools, such as guidelines, handbooks, statements [EIOPA (2020c)].

As has been mentioned, one of the most disruptive impacts of fintech in the field of (re-)insurance services is that of data collection, sharing, and analytics. To fully benefit from the added value that relates to that, EIOPA has identified four main objectives to be achieved using suptech as a means of harmonization and cooperation: knowledge and experience exchanges among NCAs and with EIOPA, improvement of the existing cooperation agreements and exchange of market data, and strengthening of data collection and data analytics. Furthermore, these tools could thrive, according to EIOPA, in the context of the Solvency II mandatory reporting: this reporting framework has built – and continues to develop – an unprecedented database of market data, which, if analyzed and exploited in its full potential thanks to technologies such as AI, could be conducive to a significant improvement of supervisory standards, and, ultimately, investor protection.

Among the challenges to this strategy, other than the aforementioned legal uncertainties, is the currently diverse approach of NCAs to suptech, which will represent a burden to harmonization and cooperation and may require time and effort to overcome.

[6] For instance, it has been discussed whether and under what conditions cryptocurrencies can be considered commodities and thus represent the underlying asset to a derivative, see AMF (2018), SEC (2017).

Guidelines on information and communication technology security and governance are a concrete example of EIOPA's course of action pursuant to all the strategies outlined [EIOPA (2020d)]. The Guidelines[7] find their purpose in the currently dominant fragmentation of information and communications technology (ICT) in the insurance sector, as well as the ever-growing reliance on technology in this sector across the E.U. To that end, EIOPA aims to provide a much-needed clarification to market participants on the minimum degree of information they can expect; avoiding regulatory arbitrage (and forum shopping), increasing supervisory convergence.

The authority adopted a dual approach with the guidelines. On the one hand, it acknowledged the peculiarities of insurtech, and technological risk in general, and thus provides for specific tech-related guidelines. On the other hand, it emphasized how such elements should be considered as part of the "business as usual" of all insurance sector participants, and thus requires said entities to include these elements in their everyday actions.

Examples of the first category of guidelines include, for example, specific requirements related to the security of access to the company's data, both in terms of logical access (i.e., identification tools) and in terms of physical access (access to data centers, as well as their safety from external threats).

A broader approach is adopted as to the second category of guidelines. EIOPA has provided that at least one of the governance bodies of (re-)insurance service providers must ensure that the company's governance undertake due measures to manage ICT and security risks (see Guideline 2). This requirement is then further developed, as the authority requires companies to adopt an ICT strategy and ensure that the business plan is aligned with such strategy (see Guideline 3). Lastly, while it is acknowledged that ordinary risk management tools and business continuity (see Guideline 21) plans may already have issues deriving from the use of technologies, EIOPA chose to specify the role that this component must be attributed in risk management systems and business continuity. These measures are then required to be constantly updated, monitored, and approved by the corporate body in charge of ICT-related matters (Guideline 4).

3. RISK GOVERNANCE WITHIN THE E.U. SOLVENCY II REGIME

The actual insurance regulatory framework cannot comprehensively assure proper risk governance for those technologies once they get out and are used on a broad scale. The Solvency II Directive (2009/138/EC) sets out the framework for a regulatory regime for the insurance sector, innovating the standards for capital requirements and risk management for insurers and reinsurers within the E.U. Articles 41 to 49 focus on ensuring insurers and reinsurers establish systems that lead to good governance. Article 49 deals with outsourcing, making it clear that insurance and reinsurance undertakings remain fully responsible for discharging all their obligations under the Solvency II Directive when they outsource functions or any insurance or reinsurance activities and require that outsourcing of critical or important operational functions or activities shall not be undertaken in such a way as to lead to any of the following:

- Materially impairing the quality of the system of governance of the undertaking concerned
- Unduly increasing the operational risk
- Impairing the ability of the supervisory authorities to monitor the compliance of the undertaking with its obligations
- Undermining continuous and satisfactory service to policyholders.

The regulatory framework sets forth specific requirements for outsourcing, including detailed provisions which must be included in a written outsourcing agreement required with any service provider providing services that are "for any critical or important operational functions or activities." Explanatory Notes to the 2013 Level 3 Guidelines by EIOPA give examples of critical or essential functions or activities, and these include the investment of assets or portfolio investment, claims handling, provision of data storage, and the provision of ongoing day-to-day systems maintenance or support (the latter two of which are likely to be of significance in many technology-related services).

[7] In the banking sector, a recent Grand Chamber court decision stated that the guidelines issued by the European Banking Authority (EBA) can be the subject of a referral for a preliminary hearing pursuant to Art. 267 TFUE, thus potentially laying the basis for the official recognition of the binding nature of this kind of instrument, see case C-911/19, https://bit.ly/2V82L8Z.

EIOPA identified the need to develop specific guidelines on outsourcing to cloud service providers. These services combine business and delivery models that enable on-demand access to a shared pool of resources such as applications, servers, storage, and network security [EIOPA (2020e)]. The Guidelines aim to (1) provide clarification and transparency to market participants avoiding potential regulatory arbitrages, and (2) foster supervisory convergence regarding the expectations and processes applicable to cloud outsourcing. In addition, as mentioned, EIOPA issued Guidelines on ICT security and governance, including a guideline on the outsourcing of ICT services and ICT systems (see Guideline 25). Without prejudice to the Guidelines on cloud services, insurers should ensure that where ICT services and ICT systems are outsourced, the relevant requirements for the ICT service or ICT system are met. Moreover, insurers must monitor and seek assurance on the level of compliance of these service providers with their security objectives, measures, and performance targets.

However, the aforementioned regulatory framework seems ineffective in dealing with insurtech's new environment. The existing regulatory framework is still strongly influenced by the model of traditional bilateral outsourcing relationships, where financial institutions purchase a solution from a service provider and negotiate the related contract documentation with them. A revision of outsourcing rules must determine whether it enables insurers to make full use of new technologies such as cloud solutions and distributed ledger technologies and integrate them into their business models while ensuring the necessary risk management, security, and regulatory compliance. Furthermore, assessing the fit and proper requirements of all persons who effectively run the undertaking or have other key functions should include knowledge of these systems and services.

4. THE NEW E.U. SUPERVISORY APPROACH TOWARD NEW TECHNOLOGIES

The E.U. 2018 Action Plan laid down a series of steps and objectives aimed at allowing innovative business models to scale up at the E.U. level, particularly by supporting the uptake of the new technologies in the financial services sector, while also further developing cybersecurity to maintain the integrity of the financial system despite the introduction of such unique factors. Furthermore, with an approach like that of the NIS Directive (the first piece of E.U.-wide legislation on cybersecurity),[8] the Commission's plan proposed to enhance supervisory convergence toward new technologies so as to better prepare the European financial services sector to embrace the opportunities provided by fintech and benefit from the scale economies of the single market while preserving financial stability and consumer protection.

To that end, the Commission gave a mandate to the European Supervisory Authorities (ESAs)[9] to deliver an opinion on ICT-related risks, outlining the areas of financial legislation that required intervention in terms of ICT-risk management requirements. First, the joint advice[10] of the ESAs proposed an overview of the current state of play in the E.U. financial regulation as to the said requirements, underlining, despite a widespread presence of operational risk requirements throughout the different sectors, the absence of specific ICT and cybersecurity risk requirements. The authorities, therefore, suggested introducing such bespoke requirements and a dedicated supervisory framework to ensure compliance and effectiveness. In particular, the ESAs considered that the two main areas of the intervention consisted of ICT incident reporting and the provision of an appropriate oversight framework for monitoring critical service providers to the extent that their activities may impact relevant entities, both of which found their expression in the proposal for digital operational resilience regulation.

As a result of the joint advice, of the convergence mentioned above among the national authorities, of several public consultations, as well as of several other initiatives[11] aimed at fostering debate on matters related to fintech among the leading players of the market, the E.U. Commission adopted a digital finance package, comprising a new digital finance strategy [E.C. (2020b)], as well as a retail payments strategy [E.C. (2020c)]. Regarding the digital finance strategy, its scope goes beyond just addressing the challenges raised by fintech, tackling its development and implementation in the E.U. With the declared objective of boosting responsible innovation in the E.U.'s financial services sector, the strategy sets out to adopt a set of legislative proposals of a broad reach as to the technology applied, covering four primary objectives: the achievement of a single digital market for financial services, a European financial

[8] https://bit.ly/3iehrwd
[9] European Banking Authority, European Insurance and Occupational Pensions Authority, European Securities and Markets Authority, established by Regulations EC/2010/1093, EC/2010/1094, and EC/2010/1095.
[10] EBA, EIOPA, ESMA, 2019, "Joint advice on the need for legislative improvements relating to ICT risk management requirements in the EU financial sector," April 10, JC 2019 26, p.4.
[11] The so-called "digital finance outreach" adopted by the European Commission on February 4, 2020, https://bit.ly/3x8HWaw

data space to promote data-driven innovation, a regulatory framework facilitating innovation, and addressing the risks of digital transformation [Zetzsche et al. (2020)].

Out of the four pillars of the strategy, only the last two have already been acted upon so far, tackling crypto assets and cyber resilience topics. On the one hand, the proposal of a Markets in Crypto-Assets Regulation (MICAR) [E.C. (2020d)] introduces a framework aimed at facilitating innovation in developing a market of digital representations of value that can be stored and traded electronically. On the other hand, the proposal for a Regulation on Digital Operational Resilience (DORA) [E.C. (2020e)] aims to ensure that all participants in the financial ecosystem have the necessary safeguards in place to prevent cyberattacks and mitigate other cyber-related risks, therefore, addressing the last of the objectives of the digital finance strategy [Zetzsche et al. (2020)], as well as the two areas of intervention identified by the ESAs joint advice of 2019. The preeminent role of DORA within the strategy appears clear, since the need for security and resilience is naturally more pressing as technologies are further developed, implemented, and streamlined within financial services, as is the case with the MICAR.

Other than pursuing the general strategy and political agenda according to which DORA was proposed, the regulation aims to tackle certain specific shortcomings of the E.U. financial services sector identified by the Commission's impact assessment [E.C. (2020f)], as well as by the public consultation processes which lead to DORA. Notably, a necessary action includes solving the currently existing differences of ICT security requirements in the different fields of the E.U. financial legislation. Thus, for example, the Commission noted how certain players in the financial services sector are subject to specific requirements regarding ICT risk,[12] while only general conditions, if any, are provided for other financial market participants.[13]

Moreover, a second action requires ensuring a level playing field throughout the E.U. about incident reporting obligations. One can achieve this outcome not only by introducing requirements where the financial regulatory framework is silent, but also by avoiding inconsistent and multiple reporting obligations where, for example, a financial institution is required to notify the incident to their NCA, and a different national authority under the NIS.

Lastly, a further essential action aims to grant a coherent oversight over ICT third-party providers (TPP) to European financial market participants. The introduction of an efficient oversight framework including TPP is an important part of the DORA proposal, since TPP may result in either operational issues or contractual limitations, which can temporarily prevent financial institutions from benefiting from their services. In addition, they are currently subject to variable monitoring, inconsistent at the E.U. level, with a material risk of failing to identify failures in a timely fashion. Moreover, financial institutions have been experiencing difficulties in gathering insight on the TPP they outsource ICT services to, which, about certain ICT services, are limited in their number, entailing possibly more severe risks related to the market concentration and subsequent contagion risks and capable of undermining the E.U. financial system.

The proposed E.U. regulation requires financial entities to equip themselves with internal governance and control frameworks capable of ensuring effective and prudent management of ICT risks. While the requirement is broad, DORA explicitly acknowledges its intention of assigning the responsibility of the company's management of ICT risks. Although the task is to be delegated to specifically identified ICT-related roles and functions, the company will be held liable for any failures, considering its obligations to approve and oversee the said governance arrangements.[14] This choice was driven by the intention to attribute particular importance to cybersecurity and resilience, granting relevance also in terms of business strategies, rather than introducing them as a mere compliance obligation, and ensuring that they receive the necessary budgetary consideration.[15]

Following the ESA joint technical advice, DORA then lays down a set of specific ICT risk management requirements, which revolve around several ICT risk management functions, including (1) identification of all ICT-related business functions and their risks (art. 7); (2) protection of the company's ICT systems and operations, aimed at preventing business

[12] This is is the case under the Payments Service Directive 2 [PSD2, E.U. 2015)], Central Securities Depositories Regulation [CSDR, E.U. (2014b)], and European Market Infrastructure Regulation [EMIR, E.U. (2012)].

[13] These include the Capital Requirements Directives [CRD, E.U. (2013a)], Capital Requirements Regulation [CRR, E.U. (2013b)], Solvency II [E.U. (2009b)], Undertakings for Collective Investment in Transferable Securities Directive [UCITS, E.U. (2009c)], and Alternative Investment Fund Managers Directive [AIFMD, E.U. (2011)].

[14] The choice to hold the management body liable for ICT risks is not uncommon and the exact requirement has been provided concerning credit institutions, payment services providers and investment firms pursuant to the CRR [EBA (2019)]

[15] Recitals 36 and 37 of the DORA.

disruptions through continuous monitoring and the provision of detailed security strategies, policies, procedures, tools and protocols (art. 8); and (3) prompt detection of any anomalies and incidents in the business's ICT functions (art. 9), so as to allow the timely activation of the company's ICT business continuity policy, or, if need be, the ICT disaster recovery plan (subject to independent audit review), and that these policies shall undergo regular testing, and be aided by the provision of a crisis management function.

5. EMBEDDING THE INSURTECH RISK GOVERNANCE INTO THE ACTUARIAL AND RISK MANAGEMENT FUNCTIONS

Sound risk management and governance systems should evaluate and control pricing, including the risk factors used and the claim reserving methods based on aggregated data. While under the Solvency II prudential regime this activity is under complete control of the insurance undertaking, in an insurtech environment the data process is less transparent, and data availability is in the technology provider's hands. Consequently, an important question to ask is whether such activities should be under the governance of the insurance company and, ultimately, under the control of humans.

From a prudential and the supervision of conduct perspective, it seems unsafe to leave the functioning of a pricing mechanism or a loss reservation process to an algorithm. As a counterbalance – which is again not technologically neutral – a second layer of checks should be performed on the activities conducted through the algorithms by an ex-ante control of the risk management and the actuarial functions.

E.U.'s Solvency II Directive requires four key functions (actuarial, risk management, compliance, and internal audit) to comply with the framework's second pillar requirements. However, new technologies, new organizational strategies, and new strategic moves might demand further discussions about these functions. For example, let us take one of the requirements for the actuarial function: "assess the sufficiency and quality of the data used in the calculation of technical provisions" (Art 48, (c), Solvency II Directive). A very challenging role for this function is when data is generated, transformed, and processed within an insurance organization and outside the company by the technology provider.

We conclude that the E.U. insurance regulation should demand that the actuarial function assesses an algorithm's performance, as well as any insurtech tool, and potentially intervene when assessing the design and the results of the algorithmic decision-making process. In this sense, a sound prudential framework for the insurance company should consider the role of the actuarial function in the new insurtech environment to adopt the internal process and ensure the effectiveness of the performance of the algorithms. Furthermore, from a practical point of view, other critical functions of the insurance company should be involved to address the reputational risk, including the technology's ethical issues. Thus, the governance rules for underwriting and loss reserving need an update for insurtech.

Furthermore, the E.U. Solvency II Directive requires insurance and reinsurance undertakings to have in place an effective risk-management system comprising strategies, processes, and reporting procedures necessary to continuously identify, measure, monitor, manage, and report the risks at an individual, as well as at an aggregate level to which they are or could be exposed, and their interdependencies.

This risk-management system shall be effective and well-integrated into the organizational structure and in the decision-making processes of the insurance or reinsurance undertaking with proper consideration of the persons who effectively run the undertaking or have other vital functions. The risk-management system shall cover at least the following areas:

- Underwriting and reserving
- Asset-liability management
- Investment, in particular derivatives and similar commitments
- Liquidity and concentration risk management
- Operational risk management
- Reinsurance and other risk-mitigation techniques.

Does the EU Solvency II Directive properly assess the implications of insurtech on the risk-management system?

Highly dynamic, usage-based insurance (UBI) products proliferate and are tailored to the behavior of individual consumers. As a result, insurance transitions from a "purchase and annual renewal" model to a continuous cycle, as product offerings constantly adapt to an individual's behavioral patterns. Furthermore, products are disaggregated substantially into micro coverage elements (for example, phone battery insurance, flight delay insurance, different coverage for a washer and dryer within the home) that consumers can customize to their needs, with the ability to instantly compare prices from various carriers for their individualized baskets of insurance products [McKinsey (2021)].

Price remains central in consumer decision making, but carriers innovate to diminish competition purely on price. Sophisticated proprietary platforms connect customers and insurers and offer customers differentiated experiences, features, and value. As a result, in some segments, price competition intensifies, and razor-thin margins are the norm, while in other parts, unique insurance offerings enable margin expansion and differentiation. In addition, pricing is available in real time based on usage and a dynamic, data-rich assessment of risk, empowering consumers to decide how their actions influence coverage, insurability, and pricing [McKinsey (2021)].

Let us mention the scenario in which there will be fierce competition with the associated risk of insolvency of insurance providers – lower margins and increased customer mobility that triggers more market instability. The development of multi-channel offers is likely to induce lower retention and more risk of default. New systemic risks may arise in case of a technology failure. Reputational risk and competition are expected to rise.

Supervisors need to review risk management requirements due to the insurtech players. However, again, technology is "not" neutral from the perspective of Pillar II of the E.U. Solvency II regulation.

In conclusion, technology-driven companies will be the providers of both data and algorithms, but the traditional insurer remains on the market as a risk carrier. Thus, both the actuarial function and risk management function are challenged in their ability to check if the insurance business is under the insurer's control. Nonetheless, their assessment of the implications of insurtech on the insurance business is unavoidable due to the repercussions on price mechanisms and risks. Insurers' management and internal control functions and supervisors should be fully aware of this.

6. FAIR TREATMENT OF CLIENTS IN THE NEW TECHNOLOGIES LANDSCAPE

Directive (EU) 2016/97 of January 20, 2016 on insurance distribution (IDD) provides an updated harmonized legal framework governing the rules applicable to the distribution of insurance and reinsurance products, including insurance-based investment products.

The insurance distribution directive aims to enhance the protection of consumers and retail investors buying insurance products or insurance-based investment products by ensuring greater transparency of insurance distributors about the price and costs of their products, better and more comprehensible product information, and improved conduct of business rules, particularly about advice. The new rules will apply to all distribution channels, including direct sales by insurance companies, to creating a level playing field for all distributors, and guaranteeing uniform high standards of protection for consumers.

The insurance distribution directive introduced generalized product oversight and governance (POG) into E.U. insurance

distribution law to ensure that all insurance products for sale to customers meet their specific target market needs to avoid and reduce an early-stage risk of failure to comply with customer protection rules. The product oversight and governance rules will be mainly addressed at manufacturers of insurance products and oblige them to maintain, operate, and review a POG policy to ensure that all insurance products marketed are appropriate for their specific target market. Insurance distributors must support this by operating product distribution arrangements to ensure that they have all the information needed to sell the product in line with the POG policy set by the manufacturer.

Product oversight requirements for manufacturers set out the core obligation for manufacturers to maintain, operate and review appropriate product oversight and governance arrangements for all newly developed insurance products and significant adaptations of existing insurance products. These arrangements include the definition of a target market for each insurance product. In addition, they shall ensure that insurance products are continuously aligned with the interests, objectives, and characteristics of the customers belonging to the target market. Thus, manufacturers must undertake appropriate testing of insurance products and monitor and regularly review their products continuously.

This task is likely to challenge manufacturers operating in the insurtech environment. The accessibility of more information will influence significant components of the company model of insurance, such as pricing and risk classification. Furthermore, additional data and new forms of digital monitoring (for instance, via apps, wearables, or GPS technology) offer additional information regarding the loss distribution. However, a more intrusive regulatory intervention on insurance pricing would limit the freedom of risk classification and probably increase the adverse selection and moral hazard as a side effect. So, as the first choice, it would be beneficial to adapt the existing regulatory framework in product oversight and governance to perform appropriate testing of insurance products and continuously monitor and regularly review their products coherently with the new insurtech environment.

7. CONCLUSION

The European Commission is committed to understanding, evaluating, and regulating the fintech phenomenon and its implications for the financial services sector, including insurance. Accordingly, European Supervisory Authorities systematically take fintech into due consideration in all their activities. In addition, market participants are testing the impacts of new technologies by creating new products or services or innovating how they provide “traditional” ones.

Regarding the insurance sector, EIOPA's work program refers to technological neutrality as one of the guiding principles of the European Commission's policies. This principle aims to repeal legal provisions that are outdated, unnecessary, or excessive about changing business models and the digital environment.

However, the technology-driven innovations applicable to the business cycle of insurance and insurance intermediation activities may lead to gaps other than those listed by authorities: technological neutrality does not mean that the technology is neutral. Along with opportunities and benefits to customers and the market participants, technology challenges the insurance business and its regulation.

Insurance business and regulation were both developed in an environment other than insurtech. The insurance business is becoming a part of an integrated environment with technology/data companies at the center of the ecosystem. Thus, the regulatory framework on the insurance business needs to be updated to level the playing field and ensuring all risks are duly identified, measured, and managed.

The European Commission adopted the digital finance package, which provides the general framework for digital transformation in the financial sector. This package includes several regulatory proposals. However, market participants must comply with the current framework, pending their adoption, which calls for sound risk management and governance system for financial operators, including insurers.

The Solvency II prudential regime requires insurers to evaluate and control pricing, including the risk factors and the claim reserving methods based on aggregated data. Outsourcing to technology/data companies challenges the actuarial function and risk management function to check if the insurance business is under the insurer’s control. Moreover, the set of rules on product oversight and governance requires manufacturers to embed customer protection in the design and distribution of insurance products in the new insurtech environment. Finally, supervisors must be aware of the challenges posed by the new environment. Digital transformation involves everyone, and no one can be unprepared to face it.

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AN EMERGENCY HEALTH FINANCING FACILITY FOR THE EUROPEAN UNION: A PROPOSAL

SIMON ASHBY | Professor of Financial Services, Vlerick Business School, Ghent University
DIMITRIOS KOLOKAS | Doctoral Fellow, Vlerick Business School, Ghent University
DAVID VEREDAS | Professor of Financial Markets, Vlerick Business School, Ghent University[1]

ABSTRACT

The unprecedented public health crisis caused by COVID-19 overstretched the structures and mechanisms of the European Union (E.U.), in particular those that deal with emergencies. To be ready for the next health emergency, we propose the creation of the Emergency Health Financing Facility. In its broader version, this facility integrates some of the existing E.U. emergency structures and adds a new layer for the most extreme emergencies that does not increase the burden on public finances. This new layer essentially consists of securitizing health emergency risks in the form of fixed income securities that are sold to institutional investors. The facility follows the growth of market-based risk financing facilities across global and regional initiatives, led by the World Bank.

1. INTRODUCTION

1.1. The problem

Systemic crises can have significant political consequences, though in Europe they have often been resolved through a strengthening of the European Union (E.U.).

The last systemic crisis was in 2008-2011 and brought several E.U. countries to the brink of default. Pre-existing structures were not sufficient to avert disaster, lessons were learned, and the E.U. adopted new regulatory and supervisory arrangements for financial institutions, as well as the implementation of E.U.-wide contingency funds. The flagship is the European Stability Mechanism (ESM), established in 2012 for providing emergency funding to countries in the euro area that are in financial difficulty – i.e., the ESM is a crisis fighting mechanism. The ESM has about €80 bln of paid-in capital from euro area countries and the capacity to raise hundreds of billions by issuing fixed income securities that are sold to institutional investors.[2]

The Great Lockdown Crisis of 2020 [as coined by the IMF (2020a)] was also a systemic event, but of a very different nature: public health. The magnitude was of a higher order than that of the financial crisis and the eurozone sovereign crisis that followed. The 2020 contraction was more like the Great Depression of the 1930s. But, just as in 2008-2011, the E.U. systems for dealing with this emergency were not enough, or they did not work efficiently. And, also as in 2008-2011, the crisis was resolved with an unprecedented E.U.-debt funded recovery fund and the largest E.U. budget ever.

While E.U. leaders, like those of any government, were aware of the risk of global disease epidemics [WEF (2020), WHO (2016)], and the viral epidemic episodes in Africa and Asia over the past decade (e.g., Ebola, SARS, and MERS) represented a strong early warning sign of the dangers to come, COVID-19 caught E.U. institutions and member states off guard. This resulted in one of the biggest economic, social, and financial crises since the beginning of the 20th century. Paradoxically,

[1] We thank numerous policy officers of the European Commission for insightful remarks on the E.U. structures for health emergencies and risk financing. Dimitrios Kolokas acknowledges funding from Vlerick Business School Academic Research Fund.
[2] https://bit.ly/3F6EMcC

the E.U. has a network of institutions, coordination centers, mechanisms, authorities, and funds related to food safety, monitoring of diseases, and environmental threats (see Section 2 for details). Despite this network, and the fact that many E.U. countries score highly in international health regulations with potent health systems [Tandon et al. (1990)], member states were overwhelmed when taking care of large numbers of severely ill patients.

1.2 The proposal

A key lesson that needs to be learned from the Great Lockdown Crisis is the need for a deeper union across the European healthcare sector. Although we do not know when the next health crisis will strike, COVID-19 is unlikely to be the last. Climate warming, the emergence of new pathogens, and the reemergence of others poses significant risks to the health security of the E.U. In addition, there are chemical, radiological, and nuclear risks to be considered, risks that demand a similar response.

To be ready for the next health emergency, the E.U. needs an effective mandate, unified health emergency response arrangements, and operative collaboration between member states.[3] It also needs a significant financial cushion (while keeping public finances under control) for rapid and predictably increasing funding.

We propose the creation of an Emergency Health Financial Facility (EHFF). The EHFF could provide the aforementioned financial cushion and would complement existing structures like rescEU and the Emergency Support Instrument. It is important to note that the EHFF is not an aftermath recovery facility for the social and economic costs associated with the health emergency, such as aid to businesses and to workers. Instead, the EHFF is used when the crisis starts and funds are needed quickly for ramping up medical supplies, testing kits, building infrastructures, and sudden increases of personnel, amongst others.

The EHFF will enhance cooperation and solidarity within the E.U., which is essential to overcome the effects of a systemic health emergency, without increasing the burden on member state finances. In addition, it could be used to increase the E.U.'s capacity to assess, report, and respond to health threats in a timely manner. In this article, we propose a design for the EHFF, focusing on its potential financing structure, leaving most of the technical aspects for further analysis.

In a nutshell, the EHFF is a financial mechanism that allows the E.U. to obtain large amounts of money from financial markets by means of the securitization of health emergency risks, similar to the securitization of catastrophe risks in the insurance industry. Health emergency risks are converted into fixed income securities that are sold to institutional investors. If a health emergency risk materializes, the principal (or a part of it) of the fixed income securities is used to cover the funding needs of the member states. The amount of principal used depends on the severity of the emergency.

Generally speaking, the EHFF is framed within the topic of "disaster risk financing" (DRF) [World Bank (2018a), Mutenga and Staikouras (2008), Cummins and Weiss (2009)]. DRF is a way to "increase financial response capacity in the aftermath of disasters and to reduce the economic and fiscal burden of disasters by transferring excess losses to the private capital and insurance markets" [Clarke and Mahul (2011)]. DRF is often layered into three categories depending on the frequency and severity of the risk. The funding of disaster risks with the highest frequency and lowest severity comes from allocated budgets. In contrast, the funding of disaster risks with the lowest frequency and highest severity are securitized and sold to institutional investors. Funding for risks in between typically comes from a contingency budget. The EHFF falls within the low frequency, high severity category. However, we also propose a version of the EHFF that integrates the "emergency support instrument" that lies in the (medium frequency and severity) contingent budget category.

Though both the European Stability Mechanism and the EHFF are E.U.-wide financing mechanisms for crisis fighting (sovereign and health respectively), there are important differences between them. First, the EHFF will be used exclusively for funding health emergencies. These emergencies are not necessarily medical, as with COVID-19, but any health emergency that is potentially systemic (such as chemical, biological, radiological, and nuclear incidents), in line with the existing health-related structures in the E.U., namely rescEU and the "crisis management framework". Second, in principle, the European Stability Mechanism lends money to countries subject to conditions, asking them to implement tough macroeconomic and fiscal reforms. A principle underpinning this conditionality is that shocks that require a bailout by the European Stability Mechanism are endogenous. In the case of the EHFF, shocks are exogenous and, therefore, funding will be provided when health-related conditions are triggered, and

[3] Paul Hudson, chief executive of Sanofi said in April 24, 2020 to reporters after first-quarter results that "There has been a lack of co-ordination at a European level […] It's starting to move now but the level of pandemic preparedness is very, very low." Source: Financial Times article "Sanofi warns Europe on Covid-19 vaccine", April 24, 2020, https://on.ft.com/3ijstQk

without conditionality. Third, the European Stability Mechanism provides lending, i.e., countries that receive money have a debt that must be repaid. In the case of the EHFF, funding for health emergencies will come from the principal of the fixed income securities that would not be repayable.

Facilities for disaster risk financing exist or are being considered in other parts of the world. The most prominent cases are the Pandemic Emergency Facility of the World Bank and the ASEAN+3 Disaster Risk Insurance Facility, that we explain in detail in Section 4. Another facility worth mentioning is the Pacific Alliance Catastrophe Bonds that offers earthquake coverage to four South American countries.[4]

The securitization of risk goes back to the early 1990s. The insurance industry (reinsurers in particular) were pioneers due to the hurricanes in the Caribbean. Securities that result from risk securitization are known as insurance linked securities, or ILS for short [Barrieu and Albertini (2009)]. Catastrophe bonds are the predominant form of ILS, though there are others like sidecars. The value of ILS has increased steadily since the mid-1990s: from U.S.$785.5 million in 1997 to U.S.$41.8 billion in 2020. The predominant risks covered are natural catastrophes, like named storms and earthquakes, though they also cover mortgage, operational, and mortality risks, among others. ILS have an average maturity of between three to five years, do not have investment and default risks, and hence the only risk covered is the insurance risk. The average annualized expected loss is around 2% and the average annualized coupon is about 6%; the average multiple is therefore about three.

1.3 The value of the proposal

The EHFF will have positive spillovers on the public finances of E.U. countries, in the sense that member states will be better off, as part of the EHFF, than managing the risk of a health emergency individually. If member states had to unilaterally manage the risk of the next health emergency, they would each be required to allocate, and lock-in, significant heath sector funding for an unknown time period. Since this funding might not be used for many years, such a move would represent a significant opportunity cost, by preventing the funds from being spent on other much needed public services or social security projects (e.g., education and social care). On the other hand, if member states do not lock-in funding for public health emergencies and the emergency materializes, public finances would suffer great stress and volatility, as we have witnessed with the COVID-19 crisis. The EHFF is, therefore, a cost-effective solution that protects national budgets from the impacts of health emergencies.

The IMF (2020b) estimates that, on average, advanced economies have pledged an additional 0.5 percent of GDP to healthcare. Since the GDP of the E.U. is about €18.3 trillion, the additional expenditure to healthcare due to COVID-19 is about €91.5 billion. More concretely, in above-the-line fiscal measures, France, Germany, Italy, and Spain spent €5.5 billion, €11.2 billion, €3.2 billion, and €3.9 billion in the health sector, respectively. The European Commission (E.C.) also pledged €3 billion from the E.U. budget to fund the Emergency Support Instrument and RescEU's common stockpile of equipment. E.U. budget was also allocated to research. The Commission joined forces with global partners in the Coronavirus Global Response and raised €9.8 billion in pledges from donors worldwide (including a pledge of €1.4 billion from the Commission, as at early July 2020) for universal access to coronavirus treatments, tests, and vaccines. In parallel, between January and June 2020, it mobilized €546.53 million to develop vaccines, new treatments, diagnostic tests, and medical systems.[5]

A key feature of the proposal is that the EHFF is pre-loss. We acknowledge that post-loss financing is also possible. Indeed, the E.U. has issued €14 billion of bonds, backed by all member states, to help finance COVID-19 recovery efforts across the Union.[6] These bonds were issued to help fund the Support to mitigate Unemployment Risks in an Emergency (SURE) initiative to help E.U. member states that are faced with a sudden increase in public expenditure to protect jobs.[7] Though it is possible to raise cost-effective finance post-loss, as in the case of the E.U. SURE bond issue, the timing of funds is also critical. Sole reliance on post-loss funds may mean that there are delays in the provision of funds, especially if there are political disagreements regarding the cost and allocation of funds, or where potential creditors are unwilling or unable to invest, because of a credit crunch, for example. In the case of pre-loss financing such delays are avoided, ensuring that funds are released immediately. This is especially important in the case of major crises like pandemics, where research has shown that delays can have significant consequences, preventing jobs from being saved or delaying expenditure in other areas like medical response [Bryce et al. (2020)].

[4] https://bit.ly/3opX9Do
[5] The E.U. budgets mentioned do not include the measures to recover the economy, such as SURE and the Recovery Plan. https://bit.ly/2ZOKJL5
[6] https://bit.ly/3AV0OMS
[7] https://bit.ly/3l08yrA

In short, the proposal has value as a complementary mechanism to post-loss financing. The proposal allows funds to be raised pre-loss, ensuring the fastest possible response. Post-loss finance can subsequently be used to help reinforce the available funds, for example, where additional funds are required, or the cost of finance is especially low.

1.4 Hurdles

The implementation of the EHFF faces several hurdles. First, E.U. countries hold primary responsibility for organizing and delivering health services and medical care. Joint initiatives, like the common ordering of vaccines, are exceptions and further integration with respect to the healthcare sector might be controversial. However, integration in the E.U. has always been controversial and subject to political compromises. A case in point is debt financing, which was taboo until the COVID crisis. NextGenerationEU will issue up to €800 billion of common debt.

Second, in some states, private or public healthcare or insurance systems exist that are clearly separated from general government finances, whereas healthcare costs of other states are financed by general tax revenues. The different national healthcare systems may have different needs and abilities for refinancing. That said, in times of E.U.-wide health crises, the needs are the same for all member states regardless of their healthcare structures.

Third, funding through the EHFF must be complemented with logistical planning. As we witnessed in 2020, many of the health challenges faced by governments were logistical, (e.g., lack of ventilators, hospital beds, healthcare workers in certain geographic regions, and bottlenecks in the production of vaccines). Consequently, developing emergency plans to address these logistical challenges complements its financing (Bryce et al. (2020)].

2. EXISTING HEALTH-RELATED E.U. STRUCTURES

2.1 Overview

The European Commission currently finances the strengthening of the healthcare systems of its member states via the E.U. Health Programme.[8] This is a funding instrument to support cooperation among E.U. countries and develop health activities. Strong healthcare infrastructure is the basis of an effective response to widespread life-threatening challenges, such as pandemics, and the E.U. Health Programme serves this goal. The third and latest E.U. Health Programme lasted seven years (2014-2020) and the budget was approximately €450 million. The next 2021-2027 program is EU4Health, with an estimated budget of €1.7 billion [European Council (2020)].

When a serious cross-border health threat at the E.U. level emerges, the Health Programme becomes overstretched. Figure 1 schematizes the E.U. structures for dealing with a health threat/emergency. The figure is divided into three parts, each one identified with a color. Blue represents monitoring and management of a health emergency, where the crisis management framework of the Directorate-General for Health and Food Safety is the cornerstone. Green concerns the active prevention preparedness and response of E.U.-wide risks, all integrated in the Directorate-General for European Civil Protection and Humanitarian Aid Operation (ECHO). Purple shows funding through the legal framework, Emergency Support Instrument. These structures relate to a 2005 set of International Health Regulations signed by all countries in the World Health Assembly. The new regulations were motivated by SARS in 2003 and the avian influenza outbreak of 2004-2005, and the aim was to "prevent, protect against, control and provide a public health response to the international spread of disease."[9]

2.2 DG health and food safety

The health security framework allows member states to coordinate preparedness activities and response planning to strengthen their capacities for the monitoring, early warning, assessment, and response to health emergencies [European Parliament (2013)]. This framework provides a backbone for developing national plans to address different types of health threats – e.g., pandemic, events caused by biological or unknown agents, accidents caused by chemical agents, natural events of environmental origin, and deliberate acts.

The health security framework is operationalized through the Health Security Committee (HSC), an expert group responsible for coordinating preparedness, response, and international cooperation. The HSC is supported by the Early Warning and Response System (EWRS), a confidential computer system that allows member states to exchange risk assessments and information, as well as sending alerts about events with a potential impact in the E.U..

[8] https://bit.ly/3m8nkLW
[9] https://bit.ly/3D0uTuZ

The HSC can request risk assessments to two E.U. agencies and a scientific committee, depending on the type of threat. The European Centre of Diseases and Control (ECDC) provides risk assessment services if the threat is an infectious disease. The European Food Safety Authority (EFSA) covers all matters with a direct or indirect impact on food and feed safety. The Scientific Committee on Health, Environmental, and Emerging Risks (SCHEER) covers emerging or newly identified health and environmental risks outside the remit of all other European Union risk assessment bodies.

2.3 DG ECHO

Although the crisis management mechanism is crucial when a healthcare crisis occurs, it has a role that does not actively improve the health emergency capacity of member states.

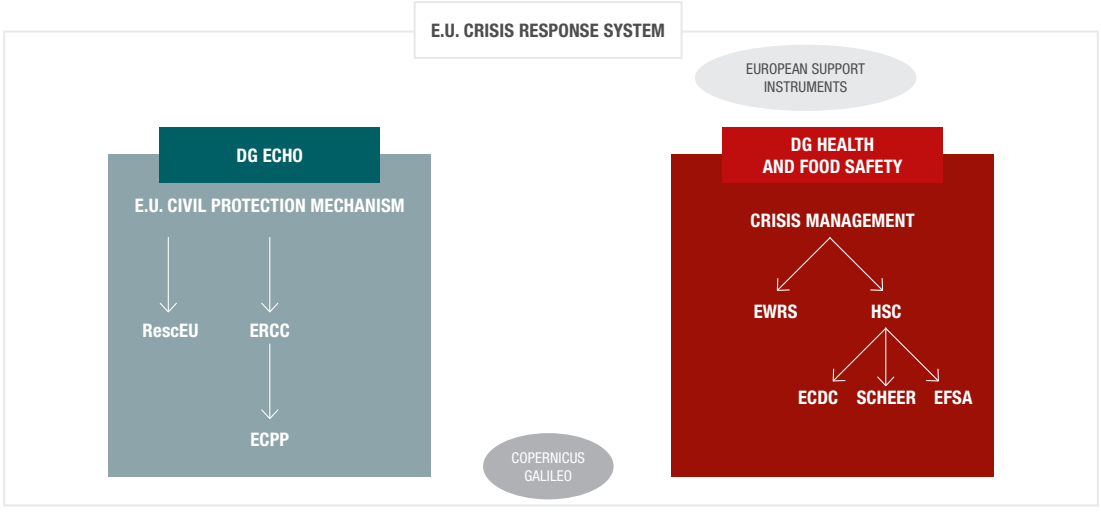
In 2013, the E.U. established the E.U. Civil Protection Mechanism (EUCPM) to support the management of crises. The EUCPM is a solidarity instrument and member states participate on a voluntary basis. The EUCPM serves as a platform to mutualize resources (or, more precisely, certified capacity such as forest fighting airplanes, medical corps, firefighters, expert teams, etc.) and is designed to provide an E.U.-wide response to support the management of disaster risks in member states.

The list of risks covered by the EUCPM is mostly based on the National Risk Assessments (NRAs) of member states. NRAs screen and report the potential risks that a country might face in the next five years. Disaster risks vary significantly across the geography of Europe and include various types. The most prominent ones range from meteorological (flooding, extreme weather), climatological (forest fire, drought), geophysical (earthquake, landslide, volcano) and biological (pandemic, epizootic, animal, and plant diseases) natural disaster risks, to human-made disaster risks of technological origin (industrial accident, radiological accident, critical infrastructure disruption).

The EUCPM is effective when emergencies affect one or a few member states. When emergencies are E.U.-wide, and given the voluntary aspect of the Mechanism, the EUCPM is not always fit for purpose. This is why rescEU was created in 2019. RescEU is a mechanism of last resort. It provides financing (from the E.U. budget) for the procurement of capacity to help respond to and recover from E.U.-wide disasters. In return, the European Commission has the right to allocate this capacity across the E.U. Put it differently, while in the EUCPM solidarity is the keyword and member states can refuse to share capacity, under RescEU, the European Commission holds the deployment rights over the capacity that is bought directly from the E.U. budget.

The coordination of all the teams and the communication between member states is managed by the Emergency Response Coordination Centre (ERCC). The ERCC coordinates the delivery of assistance to disaster-stricken countries, such as relief items, expertise, civil protection teams, and specialized equipment. The ERCC works around the clock and uses monitoring and surveillance tools like EWRS, Copernicus, and Galileo.[10] The ERCC acts as a coordination hub between all member states and six additional participating states, the affected country, and civil protection and humanitarian experts.

Figure 1: Overview of health emergency systems at the European Commission



[10] Copernicus is the E.U. earth observation program and Galileo is the E.U. global navigation satellite.

While the ERCC coordinates the delivery of assistance to a disaster zone at short notice, the European Civil Protection Pool (ECPP) brings together resources that are ready for deployment. A member state calling the ECPP is like a citizen of an E.U. country calling 112 for the emergency services. One recent example of the action of the ECPP is the forest fires in north Europe in 2018, where the ECPP coordinated various resources across Europe that assisted Sweden during this catastrophic event.

Last, the European Commission launched a proposal for reforming the EUCPM.[11] The keyword of the proposal is flexibility, especially in the budget. Currently, the budget is divided in fixed ratios across "preparedness", "prevention", and "response" classes. Under the proposal, this categorization is canceled, and the budget might be used with greater flexibility based on the ongoing needs of the member states and the severity of the emergency. It is also proposed to enhance the role of the ERCC by strengthening its cooperation with E.U.-level entities involved in crisis management and its monitoring and early warning functions.

2.4 The last resort funding: ESI

From a financing perspective, the funding provided by rescEU is limited in amount and scope (e.g., it only applies to certain types of natural disasters). Though the budget was increased twice during the pandemic, first to €80 million and then to €300 million, as implementing acts were recently approved on health emergencies, this remains well below the multi-billion Euro fiscal spending of member states on the pandemic.[12]

Additional, last resort, funding is provided by the Emergency Support Instrument (ESI). The ESI is a legal framework created in 2015 and must be activated by the European Council upon proposal of the European Commission. The ESI was activated for the first time in 2016-2019 during the immigration crisis. Due to the COVID-19 pandemic it was activated again in April 2020 for 24 months.[13]

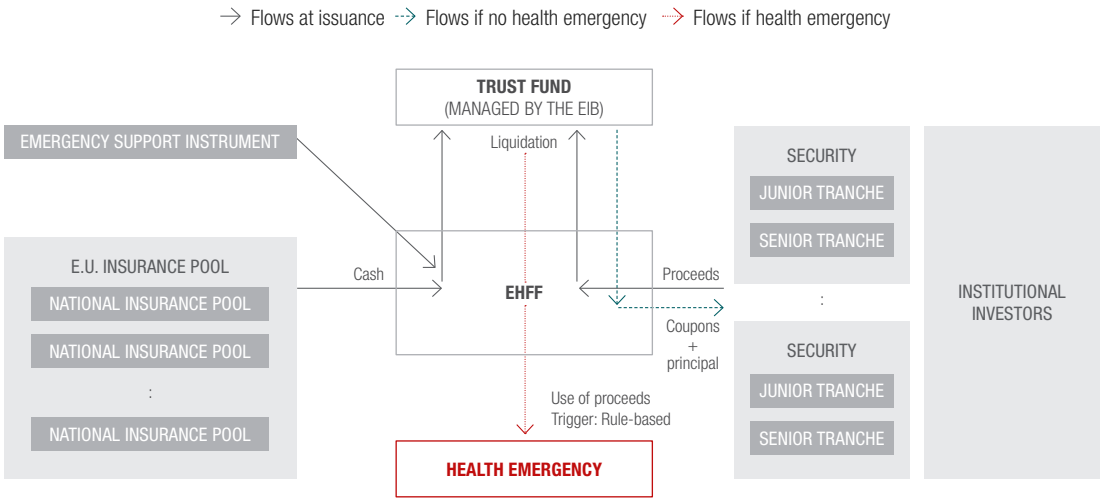
Currently, the ESI manages €2.7 billion funded by the E.U. budget. During the COVID-19 pandemic, the ESI initially focused on the supply of medical equipment. Then, in June 2020, when the European Commission announced its COVID-19 vaccination strategy [European Commission (2020)], it was decided to use a significant proportion of the €2.7 billion ESI fund to support Advanced Purchase Agreements (APAs) with the pharmaceutical industry to ensure the rapid deployment of vaccines, once developed. It is important to note that an APA is not a forward contract and, therefore, does not involve the advance purchase of any vaccine that is developed (the WHO estimates that the international cost for vaccine testing, development, and treatment will be about U.S.$31.3 billion in 2021, so the purchase costs will be much higher). Instead, these APAs work like a call option that confers a right for member states to buy a vaccine with priority over third-party countries. In this way, the APAs funded through the ESI function as a form of insurance policy. Funds are provided to the pharmaceutical industry to guarantee the supply of a vaccine to member states.

Though the ESI is a strong last resort funding instrument and with the right focus, it can lack speed and flexibility. The ESI is funded by the E.U. budget only when it is activated by the European Council. As a result, its funding is not secure and must be negotiated, as must the activities that may be underwritten. Moreover, the European Commission needs to cooperate and coordinate with member states and with the European Parliament, which can be time consuming. Indeed, in the vaccine strategic communication, the Commission acknowledges that €2.7 billion might not be enough and that "Member States will have the possibility to top-up the ESI to make up any financing gap." In addition, the Commission considers exploring alternative avenues to attracting funding, such as individuals, foundations, and crowd funding.

Last, the European Investment Bank has contributed to the research and development of a vaccine through the Horizon 2020 InnovFin Infectious Disease Finance Facility. This facility is 100% guaranteed by the European Commission. The EIB provides debt and equity-type financing.[14] Though this is not a financing instrument for emergencies, currently the facility is exclusively allocated to COVID-19 projects.

[11] https://bit.ly/3kVMgqQ
[12] NextGenerationEU and the 2021-2027 MFF allocate to RescEU €1.9 bln and €1.1 bln, respectively [see European Council (2020) for more details]
[13] At the level of the E.U. political leaders (i.e., the European Council), there is also a mechanism that can be activated for crisis response: The Integrated Political Crisis Response (IPCR). It was created in 2013 and activated for the first time during the refugee and migration crisis. More details can be found here https://bit.ly/3AUpMfn
[14] https://bit.ly/3okJ760

Figure 2: Complementary architecture of the EHFF



3. THE EHFF

The Emergency Health Financial Facility (EHFF) is a health risk management tool that provides liquidity when it is most needed and without allocating large amounts of cash in advance. The EHFF gives financial firepower, covering the possibility that the budget allocated in the ESI is not enough and without member states being forced to top up the ESI with billions of extra euros.

3.1 Architecture

The architecture of the EHFF can take two forms, depending on its relationship with the Emergency Support Instrument. The first possibility is complementary, while the second is integrative.

3.1.1 OPTION 1: EHFF COMPLEMENTS ESI

Under this option the EHFF acts as a special purpose vehicle, or a legal entity entirely devoted to deal with financing the costs of health emergencies and managed by the European Commission. Such a facility is represented by the big blue rectangle in the middle of Figure 2.

Once the EHFF is created, the next step is to decide the risks covered and their price. Both are required for the issuance of fixed income securities. As the right-hand side of Figure 2 shows, there can be as many issuances as risks covered and, for each issuance, there can be different tranches that cover different severities of the emergency. Though the figure shows a junior and a senior tranche, there can be many more (e.g., a mezzanine). We cover this issue more in detail below.

To pay the coupons to investors, the price of the risks (the premium in insurance jargon) must be transferred to the EHFF. This is a cash transfer that can come from the ESI and/or from a newly created E.U. health emergency insurance pool (we explain this point further below), as shown in the left-hand side of the figure. Cash is then transferred to a trust fund, as shown by the solid black arrows.

Once the fixed income securities are sold to institutional investors (typically bonds with a duration of three to five years), proceeds are transferred to the trust fund, which are invested. The issuance and the management of the trust fund would happen under the auspices of the European Investment Bank (again, more on this below).

If during the lifetime of the securities there is no health emergency, investors receive their coupons and upon maturity the principal is returned, as shown by the green dashed arrows. Cash transferred to the trust fund is used to pay the coupons, while the investment return (which is not significant since cash and proceeds must be invested in safe assets) is typically used to cover administrative costs.

If a health emergency that meets certain criteria occurs, then the investments (in whole or part) are liquidated and transferred to finance the emergency, as shown with the red dotted line. As a consequence, in the case of a severe emergency, institutional investors can forego future coupons and the principal. The above-mentioned triggering criteria must be unambiguous, measurable (to gauge the scale of the emergency), and clearly specified in advance. Liquidated

funds are transferred to member states or to organizations with requisite expertise. Below we expand on the triggering mechanism and how it should look like.

To sum up, under the complementary form, the EHFF is a sort of reinsurer of the ESI and the associated risks are transferred to financial market investors.

3.1.2 OPTION 2: EHFF INTEGRATES ESI

Figure 3 shows the integrative approach, in which the ESI is upgraded to the EHFF. Such a facility would consist of two elements: cash and fixed income. While the cash element plays the same role as the current ESI, the fixed income element is like the architecture in Figure 2. The difference between Figures 2 and 3 is that in Figure 3 the ESI is integrated into the EHFF. The advantage of this integration is that only one legal framework is required for funding E.U. health emergencies.

Under the integrative architecture, cash comes from the E.U. health emergency insurance pool and from the E.U. budget (similarly to today's funding of the ESI comes from the E.U. budget). The issuance of securities and the triggering criteria are the same as in Figure 2. Cash can also be used in the case of a triggering event, just like the European Commission (2020) is using cash in the ESI to finance APAs of vaccines. The main difference between the triggering criteria in the fixed income and the cash elements is that, in the former the trigger is based on rules, while in the latter an expert committee decides.

3.2 RELEVANT ASPECTS OF THE EHFF

To implement the EHFF in one of the forms just explained, several further issues must be addressed. The most important is the risks to be covered and how they are priced. Second, the criteria to trigger the (partial) liquidation of investments for funding the health emergency. Third, the mechanics for the E.U. insurance pool. In this section, we explore these issues. It is not our aim to provide a detailed implementation and operational guide. This is beyond the scope of this article and will require detailed risk and financial analysis.

We conclude the section with some remarks on the role of the European Investment Bank and its experience in running trust funds, as well as remarks on the EHFF's lack of default and investment risks.

3.2.1 WHICH RISKS AND HOW?

As mentioned in Section 2, the E.U. Civil Protection Mechanism deals with a diverse array of disaster risks, both natural (meteorological, climatological, geophysical, and biological) and man-made (e.g., chemical, radiological, and nuclear). If they were to materialize, each of these risks can lead to a health emergency, and hence potentially fall under the architecture of the EHFF. Social, economic, and financial losses due to the realization of such risks (business interruption, non-paid wages, etc.) are not covered by the EHFF.

Though the EHFF can cover many infrequent risks, the severity of an emergency must be considered. As mentioned earlier, the EHFF naturally links with the Emergency Support Instrument, an instrument used only where there is an E.U.-

Figure 3: Integrative architecture of the EHFF

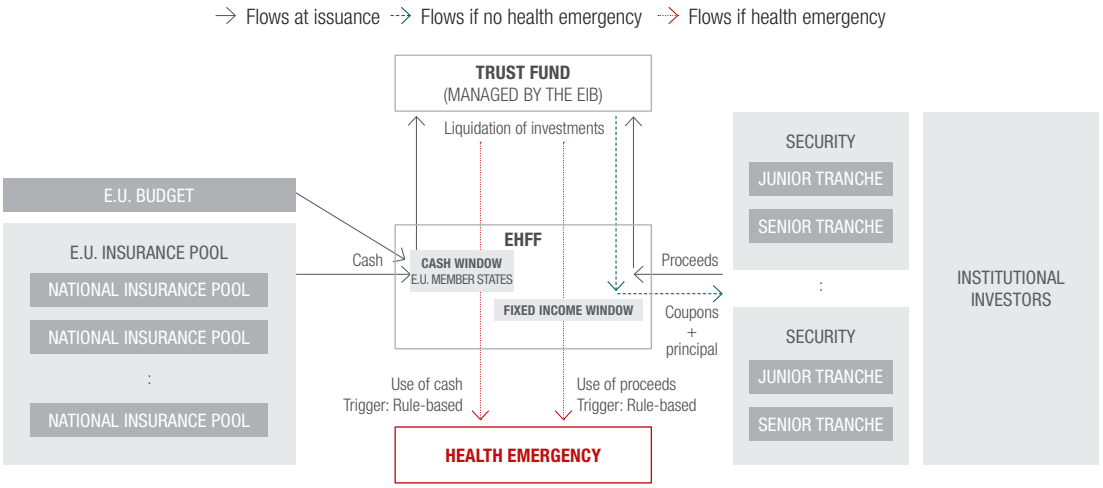
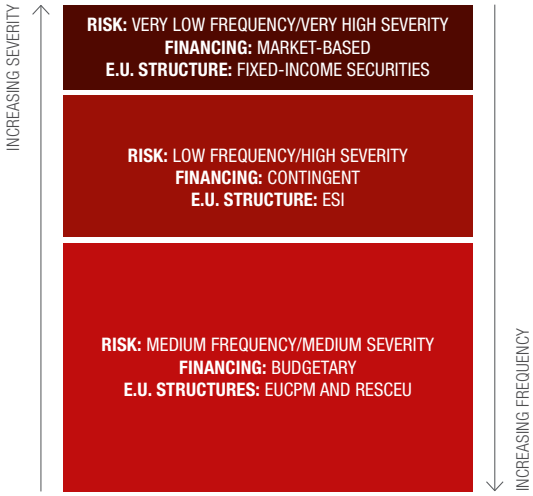


Figure 4: Risk structuring



wide emergency. This is typically in the case of (very) low frequency/(very) high severity events. For risks with higher frequency and lower severity, other tools such as rescEU and EUCPM can be used.

To put it another way, the severity and frequency of a given event can be structured in three tranches, as shown in Figure 4. The risks at the bottom tranche (medium frequency/medium severity events) are covered by the pre-existing EUCPM and rescEU mechanisms. The intermediate tranche is covered by the ESI, with funding contingent on the activation of ESI by the European Council. The last tranche (very low frequency/very high severity events) is covered by fixed income securities, and hence financing comes from financial markets. A similar classification is used for assessing the use of financial instruments in risk financing [Clark et al. (2017)], as well as for insuring risks with reinsurance and ILS [Cummins and Trainar (2009)].

Focusing on the last tranche, it can be further divided into sub-tranches, as already showed in Figures 2 and 3, whereby the higher the risk of each sub-tranche, the higher the coupon. Coupons would be equal to a prespecified interbank interest rate (e.g., LIBOR or EURIBOR), plus the price of the emergency risk, which acts as a risk premium. Issuance of the sub-tranches could be done in collaboration with a global (re)insurance company, serving as a financial market intermediary, similar to an investment bank (for instance, the insurance tranche of the WHO's Pandemic Emergency Facility was structured by MunichRe and SwissRe).

Last, a thorough risk analysis is essential for investors to buy the securities from one sub-tranche or another. Investors typically care about three risk measures: i) the probability that a fixed income security will experience losses during a given period (known as the probability of attachment), ii) the likelihood of suffering a total loss (known as the exhaustion probability), and iii) the expected loss relative to capital invested. This risk analysis is done in collaboration with specialized disaster modeling companies that function as independent reviewers and offer confidence to institutional investors.

3.2.2 THE TRIGGERING CRITERIA

The choice of trigger is a central component of any securitization mechanism for emergency funding, as it determines the scope of indemnification for the occurrence of the emergency.

Theoretically speaking, the ideal outcome is an indemnity trigger equal to the funding needs of the emergency. This is the standard outcome in the ILS industry, and currently it accounts for about 65% of outstanding capital.

Unfortunately, for the EHFF, an indemnity trigger approach is not viable. When the emergency strikes, funds need to be readily available. With an indemnity trigger, the funding needed for the emergency is subject to verification processes, which can be complex and opaque, ending up with investors demanding a higher coupon or further delaying the release of funds through legal challenge. Furthermore, indemnity triggers are subject to information asymmetries [Finken and Laux (2009)].

Instead, the EHFF should opt for a parametric trigger [Teh and Woolnough (2019)], where the European Commission defines criteria under which investments in the trust fund are (partially) liquidated. For instance, in the case of the Pandemic Emergency Facility of the World Bank, the criteria were based on the cases, deaths, and geographical spread of the pandemic (as explained in the next section). The higher the number of cases, deaths, and spread, the higher the proportion of liquidated investments. Generally speaking, a parametric trigger is insensitive to information asymmetry and, in the E.U. context, should not depend upon approval of the European Parliament and the European Council (in contrast to the ESI).

Figure 5 shows a diagrammatic representation of a parametric trigger, measured with an index of base 100 (horizontal axis). The fixed income security has two tranches, as in Figures 2 and 3. The vertical axis shows the principal of the securities: 100% means that investors recover all the principal, while

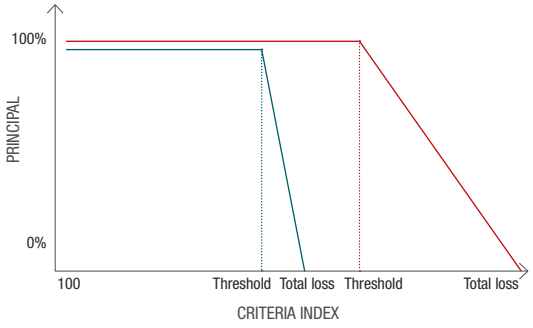
0% means that all the investments in the trust fund are fully liquidated and investors lose everything. The percentage of principal recovered depends on the index, which is verified on a regular basis since the emergency strikes. Because the junior tranche is riskier than the senior, the former starts to liquidate the principal earlier.

Currently, the European Commission already uses triggering criteria for emergency funds. The Directorate-General for Regional and Urban Policy oversees the E.U. Solidarity Fund (EUSF).[15] The main goal of this fund is to financially assist member states to cope with emergency operations due to natural disasters and health emergencies. The EUSF can mobilize up to €500 million (plus any unspent money from previous years) from the E.U. budget. To trigger the release of funds, the following criteria must be met. First, the level of the direct damage caused by the natural disaster should exceed €3 billion or more than 0.6% of GNI (these number change to €1.5 billion and 0.3% of GNI in case of a health crisis). In the case of a regional disaster, the percentage is 1.5% of the regional GDP. Second, approval of the European Parliament and the European Council is needed.[16] The European Council (2020) is considering the creation of a new €1.2 billion Solidarity and Emergency Aid Reserve envelop that covers the EUSF among others.

3.2.3 THE E.U. HEALTH EMERGENCY INSURANCE POOL

This pool would be a new creation, though based on existing national pools. Almost all member states have at least one insurance pool to cover the occurrence of very large risks, such as nuclear, environmental hazards, and terrorist threats [DG Competition (2014), OECD (2016), Skogh (2008)].

Figure 5: A typical example of parametric trigger



Insurance pools are a form of co-insurance. All pool partners contribute and share the risk without limited responsibility, on the grounds that when very large risks occur, it affects all partners, and hence they are better off mutualizing the risk in the pool. In addition, an insurance pool allows contributing partners to take on risks that they could not otherwise afford to underwrite, by reducing their individual liability and sharing the costs of any legal disputes about the nature and extent of cover. COVID-19 is a good example of such a situation. Though insurance companies claim that the fine print of insurance contracts rule out many pandemic related claims, legal actions against this by policyholders have commenced in numerous jurisdictions. It is very likely that COVID-19 will be the costliest event in history for the insurance industry.[17]

By including E.U.-wide health emergency risks in the list of pooled risks and transferring an appropriate premium to the E.U. health emergency insurance pool, insurance companies and governments of the member states could take these risks off their balance sheets [see De Mot and Faure (2019), for the role of governments on the cost of disasters]. This would have advantages for the insurer's solvency ratios and release more capital for business development. At the time of writing, similar ideas are being debated in the U.S. and in the U.K.[18]

Note that we are not proposing to merge national insurance pools across member states, but to include E.U.-wide health risks to help supplement national pools and transfer only low probability, high impact health risks to the E.U. insurance pool.

Premiums transferred by the national pools to the E.U. health emergency insurance pool could be proportional to the risks covered by each national pool. However, this can be cumbersome, difficult to compute, and highly political. Instead, once risks are priced, premiums transferred can be on the same proportions as the contributions of the member states to the Multiannual Financial Frameworks (aka the E.U. budget).[19]

3.2.4 TRUST FUNDS AND THE EIB

Since the cash and proceeds of the EHFF are placed in a trust fund at the European Investment Bank (EIB), it is worth remembering that the EIB has much experience managing trust funds.[20]

[15] https://bit.ly/3meDGTr
[16] See Faure and De Smedt (2019) on the role of the E.U. as facilitator of insurance or if it includes ex-post compensation as well
[17] https://bit.ly/39Sa88m
[18] See the Financial Times article: "Insurers plan to include pandemics in UK terror scheme" (https://on.ft.com/3AYX39n)
[19] See here for the last available https://bit.ly/2ZODPpa
[20] https://bit.ly/3menvFR

Currently, the EIB deploys trust funds to promote sustainable development within and outside the European Union. These trust funds not only ensure the financial feasibility and sustainability of these projects, they also add capacity and expertise through technical assistance.

Trust funds are co-created with the EIB, the European Commission, and most of the member states that act as donors. These donors enter into a partnership with the EIB because they have an interest in delivering sustained impacts across developing countries. On the other hand, the long-term goal of the EIB is to initiate actions and projects that will attract further investments from other institutions and organizations.

Eight trust funds have been created so far, supporting projects in 75 countries. The size of the funds varies significantly. The smallest is the Water Sector Fund and accounts for €2 million. The largest is the E.U.-Africa Infrastructure Fund, which raised €815 million.

3.2.5 EHFF DOES NOT HAVE DEFAULT AND INVESTMENT RISKS

The fixed income securities issued by the EHFF solely contain the health emergency risk. There is no default risk since the European Commission has the highest credit worthiness. But even in the case that it would default, investors would still recover the principal since it is in a trust fund of the EIB, and hence is legally separate.

Similarly, these securities would not have any investment risk, since the trust fund would only invest in safe assets that provide a return sufficient to cover administrative costs. Alternatively, the trust fund can enter in a total return swap with a triple A rated counterparty. This eliminates the investment risk, but creates a residual counterparty credit risk, in the unlikely event that the counterparty was to default on its payment obligations.

We close this section with a note on why investors would be willing to buy securities issued by the EHFF. In the ILS market, typically there is more demand than supply. This is because investors find these securities attractive as they offer a high coupon (relative to the average of fixed income products) and they are uncorrelated with other asset classes, which is good for diversification.

4. PRECEDENTS OF GLOBAL AND REGIONAL EMERGENCY RISK MANAGEMENT

In this section, we survey the most relevant (for this article) emergency risk financing initiatives taken globally and regionally; and we use Figure 3 as reference. Not all are covered in detail, but only those that are the closest to the EHFF and that are operational (i.e., we do not cover projects under development because of lack of information) – we refer readers to ODI (2020) for a comprehensive overview of the available risk financing tools.

Regarding the fixed income window in Figure 3, the World Bank (through its treasury and the IBRD) is the leading international organization for the securitization of disaster risk financing, not only because of the already mentioned PEF (Pandemic Emergency Financing Facility, and explained in detailed here below), but also the Pacific Alliance Catastrophe Bond for Earthquake Risk that covers four countries in the American Pacific Coast [IBRD (2018)], and the Catastrophe-Deferred Drawdown Option that can trigger a loan at very favorable conditions in case of natural disasters and/or health-related events in any IBRD country [World Bank (2018b)].

As for the cash window, sovereign disaster risk insurance is of interest. This type of insurance typically operates as a regional insurance pool and the trigger is parametric. Examples include the African Risk Capacity (ARC), Caribbean Catastrophe Risk Insurance Facility (CCRIF SPC), Pacific Catastrophe Risk Insurance Company (PCRIC), and the Southeast Asia Disaster Risk Insurance Facility (SEADRIF). We treat the latter in detail.

4.1 Pandemic Emergency Financing Facility

This is the most similar structure to the integrative architecture of the EHFF. On July 2017, the World Bank Group (in consultation with the World Health Organization) created the Pandemic Emergency Financing Facility (PEF).[21] The mission of the PEF is to provide emergency financing to the poorest countries (International Development Assistance – IDA – members) after an initial epidemic outbreak. More specifically, the risks covered are flu pandemics, coronavirus, filovirus (e.g., Ebola), Crimean Congo haemorrhagic fever, Rift Valley fever, and Lasa fever.

The PEF has two windows: cash and insurance. Cash comes from country donors (Germany, Japan, Australia) and IDA itself. The insurance window issued the so-called pandemic bonds and swaps agreements with a global reinsurer.

[21] See PEF (2018) for the operations manual

Pandemic bonds were structured by two leading and global reinsurers. They had a maturity of three years and an outstanding principal of U.S.$320 million.[22] There was a very high demand from institutional investors (specialized hedge funds, endowments, asset managers, and pension funds) with an oversubscription of 200%. Senior and junior tranches were issued, the latter covering more risks. The PEF sold U.S.$225 million in senior tranches and U.S.$95 million in junior tranches, with annualized coupons if there is no major pandemic outbreak of 6.9% for senior and 11.5% for junior tranches.

The definition of a "major outbreak" is that of a global pandemic, specifically the multiple sustained transmission of a highly infectious agent in multiple regions of the globe. This definition has three dimensions (size, growth, and spread) that, in the case of the pandemic bonds, are measured with the number of confirmed cases, the growth rate of cases and deaths, and the geographical spread. These parameters are calculated by an independent agent (the disaster modeler). If the agent confirms that the outbreak is "major", the trigger is met and the principal of the bonds is reduced, eventually to zero. This reduction is transferred to the World Bank Treasury, which distributes the funds, upon application, to eligible nations.

The PEF was first used in May 2018 with a U.S.$12 million grant towards the "2018 Équateur province Ebola outbreak" in the Democratic Republic of the Congo (DRC). The cash window was used since the parameters for triggering the pandemic bonds were not met. In June 2018, the World Health Organization warned that there was "significant risk" that the outbreak would spread to neighboring countries, placing pandemic bonds into focus, but in July 24 the WHO declared the outbreak over. There were 54 cases (38 confirmed and 16 probable) and 33 deaths.

The PEF was used for a second time in August 2019 with a U.S.$31 million grant (from the cash window) to the "2018 Kivu Ebola outbreak". This outbreak started in August 2018. In September, the WHO raised the risk assessment at the national and regional level from "high" to "very high", partly because of the local military conflict and civilian distress. There were 3850 cases and 2272 deaths. The outbreak spread to Uganda, as family members residing in Uganda traveled to Congo for the burial of a relative. This is the second largest Ebola outbreak in recorded history.

The PEF was used a last time with COVID-19. This time the triggering criteria were met (in April 2020) and junior tranche investors lost 100% of the principal, while senior tranche investors lost 16.7% of the principal.

The PEF was criticized because the payouts did not occur as fast as they should, either because the committee in the cash window waited too long, or because the triggering conditions in the insurance window were too restrictive [Brim and Wenham (2019)]. In July 2020, the World Bank announced that it would shelve plans for a second sale of the pandemic bonds.[23]

4.2 ASEAN+3 Disaster Risk Insurance Facility

The Association of Southeast Asian Nations is a regional intergovernmental organization comprising ten countries in Southeast Asia.[24] ASEAN+3 incorporates China, Japan and South Korea.

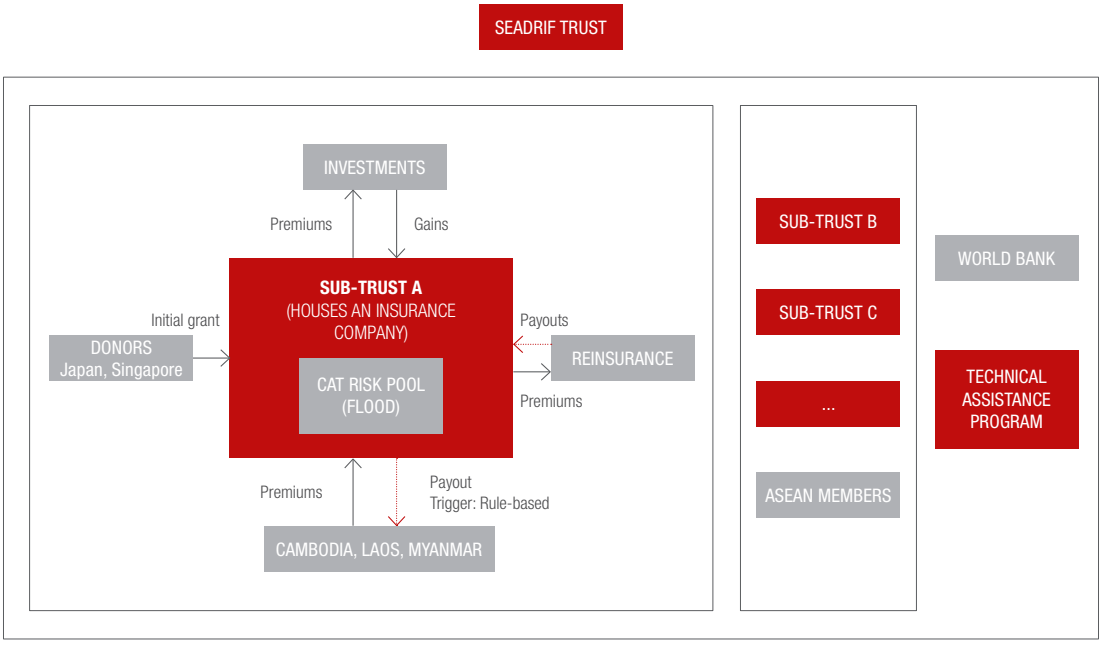
Southeast Asia is one of the worst hit regions by extreme natural phenomena. According to the United Nations, in 2018, about 8% of losses are covered by insurance and the economic toll from disaster is estimated to increase by U.S.$160 billion per year until 2030.[25]

For this region to have the capacity to address the sudden consequences of disasters, while preserving the stability of public finances, the ministers of finance and central bank governors from ASEAN+3 created the Southeast Asian Disaster Risk Insurance Facility (SEADRIF) in 2019. SEADRIF is a regional approach to disaster risk finance that aims to increase governments' fiscal capacity to manage the financial impact of natural disasters and improve access to rapid response financing for emergency response.

Figure 6 shows the basic structure of SEADRIF. It is a trust that contains sub-trusts and a technical assistance program led by the World Bank. Currently, there is only one sub-trust (A) that houses an insurance company. This company pools the parametric catastrophic flood risks of three ASEAN members (Cambodia, Laos, and Myanmar). Sub-Trust A functions like any insurance company: it invests the premiums and reinsures a significant part of the risk. The initial grant by the donors is to get the sub-trust up and running (i.e., for rapid payouts that are subsequently reimbursed by the reinsurer, retain a part of the risk in the pool, and earn income on the investments).

[23] https://on.ft.com/39VzX7C
[24] The ASEAN countries are Brunei, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam
[25] https://bit.ly/2Y4i83E

Figure 6: Diagrammatic structure of SEADRIF



Premiums in the sub-trust are sufficient to cover, in full, a 1-in-200-year insured loss. If the catastrophe occurs and if it fulfills the triggers given by the parametric criteria (which are based on a Flood Risk Monitoring Tool co-developed with the World Bank), then payouts are transferred to governments of the corresponding countries within 30 days of the occurrence.

By pooling together their risks, ASEAN countries significantly reduce the cost of insurance coverage. The likelihood that all the countries face simultaneously severe floods is limited. Hence, insurers can dedicate fewer resources to the coverage of these regions. The pooling of the risks increases the scale of the insurance project substantially, which makes it more attractive to the (re)insurers. Also, the transaction costs are reduced since all countries purchase one product to cover their respective risk exposures.

5. CONCLUSIONS AND LIMITATIONS

The EHFF complements existing structures in the E.U. without compromising the E.U. budget or the public finances of member states, which are going to be under serious strain for many years to come. The EHFF draws on thirty years of experience of the insurance industry on modeling and securitizing catastrophe risks, as well as recent experiences from international and regional organizations.

This article is a first proposal and it is subject to a number of limitations. To make the EHFF operational, the main hurdle is defining the risks to be securitized. This is easier said than done, as there is a great deal of E.U.-wide risks that can lead to an emergency. Furthermore, inside every type of risk, there are many risks that can be securitized (think of all the risks inside the wide group of "infectious diseases"). Another limitation is the loss calculation of the risks. The risks that the EHFF deals with are infrequent and hence there is not much information for risk analysis, which in turn determines the price of the securities. That said, the first limitation can be solved with the National Risk Assessments, and the second can be solved by using global information (as opposed to E.U.-only) since the effects of most of the risks are the same in the E.U. and in the rest of the world.

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ESG AND THE INSURANCE LANDSCAPE

CHARLES SINCOCK | ESG Lead, Capco
HUGO GOUVRAS | Senior Consultant, Capco

ABSTRACT

The "environmental, social, and governance" (ESG) agenda has in recent years become increasingly more important for financial services firms, including insurers. The Paris Agreement in 2016 was a landmark event for climate action, and subsequently there has been an increase in social justice considerations. This article explores what insurers need to consider when approaching their ESG agenda, including integrating ESG within the core business and operations, as part of underwriting, investing, and risk management decisions, and developing tailored ESG products and services.

1. INTRODUCTION

The environmental, social and governance (ESG) agenda has become an increasing priority for the financial services sector, including insurers. The world has seen an increased focus from the public and political institutions on the ESG agenda. The Paris Agreement in 2016 was a landmark event for climate action with the adoption of a legally binding international treaty on climate change. Subsequently, there has been an increase in social justice considerations such as gender equality, social inclusion, and diversity.

With the advent of the COVID-19 pandemic, organizations have started to prioritize their ESG strategy and corporate stewardship. Notably, financial services are accelerating their activities in this space. With the stark realities of COVID-19 have come a wider appreciation of macro level risks in general – climate change included – and how these factors can dramatically impact the business. For insurers, this includes integrating ESG within the core business and operations, as part of underwriting, investing and risk management decisions, and developing tailored ESG products and services.

2. ESG

Incorporating ESG factors and determining the opportunities and risks is essential. It both helps to determine a company's business resilience from environmental and social risks, as well as measure the sustainability and societal impact of an investment/underwriting in a company or a business.

The component parts of the ESG criteria are considered below, with examples of the financial and reputational impacts felt by companies who have been negligent in their focus on ESG responsibilities.

2.1 Environmental

This component of the three factors examines a company's impact on the planet from positive and negative perspectives. Typically, the following environmental credentials of a company will be reviewed and analyzed when ascertaining their commitment to achieving sustainability goals (Figure 1). In 2010, the Deepwater Horizon oil spill negatively affected BP's share price significantly. This was one of the worst accidental oil spills in history and had severe and devastating

Figure 1: ESG and the insurance landscape

impacts on the local wildlife and ecosystems. Compensation paid out by BP ran into the billions of dollars in the wake of this disaster, which saw close to 4.9 million barrels of oil spilled into the ocean.[1]

2.2 Social

The social component of ESG looks at the people-related elements, which include issues that impact employees, customers, consumers, supplies, company culture, and the society at large. Research shows that companies that excel in engaging their employees achieve significant per-share earnings growth when compared to their peers.[2] In August 2020, Boohoo, an online retailer saw a slump in its stock price (£4.12 to £2.47 within a three-month period) following revelations about the operational and contractual conditions under which its workers were employed.[3]

2.3 Governance

A company that has robust governance, and a strong board of directors that relate well to different stakeholders, will eventually mitigate the potential risks of the principal-agent problem – that is, the risks that exist when there is no alignment between the shareholders' and the management's vision and actions. In March 2021, Deliveroo's stock market listing was at risk of being tarnished following allegations of the company's treatment of its couriers. Additionally, a couple of the U.K.'s largest asset managers, including Aberdeen Standard (now abrdn), avoided participation in the IPO because of the company's share ownership structure, which granted 50% of voting rights to the CEO. The concerns around treatment of workers has meant that the company has allocated £112m to cover potential legal costs should the employment status of its riders change if there is a future litigation against the company.[4]

3. INSURANCE CONTEXT

As very long-term custodians of assets, insurers are more exposed to sustainability issues than most other classes of investors – for them managing ESG exposures is arguably an existential issue. They are increasingly scrutinized by policymakers, as governments and regulators explicitly focus their ESG edicts on long-term investors including major asset owners, such as the insurance sector.

Given that insurers globally control around U.S.$30 trillion of global assets,[5] and that some of these assets are held for decades, it follows that ESG regulations should impact the insurance industry more than most. This regulatory push is expanding globally, hence not only are insurers exposed to actual ESG risks via both their underwriting and investment activities, but to specific new regulatory risks as well – posing a concern on two fronts.

[1] https://bit.ly/3oVVS7d
[2] https://bit.ly/30ckpdV
[3] https://bit.ly/3oVVS7d
[4] https://cnb.cx/3BCSmSZ
[5] https://bit.ly/3ADs0yX

This paper considers how insurers assess and align to their ESG agendas from three different perspectives. Firstly, from a purely investment focus, secondly, from an underwriting capability, and finally from a business operations point of view.

3.1 ESG investment

As ESG investing continues to gain momentum, it is imperative for insurers who want to reduce portfolio risks and generate returns to pay attention to ESG criteria. Firms that fail to manage the risks emanating from E, S, and G factors will likely face consequences from their shareholders, who have an increased awareness of ESG and demand accountability from their insurance investee companies. Additionally, major institutional investors have clearly voiced their expectations regarding companies' commitments to ESG criteria, particularly the management of their exposure to environmental risks. BlackRock announced that almost all U.S.$7 trillion assets under management would be governed by ESG considerations.[6] This emphasizes the growing pressure on firms to adopt and incorporate ESG into their operating models.

3.2 Underwriting

The insurance industry has a pivotal and influential position in promoting ESG sustainability. Incorporating climate related risks in underwriting and investment policies, for example the reduction of greenhouse gas (GHG) emissions from thermal coal, will facilitate the transition towards a cleaner future. Many insurers intend to stop providing insurance or risk management services for new thermal coal mines or major pollutants, and for potential new clients that derive a significant amount of revenue from mining thermal coal. There is also a growing shift towards renewable energies. This highlights the changing priorities for insurance firms that are now actively pursuing environment and social benefits in addition to investment returns. In December 2020, Apollo Lloyd's announced that they will no longer underwrite Adani's Carmichael coal mine following their latest ESG report that sets targets for responsible underwriting and investment practices. Included in this are their plans to phase out existing coverage on certain coal and oil activities by 2030.[7]

3.3 Business operations/resilience

Insurers can promote the ESG agenda and drive towards sustainability through their own operations and business activities. Promoting diversity and inclusion, reducing their greenhouse gases (GHGs), readdressing gender equality, and supporting communities via charitable work will all enhance the firm's brand and ESG credentials. Even though there are risks and burdens associated with the implementation of ESG, such as increased costs, insurers should look past these and understand the importance of prioritizing this topic to ensure success of their businesses going forward.

4. THE EMERGING INSURANCE INDUSTRY TRENDS

A Blackrock survey has found that 78% of insurers believe that the COVID-19 pandemic has accelerated their focus on ESG, with a greater emphasis being placed on social and governance considerations. Over 50% of respondents have invested in specific ESG strategies in the previous year. A further 52% have made ESG a key component of their investment risk assessment for new investments, and nearly one in three (32%) have turned down an investment opportunity in the last 12 months due to ESG concerns.[8] In addition, Refinitiv found 63% of companies within their ESG database have a policy linked to reducing emissions.[9]

4.1 Regulatory trends

4.1.1 CLIMATE RELATED DISCLOSURES

Until the Paris Agreement was signed and ratified in 2016, there had been various other treaties to address climate change issues, such as the Kyoto Protocol. The Paris Agreement was pivotal in that it was a legally binding international treaty on climate change with a clear goal to limit the global average temperature rise to below 2 degrees Celsius to avoid impacts of human-induced climate change. It also provided a framework for financial, technical, and capacity building, and required companies to communicate the actions they will take to reduce their GHGs.

[6] https://bit.ly/3mVvoQW
[7] https://bit.ly/3aDoyte
[8] https://bit.ly/3lJ9MrD
[9] https://bit.ly/3ABU9q6

In 2015, The Financial Stability Board (FSB) created the Task Force in Climate-related Financial Disclosures (TCFD) to improve and increase reporting of climate (change) related financial information. Its objective was to look beyond the existing methodology of collecting historic metrics and targets. The task force wants the incorporation of broader aspects of understanding across governance, strategy, and risk management on a forward-looking basis using scenario planning to price risk on investments accurately.

In 2017, TCFD came up with a set of recommendations for climate risk disclosure. This has become the main go to framework for firms to disclose their risks in a climate related context, and regulators are increasingly putting pressure on companies to disclose climate related risks and ESG. Notably, the Financial Reporting Council (FRC) stated in November 2020 that corporate reporting needs to improve to meet the expectations of investors and other users on the urgent issue of climate change.

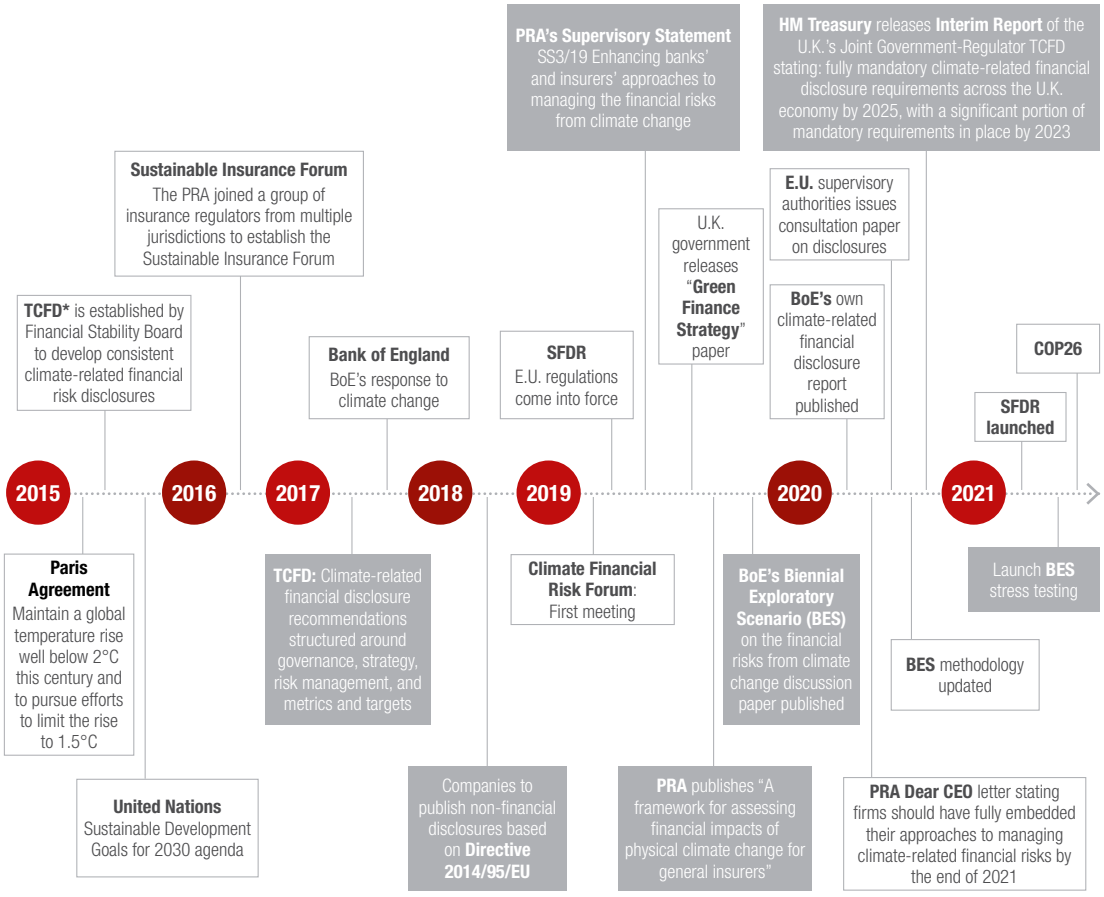
Mark Carney, who is currently the UN Special Envoy for Climate Action and the Prime Minister's Finance Adviser for COP26 (UN Climate Change Conference), highlighted how pressing an issue climate change is for the sector in October 2019, stating that, " …changes in climate policies, new technologies and growing physical risks will prompt reassessments of the values of virtually every financial asset. Firms that align their business models to the transition to a net zero world will be rewarded handsomely. Those that fail to adapt will cease to exist. The longer that meaningful adjustment is delayed, the greater the disruption will be."[10]

On November 9th, 2020, the U.K. set out its objectives to extend its global leadership in green finance including the following main action points:[11]

- Announcements of the issuance of the first Sovereign Green Bond[12]
- TCFD aligned disclosures to be fully mandatory across the economy by 2025[13]
- Implementation of a green taxonomy, taking the E.U. taxonomy as its basis[14]
- The U.K. also intends to join the International Platform on Sustainable Finance.[15]

[10] https://bit.ly/3AHER2N
[11] https://bit.ly/3oYv0Un
[12] Supra
[13] https://bit.ly/3FMdusu
[14] https://bit.ly/3BH84fU
[15] https://bit.ly/3mIE8JW

Figure 2: Financial services regulatory timeline



*Task Force on Climate-related Financial Disclosures (TCFD) to improve and increase reporting of climate-related financial information.

4.1.2 NON-FINANCIAL DISCLOSURES

The E.U. Sustainable Finance Disclosure Regulation (SFDR) introduced a set of ESG data metrics and rules. The E.U. identified 64 adverse impact indicators that should be calculated, of which 18 will be mandatory to report. The focus is across the whole of ESG and not just the environment, but includes social aspects involving human rights, equality, and employee diversity. These specific identifiable key performance indicators (KPIs) will need to be disclosed and published on a timely basis.

Figure 2 shows a timeline of the growing regulatory and public demand to embed and report on ESG across the financial service sector including the insurance industry.

4.2 Social changes and demographics

The pool of ESG-minded customers is growing, with an increasing focus on sustainability and ethical practices evident among Generation Z and Millennials as they enter the working environment. This population is typically more environmentally and socially aware. These customers take more accountability for their finances, investments, and pensions than previous generations. As such, these insurers will need to address the demands and needs of these customers and demonstrate the same values to their ESG agenda.

One company that emphasises this potential is Tickr, a platform where customers can invest in positively impactful companies whilst offsetting their own carbon footprint. 99% of Tickr's customers are Millennials.[16] These generations

[16] https://bit.ly/3BCQklJ

are also driving digitalization by expecting more product personalization and customer engagement from their insurers through the likes of IoT to bring them fairer and more accurate pricing. This indicates the growing need of insurers to adapt to this social change and ensure they can create a successful environment for both employee and customer engagement alike.

5. UNDERWRITING

Traditionally, underwriters have utilized decades of static, historical information to assess potential risk to clients. With advances in technology and innovation this method is now regarded as inadequate in predicting accurately future trends and exposures. Artificial intelligence and machine learning can interpret large pools of data and predict with a greater degree of accuracy future events and the changing ESG risk patterns. Integrating these technologies and transforming the underwriting process will provide insurers with a competitive advantage. Parametric, synthetic, and dynamic modeling are all methods used within insurers that are providing competitive advantage to satisfy investors' growing demands. Below are examples of how underwriting is advancing with new technology and innovation.

5.1 Parametric modeling

Parametric modeling offers financial protection against losses that are hard to predict. Parametric insurance pays out when a pre-defined event occurs, such as floods and earthquakes, and breaches a pre-agreed figure or index. As climate related weather risks become more complex and unpredictable the requests for this structure of insurance will increase.[17]

5.2 Synthetic modeling

Natural catastrophe modeling originally took historical losses and built factors such as wind speed and landscape profiles into predictive models. The layers of analytic data have grown considerably. Satellite images in combination with weather, traffic, building, and other ground sensors can be combined and overlaid to provide a more nuanced and accurate picture of risk.

5.3 Dynamic modeling

The ability to collect data about your customers continuously and use artificial intelligence to analyze that data is allowing insurance companies to provide more accurate, up-to-date risk analysis, and to update price polices accordingly. This is linked to ESG core values – treating all customers fairly. There are several examples where technology is driving better outcomes for customers, the following are just a few.

For many years, health insurers have been capturing fitness data among their insured populations and using it as reward points or premium discounts. Fitness to health trackers provide underwriters with a dynamic view into past health status and the ability to monitor current health, which provides a more accurate risk profile and value for money.

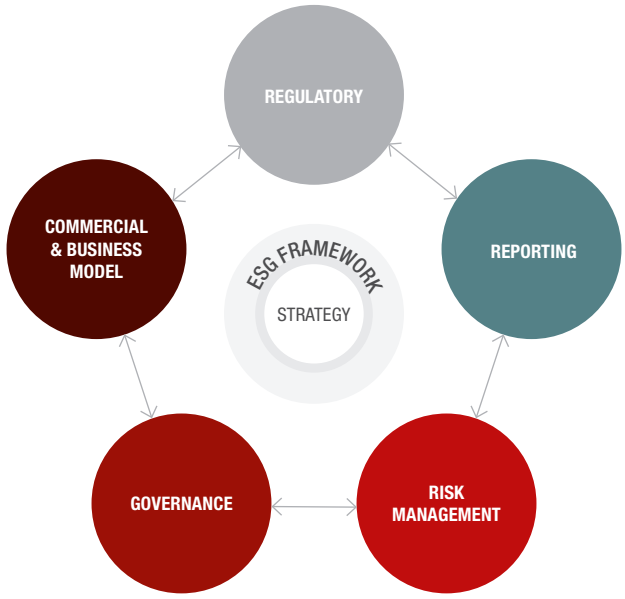
The car industry is another example where telematics supply a live feed on data and updates the overview of the insured party's driving style and risk profile.[18] Tesla is growing its own insurance business that offers Tesla car owners specific products. This is a significant threat to traditional car insurers. The size and level of the data that Tesla has about its customers compared to other manufactures is vast. Tesla CEO Elon Musk told investors at a recent earnings call: "Ultimately, where we want to get to with Tesla Insurance is to be able to use the data that is captured in the car, in the driving profile of the person in the car, to be able to assess correlations and probabilities of crash and be able then to assess a premium on a monthly basis for that customer."[19]

5.4 Responsible and sustainable underwriting

Insurers are considering alternative measures of performance outside of traditional financial metrics, looking to wider social imperatives beyond wealth enhancement. For example, Allianz refers to this as "Impact underwriting" and highlights the difference between "responsible" and "sustainable" investment/underwriting.[20] The drive is not only to focus more on the shareholders benefits, but also to achieve environmental and social benefits. The competitive advantage in this contested space is to not only adopt current and future regulations, but to also satisfy investors' growing demands for sustainability. The potential in expanding revenues in growing sustainability markets and benefiting society at the same time offers what Allianz term a "double dividend".

[17] https://bit.ly/2YP48el
[18] https://bit.ly/3oYZyFe
[19] https://bit.ly/3v82ssl
[20] https://bit.ly/3lAk78Y

Figure 3: The ESG model



6. CORPORATE CENTER – DRIVING PROFITABILITY WHILE ADHERING TO MORAL, ETHICAL AND LEGAL OBLIGATIONS

Society is facing both an environmental and health crisis that is forcing companies' hierarchies to act both through an ethical and moral obligation, and also to comply with ever increasing regulations. This is making companies and boards focus on the link between values and value. Good stakeholder governance is now an operational and strategic condition that is vital to a firm's resilience and long-term success.

Insurance companies are in a commanding position and can establish themselves as leaders in the integration and promotion of ESG within the financial services sector. The significant and large amounts of capital flows can be the catalyst to ensuring sustainability goals.[21] The moral obligation implies that companies need to take responsibility and action to focus on long-term societal impact, and contribute to positive developments through choices and behaviors. Companies with a strong sustainability approach will influence others and equally as important, increase public perspectives regarding ESG.

In addition to climate risks, many insurers are reporting on non-financial disclosures. However, the risk to the company is how can the benefits be realized from reporting this information. The European Commission has stated that there is a lack of comparability, reliability, and relevance of non-financial information provided. There needs to be stricter audit requirements and a common reporting standard.[22,23]

7. THE CAPCO FRAMEWORK – EMBEDDING ESG IN INSURANCE

There are many risks and opportunities where ESG can impact the insurance ecosystem. It is imperative that insurers capture, integrate, and monitor ESG risks and opportunities. We have designed a framework to help insurers on ESG. At the highest level, the following model creates an overall approach for ESG consideration:

[21] Supra
[22] https://bit.ly/3Dz0lkv
[23] Supra

- An ESG strategy should be established at the corporate level to integrate ESG into business operations, along with a framework to help embed ESG into the organization.
- Regulatory requirements must be met via processes and policies; reporting mechanisms must be developed to enable ESG reporting to stakeholders and customers.
- Climate-related and general ESG risks must be identified, assessed, and managed. Underpinning this should be the governance structure to help integrate ESG into the organisation's culture, businesses, and operations.

8. CONCLUSION

Insurers are moving forward with their ESG programs. These are due to regulatory and customer pressures as well as the overall current climate of "building back better". The COVID-19 pandemic has only emphasized the need for insurers to move swiftly on ESG topics. Insurers that have yet to embed and embrace ESG will face greater uncertainty in the future that will potentially impact their growth, add a degree of uncertainty to their resilience, and overall undermine their competitive positioning.

ESG is a topic that is here to stay and is growing more and more relevant in the short term, and clearly has over the horizon fundamental implications for the insurance industry. Insurers therefore need to embrace ESG and seize the opportunities that are presented, or risk being left behind. This paradigm shift towards ESG-focused strategies and business dynamics appears to be inevitable for the insurance industry. This highlights that in order to embrace the opportunity that this approach affords, insurance market participants will need to consider a new and dynamic approach to risk modeling, investments, and business operations. This imperative will seek to manage the insurers' overall risks, but ultimately provide a right to play and occupy a space in this emerging and developing business ecosystem.

THE UNINTENDED CONSEQUENCES OF MACROPRUDENTIAL REGULATION IN INSURANCE AND BANKING: ENDOGENOUS FINANCIAL SYSTEM INSTABILITY INDUCED BY REGULATORY CAPITAL STANDARDS

PERIKLIS THIVAIOS | Partner, True North Partners LLP
LAURA NUÑEZ-LETAMENDIA | Professor of Finance, IE Business School

ABSTRACT

Unlike microprudential regulation that focuses on the stability of individual institutions, macroprudential regulation focuses on the stability of the financial system as a whole. However, despite the increased interest in a system-wide lens, our empirical research indicates that the design of the Solvency II and Basel II/III frameworks, while intended to strengthen the stability of each sector individually, may be the source of endogenous destabilizing effects across the financial system, due to incentives for increased asset concentration and capital standard procyclicality. The support for the capital arbitraging hypothesis was weaker.

1. INTRODUCTION: THE DIMENSIONS OF MACROPRUDENTIAL POLICIES

Macroprudential regulation is intended to reduce systemic risk and ensure financial system stability by addressing a number of dimensions, namely time, size, cross-sectoral, and structural [BIS (2010), Borio and Drehmann (2009)].

The time dimension aims to prevent the excessive build-up of risk, resulting from external factors and market failures, with the goal of smoothing the financial cycle. The policy tools employed to address this dimension primarily focus on the offsetting behavior of prudential cushions [Borio (2004)], as well as the extension of the risk management time horizon [Borio and Drehmann (2009)].

The size dimension focuses on the potential reduction of negative externalities associated with institutions that are perceived as too-big-to-fail due to their balance sheet size and interconnectedness [BCBS (2013a)]. The prudential measures adopted aim at increasing the loss absorbing capacity of systemically significant institutions, as well as the going-concern loss absorbency pertaining to them [FSB (2010), BCBS (2013a)].

Third, the cross-section dimension is concerned with how aggregate risk is distributed in the financial system at any point in time and aims to limit contagion effects, thereby making the financial system more resilient. From a policy perspective, the main tools employed to limit cross-sectional effects have been capital requirements and insurance schemes [Borio (2009)].

Lastly, the structural dimension aims to encourage a system-wide perspective on financial regulation to create the right set of incentives for market participants. Employing macroprudential lens, there is "the possibility that actions that are optimal from the perspective of individual institutions may result in undesirable outcomes for the system as a whole, through adverse feedback effects" [Borio (2009)].

2. REGULATORY CAPITAL INDUCED SOURCES OF FINANCIAL SYSTEM INSTABILITY

There are two different approaches to identifying sources of financial instability: one approach defines financial system stability in terms of its robustness to exogenous shocks [Allen and Wood (2006)], whereas a second approach focuses on "a notion of risk that stresses the potentially destabilizing effects of the collective behavior of economic agents, i.e., what might be termed the 'endogenous' nature of risk." [Borio and Drehmann (2009)].

Under the second approach, financial system instability is the result of moral hazard, whereby the consequences of an individual actor's behavior are borne by the financial system as a whole [Acharya (2003), Borio and Drehmann (2009)]. In other words, although insurance and banking capital requirements are intended to maintain the solvency of the respective financial sectors, the incentives they create may come at the expense of sector-wide systemic risk [Acharya (2009), Borio (2009)].

The extant literature has identified a number of non-mutually exclusive endogenous sources of financial system instability, nurtured by the regulatory capital frameworks: (i) asset concentration; (ii) capital arbitraging, and (iii) pro-cyclicality. This article extends the industry-specific (insurance or banking) analyses of such capital-induced incentives [Borio (2003), Acharya (2009), Christophersen and Zschiesche (2015)] to the financial system as a whole (insurance and banking).

Table 1: Differences between Basel II/III and Solvency II

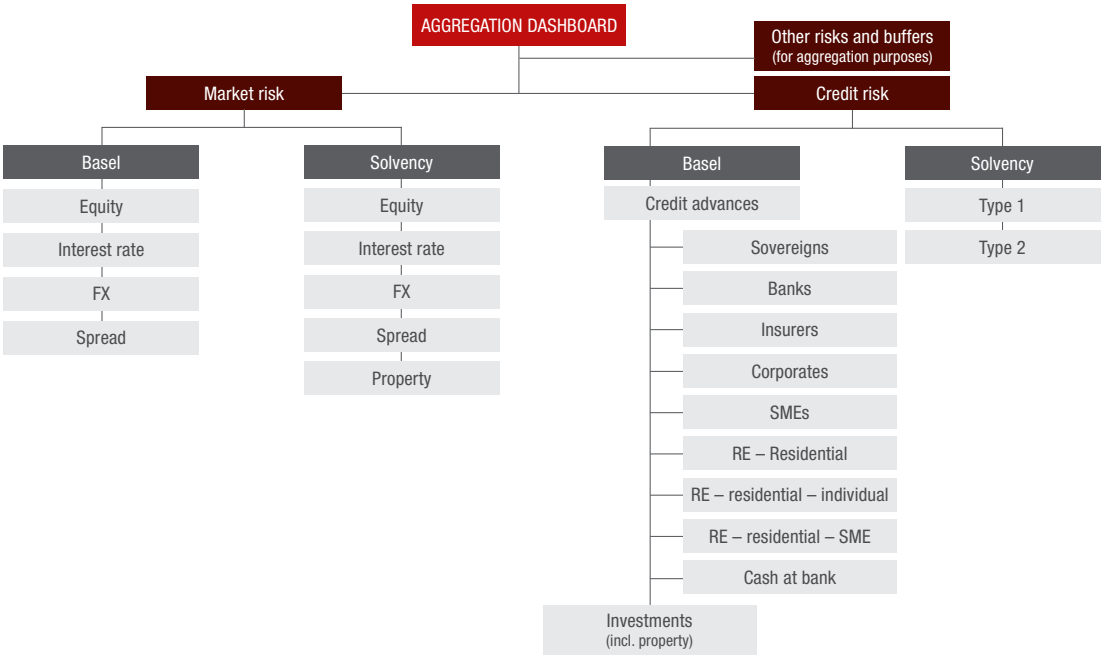
	BASEL II / III	SOLVENCY II
SCOPE	Banking operations excluding insurance and other financial subsidiaries	Insurance (life and non-life) and re-insurance undertakings
APPLICATION	A framework with no legal force but potentially global application	A legal directive (binding in the European Economic Area)
REGULATORY FOCUS	Individual banking institutions	Individual policyholder
STRUCTURE	3 pillars – quantitative requirements come first	3 "pillars" – quantitative requirements come last
APPROACH	Mixture of fair value and amortized cost	Total balance sheet (fair valued assets and liabilities)
QUANTITATIVE RISK COVERAGE	Credit, operational, market Liquidity principles	Insurance, credit, operational, market
CONFIDENCE INTERVAL	Credit and operational: 99.9%; Market: 99%	All: 99.5%
DIVERSIFICATION ACROSS RISK TYPES	None	Across all BSCR risk types, plus loss absorbing capacity of technical provisions and deferred taxes
DIVERSIFICATION WITHIN RISK TYPES	Market risk only	Market and counterparty risk
CAPITAL BUFFERS	Capital conservation buffer Countercyclical buffer G-SIB	None
CAPITAL ELIGIBILITY	Common equity tier 1, additional tier 1 and tier 2	Basic own funds, ancillary own funds
LEVERAGE	Risk-insensitive leverage ratio	Embedded in capital requirement
FUNDING LIQUIDITY STANDARDS	Explicit (non-capital based)	Embedded in overall risk management system
TIME PERSPECTIVE	Retrospective across risk types	Prospective: existing and new business within next 12 months (Article 101)
RISK MEASUREMENT TYPOLOGY	Rules-based for credit (AIRB approach is also based on a pre-calibrated formula with internal modeling of PD, EAD, and LGD only)	Standard formula: several more internally estimated parameters; IM: principles-based

- **Asset concentration:** studies have indicated that existing regulatory requirements can lead to increased demand for liquid assets [BCBS (2013b)] including sovereign paper, which is preferentially treated across the banking and insurance capital frameworks [BCBS (2017a, 2006), EU (2015)]. Consequently, capital standards may be a source of endogenously generated financial system instability by means of incentivizing increased diversification within institutions, yet simultaneously concentration across the financial system [BIS (2003)].
- **Capital arbitraging:** the inconsistent treatment of similar assets across insurance and banking may result in regulatory capital arbitraging across the financial system [Merton (1994), Ambrose et al. (2005), Calem and Follain (2007), Jones (2000)]. Financial assets may be shifted between the different sectors in order to exploit regulatory differences, while formally meeting prudential requirements [Dierick (2004)].
- **Pro-cyclicality:** in the context of financial stability, procyclicality refers to the extent that capital requirements fluctuate with the business cycle, thus amplifying swings in the real economy. Given that insurance and banking regulatory capital requirements are based on exposure to common risk drivers, individually rational responses to changes in risk over time – based on the regulatory capital incentives provided by the frameworks' structure – may result in cyclical upswings or reductions in regulatory capital requirements and capitalization ratios across the financial system without a corresponding reduction in the underlying risks [Dierick (2004), Freixas et al. (2007)], thus exacerbating procyclicality [Nijathaworn (2009)].

3. CAPITAL REGULATORY FRAMEWORKS IN BANKING AND INSURANCE

The analysis presented in this article uses as its basis the insurance regulatory framework commonly referred to as Solvency II [EU (2015, 2014, 2009)] and the banking regulatory frameworks commonly referred to as Basel II and Basel III [BCBS (2017a, 2006, 2019)].[1] While both frameworks have been characterized as mostly microprudential in nature [Hanson et al. (2010)], they also contain macroprudential elements introduced since the 2008 financial crisis [BCBS (2011), EU (2015), Christophersen and Zschiesche (2015)]. The most important differences between the respective capital frameworks are summarized in Table 1.

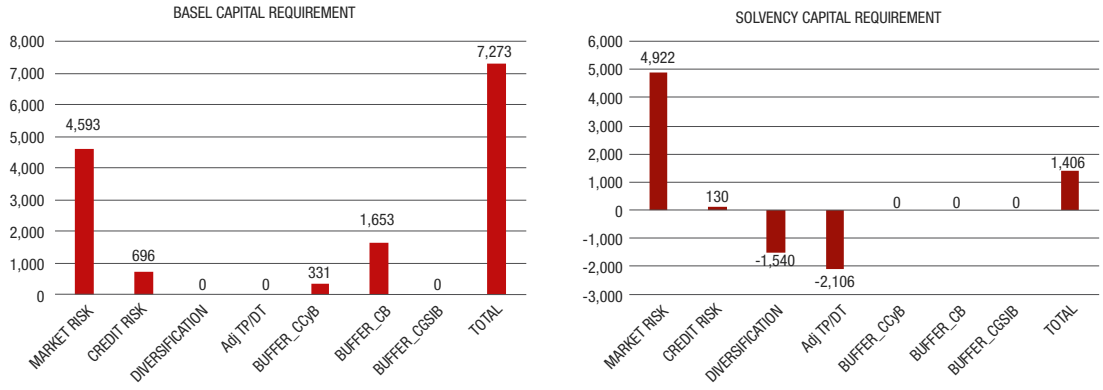
Figure 1: Framework for the regulatory capital estimates in insurance and banking



[1] Please note that unlike Basel I, which was mostly replaced by the introduction of Basel II, Basel II and Basel III are complementary frameworks and as such will be jointly referred to as the banking regulatory frameworks or the Basel framework. The 2017 finalization of the Basel III standards [BCBS (2017a)] is euphemistically termed as "Basel IV".

[2] Non-life and health insurance institutions have not been included due to the fundamentally different composition of their balance sheets (liabilities and assets), as well as due to the differences in the underlying business models.

Figure 2: Aggregate capital requirements for stylized balance sheet under the Basel and Solvency frameworks



4. FRAMEWORK FOR THE SIMULATION ANALYSIS OF REGULATORY CAPITAL-INDUCED DESTABILIZING EFFECTS

We restricted the analysis to the regulated banking and life insurance sectors,[2] and focused on the asset-related risks embedded in the credit risk and market risk capital frameworks, consistently with Acharya (2009), Froot and Stein (1998), Laas and Siegel (2017), and Thibeault and Wambeke (2014). These two financial risks are found across banks and life insurers, and make up at least 85% of the total capital requirement for banks [EBA (2015)] and 75% for solo life insurers [EIOPA (2011)]. Figure 1 provides an outline of the approach used to analyze the regulatory capital requirements in both industries.

For the purposes of our research, the regulatory standard frameworks have been selected as they provide the most harmonized approach to evaluating and comparing capital requirements across institutions [Laas and Siegel (2017)]. Unlike internal model approaches, standard frameworks provide an overall consistent calibration within each industry and are in line with the move towards standardized capital floors [BCBS (2019, 2017a, 2017b), EIOPA (2014)].

4.1 Assets and weights of the portfolio of banks and insurers

To estimate capital requirements for both sectors, we use a stylized balance sheet of insurance and banking, in line with prevailing academic research [Höring (2013), Laas and Siegel (2017), Thibeault and Wambeke (2014), Braun et al. (2017)].

Consistent with our asset side scope, we incorporate only asset classes that are shared across banking and insurance institutions. We use the median E.U. insurer investment portfolio based on data from EIOPA (2016a), namely €50,800 mln.[3] The distribution of the assets in the portfolio is outlined in Table A1 in the Appendix.

4.2 Capital requirements estimates

We estimate the capital requirements per risk type in scope, as well as the aggregate figures considering the diversification and the application of capital buffers, for both banking and life insurance industry. As previously mentioned, all data inputs, associated parameters, assumptions, and calibrations, are as per the regulatory standard frameworks. Results are summarized in Table A2 in the Appendix and Figure 2.

While at the standalone, risk type level, Solvency II capital requirements appear slightly more punitive based on our stylized balance sheet, the overall capital requirement of insurance institutions is mediated by the diversification effects allowed in the Solvency capital requirements calculations, as well as the adjustments permitted for the loss absorbing capacity of technical provisions and deferred taxes. These two effects make the Solvency capital requirement comparatively lower to the respective Basel one, based on the portfolio and assumptions employed.[4]

In summary, the quantitative differences across capital requirements for both banks and life insurers can be attributed to the following factors: the difference in the scope of each

[3] The use of a stylized balance sheet based on data from the banking sector can be an area for further research. One needs to note that, given the comparability constraints, the composition of participating asset classes would likely remain the same, with higher allocations expected primarily in real estate and structured notes.

[4] For a discussion and criticism of the structure and underlying adjustments to the capital formulas, please refer to Christiansen et al. (2012), Eling and Pankoke (2014), Repullo and Saurina Sallas (2011), and Angelini et al. (2011).

risk module, the difference in the structure of the capital calculation per asset class and risk type, and the difference in the aggregation mechanisms and buffers.

5. MAIN FINDINGS: SOURCES OF FINANCIAL SYSTEM DESTABILIZATION STEMMING FROM CAPITAL REQUIREMENTS

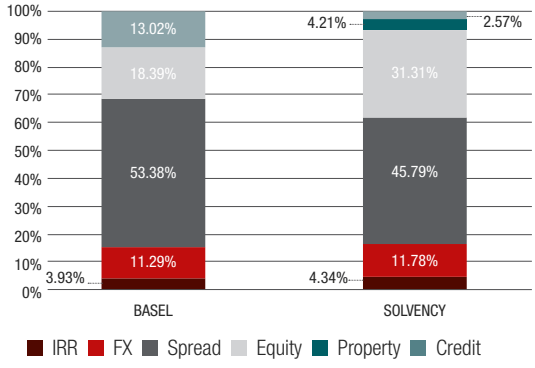
Using the afore-discussed estimates as a basis, our analysis evaluates the extent to which regulatory capital standards provide behavioral incentives detrimental to the financial system, even though individually rational for each market participant. We have evaluated these endogenous incentives along the three dimensions identified by the literature mentioned previously in this article: (i) asset concentration, (ii) capital arbitraging, and (iii) procyclicality.

5.1 Increased asset concentration

Despite the differences in capital requirements for the stylized balance sheet across the two regulatory capital frameworks, the results show a comparable rank order of capital charges and proportionate fully allocated capital amounts within each capital framework. The similarity in the rank ordering and the fully allocated capital amounts per asset class are illustrated in Figure 3.

High quality sovereign paper issued by governments domiciled in the EEA attracts the lowest capital charges and consequently becomes an investment of choice where yields are not the primary investment factor. The desirability of such assets is further augmented by the non-capital related regulatory standards for liquidity management imposed by the Basel framework [BCBS (2013b, 2010)], which necessitate a minimum level of liquid asset holdings covering cash outflows. Similarly, highly rated non-financial bonds (including the ones issued by insurers and covered bonds) also attract proportionately low capital charges and constitute desirable

Figure 3: Fully allocated capital amounts per asset class



assets from a capital perspective. On the contrary, equity investments (and alternative investments) attract significantly higher capital.

The consistency of capital charges within the two frameworks has the potential to increase asset concentrations in the same securities across the banking and insurance industries, providing an endogenous source of financial system instability. This is due to the common exposure effect, whereby "selling off assets can lead to mark-to-market losses for all market participants who hold a similar exposure" [Adrian and Brunnermeier (2011)]. Freixas et al. (2007) echo this view by stressing that "the endogeneity of risk selection [...] reverses the standard assumption that diversification has a stabilizing effect in economic downturns."

Furthermore, the consistency of capital charges within the regulated banking and insurance sectors can provide incentives for the shifting of riskier financial activity to the non-regulated sectors [Wehinger (2012)]. As Begenau and Landvoigt (2016) point out, if "regulated financial firms are competing with unregulated financial firms that provide similar services or products, then tighter regulation can cause a shift to the unregulated sector and thus potentially cause more financial instability."

Naturally, there are several factors that compensate the tendency for increased asset concentration across the financial system. The scarcity of available assets in a competitive market will inevitably reduce allocation in specific securities, and the ensuing price increases and associated yield depression [Tasca and Battiston (2012)] will also play a role in the investment decision beyond the incentives provided by capital requirements [BCBS (2001)]. The diversification factors embedded in the Solvency BSCR (Basic Solvency Capital Requirement) calculation also provide disincentives towards increased concentration in specific assets and associated risk types, however such diversification is not present in Basel's portfolio invariant assumptions [Gordy (2003)]. Lastly, the non-risk sensitive leverage ratio in Basel creates a floor to capital levels based on gross exposures [BCBS (2014)].

Instability due to asset concentration was acutely observed during the 2008 financial crisis, initially in highly rated structured notes and subsequently in sovereign paper issued by high debt countries such as Greece, Italy, and Portugal. The capital incentives created an environment where market, credit, and liquidity risks were converted to sovereign risks [BCBS (2017c)], with the repercussions extending beyond institution and financial sector risk to overall macroeconomic and financial stability [IMF (2011)].

Consequently, notwithstanding the disincentives towards asset concentration and despite the underlying differences in business models and associated risk taking activities, banking and insurance institutions are incentivized to undertake correlated asset positions, which constitutes an endogenous source of financial system instability.

5.2 Regulatory capital arbitraging

Differences in capital standards may provide incentives for regulatory capital arbitrage when the same asset attracts lower capital charges in one industry than another [Merton (1994), Ambrose et al. (2005), Calem and Follain (2007), Jones (2000)]. Regulatory capital arbitrage may be the cause of endogenously generated financial system instability because the shifting of assets from one industry sector to the other may result in a reduction of the overall capital levels in the financial system without a corresponding reduction in their overall risks [BCBS (2001), Dierick (2004), Freixas et al. (2007)].

To empirically evaluate the potential for regulatory capital arbitraging, we performed sensitivity analyses for the most material risk sub-types (equity and spread risks), illustrating the change in the previously calculated aggregate capital requirements per sector due to the shifting of assets from one regulated industry to the other. The analysis demonstrates that the incentives for arbitraging are not as straight forward as one may think.

5.2.1 EQUITY RISK

Equities constitute the most material risk class in our stylized balance sheet, and they attract the highest capitalization ratios across the Basel and Solvency frameworks. We modeled the shifting of equity assets in increments of 1% from the regulated insurance to the regulated banking sector and have quantified the capital charges for the asset class alone, as well as for total (diversified) market risk and total balance sheet on aggregate.[5] When all equities are held in the insurance sector, the total (undiversified) equity capital requirement is €3,780, while (as expected) the equity risk charge for Basel is 0. Due to the lower capitalization ratio under Basel, the standalone equity capital requirement when all assets are held in the banking sector is €1,966. However, when the sensitivity analyses are extended to the aggregate (diversified) market risk, as well as to total capital requirements, the previously apparent incentive to shift assets from insurance to banking is dampened by the countervailing forces between stand-alone and aggregate capital requirements, as the reduction of market risk under Solvency is offset by the reduction of diversification benefits for life insurers and the simultaneous increase in capital buffers for banks.

5.2.2 SPREAD RISK

Similar to the equity sensitivity analysis discussed above, we quantified the capital charges for spread risk standalone, for total (diversified) market risk, and on aggregate, assuming that assets attracting spread risk are shifting in increments of 1% from the regulated insurance to the regulated banking sector. When all spread risk assets are held in the insurance sector, the total (undiversified) spread risk capital requirement for the insurance balance sheet is €3,840, while for banking is naturally 0. When all spread risk assets have been shifted to the banking sector, the total spread risk capital requirement is €10,090. We observed the same pattern for the total capital requirements, post capital buffers, and diversification effects.

While at first sight there is an apparent capital incentive to shift spread risk assets from the banking to the insurance sector, there are a number of counterbalancing factors that would offset the overall incentives for such an activity:

- Sovereign, financial, and corporate bonds are fundamental constituents of any banking institution's balance sheet. The holding of such assets is essential for asset liability matching, fixed income flow, and, importantly, for liquidity risk management. Spread risk attracting bonds are an essential component of the required stock of "high quality liquid assets" (HQLA) and a complete removal would almost certainly result in a regulatory breach [BCBS (2013b)].
- In addition, counterparties in the scope of the European Market Infrastructure Regulation (EMIR) [EU (2012)] are obliged to post variation margins as collateral for uncleared derivatives, resulting in additional demand for government bonds in particular [Cœuré (2017)]. Additional regulations, such as for central counterparties (CCPs) have also resulted in liquid, spread risk-bearing assets, being pledged as collateral for meeting initial margins [BIS and IOSCO (2017)].

In other words, while a strict reading of the empirical results would indicate regulatory capital incentives for shifting spread risk bearing assets from the banking to the insurance industry, such a shift is moderated by a number of additional considerations that constrain the amount of liquid assets that banking institutions can shed off their balance sheet.

[5] When the split between the two sectors is 50-50, the comparative capital requirements equal the base case figures.

5.3 Procyclicality of capital standards

We have defined procyclicality as the extent to which capital requirements fluctuate consistently across the financial system (insurance and banking) due to exposure to common risk drivers, in the face of uncertainty to changes in risk over time and the incentives provided by the respective regulatory capital frameworks. The extant literature has demonstrated that there is a visceral link between procyclicality and financial stability [Borio et al. (2001), Gordy and Howells (2006), Freixas et al. (2007), Repullo and Saurina (2011), Andersen (2011), Kashyap and Stein (2004)].

Bank business models are inherently cyclical [FSB (2009)]. The two primary risk drivers of the banking business model (credit risk and market risk) are highly exposed to cyclical influences. Market risks and (to a lesser extent) credit risks are also material in the insurance sector. The underwriting component of insurance firms' business model is less cyclically affected; however, investment decisions are impacted by cyclical trends. In addition, even though the contribution of life insurers to systemic risk remains below that of banks, it has increased in recent years across advanced economies [IMF (2016)]. To the extent that banking and insurance regulatory capital requirements and associated capitalization ratios are synchronized, such procyclical behavior may endogenously undermine financial system stability.

For the purposes of this empirical analysis we focus on market risk, the biggest contributor to the overall capital requirement for our stylized portfolio. Procyclical effects have been evaluated by calculating the changes in regulatory capital requirements, eligible exposure (equity valuations), and – primarily – capitalization ratios (capital over assets) across both sectors given the EIOPA (2016b) "double hit" scenario from the insurance stress test technical specifications. The scenario represents a rapid increase of sovereign bond yields for E.U. countries complemented by a drop in the risk-free rate. We further assume that financial institutions are not able to raise new capital during a downturn [Andersen (2011), Peura and Jokivuolle (2004)]. All repricing and capital requirement assumptions have been held consistent with the base case empirical model. Consistently with the scenario, we do not assume changes in external ratings. The results are included in Table A2 in the Appendix.

Eligible exposures for equities have dropped consistently across the Basel and the Solvency calculators, given the consistent application of the stock market shock, with a proportionate drop in the undiversified equity capital requirement. Eligible exposures for interest rate risk have increased from 15,823 to 16,401 under Basel and from 40,640 to 42,199 under Solvency due to the decline in yields. Undiversified interest rate risk capital requirements for Basel have increased by 1.38% due to the higher eligible exposure base, and by 3.64% for Solvency, reflective of the incorporation of both interest rate sensitive assets and liabilities with differing weighted durations. Stress spreads have dropped the value of spread assets under Basel from 15,823 to 13,203 and under Solvency from 40,640 to 28,300, primarily driven by longer duration bonds. FX, commodity, and property figures have remained unchanged, as they were not part of the scope of the scenario.

As expected, capitalization ratios decline under the scenario for both the Basel (-19.37%; from 14.32% in the base case to 11.54% under stress) and Solvency models (-30.13%; from 2.77% in the base case to 1.93% under stress) at the aggregate level. The Basel capital requirement changes -20.61% for an asset value reduction of -1.53% while the Solvency capital requirement changes -29.97% for a +0.24% increase in asset valuations. The shifts in asset values are the combined outcome of the increase in the yields and credit spreads of the assets, and the drop in equity prices. As observed at the aggregate level, the diversification structure of the Solvency framework dampens the overall reduction in capitalization levels due to the changes in market risk capital requirements, while the capital buffers applied as part of Basel provide a similar effect for the respective capital estimates, given their linear (RWA based) impact on the final result.

The joint reduction of capitalization levels under the Basel and Solvency standard frameworks, even though totally explainable based on the structure of the supervisory formulas, echoes the concerns raised by academic commentators on the procyclical impact of regulatory capital standards for the banking and insurance industries [Freixas et al. (2007), Repullo and Saurina Salas (2011), Andersen (2011), Heid (2007), Kashyap and Stein (2004)]. Capital standards are inherently procyclical under both Basel and Solvency and their joint impact has the potential to undermine the ability of financial institutions to absorb additional losses in case of protracted stress, thus endogenously impairing the overall capitalization of the financial system and consequently financial system stability.

A number of factors, which have not been captured by our empirical model, could add to the procyclical concerns. First, as per the assumptions of the EIOPA (2016b) scenario, we have not evaluated the impact of potential external rating downgrades, which would have had a material impact on spread risk capital requirements. From a Basel point of view,

we could also assume that – as a response to such a stress – countercyclical buffers would change, while they are assumed constant in our calculation. In addition, the absence of second order effects as a response to the stress scenario highlights an additional aspect of procyclical behavior not captured by the fixed portfolio assumption of this study: the price depression on riskier assets, due to the selloff expected in order to bolster declining solvency positions [Tasca and Battiston (2012)]. Similarly, the observed reduction in regulatory capital standards, which is larger than the decline in asset valuations, may indicate that the standard formula does not appropriately capture the valuation volatility of market risk portfolios. Practically, in case of a continued downturn, the ability of capital standards to cover further P&L losses may be questioned.

In summary, the empirical evidence indicates that the structure of the respective regulations will generate comparable changes in capital requirements, asset valuations, and capitalization ratios across the stylized portfolio held in the banking and insurance sector. Such procyclical effects further indicate that the design of regulatory capital standards may also be a factor that is endogenously destabilizing the financial system as a whole.

6. CONCLUSION

Having moved beyond previous comparisons of regulatory capital levels across insurance and banking, our empirical research analyzed the capital-induced (endogenous) impact that regulatory capital standards may have on financial system stability:

- First, we observed that the rank order of capital charges as well as the proportionate, fully allocated capital amounts within the Basel and Solvency frameworks are remarkably similar, consequently, potentially providing incentives to increase asset concentrations in the same securities across the two industries. Such system-wide asset concentrations contribute to endogenously generated financial system instability due to common exposure effects across the two sectors, which may amplify the impact of exogenous shocks.
- Similarly, our empirical modeling demonstrated that the consistent application of a stress scenario to both the banking and insurance capital standards leads to material procyclical effects across both sectors, which have also been shown to endogenously undermine financial system stability.
- Our empirical analysis did not provide strong support for the hypothesis that the design of regulatory capital standards may incentivize regulatory capital arbitrage across the industries. Even though the overall capitalization levels for the financial system can be arbitraged based on the incentives provided by the respective capital frameworks, the overall structure of capital requirements – taking into account diversification and capital buffers – dampens such incentives. In addition, several other, non-capital related factors come into play that also partially mitigate the incentives and scope for arbitraging activity. We propose that capital arbitraging behavior should be studied between the regulated and non-regulated financial sectors instead.

Naturally, the expected impact of the Basel and Solvency frameworks cannot be evaluated in isolation but must rather be studied holistically, in the context of the continuously evolving insurance and banking business models and associated business objectives. Capital frameworks may undermine financial system stability due to perceived disincentives towards appropriate asset-liability matching [EC (2017), Al-Darwish et al. (2011)], the shifting of bank business activities towards non-interest income [Brunnermeier et al. (2012), Stiroh (2004)], and the effects on financial stability and economic growth of liquidity standards [Gobat et al. (2014)] and risk insensitive leverage ratios [Kiema and Jokivuolle (2014)].

The practical contributions of this study aid three distinct yet related groups of stakeholders: regulators, policymakers, and financial managers. From a regulatory point of view, "both insurance supervisors and banking supervisors are becoming increasingly aware of the need to address risks also on a system-wide, sometimes referred to as 'macroprudential', basis" [Knight (2004)]. Yet again, despite the senior calls for "a regulatory approach that is consistent across the main jurisdictions and sectors" [Caruana (2013)], regulatory capital frameworks focus on the banking or insurance sectors alone. Consequently, macroprudential approaches can benefit from our extension of stability analyses from a single industry to the financial system as a whole.

More practically, our study highlights the need for evaluating the impact of exogenous shocks across the banking and insurance industries. The results of such sector-wide stress tests can help with better calibrating capital requirements within and across the banking and insurance frameworks, and provide guidance with regards to financial system-wide recovery and resolution plans.

From a policymaker point of view, the further development of capital standards will benefit from a solid theoretical basis on which future macroprudential frameworks can be designed

[Gauthier et al. (2010), Hanson et al. (2010)]. The study of cross industry effects using an endogenous lens [Borio and Drehmann (2009)] can assist with preventing the build-up of instabilities by creating the right sets of incentives for market participants, hence better supporting the ultimate objective of macroprudential regulation, which is the strengthening of stability across the financial system as a whole.

Consistent with the literature highlighting the differences between the underlying business models of insurance and banking [Gatzert and Wesker (2012), Lehmann and Hofmann (2010)], we do not propose enacting policy changes that may lead to greater convergence of capital standards across the two sectors. Instead, by taking into account the endogenous nature of financial system instability, policymakers can focus on developing appropriate macroprudential overlays that address the interdependencies across the financial system along the dimensions of time, size, cross-section, and structure. Such policy frameworks need to focus on mitigating the procyclical impact of regulatory capital standards and the capital incentives for increased asset concentration by providing appropriate, long-term prudential cushions and self-adjusting mechanisms that minimize the behavioral incentives for destabilizing actions over a long-term window of time [Borio (2009), Borio and Drehmann (2009)].

Lastly, for bank and insurance managers, shareholder value maximization is dependent on an understanding of the intended and unintended consequences of capital standards. Beyond the narrow objective of regulatory capital arbitraging, the more efficient deployment of scarce capital resources across the banking and insurance industries can provide better returns to shareholders and spill-over effects to the wider economy.

APPENDIX 1

Table A1 – Stylized portfolio composition

CATEGORY	% OF TOTAL	TOTAL VALUE OF CATEGORY	RATING	% OF CATEGORY	BANKING BOOK VALUE	TRADING BOOK VALUE
Government bonds – E.U.	22.40%	11,379.20				
			AAA	58.8%	5,540.12	1,150.85
			AA	20.6%	1,940.93	403.19
			A	18.1%	1,705.38	354.26
			BBB	0.6%	56.53	11.74
			BB	1.9%	179.02	37.19
			B or lower	0.0%	0.00	0.00
			Unrated	0.0%	0.00	0.00
Government bonds – U.S.	5.60%	2,844.80				
			AAA	65.0%	1,531.07	318.05
			AA	17.5%	412.21	85.63
			A	2.5%	58.89	12.23
			BBB	10.0%	235.55	48.93
			BB	0.0%	0.00	0.00
			B or lower	3.0%	70.66	14.68
			Unrated	2.0%	47.11	9.79
Bonds – financials	17.00%	8,636.00				
			AAA	17.5%	1,251.36	259.94
			AA	15.0%	1,072.59	222.81
			A	40.0%	2,860.24	594.16
			BBB	20.0%	1,430.12	297.08
			BB	2.0%	143.01	29.71
			B or lower	0.5%	35.75	7.43
			Unrated	5.0%	357.53	74.27

CATEGORY	% OF TOTAL	TOTAL VALUE OF CATEGORY	RATING	% OF CATEGORY	BANKING BOOK VALUE	TRADING BOOK VALUE
Bonds – non financials	14.00%	7,112.00				
			AAA	17.5%	1,030.53	214.07
			AA	15.0%	883.31	183.49
			A	40.0%	2,355.49	489.31
			BBB	20.0%	1,177.75	244.65
			BB	2.0%	117.77	24.47
			B or lower	0.5%	29.44	6.12
			Unrated	5.0%	294.44	61.16
Collective investments	20.00%	10,160.00				
Government bonds – E.U.			AAA	23.5%	0.00	2,390.94
Government bonds – E.U.			AA	8.2%	0.00	837.64
Government bonds – E.U.			A	7.2%	0.00	735.99
Government bonds – E.U.			BBB	0.2%	0.00	24.40
Government bonds – E.U.			AAA	6.5%	0.00	660.76
Government bonds – U.S.			AA	1.8%	0.00	177.90
Government bonds – U.S.			A	0.3%	0.00	25.41
Government bonds – U.S.			BBB	1.0%	0.00	101.66
Bonds – financials			AAA	5.3%	0.00	540.05
Bonds – financials			AA	4.6%	0.00	462.90
Bonds – financials			A	12.1%	0.00	1,234.39
Bonds – financials			BBB	6.1%	0.00	617.19
Equities	8.00%	4,064.00				
Mortgages – residential	7.00%	3,556.00				
Property – commercial	2.00%	1,016.00				
SMEs	0.00%	0.00				
Cash and deposits	3.00%	1,524.00				
Structured notes	0.00%	0.00				
Covered bonds	1.00%	508.00				
			AAA	94.3%	0.00	478.85
			AA	3.3%	0.00	16.66
			A	2.5%	0.00	12.49
			BBB	0.0%	0.00	0.00
			BB	0.0%	0.00	0.00
			B or lower	0.0%	0.00	0.00
			Unrated	0.0%	0.00	0.00
TOTAL	**100%**	**50,800.00**				

Note: The Basel Committee [BCBS (2019)] defines the trading book as instruments comprising of financial instruments, foreign exchange, and commodities that have no legal impediment against selling or fully hedging them, are fair valued daily, and valuation changes are recognized in the profit and loss account. All other banking assets are part of the banking book. The Solvency II framework employs a "total balance sheet" approach and, therefore, there is no distinction between banking and trading books.

Table A2 – Comparative capital, eligible exposure, and capitalization ratios across frameworks (base, stress, and delta)

	BASEL			SOLVENCY		
	CAPITAL	ELIGIBLE EXPOSURE	CAPITAL / ASSETS	CAPITAL	ELIGIBLE EXPOSURE	CAPITAL / ASSETS
BASE						
Market diversified	4,593	19,887	23.10%	4,922	45,720	10.77%
Equities	983	4,064	24.19%	1,890	4,064	46.50%
Interest rate	179	15,823	1.13%	262	40,640	0.64%
FX	603	2,845	21.21%	711	2,845	25.00%
Spread	2,827	15,823	17.87%	2,764	40,640	6.80%
Property				254	1,016	25.00%
Credit diversified	696	30,913	2.25%	130	5,080	2.56%
Sovereigns	64	11,777	0.54%			
Banks	237	7,151	3.32%			
Insurers	144	4,323	3.32%			
Corporates	55	1,566	3.52%			
SMEs	0	0				
Mortgages	108	3,556	3.04%			
Property	88	1,016	8.67%			
Cash at bank	0	0				
Deposits	0	1,524	0.00%			
Type 1				112	1,524	7.32%
Type 2				23	3,556	0.65%
Diversification				-1,540		
Adj TP / DT				-2,106		
CCYB	331					
CB	1,653					
CG-SIB	0					
TOTAL	7,273	50,800	14.32%	1,406	50,800	2.77%

	BASEL			SOLVENCY		
	CAPITAL	ELIGIBLE EXPOSURE	CAPITAL / ASSETS	CAPITAL	ELIGIBLE EXPOSURE	CAPITAL / ASSETS
STRESS						
Market diversified	3,503	19,107	18.33%	3,395	45,841	7.41%
Equities	655	2,707	24.19%	1,259	2,707	46.50%
Interest rate	182	16,401	1.11%	274	42,119	0.65%
Fx	603	2,845	21.21%	711	2,845	25.00%
Spread	2,063	13,203	15.63%	1,726	28,300	6.10%
Property				254	1,016	25.00%
Credit diversified	696	30,913	2.25%	130	5,080	2.56%
Diversification				-1,079		
Adj TP / DT				-1,461		
CCYB	262					
CB	1,312					
CG-SIB	0					
TOTAL	5,774	50,020	11.54%	985	50,921	1.93%
DELTA (stress/base)						
Market diversified	-23.73%	-3.92%	-20.62%	-31.03%	0.27%	-31.21%
Equities	-33.40%	-33.40%	0.00%	-33.40%	-33.40%	0.00%
Interest rate	1.38%	3.65%	-2.19%	4.74%	3.64%	1.06%
FX	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Spread	-27.03%	-16.56%	-12.55%	-37.54%	-30.36%	-10.30%
Property				0.00%	0.00%	0.00%
Credit diversified	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Diversification				-29.91%		
Adj TP/DT				-30.65%		
CCYB	-20.61%					
CB	-20.61%					
CG-SIB	0.00%					
TOTAL	-20.61%	-1.53%	-19.37%	-29.97%	0.24%	-30.13%

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