Chapter 1

COVID-19: A Trigger for Innovations in Insurance?

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Abstract This chapter gives an overview of the consequences of the novel coronavirus, COVID-19 on the insurance branch. The main problems caused by the pandemic on the commercial insurance, and in particular, on the business interruption and possible innovations are discussed. The aim is to prepare the reader for the following chapters specifically by demonstrating connections between different aspects of modelling a pandemic. These models are necessary to create new insurance products supplementing governments' actions in response to a pandemic.

1.1 Introduction

An actuary's almost knee-jerk reaction to a pandemic is to model it. However, this temptation has to be moderated and an actuary must consider the implications of other important factors in planning for future pandemics. On the one hand, the legal aspects of insurance policies might outweigh any actuarial considerations. On the other hand, developing models for future pandemics based on the most recent one bears the risk of preparing for the last war. The next pandemic will most certainly be different.

Being a relatively rare event in the Western world, epidemics are a growing public health threat in Africa and Asia. The World Health Organization (WHO) considers the zoonotic diseases, those caused by pathogens transmitted from animals to humans, as the dominant cause of epidemics and pandemics. Coronaviruses (CoV) are a large family of zoonotic viruses that cause illnesses ranging from the common cold to more severe diseases such as the Severe Acute Respiratory Syndrome coronavirus

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(SARS-CoV) and Middle East respiratory syndrome coronavirus (MERS-CoV). The outbreak of SARS-CoV, started in China in 2002 and was defeated by disease prevention and control systems (Deng and Peng 2020). MERS-CoV was first reported in Saudi Arabia in 2012 and has since spread to several other countries. Although most of coronavirus infections are not severe, more than 10,000 cumulative cases have been associated with SARS-CoV and MERS-CoV in the past two decades, with mortality rates of 10% and 37% respectively (Huang et al. 2020; Sohrabi et al. 2020; Zhu et al. 2020).

COVID-19—the novel coronavirus pandemic declared as such by the World Health Organization on the 11th of March 2020—has quickly reached an incomparable dimension, and every individual, every government has been caught by surprise fighting against the crisis caused by COVID-19. The pandemic has triggered what is likely to be the deepest global recession since World War II.

The COVID-19 pandemic has strikingly proved that “we are only as safe as the most vulnerable among us”.¹ Considering nearly 55% of the world’s population do not have access to any sort of financial social protection, and many countries rely on market-based solutions to fill the gap, the recent pandemic demonstrates that the situation does not only hurt the poorest and most vulnerable, it threatens the well-being of the entire global community. Those who are unable to quarantine themselves because of precarious financial situations not only endanger their own lives but also the lives of others. It is clear that if one country does not contain the virus, others are bound to be infected and re-infected (ILO 2021). Therefore, developed countries should provide assistance, not only for altruistic motivations but for self-protection. Similar considerations hold true for the case of total vaccination.

1.2 Discussions from the Perspective of Insurance and Social Protection

1.2.1 *Commercial Insurance*

Insurance can be defined as a contract under which an insurer or the government agrees to offer a promise of coverage in the event of a specified loss, injury, sickness, or death in exchange for the payment of a specified premium. Whilst injuries are minor and occur in groups of individuals or companies, commercial insurance does an outstanding job of distributing damages that are unforeseen individually but anticipated collectively. Life insurance, pensions, insurance for motor accidents, burglaries, household fires, marine insurance, etc. are examples which fit the definition perfectly. However, significant catastrophic losses that affect large populations are single events which cannot be pooled. War casualties, epidemics/pandemics, coastal flooding triggered by rising sea levels, major tsunamis, earthquakes, big volcanic

¹ https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_739678/lang--en/index.htm.

activities are some examples of these catastrophic events which might affect entire societies. Then, it becomes the responsibility of the society to share the losses, which must be managed and performed by governments.

The *limits* of the commercial insurance are derived by both the severity and the prevalence of the damages. Considering the extent of losses, insurance companies might balance one type of extreme risk against others, such as forest fires in some place versus earthquakes in others. Additionally, it might be possible to introduce innovative insurance products, or adjusting the current ones to serve the aim to cover specific parts of the *uninsurable losses*. COVID-19, in this regard, tested the extent and the effectiveness of the current insurance products. Although it might not be the aim or duty of the commercial insurance to protect societies from possibly unbounded damages, it could still contribute to pandemic response (i.e. social protection provided by governments and international organisations) by dealing with some aspects of the damages caused by the pandemic. Some possible innovative responses might include life insurance products being adapted or converted to include deaths caused by the pandemic, or occupational sickness insurance might be extended to include new disease and conditions that have been caused by SARS-CoV-2 infections, etc. In the case of the COVID-19 pandemic, in particular, applying these innovations retrospectively in the existing insurance products may not necessarily mean an overall increase in costs to the insurance industry. For example, an increase in death claims might be compensated by a decrease in future pension/annuity claims.

A tsunami-like amount of business interruption, travel, and medical treatment claims crashed over the insurance sector in response to the COVID-19 pandemic. Whilst some insurance companies had already added pandemic exclusion clauses to their policies following the SARS-CoV epidemic in 2003, others did not incorporate a clear defined list of possible diseases to be covered, leaving some ambiguity about individual extent of cover.

Insurance associations all over the world declared that pandemic coverage had been optional and most policyholders chose to save the money and did not purchase this type of business interruption insurance. In France, the financial regulator supervising both banking and insurance, Autorité de contrôle prudentiel et de résolution (ACPR), on the 22nd June 2020 made public that 93.3% of insurance policies did not cover the pandemic, 2.6% did and 4.1% were unclear. For instance in Germany, many pre-COVID-19 insurance policies merely referred to the Infectious Diseases Protection Act, Infektionsschutzgesetz (2001) (IfSG), and the diseases listed therein. This ambiguity created by the fact that COVID-19 was not explicitly mentioned in IfSG led to a number of court cases. On the 1st of October 2020, the Munich Regional Court ruled that the insurance company Versicherungskammer Bayern had to pay out 1.01 million euros business interruption insurance to Augustinerkeller, a famous restaurant in Munich. However, after the ruling the Berlin-based German Insurance Association (GDV) stated that the Munich decision would have no implications for other pending cases.

The refusal of some insurance companies to pay pandemic-related claims has eroded trust in the sector in general. Numerous court proceedings followed as claimants sought retribution in numerous countries. The lawyers, representing the

interests of the insurance sector, insisted that businesses could not claim for losses resulting from nationwide lockdowns as it would be catastrophic for the industry.² For instance, Michael Crane, a lawyer for insurance company QBE QBE.AX, stated during one of the hearings that a pandemic had been foreseen, however a government's response in the form of introducing a nationwide lockdown had been an "inconceivable" measure before 2020. This means in particular, that the actuarial equivalence principle (expected future premium payments should be equal to expected future benefits) does not work here. The premia charged by insurance companies did not contain the possibility of protracted lockdowns, i.e. the customers did not pay for the risk of business interruption to the extent that was widely experienced during COVID-19 pandemic. In this way, COVID-19 has shifted the insurability question from the actuarial to the legal sphere.

Even one year after the start of the COVID-19 pandemic there is still no clear line of jurisprudence on the gray areas of contracts containing a list of diseases in which COVID-19 is not mentioned. As a consequence, from South Africa to USA legal decisions have been taken in favour of both insurers and policyholders. And as of March 2021, it is far from clear which legal trend, if any, will eventually prevail in this battle.

It is not surprising, now in light of COVID-19, that new contracts engaged after the beginning of the pandemic often contain a pandemic/epidemic exclusion clause. Many insurance companies are not ready to undertake the risk of a pandemic. The reason is that when this rare event happens losses occur for everybody—pandemics do not respect geographical borders—therefore collective risk sharing and balancing over time are not working for a pandemic. As an example, the Wimbledon Tennis tournament had a business interruption policy with a pandemic insurance clause which costed them around £1.5 million per year. This annual premium had been paid for 17 years before a claim occurred. Small and medium-sized businesses may not be able to afford such-a-high premia over a substantial number of years. For instance in the UK, before COVID-19 many small businesses had business interruption policies that enabled them to claim up to a maximum of between £50,000–£100,000 in case of a pandemic and lockdowns. This cap essentially reduced the premia. However, as of March 2021 the actual losses in most cases exceed these amounts by a multiple. Besides, some insurance companies are reportedly trying to reduce their losses and to pay claims as quickly as possible by offering very low settlement or interim payments. The news organisation Reuters reported on a café in East London getting a settlement offer totalling £13.³

There is a clear demand for insurance coverage for the case of a new epidemic/pandemic. Thus, insurance companies are confronted with the challenge of developing innovative policy structures and mitigation strategies for both public and private sectors.

² In this case, the contracts are subject to moral hazard since governments might influence the claim payments through national lockdowns.

³ <https://www.reuters.com/article/uk-britain-insurers-idUSKCN2AT3B6>.

Partnerships and collaborations between governments and (re)insurance companies are needed to enable insurance protection for pandemic risks that would be otherwise uninsurable. In this regard, a parametric pandemic insurance design for governments has been introduced by Boado-Penas et al. (2021). As for the practical examples, in the UK Flood Re is a joint initiative between the government and insurers to include flood cover in household insurance policies in an affordable way. In practice, every insurer that offers home insurance in the UK must pay a fee into the Flood Re Scheme and can choose to pass the risk to Flood Re for a fixed price. This keeps the premia down for consumers, and protects insurance providers from very large exposures.

1.2.2 The Role of the Governments and Social Protection

Governments must act promptly to make rapid progress toward collectively financed, comprehensive, and permanent social-protection systems which are already wretchedly inadequate at safeguarding the lives and livelihoods of their citizens. Having access to health insurance, unemployment, and sickness benefits is crucial to protect vulnerable groups and thus the whole community (ILO 2021).

During the COVID-19 pandemic, the economic shutdown and the subsequent business losses led to an unprecedented rise in the number of unemployed people. In general, Eurostat (2020), the estimated income losses at the EU level represent around 5% of total earnings and its distribution is very unequal. This inequality is present both between nations, and within them, with the greatest effect realised by the most vulnerable sub-groups of the working population. Emergency legislation in some countries made significant concessions to increase the capacity of their health systems and provide relief to those citizens and sectors that are particularly impacted by the coronavirus crisis. Spain's government, for example, launched a monthly basic income scheme up to €1,015 for the most vulnerable households in June 2020. The programme supported around 850,000 households. In the UK, social measures such as the Coronavirus Job Retention Scheme⁴ or the Self-Employment Income Support Scheme were introduced so that a portion of usual monthly wage costs was paid for the time the employee is on furlough (Machin 2021).

As a result of the economic recession caused by the coronavirus crisis, most major economies lost at least 2.4% of their GDP over 2020. In developing nations (excluding China) the pandemic crisis led to a fall in nominal US dollar GDP of 10% while the private finance dropped by \$700 billion in 2020 (OECD 2021).

Governments usually include several financial programmes in their budget which target vulnerable social groups, i.e. those who are disproportionately exposed to risk. Due to prolonged and strict lockdowns which will be discussed in Chaps. 7, 8 and 9 in various dimensions, unemployment benefits have become vital for millions to survive

⁴ Through the Coronavirus Job Retention Scheme, the UK Government have committed to reimbursing 80% of employees' wage cost up to £2,500 per worker.

during the COVID-19 pandemic. Persons who have not been considered vulnerable at the start of a pandemic may be pushed to the edge of poverty or even beyond by the loss of their jobs, illness and expensive medical treatment. Consequently, governments are facing a challenge of identifying the vulnerable depending on the current situation and preparing beforehand feedback response strategies, see for instance The Lancet Editorial (2020).

At the same time, international organisations are working closely with global experts and governments to provide advice to countries on measures to protect health and bolster economic recovery. For the most vulnerable countries, the World Bank, as we can see in Chap. 7, has approved some financial emergency support to urgent needs in the wake of the pandemic. Also, the World Bank together with the International Monetary Fund urged G20 to establish the Debt Service Suspension Initiative, so that emerging countries concentrate their resources on fighting the pandemic and safeguarding the lives.

1.3 Listening to the *Wind of Change*

The 21st century with its urbanisation, internationalisation and overpopulation has created the optimal conditions for novel infectious diseases to multiply, and spread. The increasing threat of experiencing pandemics more often in the near future will force many institutions, the insurance sector being one of the pioneers, to propose path-breaking solutions.

It is not a coincidence that the origin of actuarial modelling goes back to 14th century and the Black Death, an outbreak of medieval plague which was believed to kill 30–50% of Europe's population. That is when the City of London started recording the deaths and produced regular statistics of mortality with the aim of recognising the patterns and use past data to predict the future. Seven centuries have passed, and yet not much has changed concerning the data as it once again became the driving force of actuarial modelling in a pandemic.

On the other hand, a core change has occurred to the perception of the number of pandemic victims. Whilst in the 14th or even in the 20th century with no antibiotics the general attitude towards widespread death was rather fatalistic, in the 21st century death is considered more and more a technical problem, see for instance The Guardian (2020). The number of COVID-19 deaths affects many people not least because they strongly feel that these deaths have been preventable. Therefore, it is not surprising that there is a high demand for a more structured and more extensive additional social protection during events like COVID-19.

This book provides a collection of interdisciplinary scientific studies that can be used to develop epidemic/pandemic response strategies for both the commercial insurance sector and government provisions (social protection). By putting together innovative mathematical, statistical, actuarial, legal and social academic contributions, along with a review of existing realities, we have listened to the early breezes of the *winds of change* triggered by COVID-19.

Fig. 1.1 The structure of the book

There are direct and indirect connections between all chapters, as can be seen from the contents presented below. Figure 1.1 lists and collects the chapters of the book under four main parts—*actuarial models*, *responses*, *testing and data*, *actuarial practice*.

Below, we give a summary of each chapter and indicate potential links between them. The book starts with actuarial mathematical modelling of pandemics for two branches—compartment models and mortality models.

In Chap. 2, R. Feng et al. bridge the gap between epidemiological and actuarial models and present insurance product designs to provide healthcare coverage during a pandemic. This chapter starts with an extensive description of the main compartmental models—commonly used in the medical literature—characterised by a system of differential equations in the case of deterministic models or transition probabilities for stochastic models. Then, the authors apply actuarial techniques to COVID-19 data and calculate premia to be paid continuously from (healthy susceptible) policyholders and actuarial reserves for three epidemic models. This chapter also discusses the application of epidemic models for contingency planning and resource allocation.

In Chap. 3, A.D. Wilkie introduces an actuarial model for infections such as COVID-19. The chapter presents variations of an actuarial multiple state model which considers the duration of infection of the newly infected individuals. This is a main distinguishing feature of these models compared to SIR models. The chapter presents empirical results based on the UK data whilst emphasising the possible problems of the use of a model for prediction purposes. The prediction accuracy of

such models highly depends on actions of governments, the responses of individuals to the measures taken by governments, and the disease itself, medical improvements such as testing capacity and efficiency, advances in the treatments of those affected, vaccine availability as well as efficacy, and possible new mutations with different transmission and virulence characteristics. All these dimensions are discussed in several chapters of the book (Chaps. 7, 8, 9, 10, 11 and 12).

COVID-19 has sparked research dramatically in many different areas but mortality modelling deserves significant attention considering the heterogeneous effect of the pandemic on population. The recent experience has proved that the pandemics might have various impacts on the mortality of different sexes, age groups, ethnic and socioeconomic backgrounds which necessitates advanced mortality modelling. The book contains two chapters on mortality modelling presenting different methodologies. In Chap. 4, L. Regis and P. Jevtić discuss the discontinuity in the trends displayed in mortality rates as a result of the shocks caused by the pandemics. The chapter summarises the current literature on stochastic mortality, with a focus on multi-population models, and explores the characteristics that models should possess in order to accurately represent the behaviour of mortality rates following the COVID-19 pandemic. The authors also introduce a general framework using affine jump-diffusive processes for multi-population models with continuous-time jumps.

Statistical analysis shows that mortality models are often missing systemic risk elements which could capture the impact of the extreme events. In Chap. 5, G. Venter introduces a mortality model for contagious events including pandemics by adding annual jumps to capture both tiny and catastrophic risks. The chapter describes how to model mortality based on parametric regression by fitting smoothing splines across the age, period, and cohort variables in Markov Chain Monte Carlo (MCMC). Furthermore, the chapter examines the Bayesian shrinkage methodology for smoothing as well as the predictive benefits of such smoothing. The analyses have been illustrated using French male and female mortality data.

Insurance is the transfer of risks from individuals or corporations who cannot bear a potential unexpected financial catastrophe. When the number of individuals/contributors is high the insurers spread the financial risks from expensive claims (risk pooling) and can offer a reasonable level of premia. In the unlikely event of a pandemic, losses will happen at the same time for everybody, and consequently, the risk pooling and balancing over time principles are not working. Thus, for the macro level events, like a pandemic, insurance seems to be a suboptimal solution to mitigate risks. In Chap. 6, H. Assa and T. Boonen discuss three risk management setups: risk-sharing, insurance and market platform. They explore the efficiency of insurance schemes in the presence of a macro risk event with significant impact. They come to the conclusion that a social insurance scheme in the form of “Insurance-by-Credit” (no premia payments before the losses occur) outperforms standard insurance by changing the ex-ante view to ex-post: borrowing from the future instead of the past. This risk-sharing concept turns out to be optimal if one neglects credit risk and moral hazard.

Since the World Health Organization declared the COVID-19 outbreak as a Public Health Emergency of International Concern, governments across the world have implemented a variety of policies and strategies to contain the spread of the virus and its negative effects on their citizens. International organisations have supported these efforts through policy and best practice analyses, as well as evidence based policy recommendations. In Chap. 7, M.C. Boado-Penas et al. give an overview of the responses of international organisations, in particular of the World Bank and the EU, to the COVID-19 pandemic. Special attention is given to the guidance of these organisations towards vulnerable groups through changes in social insurance and pension plans.

Chapter 8 by N. Badenes-Plá focuses on changes in individuals' behaviour in different countries arising from a pandemic. While the virus spreads worldwide, the strategies to defeat it cannot be designed without consideration of cultural values and political organisation. This chapter presents an overview of the response and the degree of acceptance of citizens to government interventions to stop the spread of COVID-19 pandemic. The author analyses the behavioural characteristics of the citizens of different countries, toughness of measures, lockdown fatigue, and public trust in their government on the extent of compliance to pandemic measures. Changes in behavioural patterns due to isolation and/or social distancing are described in detail indicating long-term consequences that might affect the pricing of insurance products. For instance, unhealthy habits acquired during lockdowns, or newly acquired or exacerbated mental-health problems may impact on the quality of the remaining life expectancy of individuals.

Once a pandemic happens, it is too late to start planning social protection actions. Governments need to follow the proverb "Repair your cart in December, in July your sledge remember". Harsh suppression measures—that also include the social distancing of the entire population, using Personal Protective Equipment (PPE), closure of schools, leisure and hospitality sectors as well as non-essential retail have been introduced during the COVID-19 pandemic in many countries. However, due to the unprecedented surge in COVID-19 cases and fatalities, after already a few months, most countries were forced to increase the intensity of the lockdown by restricting the suppression rules to limit the spread of the virus. In Chap. 9, J.P. Caulkins et al. consider the problem of optimising the start and the duration of a lockdown, with fixed or variable intensity, considering the more virulent strains of the SARS-CoV-2. One of the important features of the considered model is the recognition of lockdown fatigue. At some point, people start breaking rules no matter how obedient they have been at the beginning of the lockdown, see Chap. 8 for details. The decision to begin or to end a lockdown is always a trade-off between the economic prosperity of a country and the saving of lives. The optimal strategy turns out to be extremely sensitive to the assumptions of the model. The duration of a lockdown depends on its start, and entering a lockdown after a certain number of days since the beginning of the pandemic will feature a different strategy. One can even get the so-called Skiba points, meaning that starting a lockdown at a particular day of the pandemic might provide several completely different optimal strategies.

Before the COVID-19 pandemic, the general public was not familiar with PPE and may not have given sufficient importance to hand hygiene. Since at least the spring of 2020, everyone learnt the new terminology around the SARS-CoV-2 outbreak, see for instance Yale Medicine (2020). Droplet transmission, incubation period, reproduction number—the COVID-19 virus has brought epidemiological language and modelling literally to our living rooms as telework has become the every day reality for many in 2020 and 2021. In 2021, one can recite like a prayer that seven of the known coronaviruses, whose name comes from the crown-like spikes, can infect people, that social distancing, masks and handwashing are the best methods to “flatten the curve”. Chapter 10 by S. Dunbar and Y.-W. Tang provides a biochemical overview of the testing procedures necessary to understand and monitor the course of an epidemic. Different biomarkers and possible laboratory specimen for identification of COVID-19 are presented and explained. Furthermore, this chapter discusses the lessons learnt from COVID-19 that would help to speed up the response to a future pandemic. In particular, preventing the high numbers of deaths will require an earlier detection of the disease by using specific biomarkers, targeted treatments, and appropriate triage of patients, particularly those who are susceptible to the most severe course of the disease.

At the beginning of a pandemic, even if the biochemical procedures to follow are clear, the question arises of how to test: individually or in groups. When the resources are scarce and the prevalence level (the ratio of the already infected to the entire population) is still comparatively low, pooled testing, also called group testing, may provide better results than individual testing. Firstly, pooled testing has the potential for very large resource-saving and second, it requires less time than individual testing. In Chap. 11, M. Aldridge and D. Ellis discuss the mathematics behind some one- and two-stage pooling strategies under perfect and imperfect tests, and consider the practical issues in the application of such protocols. The pool testing procedures can be used for instance for surveillance purposes or to monitor the prevalence of the new variants of a disease, which is particularly important if the new variants start to threaten the success of vaccination programmes.

Data collection and analysis play a crucial role in decision-making processes. Defective or deliberately forged data can have fatal consequences. For instance, an underestimation in the number of needed tests can lead to a new upward spiral of a pandemic and, consequently, to more excess deaths. In this line, Chap. 12 by C. Rieser and P. Filzmoser introduces outlier detection techniques applied to COVID-19 pandemic data from different countries. In many applications, outliers are considered the most interesting subject for analysis, because they suspiciously differ from the data majority and might indicate a “contamination” of the given data sets. The data (for instance, the number of newly infected or dead) are regarded as compositions, where the compositional parts are treated as multivariate smooth functions. Here, only relative information expressed in terms of log-ratios between the compositional parts is considered as relevant in the analysis. The presented outlier detection method focuses on the evolution of the data over time rather than on the absolute values. If the evolution of one data set steps out of line compared to similar other data sets (for instance by analysing several different infection testing stations) this clearly

indicates a problem with the data cleanliness. Considering the COVID-19 publicly available data from different countries, Chap. 12 explores which countries might have “contaminated” data sets.

COVID-19 has evoked legal challenges regarding the traditional indemnity insurance to protect people and businesses from the losses caused by pandemics. Discrepancies between the expectations of insurers and insureds considering the coverage of the policies seem to be the origin of the disputes as mentioned earlier. The recent evidence, once again, proves that indemnity-based pandemic insurance is obsolete and leads to long delays in payments. In Chap. 13, R. Hillier discusses the legal challenges of insuring against a pandemic. The chapter builds upon the insurance indemnity principle (the insurers cover just the actual loss) and illustrates the pandemic-related problems of the traditional insurance schemes by several court cases that occurred during the COVID-19 pandemic. The author states that a possible solution against business interruption caused by a pandemic could be a parametric insurance, where a pre-agreed payout is made if pre-defined event parameters (triggers) are met. This type of insurance would provide immediate help without a time-consuming loss assessment. Parametric insurance appears to be a simple method of providing quick financial support in combination with the governmental economic packages in the wake of a pandemic. Observing that a parametric design has challenges in terms of defining a robust trigger, the chapter opens a room for possible innovative hybrid insurance products combining indemnity and parametric features.

Last but not least, the closing chapter, Chap. 14 by F. Schiller, analyses the methods and ideas proposed in this book along with their feasibility in times of a pandemic from an actuary’s perspective. The chapter discusses the insurability and risk management of extreme events and pandemics in particular and reflects on the potential future consequences of COVID-19 for the insurance sector. The lessons learnt will help the insurers to better adjust and response to the future extreme events. However, the crisis caused by the COVID-19 pandemic has highlighted that the capacities of the financial and (re-)insurance markets are limited, and governmental help in “dark times” is one the whales on whom the world rests. A global disaster cannot be dealt with single-handedly—neither by states nor by insurance companies, no matter the size. Just acting together in a determined and concerted manner can help to tackle the problem.

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