Leveraging technology in insurance to enhance risk assessment and policyholder risk reduction

OECD

Foreword

Insurance markets play an essential role in providing individuals, households and businesses with financial protection against risks as well as incentives and advice to support risk management and risk reduction. The application of new data sources, analytical tools and policyholder engagement platforms can enhance the insurance sector's contribution to risk reduction. However, these new data sources and analytical tools can also create new risks for consumers who may be exposed to increased risk of unfair discrimination, privacy breaches and/or financial exclusion.

This policy paper provides an overview of the data sources, analytical tools and engagement platforms that insurance companies are increasingly applying to risk assessment and support for policyholder risk reduction and the potential challenges to adopting these technologies, including potential regulatory impediments. It also provides a set of potential good practices for governments and insurance regulators and supervisors for developing an enabling environment for the adoption of technology in insurance risk assessment and support for risk reduction while mitigating the potential risks to consumers.

The report is based on responses to questionnaires circulated to insurance regulators and supervisors and to (re)insurance companies and intermediaries from across the world on the adoption of technology, regulatory and other challenges and potential risks and regulatory adaptations. It was also informed by detailed interviews with insurance regulators and supervisors and (re)insurance companies and intermediaries in India, Indonesia, Malaysia and Nepal. The OECD greatly appreciates the input provided through responses to the questionnaire and during the interviews as well as the comments and insights provided by delegates to the Insurance and Private Pensions Committee and the insurance regulators and supervisors in India, Indonesia, Malaysia and Nepal when reviewing earlier versions of the report. The development of this report has been possible thanks to a financial contribution from the Government of Japan.

Executive Summary

The adoption of new technologies and innovation in the insurance sector has the potential to improve insurer risk assessment and increase the contribution of insurance to risk reduction. Improvements in connectivity as well as access to distributed infrastructure such as cloud computing and the analytical capacities available through the application of artificial intelligence and machine learning are enhancing insurance companies' ability to assess risk and accurately underwrite and price coverage, and are providing new mechanisms to deliver risk mitigation advice and services to policyholders. Insurance companies are increasingly leveraging external data sources to supplement "traditional" data and applying analytical tools based on artificial intelligence and machine learning to their risk assessment, underwriting and pricing decisions. They are also developing engagement platforms to deliver risk mitigation advice and services to policyholders.

Insurance companies face a number of challenges to leveraging the potential benefits of new data sources, analytical tools and policyholder engagement tools in risk assessment and support for risk reduction. In many countries, access to the skills and particularly the data and technology necessary to incorporate external data and advanced analytical tools remains a significant challenge, including as a result of consumer reluctance to share data with insurance companies. In some countries, insurance regulation and supervision also create impediments or disincentives for technology adoption, including supervisory requirements related to underwriting and pricing that reduce the benefits of investing in new risk assessment capacities, regulatory restrictions on the provision of risk mitigation services as well as emerging requirements related to digital security and outsourcing arrangements – some of which are applied more broadly across the economy.

The application of technology in insurance can clearly create risks for both insurers and their policyholders which need to be carefully managed by providers themselves as well as through the development of appropriate regulatory and supervisory frameworks. Harnessing the benefits of technological developments to improve risk assessment and risk reduction advice and services may require insurance regulators and supervisors to adapt existing regulatory and supervisory frameworks to allow for the implementation of new approaches, while taking measures to continue to ensure that policyholders are sufficiently protected from unfair discrimination, breaches of their privacy and financial exclusion.

Insurance regulators and supervisors (and governments) can adapt regulatory and supervisory frameworks to create an enabling environment that supports the adoption of technology in insurance and mitigates risks to consumers, by:

- Addressing excessive restrictions and disincentives to applying new data sources and analytical techniques to underwriting and pricing and considering whether other approaches might be more effective in achieving objectives related to consumer protection, affordability or competitive markets.
- Reviewing restrictions to insurers' ability to provide risk reduction advice and services to policyholders and consider the role of supervisors in actively encouraging a greater contribution of the insurance sector to risk reduction.

- Supporting access to data and technology by assessing the impact of data localisation, digital security and outsourcing requirements on insurer access to data, processing and analytical capacities and policyholder engagement tools developed by third parties and the potential contribution that international insurers, reinsurers and intermediaries could make in terms of technology transfer.
- Establishing regulatory sandboxes or innovation hubs to support the introduction of new approaches, products and services with potential benefits for consumers and the identification of potential regulatory or supervisory impediments to the application of new technologies in insurance.
- Monitoring and responding to financial exclusion by ensuring that the incorporation of new data sources or the application of new analytical tools does not exacerbate financial exclusion and considering measures to support financial inclusion among those excluded as a result of high exposure to risk (such as investments in risk reduction).

Ultimately, leveraging the potential benefits of technology in insurance underwriting, pricing and support for risk reduction will only be possible if consumers have trust that it will lead to outcomes that benefit them. The insurance sector clearly has an important role to play in building consumer trust in how they use personal data and apply technology in making decisions on coverage eligibility, pricing and claims settlement. Governments can support consumer trust by ensuring the implementation of a legislative framework that protects data and privacy and limits unfair discrimination, consistent with societal values. Insurance regulators and supervisors can support consumer trust by building financial literacy related to insurers' obligations in protecting personal data and delivering fair outcomes, while ensuring appropriate consumer protections are in place.

1 Introduction

New technologies and innovation may provide significant opportunities for improving the delivery of financial services. The integration of new technologies into existing business processes can create efficiencies that can ultimately benefit financial consumers by lowering the cost and expanding the reach of financial products. It can also lower barriers to market entry and lead to greater competition in - or "disruption" of - the financial industry.

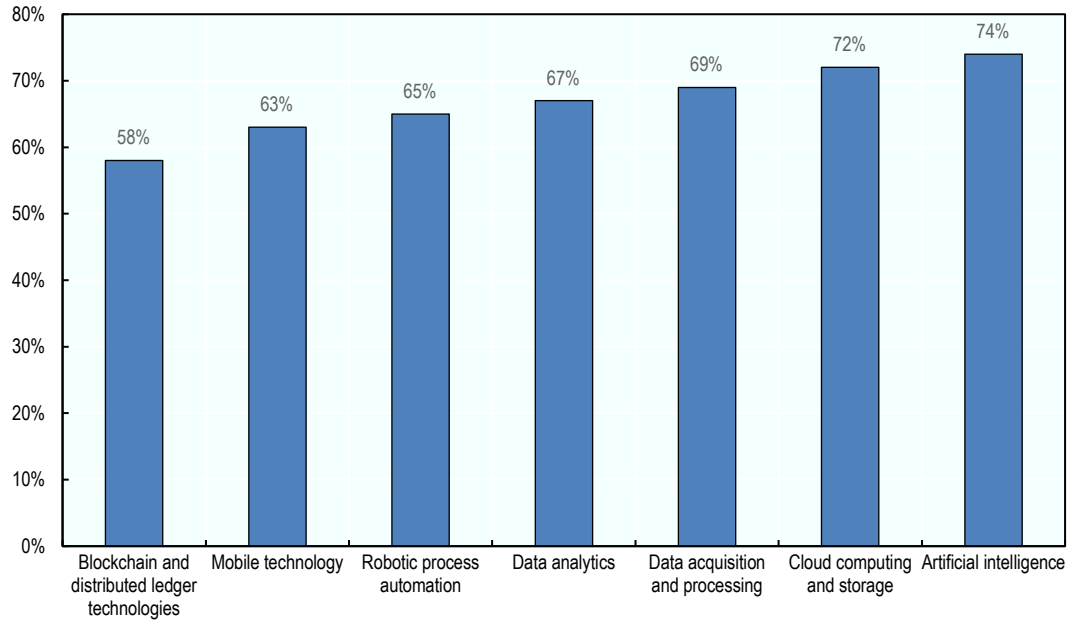
A number of technological developments[1] have direct applications and relevance for the insurance sector, including:

- Connectivity: increasing ability to connect devices to the internet (i.e., internet of things or connected devices) which creates new sources of accessible data;
- Distributed infrastructure: increasing availability of information technology infrastructure and software tools through the cloud which can provide broader access to new data and data processing and analytical capacities;
- Analytics: increasing ability to analyse large amounts of different types of data and derive predictive and prescriptive assessments, most notably through the use of artificial intelligence and machine learning; and
- Automation: increasing ability to automate processes and derive efficiencies.

The insurance sector is increasing its investment in a broad range of emerging technologies, including blockchain and distributed ledger technologies, mobile technology, robotic process automation, data analytics, data acquisition and processing, cloud computing and storage and artificial intelligence. Figure 1.1 provides an illustration of the technology investment priorities of insurance companies in terms of intentions to increase investment. More than half of all surveyed companies planned to increase investment across all types of emerging technologies and more than two thirds planned to increase investment in data analytics, acquisition and processing, cloud computing and artificial intelligence.

[1] The types of technological developments used here are adapted from (Krishnakanthan et al., 2021[2]).

Figure 1.1. Share of insurance companies that expect to increase investment in 2022 selected technologies



Note: Denotes the share of respondents to *The Deloitte Center for Financial Services 2022 Insurance Outlook Survey* that expect a large or slight increase in spending.
Source: (Shaw et al., 2021[1])

These technological developments have applications in insurance product development, how insurance coverage is underwritten and distributed and how claims are settled (see Figure 1.2). For example:

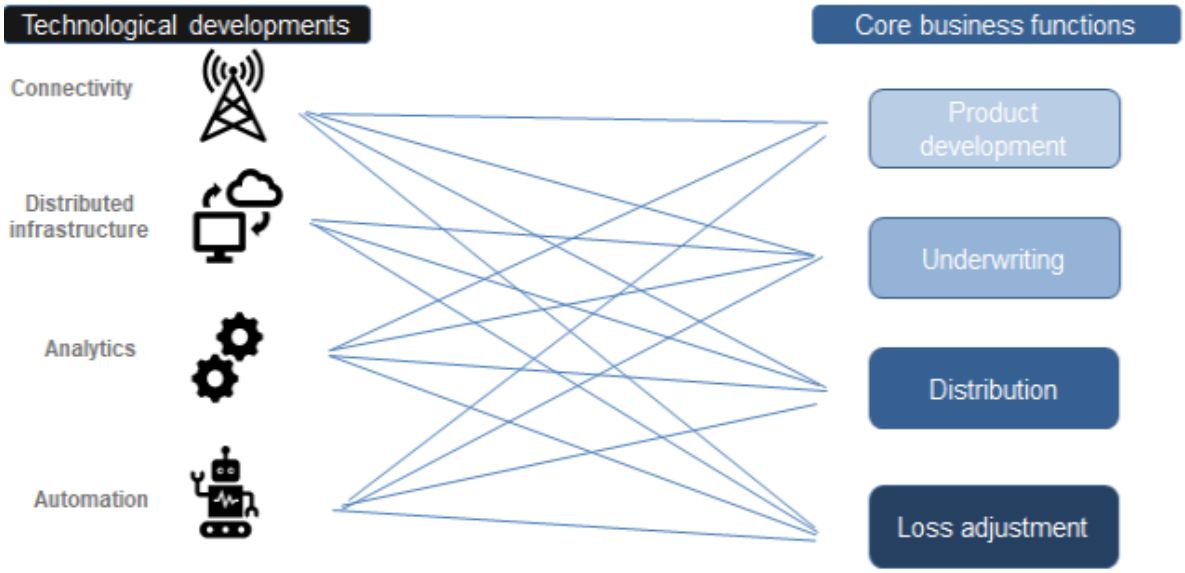
- new data sources available as a result of increasing connectivity (e.g., data from connected devices, online media), combined with a greater ability to leverage that data through the use of analytical techniques based on artificial intelligence and machine learning, can enhance the ability of insurance companies to assess and price risk and the accuracy of those assessments[2];
- processing capacity and software tools available through cloud computing can provide insurers (even smaller insurers) with improved access to the data, processing capacity and analytical tools necessary to leverage advances in risk assessment capability;
- automation can enhance efficiencies in distribution, underwriting and claims processing and lead to lower underwriting and loss adjustment expenses and potentially quicker decisions on coverage and faster claims payments[3];
- the combination of new data sources, advanced analytics and automation can improve the ability of insurers to offer new types of coverage (such as parametric or usage-based insurance); and

[2] One survey of the use of artificial intelligence and machine learning among the largest 100 US insurers found that 85% had improved their risk scoring and 80% had improved their pricing decisions as a result of the adoption of artificial intelligence and machine learning (Beal, 2019[34]).

[3] One survey of the use of artificial intelligence and machine learning among the largest 100 US insurers found that 88% had achieved faster claims settlement as a result of the adoption of artificial intelligence and machine learning (Beal, 2019[34]).

- broad access to internet connections, including through smartphones, allows policyholders to more easily access information on insurance coverage options, including through websites that permit product comparison, potentially providing consumers with improved transparency in pricing and greater choice on coverage options.

Figure 1.2. Technology developments relevant for core insurance business functions



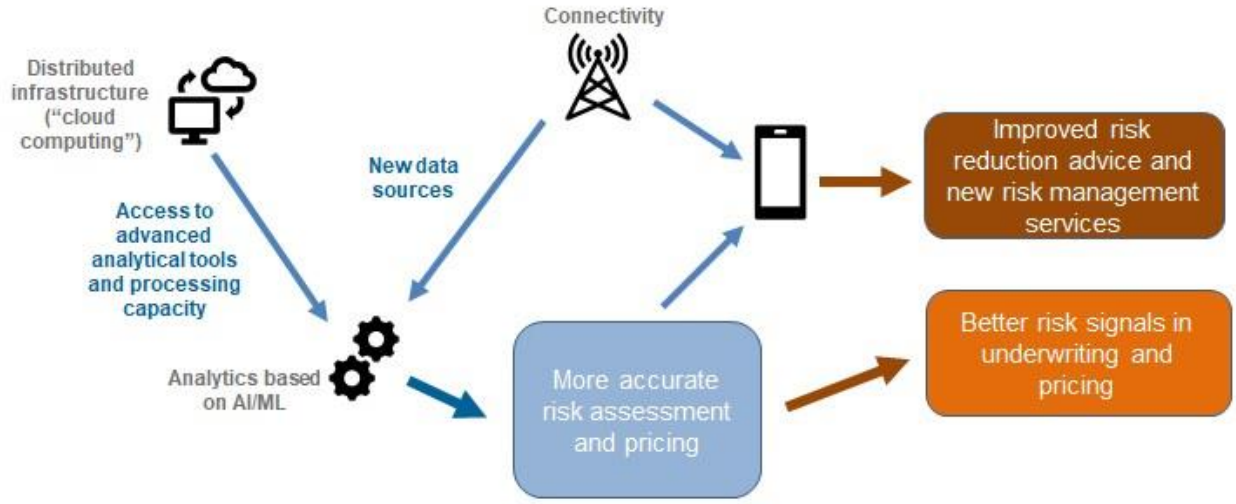
Source: OECD. The categories of technological developments were adapted from (Krishnakanthan et al., 2021[2])

The operational efficiencies that insurance companies can capture through the application of new technologies could lead to benefits for policyholders in terms of lower pricing (if the cost savings are passed on) and new forms of financial protection through product development. More affordable insurance coverage can ultimately lead to broader coverage and a reduction in financial protection gaps.

There is also the potential for the application of new technologies to contribute to encouraging policyholder risk reduction – and reinforce existing trends towards insurers playing a larger role in risk management (Miller, 2023[3]) (see Figure 1.3):

- an improved capacity to accurately assess risk using new data sources and analytical capacities based on artificial intelligence and machine learning can lead to more accurate pricing and better risk signals to policyholders; and
- better risk assessment and improved tools for policyholder engagement or interaction can enhance the effectiveness of risk reduction advice and provide new mechanisms to deliver risk mitigation advice and services to policyholders.

Figure 1.3. Technology applications in risk assessment and supporting policyholder risk reduction



Source: OECD

However, the application of new – and potentially untested technologies – can also create risks for both insurers and their policyholders which need to be carefully managed by providers themselves as well as through the development of appropriate regulatory and supervisory frameworks to ensure that the use of these technologies does not put the solvency of financial service providers at risk, lead to outcomes that are unfair to policyholders or have broader negative impacts on the availability of insurance coverage.

This report examines the potential role of emerging technologies and innovation in improving risk assessment and encouraging policyholder risk reduction, focused on three main types of insurance coverage: (i) property insurance (residential and commercial); (ii) cyber insurance; and (iii) health insurance. It is based on responses to questionnaires received from 25 insurance regulators/supervisors[4] and 166 individual (re)insurance companies and intermediaries[5] from around the world as well as detailed interviews with insurance regulators/supervisors, (re)insurance companies, intermediaries and insurance associations in India, Indonesia, Nepal and Malaysia.[6] Section 2 provides an overview of existing and

[4] Complete or partial responses to the questionnaire circulated to regulators were received from 25 insurance regulators/supervisors (including ministries of finance, insurance supervisors and market conduct supervisors): Belgium, Bulgaria, Canada (Ontario and Saskatchewan), Chile, Colombia, Costa Rica, Estonia, Germany, Greece, India, Indonesia, Japan, Lithuania, Mexico, New Zealand, Philippines, Poland, Portugal, South Africa, Chinese Taipei, Thailand, Türkiye, United Kingdom and the United States.

[5] Complete or partial responses to the questionnaire circulated to direct insurers, reinsurers and intermediaries were received from 166 (re)insurance companies and intermediaries (149 direct (primary) insurance companies, 7 reinsurance companies and 10 insurance intermediaries) from 22 jurisdictions (Austria, Bermuda, Bulgaria, Canada, Chile, Colombia, Estonia, Germany, Greece, Indonesia, Italy, Japan, Lithuania, Maldives, Mexico, New Zealand, Singapore, South Africa, Chinese Taipei, Türkiye, United Kingdom and the United States. Among the respondents, 97 identified property insurance as a line of business, 90 identified health insurance, 81 identified life insurance and 79 identified liability insurance.

[6] Interviewees included: (i) in Indonesia - *Otoritas Jasa Keuangan* (OJK), *Asosiasi Asuransi Jiwa Indonesia* (life insurance association), *Asosiasi Asuransi Umum Indonesia* (general insurance association), 6 individual insurance companies, a reinsurer and an intermediary; (ii) in India - Insurance Regulatory and Development Authority of India (IRDAI), General Insurance Council. 6 individual insurance companies, a reinsurer and an intermediary; (iii) in Malaysia – Bank Negara Malaysia (BNM), *Persatuan Insurans Am Malaysia* (general insurance association), Life Insurance Association of Malaysia, Malaysia Takaful Association and 8 individual insurance companies; and (iv) in Nepal – Nepal

potential applications of new technologies to risk assessment and risk reduction. Section 3 provides an assessment of potential challenges to technology adoption, including regulatory challenges. Section 4 outlines some potential good practices for creating an enabling environment that supports the use of technology in improving risk assessment and encouraging risk reduction, including by mitigating potential risks for consumers.

Insurance Authority (NIA), Nepal Insurance Association, Nepal Life Insurance Association and 4 individual insurance companies.

2 Applications of new technologies in insurance for risk assessment and supporting policyholder risk reduction

New sources of data for risk assessment and supporting policyholder risk reduction

Risk-related data are a critical input into assessing risk for the purposes of underwriting and pricing insurance coverage. Insurance companies have traditionally collected data from those wishing to acquire insurance (can be referred to as "provided data" (Noordhoek, 2023[4])) and used reference data such as historical losses or mortality tables, actuarial methods and statistical models to assess the probability that the applicant will face a covered loss.

Increasing connectivity has greatly increased the availability of risk-relevant data on potential applicants, including new sources of "external data" (i.e., data that may be relevant for assessing the risk of an insurance applicant that is not directly provided by the policyholder) (IAIS, 2020[5]). This includes new (or sometimes improved) sources of earth observation data (e.g., imagery from satellites and drones), data from connected devices (e.g., sensors, wearables) and online media (e.g., publicly-available information on social networks or other websites) - which may be referred to as "observed data" (Noordhoek, 2023[4]):

- *Earth observation:* Innovations in earth observation technologies have greatly increased the range of information and level of granularity available. Technical advances and growing competition in space programs have driven down the costs of satellite imagery, with the price of high-resolution imagery falling almost 50% in the last decade. The technology has also benefited from significant innovation that allows for increased coverage and resolution, improved characterisation of the built environment and enhanced reliability (OECD and ADB, 2020[6]). Earth observation data are also increasingly available from aircraft, particularly unmanned aerial vehicles (or drones) which have also benefitted from innovations that have increased drone range, allowed for higher-resolution geo-coded imagery and reduced costs (OECD and ADB, 2020[6]). A number of technology service providers have developed solutions aimed at supporting the incorporation of earth observation imagery into underwriting and pricing (as well as for loss assessment – see Box 2.1).
- *Connected devices*: The growing network of connected devices provides new sources of (generally) reliable, accurate and cheaply-acquired (Pieroni, 2022[7]) data on the physical parameters of the natural and built environment (with relevance for measuring property insurance risks), activity on the internet (with relevance for cyber insurance) and on the behaviours and lifestyles of health insurance policyholders. The reliability and precision of connected sensors has improved as a result of technological advances (OECD and ADB, 2020[6]). Sensors and monitors

are also increasingly integrated into consumer goods. Smartphones, for example, often include pressure sensors (which can signal weather changes, storm development), proximity sensors, accelerometers (which can signal seismic activity) and health and lifestyle monitoring applications. Smart watches ("wearables") that are connected to smartphones offer increasing levels of data capture and analysis and many wearables incorporate monitors for heart rate, respiration rate, blood oxygen saturation. sleep quality and stress levels among other data points (Blackmore, 2022[8]). Technological advances have also allowed for a greater diversity of devices to communicate with each other without human intervention. The expansion of 5G mobile networks will greatly increase the speed and capacity for information transmission from connected devices.

- *Online media*: The increasing availability of information and images on the internet provides a real-time (and often geocoded) source of data that can be accessed and analysed to complement other sources of data on natural and built environments, network activity, policyholder behaviour and other characteristics. Images and data posted by individuals or corporations on social media (or social networks) and other websites can, for example, provide updated information on impacts of weather events, such as an indication of the number of people or structures affected (with relevance for measuring property insurance risks) or on lifestyle choices that can affect long-term health and susceptibility to illness (with relevance for measuring health insurance risks). The increasing availability of broadband internet connections and access to smartphones should facilitate continued growth in the usage of social networks and availability of online media data (social network users are projected to increase from an estimated 4.59 billion in 2022 to 5.85 billion by 2027 (Statista, 2023[9])).

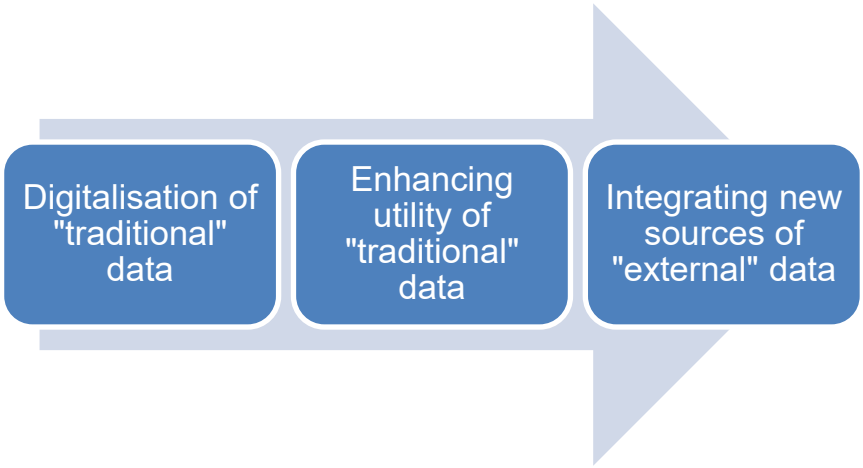
The collection of data from external sources is not completely new to the insurance business model. Insurers have long had access to reference data on the prevalence of certain risk-relevant characteristics (smoking rates, construction standards) and the frequency and severity of losses/claims (e.g., natural hazard damages and losses (including estimates derived through catastrophe modelling), mortality/morbidity, accident rates). However, the amounts of data available and sources of data have increased substantially (EIOPA, 2019[10]; IAIS, 2020[5]; Keller, 2018[11]).

Insurance companies are at different stages in their efforts to leverage data for underwriting and pricing. Some insurers are focused on the digitalisation of "traditional" data (data provided by policyholders and claims data)[7], others are working on improving the utility of traditional data sources (such as through geocoding of address data)[8] while others are investing in supplementing traditional data sources with new external sources of data (see Figure 2.1).

[7] Digitalisation of policyholder data (including claims data) was a priority for technology investment among many of the insurance companies interviewed in Indonesia and Nepal, in particular.

[8] Geocoding involves the matching of address data with geographic latitude and longitude coordinates, which allows insurers to improve location accuracy and also to integrate risk insights from geographic information systems (GIS) (Barth and Wafer, 2023[231]). A number of insurance companies in India and Malaysia indicated that investments in geocoding were being made.

Figure 2.1. Leveraging data for risk assessment and support for risk reduction



Source: OECD

In some jurisdictions, new sources of data are generally being used (where permitted) as a complement to traditional sources of policyholder (provided) data and reference data by increasing numbers of insurance companies and intermediaries. For example:

- An EIOPA survey of 222 motor and health insurance companies and intermediaries from 28 jurisdictions found that traditional data for motor and health insurance underwriting and pricing was being supplemented by online media data and data from connected devices by approximately 20%-23% of responding companies (EIOPA, 2019[10]). A further 13% of responding companies expected to use online media data within three years and 34% expected to use data from connected devices (EIOPA, 2019[10]).
- A survey of 44 insurers and reinsurers by the Central Bank of Ireland (circulated in late 2022) found that all surveyed insurers were using or planning to use “big data and related technologies” in underwriting and pricing insurance coverage, including past loss/claims data and population and demographic data from both internal and external sources - and, to a lesser extent, geo-coded and online media data. Data from connected devices was identified as the data source likely to expand the most in the near future (Central Bank of Ireland, 2023[12]).
- The 2022 OECD survey for this project of insurance companies from across the world found that approximately 65% of the direct (primary) insurer respondents had applied or examined the use of “innovative data sources” such as data from online media or connected devices. For example, one of the insurance companies that responded to the OECD survey for this project is using Application Programming Interfaces (APIs – see Box 2.2) to collect data on insureds’ revenue performance from across various websites as an input to underwriting insurance coverage. Respondents to the OECD survey from North America, Latin America and Asia-Pacific were slightly more likely to examine or apply new data sources than insurers in Europe, and particularly in property, liability and health (rather than life) insurance.
- An NAIC survey on the use of artificial intelligence and machine learning in residential property insurance in 2022-2023 found that some insurers are using various types of imagery (along with analytical techniques based on artificial intelligence and machine learning) for pricing coverage, including hazard detection imagery, defect detection imagery and geospatial imagery – along with supplemental data on the insured, claims experience, hazard exposure and roof condition (amongst others) (NAIC, 2023[13]).

Box 2.1. Incorporating earth observation imagery into property insurance underwriting and pricing

A number of companies have developed data services and platforms for incorporating earth observation and other sources of external data into property insurance underwriting and pricing. Some companies are focused on creating and providing imagery from specific sources (satellite, airplane, drone or balloon) (Near Space Labs, n.d.[14]; Nearmap, 2022[15]) which can be used to assess roof condition and building or property characteristics. Some companies provide imagery from multiple sources and integrate it with data on property characteristics, catastrophe risk exposure and/or historical losses from other sources such as public databases as well as other third party data providers (Addresscloud, 2023[16]; Arturo, 2021[17]; Betterview, 2023[18]; CAPE Analytics, 2023[19]; LightBox, 2023[20]; TensorFlight, n.d.[21]; WhenFresh, 2023[22]). At least one company is offering a platform to allow insurers to incorporate imagery from different sources into insurance functions (including underwriting) (Geosite, n.d.[23]). Many of these technology service providers integrate analytical techniques based on artificial intelligence and machine learning (see next section) to extract relevant data from available imagery, derive risk scores for individual properties and also facilitate renewals and loss adjustment through change detection analytics. One company, for example, is using machine vision and deep learning to extract 3D models of property attributes and assign risk scores based on those characteristics (GeoX Analytics, n.d.[24]). One provider has estimated that the integration of data from earth observation and other sources combined with change detection analytics has improved pricing accuracy by 20% (Arturo, 2021[17]).

Some of the devices that provide new sources of data can also contribute directly to risk reduction (Hogarth, 2022[25]). For example, connected devices such as water sensors can be used to identify sudden increases in water use that could indicate a leak or the presence of water in locations where it should not be - whether as a result of a water leak or external water infiltration (Cooper, 2022[26]; Notion, 2022[27]). Early detection of potential water damage can reduce the eventual repair cost and some sensors have the capability to turn off the water source causing the leak (Notion, 2022[27]) and/or disable the water supply (StreamLabs, 2023[28]). One insurance company in the United States is offering connected water sensors to its household property insurance policyholders with a discount on the cost of the device and a reduction in premiums (Insurance Journal, 2022[29]). Another company (owned by an insurance company) has developed a leak and freeze detector for installation in commercial and residential buildings that monitors for water leaks, frozen pipes, temperature changes and humidity and provides alerts to policyholders through a mobile app (HSB, 2023[30]; Meshify, 2022[31]). Another provides water sensors to monitor for leaks at building sites as a service tied to its insurance coverage (Insight Risk, 2021[32]). Connected devices are also being used to detect and notify irregularities in electrical voltage (Miller, 2023[3]). One insurance company in the United States offers all of its household property policyholders a free smart plug that provides continuous monitoring of electrical hazards in the home (State Farm, 2023[33]). In Poland, insurance companies are testing solutions that incorporate sensors that measure whether an object is in need of repair. Similarly, data from wearables such as fitness trackers can be used to provide rewards or premium discounts to incentivise healthy behaviour (see Box 2.5). In India, one insurance company has been involved in the development of a fall detection sensor that can be added to a wearable device and will trigger a notification to a help desk in case of a fall.[9] While not a focus of this report, the use of connected devices in motor vehicles (telematics) allows for the provision of incentives for safe driving (as well as the establishment of usage-based premiums).

The increasing use of analytics based on artificial intelligence and machine learning is also a driver of demand for external data as the amount of data available internally at many insurance companies is

[9] Author's interview with an Indian insurance company (29 May 2023).

insufficient to support the data needs for training artificial intelligence and machine learning models (Beal, 2019[34]). A survey of the largest US insurance companies published in 2019 found that 82% of the companies that had integrated artificial intelligence or machine learning into their operations had purchased or were planning to acquire external data to support their use of artificial intelligence or machine learning (Beal, 2019[34]).

Box 2.2. Data sharing and integration: the role of APIs

Application Programming Interfaces (APIs) provide a means to access and integrate data from a variety of sources using a common protocol and allow different software applications to communicate with each other. The use of APIs can greatly facilitate the ability of insurance companies to leverage artificial intelligence, machine learning and cloud computing capacities by automating the flow of different types of data for processing.

The use of APIs in the insurance sector is growing although reportedly remains below levels in other financial services sectors (Gasc, 2020[35]). Some insurance companies (particularly "insurtech" companies) have integrated APIs into their processes, with a particular focus on facilitating distribution and electronic placement (Insurance Journal, 2020[36]; Sclafane, 2017[37]). Other potential applications of APIs could include more efficient claims processing through automated integration of location data and imagery as well as improved risk assessment and product customisation through the integration of new data sources (Value Momentum, n.d.[38]).

New analytical tools based on artificial intelligence or machine learning for risk assessment and supporting policyholder risk reduction

Analytical tools such as actuarial methods, statistical models and catastrophe models provide insurers with an ability to estimate the probability that policyholders will face an insured loss and take decisions on whether to provide coverage, insured limits to apply, the premium to charge and the amount of capital to set aside to ensure sufficient capacity to pay all claims.

New analytical tools, and particularly techniques made available as a result of developments in artificial intelligence and machine learning, provide new approaches to assessing risk and pricing coverage. Artificial intelligence and machine learning can provide insurers with underwriting and pricing models that: (i) have the ability to efficiently analyse different types of structured and unstructured data (such as sensor data, audio, images, emails, and online media data using image analysis or computer vision, speech-to-text conversion and natural language processing techniques); and (ii) can identify complex interactions that may be difficult for a (human) underwriter to detect (Bank of England and Financial Conduct Authority, 2022[39]; Cooper, 2022[26]; Davis, 2019[40]; EIOPA Consultative Expert Group on Digital Ethics in Insurance, 2021[41]; Eling, Nuessle and Staubli, 2022[42]; Keller, 2020[43]; Noordhoek, 2023[4]; Spry, 2022[44]). Underwriting and pricing models that incorporate machine learning (or deep learning)[10] can continually self-adjust to optimise the model as new data are incorporated[11] (Noordhoek, 2023[4]; Sharma, 2022[45]; Smith, 2020[46]). Analytical tools based on artificial intelligence and machine learning can provide insurance

[10] Machine learning involves the use of algorithms that can learn from data without relying on rules-based programming. Deep learning is a subset of machine learning composed of algorithms that permit software to perform tasks, like image recognition, by exposing multilayered neural networks to vast amounts of data (Beal, 2019[181]).

[11] Machine learning models can also provide insurers with an ability to offer real-time or dynamic pricing based on data collected from connected devices (Eling, Nuessle and Staubli, 2022[42]).

companies with improved abilities to leverage increasingly available external data along with provided data and reference data for the purposes of improving risk assessments, underwriting and pricing (Cooper, 2022[26]). The increasing amounts of data available to insurers and improvements in the ability of insurers to leverage that data can improve accuracy in underwriting and pricing and allow insurers to increase pricing differentiation for policyholders facing varying levels of risk.

Data on the use of artificial intelligence and machine learning in insurance suggest a significant uptake in many countries. In the United States, a survey of the largest 100 insurers published in 2019 suggested that 44% had applied artificial intelligence into their operations, 39% were piloting the use of this technology and 42% had approved artificial intelligence or machine learning projects planned for commencement within 12 months (approximately 38% were, at the time, considered non-adopters) (Beal, 2019[34]). A 2021 survey by the National Association of Insurance Commissioners (NAIC) found that 87.6% of private passenger motor insurers used, planned to use or were exploring artificial intelligence or machine learning (NAIC, 2022[47]). A 2022-2023 NAIC survey found that 70% of large residential property insurers used, planned to use or were exploring the use of artificial intelligence and machine learning (NAIC, 2023[13]). In Europe, an EIOPA survey in 2018 found that 31% of surveyed health and motor insurers were actively applying artificial intelligence or machine learning and 24% were experimenting with these technologies (EIOPA, 2019[10]). A 2022 survey by the *Istituto per la vigilanza sulle assicurazioni* (IVASS) of insurance companies operating in Italy found that 27% were making use of machine learning in processes with direct impacts on customers (Vergati, Rositano and Laurenza, 2023[48]). Regulators and supervisors from other countries that responded to the OECD questionnaire also indicated that insurers were applying advanced analytical tools such as artificial intelligence and machine learning (e.g., Japan, South Africa, United Kingdom).

The use of analytics based on artificial intelligence and machine learning appears to be higher in motor vehicle and life and health insurance. The IVASS machine learning survey found that, among those that were using machine learning, 42.8% were using it in motor insurance, 12.8% in health insurance (and 3.9% in long-term care insurance) while only 8.6% were using it in home insurance (Vergati, Rositano and Laurenza, 2023[48]). Similarly, a survey of the largest 100 US insurance companies found that the companies adopting artificial intelligence were applying it mostly to motor (68%) and life insurance (65%) (Beal, 2019[34]). The OECD's survey for this project of (re)insurance companies and intermediaries from around the world also found higher usage of (or interest in) applying these technologies to life and health insurance lines of business relative to property insurance (59.3%, 57.8% and 49.5%, respectively – information on usage in motor insurance was not requested).

There is also some data on the extent to which insurance companies are specifically incorporating analytics based on artificial intelligence or machine learning into underwriting and pricing:

- EIOPA's 2018 survey on the use of artificial intelligence by motor and health insurers and intermediaries found that just under 11%[12] were applying big data analytical tools such as artificial intelligence and machine learning to underwriting and pricing (EIOPA, 2019[10]);
- The survey of the top 100 US insurance companies across lines of business in 2019 found that approximately 58%[13] had applied or planned to apply artificial intelligence and machine learning to underwriting and pricing (Beal, 2019[34]);
- The 2021 NAIC survey of large insurers providing retail (private passenger) motor vehicle insurance coverage found that approximately 18% of respondents had applied artificial intelligence

[12] According to the study, 31% of all respondents were applying artificial intelligence or machine learning, of which 35% were applying these tools to pricing and underwriting (EIOPA, 2019[10]).

[13] The study classified 62% of the surveyed insurance companies as adopters (defined as those applying, piloting or planning artificial intelligence or machine learning initiatives) and found that 93% of adopters are focused on applications in underwriting (Beal, 2019[34]).

or machine learning to underwriting and 27% to pricing - while a further 13% had underwriting and pricing applications under development (NAIC, 2022[47]). The 2022-2023 NAIC survey of large insurers providing residential property insurance found that 67% of companies were applying artificial intelligence and machine learning in underwriting and 50% in pricing (while a further 15% were actively examining the application of artificial intelligence and machine learning to underwriting and 11% to pricing). In addition, just under 21% for of the surveyed companies were applying this technology to loss prevention, including 9% that were using artificial intelligence and machine learning to provide risk mitigation advice (NAIC, 2023[13]).[14]

- The 2022 IVASS survey on the use of machine learning by insurers operating in Italy (across lines of business) found that approximately 4% were applying machine learning to pricing and 3% to underwriting (Vergati, Rositano and Laurenza, 2023[48]).
- Responses to the 2022 OECD questionnaire circulated for this project found that approximately 49% of the 149 direct (primary) insurers that responded to the survey had examined or applied advanced analytical tools such as artificial intelligence for improving underwriting assessment (with higher levels of adoption in North America and Europe and, as noted above, among life and health insurance companies).

There are numerous applications of analytics based on artificial intelligence and machine learning across lines of business, including in property, cyber and health insurance:

- As outlined in Box 2.1, analytics based on artificial intelligence and machine learning are being used to extract risk-relevant data and generate risk scores from earth observation imagery and other sources of data on hazards and property characteristics. Insurers are also applying these types of analytics to identify weather patterns in (parametric) insurance coverage of natural catastrophe risks;[15]
- A number of insurance companies are using artificial intelligence and machine learning to analyse various types of health records to identify factors that could lead to hospitalisation or the development of critical illnesses. One insurer in India noted the potential use of artificial intelligence and machine learning to measure health-related criteria such as body mass index, stress levels and hypertension from video imagery[16];
- Cyber insurers are using artificial intelligence and machine learning to continuously monitor Internet Protocol (IP) addresses to assess risk and underwrite coverage (as a complement to other sources of risk data) as well as to provide recommendations for addressing cyber vulnerabilities and ongoing threat monitoring services and alerts (Capgemini, 2020[49]; Coalition, 2023[50]; Corvusinsurance, 2022[51]; CyberCube, 2023[52]; Measured Analytics and Insurance, 2023[53]; Protos Labs, n.d.[54]). At least one cyber insurer is using its continuous monitoring and analytics capabilities to reward policyholders for security improvements with premium credits and/or more favourable terms at renewal (Cowbell, 2022[55]).

The use of cloud computing (see Box 2.3 – as well as APIs – see Box 2.2) is providing greater access to the data and analytical tools provided by third party service providers, including insurtechs, and appears to be an increasingly important tool for implementing advanced analytics (EIOPA, 2019[10]). The OECD survey for this project found that approximately two thirds of (re)insurance companies and intermediaries that responded are examining or applying cloud computing to functions related to risk assessment or supporting policyholder risk reduction, particularly respondents based in Latin America and North America

[14] The NAIC's Big Data and Artificial Intelligence Working Group has also undertaken a survey on the use of artificial intelligence and machine learning in life insurance (Hamilton et al., 2023[100]) although a report on findings was not available at the time of writing.

[15] This example was provided in the response to the OECD regulator survey from the United Kingdom.

[16] Author's interview with an Indian insurance company (29 May 2023).

(by comparison, just over half of European respondents are examining or have applied cloud computing related to these functions). EIOPA's survey of motor and health insurers found that only about a third of the European insurers and intermediaries were making use of cloud computing in their business functions although 32% indicated that they were examining the use of cloud computing and would likely migrate some operations to the cloud within three years (EIOPA, 2019[10]). The IVASS survey in 2022 found similar levels of take-up of cloud computing (37%) among insurers operating in Italy (Vergati, Rositano and Laurenza, 2023[48]). Some insurance companies in India, Indonesia, Malaysia and Nepal are making use of cloud computing although access to cloud services varies and there are differentiated regulatory approaches to cloud computing that may impede the use of cloud services in some jurisdictions. For example, access to large international service providers is limited by a lack of local presence in some countries with data localisation requirements (see below).

Despite the increasing use of cloud computing and the access to third-party underwriting and pricing tools provided through the cloud, many insurers appear to have a preference for internally developed tools. The NAIC surveys of private passenger motor vehicle and residential property insurers found that only 11% and 16% (respectively) actually relied on third party service providers for determining risk pools/rating classes (NAIC, 2022[47]; NAIC, 2023[13]). The survey of the largest 100 US insurers also found that the majority (65%) of those companies adopting artificial intelligence and machine learning technologies preferred to use internally developed applications (only 14% indicated that they are using third party solutions) (Beal, 2019[34]). Some insurers in India, Indonesia, Malaysia and Nepal highlighted the lack of adaptation of third-party tools to local market needs as a barrier to broader use of those tools.

Box 2.3. Providing access to advanced analytical capacities: the role of cloud computing

Cloud computing is transforming the way that society accesses software and hardware (DeStefano, Kneller and Timmis, 2019[56]), providing individuals and businesses with access to on-demand information technology services via the internet, including software, platforms (such as application development platforms) and infrastructure (such as data storage and servers). Among other benefits, the availability of cloud computing services provides greater access to low-cost processing capacity (which is usually needed in the analysis of large data sets (Horst, 2023[57])) and the latest technological developments, while also allowing users to access these services from anywhere with an internet connection.

Cloud computing can provide access for even smaller insurers to software and platforms for core insurance business functions, data for risk assessment and pricing as well as analytical tools based on artificial intelligence and machine learning. There are a number of service providers that offer integrated suites of insurance-specific, cloud-based, software applications for core insurance business processes, including underwriting, policy administration and claims settlement (Duck Creek Technologies, 2023[58]; Guidewire, 2023[59]; Majesco, 2023[60]; socotra, 2023[61]). Most of the service providers also offer additional tools that can be integrated into the platform, including data analytics that can support more accurate underwriting assessments and pricing decisions.

Artificial intelligence and machine learning analytical tools could also be used in automating underwriting and pricing decisions – particularly in "retail" lines of business that usually require lower levels of risk assessment and customisation of coverage (Keller, 2020[43]) (see Box 2.4). Currently, most insurers appear to be using artificial intelligence and machine learning as tools to support or augment underwriting and pricing decisions rather than to directly make such decisions (although automation may be increasing). For example, only 1 of the 193 insurance companies that responded to the NAIC survey on the use of artificial intelligence and machine learning in private passenger motor vehicle insurance in 2021 indicated that these tools were being used to automate decisions (NAIC, 2022[47]). However, the 2022-2023 NAIC

survey of residential property insurers found that almost 26% were using or developing artificial intelligence and machine learning tools to automate decisions on rating class allocation and almost 28% for the purposes of underwriting denials (NAIC, 2023[13]).

Box 2.4. Automated underwriting systems

Insurers companies are implementing different types of tools to automate all or a portion of the underwriting process, particularly for high-volume/low-value (retail) lines of business. These tools range from more simple rules-based systems that use applicant data to determine whether an insurance applicant meets basic criteria for coverage eligibility to more complicated systems that integrate external data and artificial intelligence/machine learning analytics to generate recommendations on coverage eligibility, limits and even pricing. Rules-based systems automate a portion of the underwriting process by filtering insurance applications into applicants that do not meet an insurer's underwriting prerequisites or, alternatively, applicants that should be automatically approved for coverage.[1] Tools that integrate external data and artificial intelligence/machine learning can provide the capacity to automate all elements of the underwriting and pricing process, although are currently only used by most insurers for providing input into underwriting decisions.

The use of automated underwriting systems – and the complexity of the systems used – varies across countries (and individual companies). Some insurers in India, Indonesia, Malaysia and Nepal have automated parts of the underwriting process using rules-based systems, particularly (but not exclusively) insurers that are part of an international insurance group (which sometimes provided automated underwriting solutions for local use). In some countries (particularly Nepal), automation investment is focused on automating agency distribution. In others (particularly India and Malaysia), some insurers are investing in developing (more complex) automated risk scoring and pricing systems. At least one of the insurers interviewed in India has developed an automated underwriting system (for use by agents) that integrates external data and artificial intelligence analytics to price lower value property insurance coverage.

Note: [1] Automated approval for coverage using a rules-based system may only be feasible where coverage and pricing is standardised, such as in countries where some insurance coverage is subject to fixed pricing.

Platforms for providing risk reduction advice

In addition to providing new sources of data, the internet, social networks, and mobile phone apps have also transformed the way information is communicated. The expansion of broadband connections and internet-connected mobile phones is greatly expanding the effectiveness and reach of communication through these channels. These communications tools offer new opportunities to communicate risk information to policyholders, including information on future (or even imminent) hazards as well as on targeted measures to mitigate risk to property, information technology networks or health (EIOPA Consultative Expert Group on Digital Ethics in Insurance, 2021[41]). The proliferation of internet and mobile phone (particularly smartphone) users, combined with increasing broadband and cellular data speeds, can support faster, broader and more effective transmission of risk and risk management information.

The OECD survey circulated for this project found that approximately 44% of (re)insurance companies and intermediaries are examining or have developed dedicated smartphone apps aimed at supporting policyholder risk reduction. Interest in - and development of - these communications tools was highest in Asia-Pacific and Europe and slightly more prevalent among those providing life and health insurance.

These communications tools are being applied in property and cyber insurance to provide risk reduction advice as well as warnings of imminent threats:

- Some property insurance companies (including two respondents to the OECD survey from Asian insurance companies) are using mobile apps and social media alerts to communicate warnings to policyholders of potentially serious weather risks as well as to provide advice on actions that policyholders can take to mitigate losses. One insurance company is leveraging geospatial data to alert policyholders through a mobile app of the potential for flooding based on weather risks in close proximity to their property (Lebrun, 2022[62]). Another company has developed an app to guide homeowners through an inspection of their property to identify risks related to wildfires and possible mitigation actions (FireBreak, 2023[63]). One company in India has developed an app that uses photo imagery of a property and artificial intelligence and machine learning analytics to provide a risk rating as well as tailored recommendations for reducing risk.[17]
- In cyber insurance, mobile apps are being used by at least one insurance company to allow for reporting of a cyber incident and to link policyholders directly with incident response services included with their coverage (Chubb, 2023[64]).

The use of these tools for providing risk reduction advice is increasingly common in health insurance. One survey undertaken in 2020 of insurance companies from around the world found that 35.1% of respondents had implemented a "digital health engagement platform" while 24.5% were actively implementing or planning the implementation of this type of communications tool (dacadoo, 2020[65]). Some insurers in India, Indonesia and Malaysia are offering health and wellness platforms for policyholders and at least one insurer in Nepal is developing this type of service.

The combination of smartphone apps and wearables that can monitor policyholder's physical activities (e.g. steps taken) and health indicators such as heart rate and stress levels allows insurers to offer tailored advice on potential ways to address health and wellness-related risks (OECD, 2023[66]). Some insurance companies (or third party service providers working with insurance companies) are combining data from health records and data from wearables to provide automated advice to individual policyholders, including symptoms assessors and referrals to appropriate care when needed (dacadoo, 2020[65]; OECD, 2023[66]). For example, at least one insurer in Malaysia is offering policyholders that have acquired specific health insurance coverage for diabetes with access to a programme that helps them manage the disease.[18]

Many of the health and wellness platforms are also providing rewards to incentivise healthy lifestyles, such as discounted access to products and services that could promote health and wellness (gym memberships, access to mindfulness apps or funds for the purchase of healthy foods). One programme offered by many insurance companies provides users with points for activities such as reading health articles, walking or going to the dentist (Manulife, 2023[67]). Some insurers are also encouraging healthy behaviour with premium discounts or (higher coverage limits) (OECD, 2023[66]). For example, one Malaysian insurance company has worked on an insurance product for diabetes that would provide premium discounts to policyholders that demonstrate behaviour (such as nutritional choices) consistent with managing the disease.[19] Some of these programmes have integrated dynamic pricing into their health and wellness platforms and vary premiums based on policyholder efforts to follow a healthy lifestyle (as verified through wearable data) (OECD, 2023[66]). An overview of the types of health and wellness platforms offered by health (and life) insurers is included in Box 2.5.

[17] Author's interview with an Indian insurance company (29 May 2023).

[18] Author's interview with a Malaysian insurance company (5 July 2023).

[19] Author's interview with a Malaysian insurance company (6 July 2023).

Box 2.5. Digital health and wellness platforms offered by insurance companies: selected examples

Health (and life) insurers around the world are increasingly providing their policyholders with access to digital platforms aimed at supporting health, activity and fitness, nutrition, and/or wellness and leisure – with either a particular focus on one of these areas or as a package combining these different areas into a single platform. The platforms often involve an initial risk assessment that is complemented by general or tailored advice aimed at supporting healthy lifestyles and addressing specific health risks.

Some of these platforms offer advice (and incentives/rewards) across a number of health areas, such as nutrition, physical fitness and mental well-being. Some focus on specific medical challenges, such as back pain, high blood pressure, diabetes or mental health. For example, one insurance company has developed a web/mobile platform to support policyholders that have acquired a dementia insurance product. The app provides access to cognitive tests (including a test that uses artificial intelligence to assess cognitive capacities using an image of the policyholder's eyes) as well as advice on how to maintain cognitive health.

Source: (OECD, 2023[66])

3 Challenges to technology adoption in insurance for risk assessment and supporting policyholder risk reduction

Technology adoption prerequisites: infrastructure, skills and data access

The capacity of insurance companies to apply emerging technologies in risk assessment and for supporting policyholder risk reduction will depend on a number of broader prerequisite conditions, including the availability of: (i) resilient communication infrastructure; (ii) necessary technical skills; and particularly (iii) sufficient, reliable and quality data and technology.

Resilient communications infrastructure

Reliable broadband and cellular communications networks that provide universal access, including in remote areas, is critical to the application of many emerging technologies for risk assessment and supporting policyholder risk reduction. Widespread internet connectivity and higher smartphone penetration will increase the utility of applying these technologies – for example:

- The availability of earth observation, connected device and online media data and content will be lower in areas with unreliable access to internet and cellular networks or limited smartphone penetration, potentially creating a bias in coverage that favours more developed regions—which could impact the accuracy of analytical tools based on such data.
- The value of cloud computing processing and analytical functions could not be leveraged in areas without a reliable internet connection.

Based on the response to the OECD survey circulated for this project, unreliable communications infrastructure for internet access does not appear to be a major impediment to technology adoption. Only a small minority of respondents (15%) from Asia-Pacific, Latin America and – to a lesser extent, Europe – identified the reliability of communications infrastructure as a challenge for technology adoption.

Technical skills

Many emerging technologies with applications in risk assessment and supporting policyholder risk reduction, particularly those related to the application of artificial intelligence and machine learning, require a high level of technical skills (including both the technology-related skills to develop and integrate new technologies as well as the financial analysis skills needed to apply the outputs to financial management decisions). A lack of necessary technical skills could, in particular, limit:

- The ability to process and analyse large volumes of imagery and/or online media data and content.

- The integration of hazard, exposure and vulnerability data from different sources.
- The development of artificial intelligence and machine learning analytics for the analysis of risk and to support decisions on risk assessment, underwriting, pricing and risk mitigation strategies.

A lack of access to technical skills necessary for the development and implementation of new technologies appears to be a more significant challenge. Over half of the industry respondents to the OECD survey circulated for this project from Asia-Pacific and Latin America identified a lack of technical skills as a challenge (or possible challenge) – which was also identified by 44% of North American respondents and 38% of European respondents. Some of the insurance companies interviewed in India, Indonesia, Malaysia and Nepal confirmed that a lack of skilled workers can be a challenge to applying technology solutions in insurance business functions, including the need to train employees that have traditionally been working manually on how to use digital tools.

Sufficient, reliable and quality data and technology

The ability of insurance companies to apply new technologies to underwriting, pricing and risk reduction depends on their ability to access sufficient, reliable and quality data (whether external or internal). As noted above, the development of analytical tools based on artificial intelligence and machine learning requires large amounts of data to train the algorithms to identify correlations that are relevant to assessing risk.

In many countries, the volume of (reliable) historical data that can be used to train algorithms may be limited - and environments may be evolving - creating the need for dynamic datasets. Data from connected devices or online media may only be available with broad coverage for more recent years. Changing demographics and/or consumer behaviour could make some datasets obsolete. As discussed in the next section, data access might also be restricted by horizontal or insurance-specific legislation, regulation or supervisory requirements (including data protection and privacy, cybersecurity and outsourcing requirements) or by commercial copyright (and licensing costs). There may also be a reluctance among consumers to make data available to insurance companies (a necessary condition in jurisdictions that require consent for data access – see Box 3.1).

Responses to the industry survey suggest that there are challenges related to access to technology and reliable data across regions and lines of business – and these challenges are more significant in some regions and for some lines of business. Lack of access to technology, potentially as a result of availability or licensing costs, appears to be a more significant challenges for (re)insurers in Latin America and Asia-Pacific. Some insurers in Malaysia noted the lack of locally adapted catastrophe models, particularly for assessing the potential (local) implications of climate change. In Nepal, insurers did not generally have access to any catastrophe models for the earthquake, flood and landslide risks common to the country. Some insurers in Nepal noted a lack of reliable options for core insurance software platforms as few (reliable) local vendors existed while foreign vendors provided limited after-sales service to the Nepali insurance market. One company in India noted the need to customise core software platforms to local market practices and conditions which also limited the number of providers.[20] Data localisation requirements might also impede the ability of insurance companies to access services through the cloud if major cloud service providers do not have a local data centre (see below).

A lack of access to data necessary for risk assessment appears to be a significantly greater challenge for (re)insurers in Europe and a somewhat greater challenge for (re)insurers operating in health and liability insurance (as noted below, health data are often subject to a higher level of protection than other types of personal data). However, challenges to data access exist across all lines of business. In Malaysia, for example, some insurers noted the significant cost of obtaining hydrological data, including from

[20] Author's interview with an Indian insurance company (29 May 2023).

government sources. Data inconsistencies or unreliability, including difficulties in interpreting data, appear to be somewhat of a challenge in all regions (particularly Europe, Asia-Pacific and Latin America) and a slightly more significant challenge for (re)insurers active in property insurance and liability insurance. Some insurers in Indonesia noted that frequent errors in manual data entry of past claims had severely limited the utility of this data for underwriting and pricing health insurance.

Box 3.1. Consumer willingness to share data

In most jurisdictions, access to data relevant for underwriting or pricing insurance and in possession of consumers will require the consent of the consumer for sharing that data with the insurer. Subject to data protection and privacy requirements, including lawful purpose and data minimisation requirements (see below), insurance companies may request access to that data although consumers may not have an obligation to share that data. The clearest example of this is the case of connected devices in the possession of the consumer (such as home sensors, wearables, motor vehicle telematics) where consumer are normally not under any obligation to share the data generated by the device with their insurer.

Some consumer surveys have found significant concerns about sharing personal data with insurance companies. For example, a survey of consumers in Asia-Pacific on the willingness to share personal health data with insurers found that a significant share of consumers in Australia (35%), Japan (32%) and New Zealand (29%) would be reluctant to share that type (Swiss Re Institute, 2023[68]) – although the share of consumers in other countries in Asia-Pacific that would be reluctant to share personal health data was lower, ranging from 4% in Viet Nam and 7% in India to 11%-13% in Thailand, Indonesia and Malaysia.

Consumer surveys have generally found that consumer's willingness to share data with insurers depends on: (i) whether they expect to benefit from the sharing of that data (Calvert, 2020[69]); and (ii) trust in the insurer's ability to protect data collected and to be responsible and transparent in the use of that data (Boehm et al., 2022[70]), (Hoad, 2020[71]) (see discussion on building trust below). Multiple surveys of consumer attitudes towards data sharing with insurers have found a high-level of willingness when data sharing is tied to reductions in premiums or other rewards. For example:

- A survey of US health, motor vehicle, life and household property insurance policyholders found that the majority (66%, 75%, 79% and 82%, respectively) would be at least moderately interested in sharing data from connected devices with insurers in exchange for rewards (LaRock, 2019[72]). The survey of consumers in Asia-Pacific found that the share of consumers willing to share such data was much higher when rewards (and to a lesser extent, simpler applications for insurance) would be offered in exchange for data sharing across all of the countries surveyed (Swiss Re Institute, 2023[68])
- A survey of consumers from 12 developed and emerging countries in 2021 found that 72% of individuals would be willing to share personal data with insurers to get cheaper insurance premiums – with a slight preference for sharing data from fitness and health tests (33%), smart home devices (32%), wearables (29%) over social media data (20%) and vehicle telematics (19%) (Webster and Steele, 2021[73]). A survey of consumers in 28 markets found that 69% would be willing to share significant data on their health, exercise and driving habits in exchange for lower prices (Saldanha and Staehle, 2021[74]);
- A more recent (2023) survey of policyholders across 14 jurisdictions in Europe, Asia and North and South America found a slightly lower willingness to share additional personal data with insurers in exchange for lower premiums (only 25% of policyholders in Brazil, 42% in Europe (Belgium, Germany, Italy, Poland, Switzerland, United Kingdom), 43% in Asia-Pacific (Hong Kong, China; Malaysia, Singapore, Thailand) and 47% in North America (Canada, United States) would be willing to share more personal data to receive cheaper premiums (Capco, 2023[75])). This survey also found that consumers appear to be more comfortable sharing certain types of data with insurers (to support personalisation of products or premiums) than others. Consumers in Canada, Germany, Malaysia, Switzerland, the United Kingdom and the United States appear more willing to share data from smart home devices (34%) and wearables (33%)

than social media data (18%) with some differences across countries (consumers in the United States and Malaysia are generally more willing to share this data than consumers in Switzerland and Germany (in the case of smart home devices) and Canada and the United Kingdom (in the case of wearables). Approximately 20% of consumers surveyed in these countries (with the exception of Malaysia for which data was not published) would be unwilling to share any data from connected devices with insurers (Capco, 2023[76]; Capco, 2023[77]; Capco, 2023[78]; Capco, 2023[79]; Capco, 2023[80]; Capco, 2023[81]).

In some countries, insurance companies (or supervisors) have established organisations that provide data services to insurance companies. The Insurance Information Bureau of India (IIB) was initially established by the insurance supervisor (IRDAI) but has since been established as an independent organisation. All insurance companies in India are required to submit data to IIB. IIB leverages the data provided by the insurance companies as well as external sources (such as catastrophe models as well as government databases) to provide data services and analytics to the insurance sector. For example, IIB is able to provide insurers with basic information on vehicle characteristics based on data received from national and state governments and risk information for specific properties based on past claims and modelling tools.[21] Insurance Services Malaysia Berhad (ISM) was initially established by the general insurance association (*Persatuan Insurans Am Malaysia* (PIAM)) but has since been transformed into a separate company. Similar to IIB, ISM collects and aggregates data from its insurance and takaful member companies as well as external sources in order to provide data services and analytics based on this data to support underwriting and pricing of coverage (ISM, 2020[82]).

In some cases, governments are also support the availability of reliable data. For example, in India, the national government has developed a National Health Claims Exchange that leverages a national system of health account numbers (*Ayushman Bharat* Health Account) to digitalise individual health claims across all participating insurers and support more efficient health service delivery and claims processing (Ministry of Health and Family Welfare, 2023[83]). Insurers in India have been encouraged by IRDAI to participate in the exchange (IRDAI, 2023[84]). While not aimed at supporting data for underwriting, the exchange should provide data on individual health records that could also be valuable for underwriting and pricing coverage.

Legislative, regulatory or supervisory requirements that impact technology adoption in insurance

The ability of insurance companies to apply new data sources, analytical tools based on artificial intelligence and machine learning and policyholder risk reduction platforms is impacted by the legislation, regulation and supervisory measures implemented to ensure privacy and data protection, protect against unfair discrimination and support digital security and sound outsourcing arrangements. In some cases, the requirements have been established by insurance regulators and supervisors – in other cases the requirements apply across sectors, including to insurance.

Horizontal and insurance-specific legislation or regulatory requirements applicable to the use of data and analytical techniques based on artificial intelligence and machine learning

The increasing use of data sources and analytical tools based on artificial intelligence and machine learning in underwriting and pricing insurance has implication in terms of compliance with requirements related to privacy and data protection and fair treatment of consumers (including non-discrimination) as well as for

[21] Author's interview with representatives from IIB (29 May 2023).

achieving objectives related to financial inclusion. These risks emerge as a result of three main characteristics of this approach to underwriting and pricing: (i) the collection and use of massive amounts of data, including as input into the training of artificial intelligence and machine learning models, which must be done in compliance with requirements related to the collection and use of data;[22] (ii) the complexity and level of human oversight of models based on artificial intelligence and machine learning which could (inadvertently) lead to disparate impact on protected or vulnerable groups within society and non-compliance with non-discrimination requirements; and (iii) the potential for more accurate risk assessments and pricing decisions to lead to the exclusion of some consumers deemed to be high-risk (whether due to decisions to not provide coverage or premiums that are unaffordable to account for the level of assessed risk). As outlined in section 4 below, mitigating these risks will be critical for building consumer trust in the use of these technologies in insurance.

Data protection and privacy requirements

Generally-applicable data protection or privacy requirements exist in many jurisdictions and are applicable to the operations of insurance companies, including where data are collected and used for the purpose of underwriting and pricing insurance coverage. While there are differences across jurisdictions, data protection and privacy legislation generally imposes obligations on those collecting and using data to ensure that there is a lawful basis for data collection and use and that the amount of data collected is limited to a specific and specified purpose, proportionate to that intended purpose and kept confidential and subject to time limitations. There are also usually obligations to ensure the integrity and/or accuracy of data used and to provide transparency on collection and use to those providing their data – who will also need to be offered an opportunity to provide consent to the collection and use of their data. Data protection and privacy protection requirements usually apply to the collection and use of "personal information" which generally refers to information that relates to an identifiable (natural) person and allows for the identification of that individual. As a result, these requirements likely have a more significant impact on data collection and use in lines of business that involve underwriting insurance coverage for individuals or households (including household property and health insurance lines). Stricter (or specific) protections apply to the collection and use of health-related data in some jurisdictions. For example, in the United States, the *Health Information Portability and Accountability Act* (HIPAA) sets national standards for the protection of medical records and health information for identifiable individuals and the *Health Breach Notification Rule* (HBNR) establishes requirements for the notification of breaches of other types of personal health data (i.e., outside the scope of HIPPA). The US Federal Trade Commission has recently proposed changes to the HBNR to ensure that health data collected through health and wellness apps are included within the scope of these requirements (Loughlin, Golay and Oké, 2023[85]).

The collection and use of data subject to privacy protections can potentially expose (re)insurers and intermediaries to compliance risks if data collection or use is inconsistent with its original purpose, if the collected data is disclosed to an unauthorised third party (whether inadvertently or through theft) or if other legislative requirements are not met. Some data that are available to insurance companies (e.g., online media activity or data from wearables[23]) might be unreliable or erroneous which could risk non-compliance with requirements related data reliability and accuracy (EIOPA Consultative Expert Group on Digital Ethics in Insurance, 2021[41]). In addition, insurance companies that make use of datasets provided by third parties may also face legal or regulatory risk if the third party's collection and use of data fails to meet the

[22] For example, a number of investigations and legal actions involving OpenAI's generative artificial intelligence tool (Chat GPT) have been initiated alleging non-compliance with privacy (and copyright) laws in the collection of massive amounts of data for training the tool (Allnut and Hardy, 2023[232]).

[23] For example, data collected from wearables could potentially be manipulated by the provider, as there is no way to validate that the data belongs to a specific person or that the data are representative of long-term habits (Blackmore, 2022[8]).

requirements of data protection and privacy legislation (see the section below on digital security and outsourcing requirements).[24] A failure to comply with data protection and privacy requirements or to safeguard information that is collected could lead to fines and penalties under privacy legislation or regulation, lawsuits as well as significant reputational harm (Cooper, 2022[26]).

According to UNCTAD, 71% of countries have enacted data protection and privacy legislation (including all OECD member countries) while a further 15% have developed draft legislation (UNCTAD, 2021[86]). India, Indonesia, Malaysia and Nepal have all passed horizontal legislation on privacy and the protection of personal data (although the legislative requirements in Indonesia[25] and India[26] have not come into effect at the time of writing).

In a few jurisdictions, insurance-specific legislative or regulatory requirements related to data protection and privacy have been established for insurance companies (or for financial institutions more generally). For example, Bank Negara Malaysia has published a policy document on the *Management of Customer Information and Permitted Disclosures* that sets out requirements and expectations for the handling of customer data, including data protection requirements and permissible disclosures (applicable across the financial sector) (Bank Negara Malaysia, 2023[87]). In Chile, India, Indonesia, Japan, Malaysia and Mexico, supervisors have included requirements related to the protection of data collected from policyholders as part of the requirements applicable to digital security standards and/or guidelines on outsourcing (see below). In India, Indonesia and Mexico, specific data protection requirements or affirmation of existing requirements have been incorporated into legislative or regulatory frameworks establishing regulatory sandboxes.

In some jurisdictions, insurance regulators or supervisors have developed (or are developing) specific data protection requirements for insurance companies, either as additional requirements or for the implementation of requirements established in non-insurance legislation or regulation. For example, in the United States, the National Association of Insurance Commissioners (NAIC) has developed model acts related to privacy protection for implementation by state insurance supervisors. The NAIC's Privacy Protections Working Group is currently reviewing existing model acts (*Insurance Information and Privacy Protection Model Act* and the *Privacy of Consumer Financial and Health Information Regulation*) and has developed a draft *Consumer Privacy Protections Model Law* to consolidate and replace existing model acts (see Box 3.2).[27]

[24] For example, Fitbit (provider of wearables) is reportedly the subject of a number of privacy complaints in Europe as a result of allegations that the company is transferring personal data outside of Europe without users' free and informed consent (Lomas, 2023[233]).

[25] Data protection and privacy protection legislation has been in place since 2008 (*Law No. 11/2008 on Electronic Information and Transactions*) with further requirements enacted in 2012 and 2019. In 2022, the *Personal Data Protection* law was enacted with a two-year transition period for compliance with the new requirements (DLA Piper, 2022[234]) (i.e., obligations not included in earlier legislation).

[26] The *Digital Personal Data Protection Act* was passed in August 2023 and the Government of India has reportedly indicated that the legislation will come into effect within 10 months from the date that it was passed (Mathias, 2023[138]).

[27] The same committee is also developing a white paper examining data ownership and use rights that will include an examination of how personal data are collected, used and processed in insurance transactions as well as potential recommendations on data ownership (Bannigan et al., 2022[190]), (Alberts et al., 2022[195]).

Box 3.2. NAIC's draft *Consumer Privacy Protections Model Law*

The NAIC Privacy Protections Working Group published an initial draft *Consumer Privacy Protections Model Act* in January 2023 aimed at improving protection of consumer data collected and used by insurance companies and consolidating requirements related to privacy protection from existing model acts and other state and federal legislation (Holland et al., 2023[88]). The initial draft model act introduced some changes from existing requirements, including the incorporation of third-party service providers into the scope of the requirements, a prior consent requirement for cross-border data transfers, new notification requirements, data minimisation and deletion requirements and a private right of action for consumers who suspect that their data have been used in ways inconsistent with the requirements (amongst other changes) (Alvarez et al., 2023[89]; Baysinger et al., 2023[90]; Holland et al., 2023[88]; Pruitt et al., 2023[91]). The draft was discussed with stakeholders at the NAIC Spring Meeting and was subsequently revised to address some of the concerns raised.[1] A further discussion was held on a revised version of the draft Model Act in August 2023 which led to further changes and a consultation on the next iteration (Hamilton et al., 2023[92]). At the 2023 Fall National Meeting, NAIC members discussed the process for moving forward with drafting of the new Model Law.

Note: [1] Stakeholders reportedly raised concerns related to many of the new requirements introduced, including the consent requirements for cross-border data transfers, the obligation for insurers to ensure compliance among third-party service providers and the potential for overlap and/or inconsistency with other regulatory requirements such as *the Health Insurance Portability and Accountability Act* (Baysinger et al., 2023[90]; Holland et al., 2023[88]; Pruitt et al., 2023[91]).

Anti-discrimination requirements

Many jurisdictions have generally-applicable anti-discrimination laws aimed at protecting against discrimination on the basis of race, gender, nationality, ethnic origin, religion, sexual orientation and/or other factors. These protections often apply to a wide-variety of economic and social activities, such as access to employment, housing or education as well as to the offering of goods or services by businesses – including for the provision of insurance coverage. In practice, these requirements mean that the protected characteristics cannot be taken into account in decisions on whether to offer a good or service that is generally available to the public nor in determining the price of the good or service. For insurers, this means that data on protected characteristics cannot be taken into account in decisions on whether to offer coverage or as rating factors for pricing premiums. Similar to the case of privacy and data protection, insurance companies that do not meet the obligations imposed by anti-discrimination legislation could face fines and penalties and reputational damage.

The list of protected characteristics (or protected groups) varies across different countries and may apply in specific ways to insurance underwriting and pricing. For example, exceptions on the use of some characteristics may apply in some jurisdictions for characteristics that have a clear impact on risk levels in some lines of insurance business.[28] Some jurisdictions may apply an expanded list of characteristics that cannot be applied to insurance underwriting and pricing decisions.[29] In others, certain factors may only be

[28] For example, in Europe, age and disability can be used as risk factors for underwriting some types of insurance coverage in some jurisdictions (EIOPA Consultative Expert Group on Digital Ethics in Insurance, 2021[41]).

[29] For example, many European jurisdictions do not allow pregnancy or maternity to be a factor in determining the cost or available limits of insurance coverage offered. Many US states do not allow the use of credit scores as a rating factor for some lines of business.

used in underwriting or pricing with justification.[30] Some countries do not apply any specific restrictions on the use of certain characteristics or data in underwriting and pricing and rely on more general requirements related to fair treatment of consumers.[31] For example, in Indonesia, the requirements related to the business operations of (re)insurance companies and sharia (re)insurance companies impose an obligation to implement principles of balance, justice and universality (OJK, 2016[93])while requirements on insurance products and product distribution include a principle that premiums not be applied in a discriminatory manner (OJK, 2015[94]).

A number of jurisdictions impose restrictions on the use of some types of health-related information in underwriting and pricing health (and sometimes other types of) insurance coverage. Many jurisdictions do not allow insurers to request the results of genetic testing or require genetic testing as a condition for accessing some or all forms of health and/or life insurance coverage (e.g., Canada, Costa Rica, Denmark, Germany[32], Lithuania, Switzerland, United States[33]) (EIOPA Consultative Expert Group on Digital Ethics in Insurance, 2021[41]; IAIS, 2020[5]). In some countries, the use of certain types of data on health conditions (particularly in the context of cancer survivors) is limited for life and health insurance underwriting or pricing credit insurance in order to facilitate the financial inclusion of vulnerable groups (e.g., Belgium, France, Luxembourg, Netherlands, Spain) (EIOPA Consultative Expert Group on Digital Ethics in Insurance, 2021[41]). In the European Union, a proposed *European Health Data Space Regulation* outlines requirements for the use of health data in artificial intelligence systems and digital health applications, although prohibits the use of this data for taking decisions that are detrimental to a natural person, including for excluding natural persons from insurance benefits or modifying insurance premiums (Gallego, Ramón Robles and Baron, 2023[95]).

A challenge in implementing these requirements in insurance underwriting and pricing is the potential for protected factors to be highly correlated with other risk factors (often referred to as “proxy discrimination”). For example, data on location will be very relevant for underwriting and pricing coverage for natural hazard risks although location data could also be highly correlated with protected characteristics such as ethnic origin or nationality (for example, if a protected group accounts for a disproportionately high share of the population in a given neighbourhood) (Cooper, 2022[26]). This type of discrimination, even where the outcome is similar to discrimination based on a protected characteristic, may be permissible if premium differentiation can be objectively justified by a legitimate aim and the means of achieving that aim are appropriate and necessary (EIOPA Consultative Expert Group on Digital Ethics in Insurance, 2021[41]) (i.e., charging higher premiums to a risk pool that includes a high proportion of individuals with protected characteristics could potentially be justified by the higher exposure to natural hazard risk within the pool).

Managing risks related to unlawful discrimination may be simpler when using underwriting and pricing models with controlled data inputs and simple/explainable rules for pricing based on inputted data. Data on protected characteristics can be excluded as data inputs and the calibration of rating factors can be controlled to limit the potential for protected characteristics to have explanatory power in outcomes.

The use of large amounts of data and more complex analytics may make it more difficult for insurance companies to ensure that protected characteristics are not a factor in underwriting and pricing decisions –

[30] For example, in New Zealand, any use of gender as a rating factor must be justified by statistical analysis.

[31] India, Indonesia, Malaysia and Nepal do not apply restrictions on the use of certain characteristics or data in underwriting and pricing insurance coverage.

[32] The restriction on requesting genetic testing in Germany does not apply to life insurance, occupation disability insurance or long-term care insurance that offer benefits greater than EUR 300 000 or EUR 30 000 per year (IAIS, 2020[5]).

[33] The restriction is applicable to health insurance on a national basis and to some other forms of insurance such as long-term care, life and disability insurance in some states (IAIS, 2020[5]).

particularly where the analytical model has significant flexibility in designing the underwriting or pricing algorithm (EIOPA Consultative Expert Group on Digital Ethics in Insurance, 2021[41]). Machine learning (particularly unsupervised machine learning or deep learning)[34] may pose particular challenges as the "machine" is responsible for designing and adjusting the model. Some artificial intelligence systems are capable of finding multi-variable, non-linear correlations in the training data that could potentially replicate protected information in a manner that is not obvious for the human programmer (commonly known as the "black-box" effect). In addition, discrimination based on (or linked to) protected characteristics may occur if the data used to train the model: (i) include data on protected characteristics; (ii) include variables that are highly correlated with protected characteristics; or (iii) if the dataset is labelled in a way that reflects biases or if the data collected are not representative of the entire population (EIOPA Consultative Expert Group on Digital Ethics in Insurance, 2021[41]).

Insurance regulators and supervisors that responded to the OECD survey circulated for this project identified unfair discrimination and unfair treatment of customers as a key area of focus for regulatory and supervisory attention. Some respondents noted that insurance regulators and/or supervisors had contributed to the development of some of the general-purpose principles or legislation for the application of artificial intelligence by companies across sectors (such as the proposed *EU Artificial Intelligence Act* (see below)). A few have also developed (or are developing or considering) additional guidance or requirements related to the application of artificial intelligence:

- Financial regulators in the United Kingdom published a discussion paper on *Artificial Intelligence and Machine Learning* in October 2022 that examines the application of existing legal requirements to artificial intelligence and seeks feedback on whether there is a need for additional guidance or regulation to support safe and responsible artificial intelligence adoption across UK financial markets (Bank of England and Financial Conduct Authority, 2022[39]).
- In Germany, BaFin has issued *Principles for the use of algorithms in decision-making processes* that cover issues such as clear management responsibility, appropriate risk and outsourcing management, preventing bias and eliminating unlawful differentiation of customers (BaFin, 2021[96]).
- The US National Association of Insurance Commissioners has adopted *Principles on Artificial Intelligence* (NAIC, 2020[97]) and a *Model Bulletin on Use of Algorithms, Predictive Models, and Artificial Intelligence (AI) Systems by Insurers*. The model bulletin, approved at the 2023 Fall National Meeting, establishes a set of principles for insurers to implement in terms of the governance, risk management and internal controls to be applied to "artificial intelligence systems", including in terms of compliance with existing legislative requirements - as well as an approach to regulatory oversight to be applied by state insurance regulators (Dobecki et al., 2023[98]; NAIC, 2023[99]). The requirements apply to artificial intelligence systems implemented by both insurers and third-party service providers. The NAIC has also established various working groups that are examining issues related to the use of artificial intelligence and machine learning in insurance:
    - The Big Data and Artificial Intelligence Working Group has undertaken surveys on the use of artificial intelligence and machine learning in private passenger motor vehicle, household property and life insurance. The Working Group has also developed a draft set of *Model and Data Regulatory Questions* for use by state supervisors in examining the use of models (insurer models and third-party models) based on artificial intelligence and machine learning (Baysinger et al., 2023[90]), (Hamilton et al., 2023[100]). The Working Group is also collaborating

[34] The development of machine learning models can be based on different techniques that incorporate varying levels of human oversight and machine autonomy, including supervised learning, unsupervised learning, semi-supervised learning, reinforcement learning, and even deep learning – as well as combinations of these techniques such as a combination of reinforcement learning with deep learning (referred to as deep reinforcement learning) (Sharma, 2022[45]).

with third parties (such as academics) on the development of a dataset that could be used for testing for unfair bias (Pruitt et al., 2023[91]).

- The Casualty Actuarial and Statistical Task Force developed a white paper on *Regulatory Review of Predictive Models* to support regulators in reviewing premium rate filings based on the application of predictive models and accelerated underwriting programmes [35] in life insurance, including compliance with existing laws (Casualty Actuarial and Statistical (C) Task Force, 2020[101]).
- The Accelerated Underwriting Working Group has issued draft guidance to support regulatory review of life insurers' accelerated underwriting programmes with a focus on ensuring transparent and reliable data inputs, the application of sound actuarial principles, avoidance of unfair discrimination and transparency on the reasons for adverse underwriting decisions (Hamilton et al., 2023[102]).

- A number of individual US states have also imposed requirements or issued guidance applicable to the use of artificial intelligence and machine learning in insurance:
  - The State of Connecticut Insurance Department issued an (updated) *Notice concerning the usage of big data and avoidance of discriminatory practices* that is aimed at reminding insurers of their obligation to comply with anti-discrimination laws when using "big data"[36] in insurance business activities and includes an overview of the type of information that may be requested in supervisory reviews of big data usage (State of Connecticut Insurance Department, 2022[103]).
  - The California Insurance Commissioner issued a *Bulletin on Allegations of Racial Bias and Unfair Discrimination in Marketing, Rating, Underwriting, and Claims Practices by the Insurance Industry* that aims to re-affirm the obligation of insurance companies to ensure that their use of predictive analytics tools such as artificial intelligence does not inadvertently lead to underwriting or pricing (or claims) decisions that are discriminatory based on protected classes of information related to individual characteristics (Lara, 2022[104]).
  - In the US state of Colorado, legislation passed in 2021 (SB21-169) prohibits insurers from unfairly discriminating against any individual based on "individual's race, color, national or ethnic origin, religion, sex, sexual orientation, disability, gender identity, or gender expression" in insurance practices or using any "external consumer data and information source, algorithm, or predictive model" that results in discrimination based on those characteristics (Colorado General Assembly, 2021[105]). The legislation required the Colorado Insurance Commissioner to develop guidance on how insurance companies offering different classes of insurance can demonstrate compliance with this legislative requirement. In September 2023, the Colorado Division of Insurance issued a regulation outlining *Governance and Risk Management Framework Requirements for Life Insurers' use of External Consumer Data and Information Sources, Algorithms, and Predictive Models* including a governance framework and documentation and reporting requirements as well as a requirement for insurers to test whether their use of external data or analytics based on artificial intelligence has led to unfair discrimination (Baysinger et al., 2023[106]).

[35] According to the NAIC, accelerated underwriting programmes refers to "the use of big data, artificial intelligence, and machine learning to underwrite life insurance in an expedited manner" (NAIC, 2022[220]).

[36] The notice includes a number of examples of "big data" sources, including "consumer intelligence, social media, credit and alternative credit information, retail purchase history, geographic location tracking and telematics, mobile, satellite, behavioral monitoring, psychographic/biographic/demographic/firmographic data, sensors, wearable devices, RFID, etc".

Box 3.3. The use of analytics for price optimisation, price walking and differential pricing

Analytical tools based on artificial intelligence and machine learning can be used to provide insurance companies with insights into the "price elasticity" of policyholder demand for coverage and the likelihood that policyholders will compare different providers and coverage options when renewing their coverage. Insurance companies could potentially use these insights to charge higher premiums upon renewal to policyholders unlikely to change providers (a practice known as "price walking"). While the practice of setting prices based on willingness-to-pay is common across industries, the application of this type of price optimisation or differential pricing is counter to the principle of actuarial fairness (i.e., that policyholders facing the same level of risk are charged the same premium). The practice might also penalise vulnerable groups with more limited access or capacity to undertake price comparison (EIOPA, 2023[107]).

A number of regulators and supervisors have taken steps to mitigate the potential for unfair outcomes as a result of price optimisation, price walking and/or differential pricing:

- In the United States, price optimisation practices (although defined in different ways) have been prohibited by at least 20 individual state regulators (as of 2016) (Cotter, 2016[108]);
- In the United Kingdom, the Financial Conduct Authority undertook a market study on general insurance pricing practices which led to rule changes to introduce a price remedy that aims to mitigate the impact of price walking on consumers (FCA, 2021[109]);
- In the European Union, EIOPA issued a supervisory statement in 2023 aimed at clarifying supervisory expectations in the implementation of requirements to treat costumers fairly as well as in implementing the Product Oversight and Governance requirements included in the *Insurance Distribution Directive* with the aim of preventing unfair differential pricing practices that are detrimental to consumers (EIOPA, 2023[107]).

Financial exclusion

While not strictly unlawful discrimination, to the extent that the use of new data sources and analytical tools based on artificial intelligence and machine learning lead to improved accuracy in risk assessment and pricing, some consumers deemed to be at high-risk could face unaffordable premiums or limits on the availability of insurance coverage (Cooper, 2022[26]). Increasing granularity and accuracy in risk assessment may ultimately reduce the mutuality element of the insurance business model as every policyholder's contribution to the insurance pool will increasingly equate to their withdrawals from the insurance pool to pay claims. Financial exclusion could also potentially be exacerbated if the use of these tools leads to the inclusion of rating variables that are correlated with characteristics of vulnerability as vulnerable groups are less likely to have the capacity to absorb model-driven increases in the cost of insurance coverage.

However, there is also the potential for improvements in risk assessment to have a positive impact on the availability of affordable insurance for high-risk consumers – such as consumers with a severe disease or facing high risk of flooding (IAIS, 2020[5]) or even those with a predisposition to a severe illness based on family medical history.[37] This may particularly be possible where policyholder mitigation actions can be observed and integrated into underwriting and pricing. For example, new drivers who might normally be

[37] For example, a life or health insurance applicant may need to provide information on serious illnesses in their family to which they may be pre-disposed, which could lead to their exclusion from eligibility for insurance coverage. Genetic testing could be used to confirm an applicants' susceptibility to that illness – or demonstrate that the applicant is unlikely to develop the illness and therefore make them eligible for coverage (Baggs, 2021[235]).

considered higher-risk might be able to demonstrate low-risk driving habits through the installation of a telematic sensor in their vehicle. (EIOPA Consultative Expert Group on Digital Ethics in Insurance, 2021[41]). Similarly, an individual with a serious health condition that would normally lead to higher health insurance premiums (e.g., Type 2 diabetes) might be able to demonstrate healthy behaviours by sharing data from a wearable device with their insurer (EIOPA Consultative Expert Group on Digital Ethics in Insurance, 2021[41]). That said, both of these examples involve a cost to the policyholder (installation and use of a connected device) and would require a willingness to share data from the device with the insurer (see Box 3.1) (EIOPA Consultative Expert Group on Digital Ethics in Insurance, 2021[41]; IAIS, 2020[5]).

There is limited data on whether the use of external data and analytics based on artificial intelligence have led to higher premiums for high-risk policyholders and/or financial exclusion. EIOPA's review of the use of external data and artificial intelligence and machine learning in motor and health insurance in 2019 did not find significant levels of financial exclusion of high-risk consumers, although the impact was expected to increase in the years to come (EIOPA, 2019[10]). Examinations of this issue in other lines of business have found some connection between the use of more granular risk assessment and increases in premiums in household property insurance (for example, in the case of flood insurance pricing in Northern Australia (Australian Competition and Consumer Commission, 2018[110])).

Some of the insurance regulator and supervisor responses to the OECD survey circulated for this project identified increasing granularity in risk assessment as a potential risk that could lead to financial exclusion. In New Zealand, for example, more granular pricing for earthquake and flood risk based on the use of detailed geospatial analysis has led to significant premium increases for some policyholders.

Emerging requirements related to the use of artificial intelligence

In addition, the emergence of specific (and generally-applicable) legislative or regulatory requirements on the use of artificial intelligence will also create compliance requirements for insurers. A number of jurisdictions are considering the need for generally-applicable legislation, regulation or guidance on the use of artificial intelligence and machine learning based on different approaches and objectives:

- The European Union has introduced a draft *Artificial Intelligence Act* which sets out requirements related to data quality, transparency, human oversight and accountability to be applied using a risk-based approach that classifies different applications of artificial intelligence as unacceptable, high, limited or minimal risk (where applications involving unacceptable risk would be prohibited and most requirements would be imposed on high-risk applications[38]) (Feingold, 2023[111]; Shapiro and Cota, 2023[112]);
- In Canada, a draft *Artificial Intelligence and Data Act* has been introduced to Parliament, which if passed and once regulations are completed to bring it into force, would similarly incorporate a risk-based approach and establish requirements related to human oversight, transparency and fairness although without any prohibition on applications of artificial intelligence in critical areas (Macek et al., 2023[113]; Shapiro and Cota, 2023[112]);
- In the United States, no national legislation has been proposed although the National Institute of Standards and Technology has developed an *AI Risk Management Framework* to provide guidance on addressing risk related to the use of artificial intelligence. In addition, The White House has released a *Blueprint for an AI Bill of Rights* which establishes five principles for the safe deployment of artificial intelligence (Safe and Effective Systems, Algorithmic Discrimination Protections, Data Privacy, Notice and Explanation and Human Alternatives, Consideration, and Fallback). Some individual states have passed legislation related to the use of artificial intelligence

[38] While still under discussion, some artificial intelligence applications in life and health insurance may be classified as high risk (Hielkema, 2023[236]).

or machine learning, sometimes limited to specific types of applications (Shapiro and Cota, 2023[112]; The White House, 2022[114]).

- In Australia, Japan and the United Kingdom, some guidelines have been developed by public and/or private sector entities to encourage responsible deployment of artificial intelligence and machine learning (O'Connell et al., 2023[115]).[39]

Despite the differences in approach and guidance, there appears to continue to be a convergence around five core principles across legislative and regulatory initiatives and guidelines and standards: safety, transparency, privacy, accountability and fairness (Keller, 2020[43]). This is consistent with the *OECD Recommendation on Artificial Intelligence* (the OECD AI Principles) which outlines five values-based principles: (i) inclusive growth, sustainable development and well-being; (ii) human-centred values and fairness; (iii) transparency and explainability; (iv) robustness, security and safety; and (v) accountability (OECD, 2019[116]).

Other insurance legislative, regulatory or supervisory requirements with potential implications for technology adoption

In some countries, insurance legislation, regulation and/or supervisory requirements aimed at protecting consumers or addressing operational risks could create impediments or disincentives to the application of new technologies to insurance underwriting, pricing and/or support for risk reduction. Approximately 38% of the industry respondents to the survey circulated for this project identified insurance regulation and supervision as a challenge or potential challenge to technology adoption, particularly in North America (56%) and Asia-Pacific (41%). Similarly, a survey of the largest 100 US insurers found that, among those that had applied or are implementing artificial intelligence and machine learning into their operations, 65% were concerned that regulators might block their efforts to leverage these technologies and 59% were concerned that regulators might impose limits (Beal, 2019[34]).

Supervisory requirements related to underwriting and pricing

The data, rating factors and/or models that insurers use to set premium rates for coverage may be subject to supervisory oversight. The supervisory review may take place when the insurance product is first introduced to the market and may require prior approval (supervisory approval before the product is introduced) – or may be undertaken after the product is distributed through a "file and use" requirement (where insurers are allowed to offer the product after providing the supervisor with the necessary documentation). Prior approval requirements are applied for some or all lines of business in Colombia40, Indonesia41, Malaysia (in the case of some property insurance, see Box 3.5), Nepal, Japan, Chinese

[39] For example, the *AI Ethics Framework and AI Action Plan* (2021) in Australia, the *Data Ethics Framework* in the United Kingdom and the *Governance Guidelines for Implementation of AI Principles and the Machine Learning Quality Management Guideline* in Japan (O'Connell et al., 2023[115]).

[40] In Colombia, insurance companies are required to submit sample policy documents and corresponding premium rates as well as technical and statistical studies to justify the premium rate – although prior approval is only required in cases where the insurer is entering a new line of business. In addition, there are two types of approval – general approval and individual approval where the former involves a less stringent review and is applied to insurers (outside of social security lines of business) that have operated for more than a year and have not faced recent sanctions or suspensions or been forced to implement a recovery plan. The supervisory review of pricing considers factors such as fairness in the criteria applied to pricing and premium adequacy.

[41] In Indonesia, insurers must submit data on rating and pricing approaches for cyber insurance and health insurance lines (the criteria for setting property insurance premiums are defined by the supervisor). A regulation concerning insurance products and distribution requires insurers to calculate premiums based on reasonable assumptions including the risk and loss profile of the insured (OJK, 2015[94]).

Taipei[42] and some US states. File and use requirements are applied in Costa Rica, India (see Box 3.4), Malaysia (in the case of health insurance) and some (other) US states. In other jurisdictions, supervisory review may only occur if the supervisor becomes aware of issues with the pricing approach (for example, as a result of policyholder complaints or poor performance/premium inadequacy) (for example, in Bulgaria, Estonia, Germany, Lithuania and Portugal).

Box 3.4. Evolutions in rate and form regulation in India

The Insurance Regulatory and Development Authority of India (IRDAI) has provided increasing flexibility to insurers in terms of pricing and form regulation, including: (i) elimination of fixed pricing requirements in 2007; (ii) authorisation for the use of non-standardised policy forms, complemented by guidance on common definitions and coverage headings[1] and a requirement that basic coverages could not be removed[2]; and (iii) a transition from prior approval of policy forms and pricing to file and use in 2022. IRDAI reviews products offered by insurers to ensure that they comply with existing guidance and that premium approaches are justified and ranges are reasonable.

Note: [1] For example, IRDAI released guidance on common definitions of critical illnesses (IRDAI, 2020[117])and a product structure for cyber insurance (IRDAI, 2021[118]).
[2] In permitting alternative fire insurance coverage options, IRDAI outlined some objectives that the new coverages should aim to achieve, including increasing insurance penetration, addressing protection gaps and customer needs and promoting a sustainable fire insurance market that broadens coverage options (IRDAI, 2022[119]).

A few jurisdictions limit the use of data for underwriting and pricing coverage to what is provided by the policyholder (i.e., the use of external data is effectively not authorised). This limitation is applied to property and health insurance in Japan and Mexico.

In a few jurisdictions, premium levels or approaches to setting premium levels for some or all lines of businesses are defined or imposed by the supervisor, for example:

- In Indonesia, household and commercial property insurance premiums (as well as motor vehicle insurance premiums) are subject to a minimum and maximum premium rate with fixed rates for natural catastrophe coverage based on risk zones and construction characteristics (although insurers are explicitly authorised to use external data sources in other lines of business.[43]
- In Malaysia, there is a standard tariff property insurance coverage although insurers are authorised to offer a non-tariff coverage subject to certain conditions (see Box 3.5).

[42] In Chinese Taipei, the *Regulations Governing Pre-sale Procedures for Insurance Products* require insurers to seek prior approval before offering a new type of (individual) insurance product, which includes a description of pricing and rates to be applied and must be supported by analyses demonstrating that premium rates are adequate, reasonable and fair. In addition, the *Regulations Governing Business Solicitation, Policy Underwriting and Claim Adjusting of Insurance Enterprises* requires that the procedure for evaluating risks and setting premiums should be based on actuarial science and statistical data.

[43] OJK's product and product distribution regulations specifically identify examples of external data that may be used in the underwriting and determining premiums or contributions for insurance products. For example, when determining premiums or contributions for health insurance products, the insurance company may incorporate data concerning policyholders' lifestyles or exercise habits. When determining premiums or contributions for cyber insurance products, the insurance company may consider data related to information technology systems, cyber security practices, and so forth (OJK, 2015[94]).

- In Nepal, property insurance premiums are fixed based on sum insured and minimum premium rates are applied for other lines of non-life insurance business (or fixed rates in the case of motor vehicle insurance). A transition to risk-based premiums is being considered.[44]
- In the Philippines, fixed rates are applied across all lines of business based on pre-defined policyholder characteristics.[45]
- In Türkiye, voluntary earthquake insurance provided by private insurers is priced based on location, construction characteristics and size of the residence (the same criteria used for the Compulsory Earthquake Insurance for households provided by the Turkish Catastrophe Insurance Pool (TCIP)).
- In Belgium, Germany, Mexico and the United States, the factors that can be used as input into underwriting and pricing health insurance coverage (with the exception of large group health insurance policies and long-term care insurance in the United States) are limited to specific pre-determined criteria.
- In some jurisdictions, household (sometimes commercial) property insurance coverage for some types of disaster risks is provided through a catastrophe risk insurance programme that may apply fixed premium rates based on sum insured[46] or specific criteria for setting premium rates.[47]

[44] The development of a flood risk model is expected to support the ability of insurers to charge risk-based premiums for property insurance.

[45] For example, in the case of property premiums, rates are calculated based on location, construction characteristics, occupancy and activities with minimum rates applied for natural catastrophe coverage (OECD, 2020[202]).

[46] Including Belgium (terrorism), Denmark (flood), France (natural catastrophes and terrorism), Iceland (natural catastrophes), Netherlands (terrorism), New Zealand (earthquake), Norway (natural catastrophes) and Spain (natural catastrophes and terrorism) (OECD, 2021[203]).

[47] Including Australia (terrorism), Japan (earthquake), Switzerland (natural catastrophes in some cantons), Türkiye (earthquake), United Kingdom (terrorism) and the United States (flood) (OECD, 2021[203]).

Box 3.5. Phased de-tarrification of property and motor vehicle insurance in Malaysia

In Malaysia, fixed premiums (tariffs) have been required for fire insurance for residential and commercial property and insurance for motor vehicles although a gradual de-tariffication process was initiated in 2016 (Bank Negara Malaysia, 2016[120]). Under the current phase of liberalisation, insurers have been authorised to offer fire insurance coverage that does not apply the fixed tariff rate (although insurers must continue to offer the tariffed fire insurance coverage). Non-tariff fire insurance products for residential and commercial property must offer new services or coverage options and are subject to prior approval if the premium rate deviates from the tariff rate beyond a prescribed threshold.[1] Tariff and non-tariff motor vehicle insurance products are allowed to deviate within +/-15% from tariff rates, with larger deviations requiring regulatory approval. Insurers are also required to educate policyholders on the key factors that affect the premium cost and ways to reduce their premiums (Bank Negara Malaysia, 2016[120]). Malaysian insurers are making use of the new flexibility to offer non-tariff products while reportedly maintaining underwriting and pricing discipline (particularly in property insurance) (AM Best, 2022[121]).

Note: [1] For residential property, a premium rate for a non-tariff product that is higher than the tariff rate requires regulatory approval. In addition, all non-tariff products for residential and commercial property must not charge premium rates that are lower than 30% from the tariff rates.

While these practices aim to achieve important prudential (solvency)[48], market conduct (unfair pricing) and other policy objectives, they may in some cases limit the ability of insurance companies to implement innovative approaches to risk assessment and underwriting/pricing through the application of new data sources and analytical approaches based on artificial intelligence and machine learning (Noordhoek, Marcoux and Schanz, 2022[122]). Supervisory approaches that significantly limit pricing flexibility through fixed or *de facto* fixed tariffs[49] reduce (if not eliminate) the incentive for insurers to invest in collecting new data or applying these types of advanced analytics. This was confirmed through interviews with insurers in Indonesia, Malaysia and Nepal who indicated that they had few incentives to invest in risk assessment for lines of business subject to limits on pricing flexibility. Insurance companies interviewed in Indonesia and Nepal indicated that a removal of pricing restrictions ("de-tariffication") would increase the use of data and analytical tools in underwriting and pricing insurance coverage. Insurance companies interviewed in Malaysia indicated that partial de-tariffication in property (and motor vehicle) insurance had already led to the use of new data in underwriting and pricing.[50]

Supervisory approaches that involve a review of underwriting and pricing approaches could also discourage the application of innovative technology if supervisors are reluctant (or perceived to be reluctant) to authorise such approaches. Approximately 17% of the industry respondents to the survey circulated for this project indicated that they had faced challenges in receiving supervisory approval for the use of new data sources or advanced analytical tools in underwriting and pricing, with a slightly higher

[48] A number of jurisdictions where fixed or minimum pricing has been applied have raised concerns that liberalised pricing, particularly for retail lines of business such as property and motor vehicle, could lead to destructive competition among insurers for market share and premium inadequacy that could threaten insurer solvency.

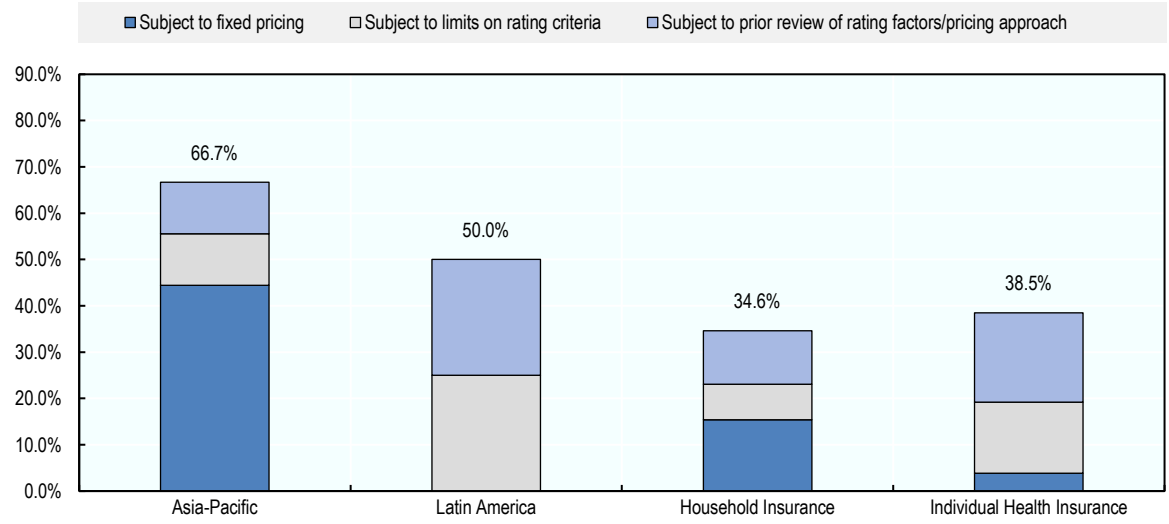
[49] Jurisdictions that apply a minimum premium rate have often found that insurers will tend to charge the minimum rate in practice (i.e., the minimum rate becomes a fixed rate in practice),

[50] Examples provided by insurers include the use of location tracking data (with consent) to identify vehicles being driven in high-risk zones, integration of driver characteristics (e.g., years of experience, occupation) into underwriting motor vehicle insurance and increased data collection on flood history and geography (flood maps and models) for property insurance underwriting.

proportion of companies from Asia-Pacific and Europe indicating they faced these types of challenges. Supervisory review requirements (including the need to justify data relevance), fixed rates or rating criteria as well as privacy-related requirements were identified by some respondents as specific challenges.

Figure 3.1 provides an overview (for certain regions and lines of business) of the prevalence of regulatory or supervisory practices that could potentially limit or discourage the use of new data sources and/or analytical tools based on artificial intelligence and machine learning, including fixed pricing, limits on the use of rating factors and prior approval of rating factors and pricing approaches. Potential limitations appear to be more common in Asia-Pacific and Latin America and slightly more common for individual health insurance and household property insurance coverage.

Figure 3.1. Potential regulatory limitations to applying new data or advanced analytics in underwriting and pricing



Note: The graph shows the share of jurisdictions where insurance coverage is subject to: (i) fixed pricing in the identified or other limes of business (excluding for coverage provided by catastrophe risk insurance programmes); (ii) limits on rating factors, including restrictions on the use of external data, in the identified or other limes of business (excluding for coverage provided by catastrophe risk insurance programmes); or (iii) prior approval of rating factors and pricing approaches in the identified or other limes of business (excluding for coverage provided by catastrophe risk insurance programmes). For example, in Asia-Pacific, fixed pricing approaches are applied to some lines of business in 4 of the 9 jurisdictions examined, limits on rating criteria were applied in one (additional) jurisdiction and prior approval was applied in another (additional) jurisdiction – in aggregate, 6 of 9 jurisdictions in Asia-Pacific applied at least one of these three measures.
Source: Responses to the OECD Regulator survey on leveraging emerging technologies for risk management and interviews with insurance regulators and insurance companies in India, Indonesia, Malaysia and Nepal.

As noted above, a potential benefit of the application of new data sources and advanced analytics in underwriting and pricing is more accurate risk assessment and therefore improved price signals on policyholder risk levels through the premiums charged. Jurisdictions that require pricing approaches based on fixed criteria or that are restrictive in terms of authorising the use of new or external data sources or advanced analytics may miss opportunities to benefit from improved price signals and ultimately limit incentives for policyholder risk reduction (although there are other factors that impact the use of risk-based pricing and/or the interest and capacity of policyholders to invest in risk reduction[51]).

[51] The IPPC published a report on *Enhancing the insurance sector contribution to climate adaptation* in 2023 (OECD, 2023[124]). This analysis identified a number of factors that may reduce the application of risk-based pricing (including the bundling of different coverages, incorporation of other factors such as competition, reputational or other business considerations into pricing) as well as the interest and capacity of policyholders to invest in risk reduction (including

The availability of premium discounts for measures or behaviours that reduce risk should provide an incentive for policyholders to implement such measures or behaviours. Most jurisdictions allow insurers to provide discounts in property, cyber and health insurance (with the exception of jurisdictions that have implemented fixed pricing regime for property insurance (such as Indonesia, Nepal, Philippines, Türkiye) where, by definition, insurers would be unable to provide premium discounts for risk reduction). Similarly, insurers in jurisdictions that limit authorised rating factors for health insurance (such as Belgium, Germany, Mexico, United States[52]) would have limited potential to offer premium discounts based on healthy behaviours. Supervisors that specifically request and review information on pricing/rating approaches as part of product approval would also require insurers to include information on available discounts.

Potential restrictions on offering risk mitigation services

As in the case of underwriting and pricing, an insurance product's terms and conditions ("policy form") may be subject to supervisory oversight (prior approval, file and use or *ex post* supervisory review as needed). As noted above, Colombia, Costa Rica, India, Indonesia, Malaysia, Nepal, Japan, Chinese Tapei and the United States (some states) require insurers to submit information on the insurance coverage that they plan to offer.[53]

Insurers that wish to offer risk mitigation services would usually need to include information on those services when seeking prior approval or review under file and use approaches. In many jurisdictions, the inclusion of risk mitigation services would not have any impact on policy form or product approval (e.g., Costa Rica, Indonesia, Japan and Chinese Taipei). In the Philippines, risk mitigation services would be considered as part of the supervisory review process.[54] In Mexico, risk mitigation elements or services that would be considered in premium-setting or decisions on insured limits must be included in submissions for supervisory review and could impact approval. In addition, many jurisdictions have established requirements that risk mitigation services provided are relevant to the type of insurance coverage offered. In US states that require policy form approval, risk mitigation services would need to be included if they affect pricing. In the case of health insurance, any provided networks of medical practitioners must be listed and any wellness programmes offered would need to be described with a commitment by the insurer to review utilisation of such programmes. In addition, risk mitigation services offered without charge would need to comply with rebate laws[55] that exist in some states. In India, insurance companies are not allowed

lack of awareness, cost, limited effectiveness of individual risk reduction measures in some cases, uncertainty about premium discounts).

[52] In the United States, some premium discounts may be available for individual health insurance and small group health coverage (for which fixed criteria must be used in pricing) although these discounts cannot be used to circumvent restrictions on the use of health factors in pricing and cannot be discriminatory.

[53] Chile maintains a depository ("Policy Deposit") of policy wordings in use in the market. Insurers may use the policy wordings included in the depository or their own policy wording in certain lines of business (transport, marine, air hull) and for coverage involving premiums above 200 Unidades de Fomento without any requirement for *ex ante* supervisory review. However, policies in some lines of business must be authorised by the CMF based on legislation (e.g., pension life annuity policies, compulsory personal accident insurance (SOAP)).

[54] The Philippines indicated that a number of such services have been approved by the Insurance Commission across different lines of business. For example, the Insurance Commission has approved coverage for expenses paid to fire brigades for preventative services aimed at reducing loss from fire. A number of exclusions aimed at discouraging risky behaviour have also been approved, including an exclusion for Unauthorized Use of Mobile Payment Application Service as well as exclusions to health insurance policies for illness arising directly or indirectly out of excessive consumption of alcohol, misuse or irrational use of drugs/medications, solvent/substance or any addicting and habit-forming drugs which cause complications that will require treatment or medical intervention.

[55] In the United States, the NAIC has developed a model *Unfair Trade Practices Act* that establishes limitations on the provision of rebates or inducements in the distribution of insurance policies. The model Act was revised in 2021 to

to provide non-insurance services and therefore any health or wellness programmes offered must be provided by a third party. IRDAI has developed specific guidance for insurers wishing to offer third-party health and wellness programmes to their policyholders (see Box 3.6). In Malaysia, insurers are not authorised to provide healthcare although they can provide advice on fitness and wellness and are also permitted to work with third parties to offer healthcare-related services. Only one jurisdiction (Poland) noted the existence of a legislative restriction on the provision of risk mitigation services.[56]

Box 3.6. IRDAI Guidelines on Wellness and Preventive Features

In 2020, the Insurance Regulatory and Development Authority of India (IRDAI) issued a circular that provides guidelines for insurers when offering wellness and preventive features to their health insurance policyholders. The guidelines establish the types of rewards that policyholders can earn, which include: (i) offered or discounted health care services; (ii) vouchers for health supplements; (iii) vouchers for membership in fitness centres and sports clubs; and (iv) premium discounts or increases in sum insured. The guidelines also include a number of requirements to ensure fair treatment of policyholders, such as non-discrimination in terms of access to reward programmes, confidentiality of information collected during the process of offering such programmes, disclosure to policyholders on services offered, rewards earned and redemption procedures as well as requirements to provide policyholders with choice in the use of rewards and service provider (where multiple uses of rewards and/or service providers are available). Insurance companies are also required to monitor the service providers accepting rewards although may not assume any liability for the services provided by those service providers. The guidelines also outline IRDAI's expectations in terms of supervisory oversight, including the inclusion of programme details when seeking product approval and the ability of IRDAI to reject the inclusion of wellness and preventive features or to require insurers to withdraw such programmes.

Source: (IRDAI, 2020[123])

Some industry respondents (15%) to the survey circulated for this project indicated that they had faced challenges in securing approval for risk mitigation services involving the use of new data sources or advanced analytics, with such challenges identified more often by respondents in Asia-Pacific and Europe.[57]

In some lines of business (e.g. property, cyber), a loss event may offer an opportunity to support risk reduction through more resilient reinstatement of damaged property or equipment. As examined in the OECD's work on *Enhancing the insurance sector's contribution to climate adaptation* (OECD, 2023[124]), resilient reinstatement after an event can provide a cost-effective means for supporting policyholder risk reduction in the case of property insurance although there are limited (if any) incentives for insurers to

allow for insurers to provide risk mitigation services or products at no or low cost with certain conditions. Most US states have related legislation or regulations or other administrative guidance such as bulletins and notices that address the issue of rebates.

[56] In Poland, the *Insurance and Reinsurance Activity Act* prohibits insurers from involvement in any activity other than insurance.

[57] For example, one respondent identified challenges in providing direct services to policyholders as a result of insurance and health related legislation in Japan, requiring the insurer to deliver services through external partners. A US-based respondent suggested that recent amendments to rebate laws do not provide sufficient flexibility to allow insurers to offer effective incentives for policyholder risk reduction.

support costly improvements.[58] A small number of jurisdictions have legislative, regulatory or supervisory limitations that could impede insurer involvement in supporting resilient reinstatement. For example, in Colombia and Costa Rica, insurers are obligated to focus their activities on providing insurance which may preclude any involvement in supporting post-claim risk reduction. In Poland, the sum of money paid by the insurance company cannot exceed the cost of damage suffered (unless otherwise agreed in advance). In the United States, rebate laws applied in some states could pose an impediment to supporting resilient reinstatement.

Requirements related to insurer operational resilience (including digital security and outsourcing)

Requirements established by insurance regulators and supervisors to ensure sound management of operational risks by insurance companies, particularly risks related to digital security and outsourcing, may also have an impact on the ability of insurance companies to adopt new technologies for risk assessment. A number of the regulator/supervisor respondents to the OECD survey for this project identified a need to enhance requirements and supervisory guidance related to operational risk management with a particular focus on digital security risks as well as outsourcing to third-party service providers.

As noted above, some insurance regulators and supervisors have included requirements related to data protection and privacy in digital security requirements applicable to the insurance sector (including Chile, India, Indonesia, Japan, Malaysia and Mexico). For example, in Indonesia, the requirements established for information technology risk management include an obligation for insurers to ensure that consumer personal data are only acquired, processed, used, stored and disclosed with the consent of consumers and that the use or disclosure is consistent with the consent provided (OJK, 2021[125]). Many regulators and supervisors have included requirements for insurers to also ensure that the data they share with outsourced service providers is equivalently protected and used in accordance with data protection and privacy requirements. For example, in Malaysia, the *Risk Management in Technology* policy document sets out Bank Negara's expectations for protecting data held both in financial institutions, including insurance company's own networks and data centres as well as in the networks and data centres of outsourced service providers (including cloud service providers – see below) (Bank Negara Malaysia, 2023[126]). In India, IRDAI's *Information and Cyber Security Guidelines* require insurers using cloud service providers to have contractual arrangements to ensure compliance with data protection and privacy requirements and expectations (IRDAI, 2023[127]).

In addition, some insurance regulators and supervisors have established requirements related to outsourcing arrangements, with a particular focus on outsourcing of core business functions (see Box 3.7). These requirements could potentially impact the use of third-party suppliers of technology for underwriting and pricing (and potentially for providing risk reduction advice and services). The use of outsourcing for core insurance business functions can create potential risks (for insurers and their supervisors) and raise broader policy questions:

- **Operational risk**: regulated and supervised insurance companies could have more limited control over the operational resilience of outsourced functions that are critical to their business or more limited access to necessary data and processes in the control of an outsourced service provider. Outsourced service providers might also create new security vulnerabilities.

[58] Most residential and commercial property insurance coverage only requires insurance companies to reinstate damaged property to the same (or a materially equivalent) condition as prior to incurring the loss (Rosenfield, 2022[204]). Insurance companies are not obligated to pay for any form of betterment and there is little incentive for private (profit-motivated) insurers to help policyholders implement more resilient reinstatement at greater cost as policyholders may choose to purchase future coverage from another insurance company who will then capture the benefits of reduced future losses (Warner et al., 2009[205]).

- **Compliance risk**: regulated and supervised insurance companies could have more limited control over the compliance of outsourced business processes with regulatory requirements, both insurance specific and generally-applicable legislation and regulation (e.g. consumer protection, anti-discrimination, data protection and privacy).
- **Systemic or financial stability risk**: a disruption to a dominant provider of outsourced services to the insurance sector could potentially lead to financial stability risk if a number of insurance companies are dependent on that provider.

Sub-outsourcing and outsourcing to cross-border service providers can potentially exacerbate these risks. For example, outsourcing to a service provider (or a service provider with suppliers) based in another jurisdiction could raise issues related to the sharing of protected data with foreign companies and/or the prioritisation of service restoration and access in case of a disruption. Ultimately, the reliance on outsourced service providers for core insurance functions raises questions related to the ability of insurance companies to exercise full control over regulated activities as well as the reach of regulatory and supervisory oversight and the applicability of intervention and enforcement tools to companies that are not licensed by insurance supervisors.

Box 3.7. Supervisory guidance and requirements on (cloud) outsourcing by insurance companies

Supervisory guidance on outsourcing arrangements have been in place for a number of years. For example, IAIS *Insurance Core Principles* (IAIS, 2019[128]) include a number of principles relevant for the supervision of insurers' outsourcing arrangements, including in licencing, risk management and internal controls, supervisory access to service providers engaged in providing material functions, preventative measures including the power to prohibit an insurer from continuing a business relationship with an outsourced service provider and conduct of business in terms of ensuring that service providers have policies, procedures and processes that are expected to lead to fair treatment of customers. In May 2023, the IAIS published an *Issues Paper on Insurance Sector Operational Resilience* providing an analysis of issues that could impact operational resilience and potential supervisory approaches, with a specific focus on: (i) cyber resilience; (ii) IT third-party outsourcing; and (iii) business continuity management (BCM) (IAIS, 2023[129]).

Some insurance regulators or supervisors have provided additional guidance on how existing requirements apply to cloud service or other information and communications technology (ICT) service providers:

- EIOPA released a specific set of guidance on outsourcing to cloud service providers in February 2020 to supplement existing requirements on outsourcing included in the *Solvency II* framework. The guidance sets out expectations in terms of the governance of cloud outsourcing arrangements, supervisory notification and documentation requirements, risk assessment, monitoring and due diligence for cloud outsourcing arrangements, contractual requirements, exit strategies and supervision of cloud outsourcing arrangements by national supervisors (amongst other issues) (EIOPA, 2020[130]). EIOPA has also issued more recent guidelines on ICT security and governance that should be equivalently applied to insurers' ICT outsourcing arrangements (EIOPA, 2020[131]).
- The European Commission has established requirements for digital operational resilience in the financial services sector which also applies to insurance companies (*Regulation on Digital Operational Resilience for the Financial Sector (DORA)*). The regulation requires that competent authorities have supervisory access to major ICT service providers and requires that ICT service providers established outside of the European Union and designated as "critical ICT third party service providers" (CTPPs) under the regulation establish a subsidiary in the EU within 12 months of their designation (Long. William R.M., Cuyvers and Quartilho, 2023[132]). In September 2023, EU financial supervisory authorities published their technical advice on criteria for identifying CTPPs (EBA, EIOPA and ESMA, 2023[133]).
- In the United Kingdom, the Prudential Regulation Authority (PRA) issued a supervisory statement on outsourcing and third-party risk management in March 2021 applicable to all outsourcing and third-party arrangements across the financial sector, including insurance companies. The supervisory statement applies to all types of outsourcing arrangements but includes specific guidance on the application to cloud and other IT service providers, including a requirement to assess risks related to the storage of data abroad (PRA, 2021[134]).
- In Malaysia, Bank Negara Malaysia's policy on *Risk Management in Technology* includes an Appendix providing a *Cloud Technology Risk Assessment Guideline* (CTRAG). The Appendix provides guidance on the assessment of common key risks in outsourcing functions to cloud service providers and possible measures that financial institutions (including insurers) should take to mitigate those risks. It includes a requirement for financial institutions to consult with

Bank Negara Malaysia should they intend to migrate critical functions or systems to the cloud (Bank Negara Malaysia, 2023[126]).

Some regulators and supervisors have established requirements that data collected by insurance companies from domestic policyholders be stored in data centres located within the jurisdiction (sometimes with potential exceptions) – which are often a reflection of national requirements applicable across sectors (see Box 3.8).

Box 3.8. Data localisation requirements

Data localisation requirements can be defined as "a mandatory legal or administrative requirement directly or indirectly stipulating that data be stored or processed, exclusively or non-exclusively, within a specified jurisdiction" (Svantesson, 2020[135]). An OECD analysis found that some element of a data localisation requirement exists in at least 40 jurisdictions including both OECD countries and emerging economies (Svantesson, 2020[135]). These types of requirements are generally aimed at ensuring that personal data (as well as other types of data such as confidential public sector or commercial data) are protected from unauthorised disclosure or use in third countries. Businesses generally perceive such restrictions as a potential barrier to realising the benefits of digitalisation and a compliance burden (International Regulatory Strategy Group and KPMG Law, 2022[136]; Svantesson, 2020[135]) and advocate for improved international consistency and cooperation on the requirements governing cross-border data transfers (OECD, 2023[137]),

Data localisation requirements exist in Indonesia and Nepal. In Nepal, data collected by financial institutions must be stored in Nepal, reflecting a government policy (rather than insurance regulatory requirement). In Indonesia, the regulation on risk management in information technology includes a requirement for data centres (and data recovery centres) to be located in Indonesia (also reflecting broader government policy) although some exceptions are possible for companies with international operations (OJK, 2021[125]). In India, insurers have been implementing a requirement for data localisation although the recently adopted data privacy act will reportedly authorise international data transfers to most countries (with exceptions that will be notified). However, any data localisation requirements in sectoral regulation may remain applicable (Mathias, 2023[138]).

For the insurance sector, data localisation requirements can create costs and may limit their ability to collect and process data from some jurisdictions. An inability to include data on citizens from those jurisdictions could limit the representativeness of the data used for building predictive analytics (GlobalData Thematic Research, 2021[139]). Data localisation and limits on IT-related outsourcing could potentially limit the ability of insurers to access or make use of third-party data sets and processing and analytics capacity from third parties established in foreign jurisdictions. The OECD survey for this project identified some challenges in access to data as a result of data localisation requirements (just under 20% of respondents identified data localisation as a challenge or possible challenge) – particularly among respondents from Asia-Pacific and among reinsurers and intermediaries.

Some insurers in Indonesia and (to a lesser extent) Nepal indicated that data localisation requirements were an impediment to accessing cloud services (and technology solutions available in the cloud, including solutions developed by foreign subsidiaries of the same insurer group). In Indonesia, foreign cloud service providers are increasingly establishing local data centres which will allow them to provide services to Indonesian insurers. However, in Nepal, none of the major foreign cloud service providers have established a local data centre which means that insurers in Nepal need to rely on local cloud service providers or a government-provided data storage service. In India, most major cloud service providers have a local

presence and local data centres and therefore access to cloud computing was not identified as a constraint. Some insurers in all four jurisdictions indicated a preference for storing data in their own data centres.

Access to cloud services could also be impeded by other requirements related to outsourcing and digital security (i.e., beyond data localisation requirements). For example, some insurers have raised concerns that efforts in the European Union to enhance the cloud security could impact access to foreign cloud service providers.[59]

[59] The concerns appear to relate to the possibility that an effort to classify cloud service providers under a European Cybersecurity Certification Scheme for Cloud Services (EUCS) could lead to requirements that only cloud service providers that achieve the highest certification could be used for some or all types of functions – and the possibility that only providers headquartered in the EU might be able to achieve that standard (GDV, 2023[242]).

4 Creating an enabling environment for the application of technology for risk assessment and supporting policyholder risk reduction in insurance

As highlighted above, the regulatory and supervisory framework for insurance companies, including both generally-applicable and insurance-specific legislation and regulation, can have an impact on the ability of – or the incentives for – insurers to apply new data sources, analytical tools based on artificial intelligence and machine learning or policyholder engagement platforms into underwriting and pricing and in providing services to support policyholder risk reduction. It can also have a critical impact on the level of consumer trust in the application of technology in insurance.

Insurance regulators and supervisors are primarily concerned with ensuring that insurance companies are financially sound and able to meet their obligations to policyholders (prudential supervision) and that policyholders are adequately protected against unfair practices by insurance companies or intermediaries (market conduct supervision). Harnessing the benefits of technological developments to improve risk assessment and risk reduction advice and services may require insurance regulators and supervisors to adapt existing regulatory and supervisory frameworks to allow for the implementation of new approaches, while taking measures to continue to ensure that policyholders are sufficiently protected from insurer insolvencies and unfair practices.

Insurance regulators and supervisors are monitoring and reviewing existing regulatory and supervisory frameworks to ensure that there are no undue impediments to the adoption of emerging technologies.[60] Many have made adaptations (or are considering adaptations) to existing regulatory and supervisory frameworks to enable digital delivery of insurance products, documentation and advice (e.g., (Canada

[60] In the United States, for example, in establishing the Innovation and Technology (EX) Task Force, insurance regulators have sought to better understand where existing laws, regulations and practices might be creating impediments to the availability of products and services that offer benefits to consumers and efficiencies to the industry. The E-Commerce (H) Working Group was established following the Innovation and Technology (EX) Task Force's Request for Information (RFI) to the industry to identify specific areas of regulatory concern related to leveraging emerging technologies and data. In Europe, EIOPA launched a *Digitalisation Market Monitoring Survey* in 2023 aimed at improving supervisory understanding of financial innovation and identifying potential risks for consumers as well as potential regulatory or supervisory obstacles to financial innovation (EIOPA, 2023[229]). In Canada, the Department of Finance launched a public consultation in October 2023 on *Upholding the Integrity of Canada's Financial Sector*, including on how the financial sector legislative and regulatory framework should be adapted to leverage the benefits of artificial intelligence and other innovations while managing any risks (Department of Finance Canada, 2023[238]).

(Saskatchewan), Indonesia, Nepal (in progress)[61], Poland, Thailand, Türkiye (in progress)) which can potentially contribute to improving access in underserved communities.[62] They are also making changes to respond to technological developments in specific areas, such as the provision of automated advice.[63] As noted above, some insurance regulators and supervisors have also developed rules and guidance to ensure that data protection and privacy and anti-discrimination requirements are appropriately applied in the delivery of insurance products and that operational risks related to digitalisation (including digital security and IT-related outsourcing) are appropriately managed.

However, there may be limited need for broad changes to existing regulatory and supervisory frameworks, particularly where regulatory and supervisory frameworks apply principles-based and technology-neutral approaches. There may also be some risk to making significant changes to specifically respond to current technological developments given the pace of technological change.

The following section provides some possible approaches to ensuring that the regulatory and supervisory framework provides an enabling environment to support the responsible use of new technologies in support of underwriting, pricing and risk reduction while addressing the potential risks for consumers.

Addressing excessive restrictions and disincentives to applying new data sources and analytical techniques to underwriting and pricing

Fixed pricing and/or restrictions on rating criteria (other than restrictions related to unlawful discrimination) are likely the most significant impediment to innovation in underwriting and pricing. While these types of restrictions have usually been established to address particular policy objectives, such as consumer protection, affordability or competitive markets, consideration could be given to whether such restrictions are the most effective way to achieve those outcomes and if the benefits outweigh the costs in terms of dampened price signals and reduced incentives for risk reduction and innovation in risk assessment.

Where applicable, insurance regulators and supervisors may want to review strict restrictions on the use of external data or analytics based on artificial intelligence and machine learning, whether imposed through regulation, guidelines or the product approval/review process. The existence of robust data protection and privacy and anti-discrimination requirements (including on price optimisation), potentially supported by specific guidance for implementation by insurance companies, could potentially address some of the concerns related to the use of external data and advanced analytical tools based on artificial intelligence and machine learning.

Insurance-specific guidance could be focused on ensuring that insurance companies understand and implement obligations for protecting data and privacy and preventing unfair or unlawful discrimination based on protected characteristics when applying external data and advanced analytics to underwriting, pricing and other decisions. Such guidance could provide useful interpretation of the applicability of these

[61] At the time of writing, the Nepal Insurance Authority was undertaking consultations on draft guidelines related to the distribution of digital insurance products.

[62] The Financial Services Regulatory Authority of Ontario (Canada), for example, is examining the potential for digitalisation to provide new opportunities to improve access to advice in remote locations (and any risks that may arise).

[63] For example, in South Africa, the Financial Sector Conduct Authority has made amendments to fit and proper requirements for financial services providers to include a definition of robo or automated advice and prescribe additional requirements applicable to the provision of automated advice. The changes require that Financial Services Providers (FSPs) that provide automated advice (e.g., robo-advice that uses algorithms and technology, without the direct involvement of a natural person) must monitor and review the automated advice generated by algorithms and ensure the quality and suitability of the automated advice for their clients.

requirements to insurance (including any insurance-specific derogations) and reduce any uncertainty regarding what can and cannot be incorporated into underwriting models. It could also reinforce the need to ensure that underwriting and pricing factors are relevant for the assessment of risk and consistent with generally-accepted actuarial principles in terms of being appropriate for use and with a demonstrated causal link (such as the International Actuarial Association's International Standards of Actuarial Practice (ISAPs)) (see section below on Building trust in the application of technology in insurance)

Supervisors could potentially shift their focus to monitoring the broad outcomes of underwriting and pricing decisions to ensure fair treatment of customers and minimise financial exclusion. Insurance companies wishing to apply new data sources or analytical tools based on artificial intelligence and machine learning could be required to demonstrate that the data and models lead to outcomes that are fair for consumers and are consistent with existing obligations related to data protection and privacy and anti-discrimination (see Box 4.1).

Box 4.1. Measuring impact of artificial intelligence and machine learning models on customer outcomes

As noted above, one of the significant risks of applying analytical tools based on artificial intelligence and machine learning is the potential for proxy discrimination based on correlations between explanatory variables included in model outcomes and protected characteristics. Insurers could be encouraged (or required) to undertake *ex post* examinations of the outcomes generated by the use of models incorporating artificial intelligence or machine learning on consumers with protected characteristics to identify whether these outcomes are leading to higher pricing or more frequent coverage denials among those with protected characteristics (Noordhoek, 2023[4]). For example (as noted above), the US state of Colorado regulation on *Governance and Risk Management Framework Requirements for Life Insurers' use of External Consumer Data and Information Sources, Algorithms, and Predictive Models* includes a requirement for insurers to test whether their use of external data or analytics based on artificial intelligence has led to unfair discrimination (Baysinger et al., 2023[106]). In some jurisdictions, however, implementing these types of examinations may be limited by a lack of access to data on protected characteristics that would be necessary for testing outcomes (Alberts et al., 2022[140]; EIOPA Consultative Expert Group on Digital Ethics in Insurance, 2021[41]).

Reviewing restrictions to – and encouraging – the provision of risk reduction advice and services

The limited number of jurisdictions where regulatory or supervisory requirements may impede the provision of risk expertise and mitigation services by insurance companies may wish to consider whether other approaches may be more effective in meeting the related policy or supervisory objective. Where these requirements exist, they appear to be linked to either: (i) efforts to limit the scope of business activities that licensed insurance companies engage in, potentially as a means to ensure that the primary activity of a licensed insurance company is providing insurance coverage (i.e., instead of other commercial activities); or (ii) as a means to ensure that insurance companies do not circumvent pricing regulation or otherwise distort market contestability by offering benefits to policyholders without charge.

Insurance sector support for policyholder risk reduction should be considered a critical and beneficial activity that is core to the delivery of insurance. Regulators and supervisors could consider providing further guidance or interpretation on the types of activities that insurance companies can engage in (see Box 3.6) - to ensure that such restrictions do not unnecessarily impede insurance company involvement in providing risk reduction advice and services. They could also provide further guidance on activities that would – and

would not – circumvent any relevant pricing regulation (where applied), distort insurance market contestability or result in other detrimental impacts for consumers. For example, in the United States, the National Association of Insurance Commissioners made amendments to its model *Unfair Trade Practices Act* in 2021 in order to allow insurance companies to offer value-added products and services in connection with the sale of insurance, including risk expertise and management services (Holahan, Lee and Roehl, 2021[141]) (see Box 4.2).

Box 4.2. Revisions to the NAIC Unfair Trade Practices Act (United States)

In the United States, the NAIC has made a number of revisions to the *Unfair Trade Practices Act* (sometimes referred to as "rebate laws") to allow insurers to offer risk mitigation services and products to policyholders along with insurance coverage while ensuring that the offering of these products and services is not considered as non-compliant with rebate laws. The revisions are meant to ensure that risk mitigation services or products offered at low or no cost and are aimed at one or more of the following objectives will be considered as compliant with the Act: (i) provide loss mitigation or loss control; (ii) reduce claim costs or claim settlement costs; (iii) provide education about liability risks or risk of loss to persons or property; (iv) monitor or assess risk, identify sources of risk, or develop strategies for eliminating or reducing risk; (v) enhance health; (vi) enhance financial wellness through items such as education or financial planning services; (vii) provide post-loss services; (viii) encourage behavioural changes to improve the health or reduce the risk of death or disability of a customer; or (ix) assist in the administration of employee or retiree benefit insurance coverage.

Regulators and supervisors should consider whether they have a role in actively encouraging insurance companies to support policyholder risk reduction through advice and incentives.[64] Insurers could be encouraged to provide policyholders with information on effective risk reduction measures (such as structural reinforcement measures in property, digital security measures in cyber or healthy behavioural changes in health) – and how their premium might be impacted by investing in such measures. Insurers could also be encouraged to disclose information on specific risk reduction measures that would lead to premium discounts – and potentially be required to offer premium discounts for specific (and effective) risk reduction measures.

Supporting access to data and technology

Regulators and supervisors should specifically consider how data localisation, digital security and outsourcing requirements impact insurer access to data, processing and analytical capacities and policyholder engagement tools developed by third parties in other jurisdictions. One approach might be to consider information exchange, reciprocity or cooperation agreements with supervisors in other countries that might allow for effective oversight of important third-party service providers by the foreign supervisor (not unlike the approach taken to the supervision of internationally-active (re)insurance groups) (although the level of oversight of critical insurance-related third-party vendors by insurance supervisors differs across countries).

Data localisation requirements exist in many jurisdictions although the OECD and its members have committed to address challenges to cross-border data flows and have been working to address potential impediments (see Box 4.3).While data localisation requirements are often applied across sectors and outside the control of insurance regulators and supervisors, efforts could be made to ensure that some of

[64] In India, IRDAI has established a working group to make recommendations on loss prevention and minimisation in the general (non-life) insurance industry (IRDAI, 2022[239]).

the unique characteristics of the insurance business model (such as a heavy reliance on data) are taken into account by policymakers and regulators responsible for setting data localisation requirements, with the aim of ensuring appropriate exceptions where necessary.

Box 4.3. International efforts to build trust in cross-border data flows

The *OECD Recommendation concerning Guidelines Governing the Protection of Privacy and Transborder Flows of Personal Data* was adopted by the OECD Council in 1980. It establishes a set of basic principles for application in national data protection and privacy regulation (principles, such as limits to collection, purpose specification and consent for use, that have been applied in most national regulation) as well as a recommendation to refrain from restricting the transborder flow of personal data to countries that observe these basic principles and implement sufficient safeguards to ensure data protection (OECD, 2013[142]). To reinforce their commitment to enabling cross-border data flows in the context of significant remaining barriers across countries, a number of OECD and non-OECD countries issued a *Declaration on a Trusted, Sustainable and Inclusive Digital Future* in 2022 that includes a commitment to strengthen efforts to identify commonalities, complementarities and elements of convergence between existing regulatory approaches and instruments with the aim of enabling data to flow with trust, including across borders (OECD, 2022[143]). These countries also issued a *Declaration on Government Access to Personal Data Held by Private Sector Entities* aimed at establishing some principles for ensuring appropriate safeguards for government access to personal data when fulfilling responsibilities related to national security and law enforcement (identified as a gap in building trust in cross-border data flows) (OECD, 2022[144]).

OECD members have also developed reciprocal arrangements to enable cross-border data flows. The European Union and the United States have negotiated an agreement to facilitate the transfer of personal data ("EU-US Data Privacy Framework"). The agreement, which is not the first data transfer agreement between the two jurisdictions, was implemented in July 2023 as a result of an adequacy decision by the European Commission. The agreement allows for the transfer of personal data to organisations in the other jurisdictions that commit to adhere to and certify adherence with set of principles related to the protection of transferred data. Switzerland and the United Kingdom also participate in the agreement allowing for the transfer of personal data to certified US organisations (International Trade Administration, n.d.[145]; Kowalski and Dimitrov, 2023[146]; Kowalski and Mackenzie, 2023[147]).

Restrictions on foreign participation in domestic insurance markets can also have an impact on access to data and technology. International insurers and reinsurers can be an important source of data and analytical tools to enhance underwriting and pricing of insurance. A number of the insurers interviewed in India, Indonesia, Malaysia and Nepal had accessed data, analytical tools and policyholder engagement platforms provided by international (re)insurers, including global reinsurers, joint venture partners and parent or group companies (as part of an internationally-active insurance group).[65] Internationally active (re)insurance groups and companies often have the economies of scale to invest in new technology and also benefit from experience with risk assessment and risk reduction solutions implemented around the world (in both advanced and emerging markets).

[65] The insurers interviewed provided a number of examples of data or technology provided by global reinsurers, joint venture partners and parent companies, including accelerated underwriting engines in life insurance, risk maps and risk scoring, catastrophe models and health and wellness platforms.

However, India,[66] Indonesia,[67] Malaysia[68] and Nepal[69] have all implemented some form of mandatory or preferential cession to domestic reinsurers which could have an impact on the participation of foreign reinsurers in assuming domestic risk (and transferring data and technology).The restrictions vary in terms of their impact on insurer access to international reinsurance markets and – as noted – insurers in all four countries are receiving data and technology from foreign reinsurers. However, a few of the insurers interviewed indicated that restrictions or limits on risk transfer to international reinsurers could have a negative impact on access to data on technology. India, Indonesia and Malaysia also apply ceilings on the foreign ownership share of insurance companies (80% in Indonesia[70], 70% in Malaysia and 74% in India) which could have an impact on foreign insurer participation in the domestic market (although foreign insurers are present in all three markets).

Establishing regulatory sandboxes or innovation hubs

A number of jurisdictions have established regulatory sandboxes or innovation hubs (or both) to support the adoption of new technologies in insurance (or financial services more broadly) and also to provide insights into any regulatory or supervisory impediments to technology adoption. Regulatory sandboxes71 usually provide participating entities with an opportunity to test new approaches or business models for a specified period of time, often with some flexibility in the application of regulatory or supervisory requirements. Innovation hubs72 provide companies with a single point of contact to support innovation and respond to questions about how regulatory and supervisory requirements might apply. Regulatory sandboxes can provide a number of benefits, including: (i) opportunities to learn from industry about any challenges to technology adoption and facilitate technology adoption (including a means for providers to test the viability of their approach); and (ii) a means to identify potential regulatory or supervisory

[66] In India, insurers are required to cede a portion of their risk to GIC Re and to allocate cessions based on an order of preference favouring placements with GIC Re, Foreign Reinsurer Branches and International Financial Services Centre Insurance Offices (IRDAI, 2023[240]).

[67] In Indonesia, requirements to place 100% of “simple risks” and a minimum amount of “non-simple risks” have been removed although the increased ability to assume risk from Indonesian insurers only applies to foreign reinsurance companies domiciled in a country that has a bilateral agreement that incorporates provisions related to reinsurance access (OJK, 2020[241]).

[68] In Malaysia, insurers are required to cede a portion of their risk to Malaysia Re and also accord priority to optimising Malaysia insurance capacity.

[69] In Nepal, insurers have been required to cede a portion of their risk to local reinsurers although this is being gradually replaced by a right of first refusal to be granted on all cessions to two domestic reinsurers.

[70] The foreign equity participation of insurance companies, including reinsurance companies is governed by *Government Regulation (GR) No.3/2020* (a revision to Government Regulation No.14/2018). For non-listed companies, the maximum foreign equity participation is 80% although ownership of more than 80% is allowed if a higher share of foreign ownership existed when the regulation was enacted. There are no restrictions related to foreign ownership of listed companies.

[71] Regulatory sandboxes for insurance (or applicable to insurance) have been established in Canada (Ontario – “Test and Learn Environments”), Colombia, India, Indonesia, Greece, Japan, Lithuania, Malaysia, Mexico, Philippines, South Africa, Chinese Taipei, Thailand, United Kingdom and various US states (including Kentucky, South Dakota, Utah, Vermont, and West Virginia).

[72] Innovation hubs (or contact points for companies wishing to implement innovative business models) have been established in Belgium (contact point for FinTech), Bulgaria, Colombia, Estonia, Germany, Poland, Portugal, South Africa, United Kingdom, United States (all states have a designated contact point to address issues related to regulatory implications in applying emerging technologies).

adaptations that may be required[73] to encourage the adoption of emerging technologies or new business models as well as to identify and mitigate potential risks. Similarly, innovation hubs can provide a forum in which to identify potential impediments to technology application and possible regulatory and supervisory adaptations.

Insurance regulators and supervisors that wish to promote technology adoption and innovation in insurance may wish to consider the establishment of an innovation hub, regulatory sandbox or both. Operating both an innovation hub and a regulatory sandbox may offer a potential continuum for companies wishing to develop a business plan that will meet (sometimes adapted) regulatory and supervisory requirements and then to test that plan.

Most sandboxes incorporate an application process with specific criteria for participation, time limitations on testing, limits on the scale of business transacted (e.g., limited number of customers or amount of premium collected) and intensive and continuous supervisory engagement with participating entities. Some jurisdictions also require participants to have clear strategies for exit from the sandbox (to become entities subject to standard regulatory and supervisory requirements). Table 4.1 provides an overview of some of main design elements included in the regulatory sandboxes established in India, Indonesia and Malaysia (a regulatory sandbox has not been established in Nepal).

Table 4.1. Regulatory sandbox design elements in India, Indonesia and Malaysia

	India	Indonesia	Malaysia
Criteria for participation	Demonstrate that the solution will help increase insurance penetration or provide enhanced services to policyholders; Must be a genuine innovation, not just a request for regulatory relaxation; Involvement of a licensed insurer; Specification of regulatory provisions that would need to be relaxed; Identification of potential risks;	Innovative and future-oriented; Uses ICT to provide financial services to consumers; Supports financial inclusion and literacy; Useful and widely used; Integrated into financial services that exist; Involves a collaborative approach; Considers consumer protection and data protection;	Solution is genuinely innovative (improves accessibility, efficiency, security, quality; enhances risk management; or addresses gaps in financial services); Usefulness of solution and potential risks have been assessed; Necessary resources and expertise to support testing; Realistic exit plan; Incompatibility with laws, regulations or standards administered by Bank Negara Malaysia; Led and managed by persons with credibility and integrity.
Types of regulatory exemptions	IRDAI may consider granting limited regulatory relaxation (except for requirements set out in legislation and with limits on the relaxation of requirements related to policyholder protection and grievances) (subject to the approval of the IRDAI Chair).	OJK can provide flexibility for non-prudential OJK requirements only (subject to the approval of the relevant supervisory unit at OJK).	Regulatory flexibility may be granted for laws, regulations or standards administered by Bank Negara Malaysia.
Duration of testing	36 months (initial) with possibility of extension to 48 months	12 months with a possible extension of 6 months if need for improvements	12 months with possibility of extensions subject to prior written approval
Limits on scope of testing	100 000 customers INR 50 million in premiums collected	No specific limits established in regulation	Bank Negara Malaysia may limit the scope of testing such as the number of customers participating or the aggregate

[73] There are a number of examples of specific regulatory or supervisory adaptations that have been implemented as a result of experience gained through the sandbox. For example, in Colombia, changes were made to requirements related to the management of anti-money laundering risks as a result of lessons from two insurance-related projects tested in the sandbox. In Lithuania, peer-to-peer insurance guidelines were developed based on the experience of a peer-to-peer insurance platform tested in the sandbox.

			value of transactions
Consumer protection requirements	Disclosure to consumer of participation in a sandbox test and written consent on willingness to participate.	No specific consumer protection requirements (basic consumer protection principles apply)	Disclosure of potential risks to consumers and confirmation that risks are accepted by consumer; Inclusion of a consumer redress mechanism;

Source: (Bank Negara Malaysia, 2016[148]), (IRDAI, 2022[149]), (IRDAI, 2023[150]), (OJK, 2018[151])

There are differences in terms of the relevance for – and participation of – licensed insurance companies in regulatory sandboxes in different countries. For example, in India, applications for participation in the regulatory sandbox require the involvement of a licensed insurance company and many of the licensed insurance companies interviewed in India had experience with sandbox testing of new products or approaches. In Indonesia and Malaysia, insurance companies that were interviewed had more limited experience participating in regulatory sandbox testing. Bank Negara Malaysia has released an exposure draft with enhancements to the Fintech Regulatory Sandbox Framework aimed at encouraging greater participation by licensed insurance companies, particularly through the establishment of an "Innovation Green Lane" that will provide financial institutions with demonstrated risk management capacity with a quicker and simpler way to test new approaches and solutions on a continuous basis (Bank Negara Malaysia, 2023[152]). Some insurers interviewed in Malaysia expected the Innovation Green Lane would bring more testing of innovative approaches by licensed insurance companies.

There may be some advantages in introducing some flexibility into the limits on duration for testing approaches in the sandbox. Short testing periods might not allow for a comprehensive evaluation of the viability and consumer acceptance of new products or solutions. In India, some insurance companies noted concerns with the six-month testing period initially included in IRDAI's regulatory sandbox as insufficient to evaluate the viability of some approaches or products – and support for recent changes that would allow for longer testing periods to 36 months (with a possibility for extension to 48 months). Flexibility to extend the duration of testing may also be necessary in cases where a regulatory change would be required to introduce the product or solution into the broader market (i.e., outside the sandbox environment). A longer duration may also be necessary in cases where a new product tested in the sandbox environment would require a (potentially lengthy) prior product approval for distribution to the broader market.

The integration of beneficial approaches or products tested in the regulatory sandbox into the regulated insurance market should be the ultimate objective of a regulatory sandbox. Where products or approaches have proven to be successful and beneficial for consumers, insurance regulators and supervisors should be willing and able to make changes to the regulatory or supervisory framework to allow for the continuation of the approach or product once the testing period has ended. The regulatory sandboxes in India, Indonesia and Malaysia have led to the introduction (or ongoing testing) of a number of new products and approaches, including digital distribution platforms/product aggregators, digital insurers (and micro-insurers), peer-to-peer insurance and takaful solutions, usage-based insurance products (such as telematics in motor vehicle insurance), use of artificial intelligence in claims adjustment and the introduction health and wellness platforms and loyalty programmes (amongst others). Box 4.4 provides some features of regulatory sandboxes that may be effective in supporting the testing and ultimate introduction of innovative and beneficial insurance products and solutions.

Box 4.4. Regulatory sandboxes: effective design features

Designing an effective approach to implementing a regulatory sandbox requires consideration of some of the following elements:

- Applicants should be required to demonstrate that the proposed product or approach is truly innovative and has potential benefits for consumers and that there are specific regulatory or supervisory impediments to the implementation of their product or approach;
- Regulatory sandboxes that encourage licensed insurance companies to apply for participation seem to be more successful in terms of volume of pilots and successful exits;
- Time and scope limitations may need to be flexible to allow for the testing of approaches or products where a longer evaluation period or larger population sample may be required to demonstrate viability and where regulatory amendments or prior product approvals will be required for broader introduction; and
- Insurance regulators or supervisors should be willing and able to make changes to the regulatory or supervisory framework to allow for introduction of insurance products or solutions that have been demonstrated as viable and beneficial for consumers once the testing period has ended.

Bank Negara Malaysia has issued an Exposure Draft on a *Licensing and Regulatory Framework for Digital Insurers and Takaful Operators* (DITO) which is aimed at further encouraging digital innovation in the insurance and takaful sector, complementing Bank Negara Malaysia's other initiatives on digitalisation in the financial sector. The framework seeks to facilitate the entry of DITOs that can deliver strong value propositions related to inclusion, competition and efficiency to address critical protection gaps and better serve the needs of the consumers (Bank Negara Malaysia, 2022[153]).

Monitoring and responding to financial exclusion

One of the risks of more accurate risk assessment supported by new data sources and more sophisticated analytical tools could be that insurance coverage becomes unaffordable for those facing high risks – which, as noted above – is likely to include consumers belonging to vulnerable groups (although, as noted above, more accurate risk assessment can also result in increases in access to coverage for some groups that had previously been excluded).

Insurance regulators and supervisors can respond to the potential for financial exclusion as a result of technology application by requiring insurance companies wishing to use such tools to provide evaluations on the impact on financial inclusion/exclusion. The application of technological approaches that exacerbate financial exclusion without offering significant benefits in terms of efficiency, incentives for risk reduction or other consumer or societal benefits should be discouraged or prohibited. However, to the extent that financial exclusion results from improved assessment of risk, other measures to support risk reduction may be a more effective approach to responding to financial exclusion than restricting the use of granular risk-based pricing. Governments likely have a role in providing support for individuals or groups that are excluded from access to affordable insurance coverage based on their level of risk. Insurance supervisors have a role in monitoring and identifying risks to financial inclusion.

Building trust in the application of technology in insurance

Ultimately, the application of technology in insurance underwriting, pricing and support for risk reduction will only be successful if consumer's have trust that it will lead to outcomes that benefit consumers (whether in terms of lower pricing or improved services). Some consumer surveys have found significant concerns about the use of external data and analytical tools based on artificial intelligence and machine learning in the delivery of insurance.[74] Consumer concerns related to the application of new technologies in insurance appear to be driven by a variety of factors, including a mistrust in decision-making using the technology, loss of human interaction, a lack of transparency related to the insurers' use of artificial intelligence and data privacy concerns (Sprout.ai, 2023[154]). Assurances that data would be kept safe and secure and that it would only be used when necessary or only in the policyholders' best interest[75] along with incentives in terms of reduced premiums or discounts (see Box 3.1) could increase consumer comfort and willingness to share data with insurers.

Trust in technology and the importance of data privacy clearly varies across countries. One examination of digital trust suggests that the major drivers of digital trust relate to cultural/generational attitudes (for example, higher levels of trust among younger generations) – as well as on factors related to how technologies are implemented such as in providing ease of use and access to the internet as well as artificial intelligence explainability and data ethics and privacy (Woodward, Chatterjee and U, 2023[155]).

The insurance sector clearly has an important role to play in building consumer trust in how they use personal data and apply technology in making decisions on coverage eligibility, pricing and claims settlement. Governments can support consumer trust by ensuring the implementation of a legislative framework that protects data and privacy and limits unfair or unlawful discrimination, consistent with societal values. Insurance regulators and supervisors can support consumer trust by building financial literacy related to insurers' obligations in protecting personal data and delivering fair outcomes, while ensuring appropriate consumer protections are in place – potentially as part of insurance-specific guidance on the use of external data and analytical tools based on artificial intelligence and machine learning.

[74] For example, one survey of consumers in the United Kingdom and United States (focused on claims settlement) found that only 9% would prefer to choose an insurer that uses artificial intelligence while 36% would specifically select an insurer that was not using this technology (the use of artificial intelligence would have no impact on the decisions of 33% of survey respondents) (Sprout.ai, 2023[154]).

[75] For example, a set of surveys of consumers in Canada, the United States and a number of European countries examined factors that would provide consumers with greater comfort in sharing data with their insurers - just under half indicated that assurances that data would be kept safe and secure would make consumers feel safe to share data while approximately one third indicated that assurances that the data would only be used when necessary or only in the policyholders' best interest would provide the necessary comfort (Capco, 2023[76]; Capco, 2023[77]; Capco, 2023[78]; Capco, 2023[79]; Capco, 2023[80]; Capco, 2023[81]).

Box 4.5. Responding to financial education and consumer protection implications of digitalisation

The G20/OECD International Network on Financial Education (INFE) and the G20/OECD Task Force on Financial Consumer Protection have developed guidance for authorities with responsibility for supporting financial literacy and enforcing consumer protection requirements on empowering and protecting financial consumers in the context of increasingly digitalised delivery of financial services. It includes ensuring that financial consumers are aware of the potential for their online activities to be used in decisions on access to financial services and the consequences of decisions to share personal information with financial institutions. In terms of financial consumer protection, the guidance outlines measures that authorities can take to enhance digital security, protect consumers' assets, data and privacy, as well as enhancing disclosure and transparency relating to collection and use of consumers' personal information.

Source: (OECD, 2020[156]; OECD, 2020[157])

One aspect of building trust in the use of data in risk assessment, underwriting and pricing could be to develop clear guidance on the types of data that can be used for this purpose. As noted above, many jurisdictions have anti-discrimination laws that have established a set of protected characteristics that cannot be used in determining eligibility for coverage or setting pricing for coverage. However, not all jurisdictions have established such rules.

There may also be a need to establish insurance-specific guidance to ensure that only factors that are generally considered to be fair or ethical and that are consistent with generally accepted actuarial principles related to appropriateness and causality can be considered in underwriting and pricing decisions. Consumers will have a view on what types of factors might be considered fair for the purposes of insurance coverage decisions. For example, in the United States, a survey of consumer views on rating variables in household property and (personal) motor vehicle insurance found more favourable perceptions of rating factors that are (at least perceived to be) directly related to the risk.[76]

Different countries will have different societal perceptions on what data should be ineligible for use in underwriting and pricing. Insurance regulators and supervisors (if not policymakers) can play a role in ensuring that these societal preferences are respected. This role will become ever more important in the context of increasing access to data. Some areas that likely warrant further examination could include the use of genetic testing (as such testing becomes more available and affordable) as well as the use of data gathered through the delivery of risk reduction services (e.g., health questionnaires and wearables).

[76] For example, in the case of household property insurance, factors related to the presence of safety systems (such as smoke detectors) and the physical condition of the home were generally considered fair while factors related to the condition of surrounding buildings, the profile of the insured occupant and the length of time with the insurer or data from connected devices were seen as unfair or somewhat unfair by close to 40% of respondents (Insurance Research Council, 2023[237]).

5 Conclusion

The adoption of new technologies and innovation in the insurance sector has the potential to improve insurer risk assessment and increase the contribution of insurance to risk reduction. Drawing on the responses to questionnaires from insurance regulators and supervisors and (re)insurance companies and intermediaries from across the world as well as the detailed interviews with insurance regulators and supervisors and (re)insurance companies and intermediaries in India, Indonesia, Malaysia and Nepal, this report has examined: (i) the application of new data sources, analytical tools and engagement platforms in insurance risk assessment and support for risk reduction; (ii) potential challenges to technology adoption related to access to skills, technology and data as well as to horizontal and insurance-specific legislation, regulation and supervision; and (iii) potential good practices for creating and enabling environment to support the adoption of technology while mitigating potential risks for consumers.

Insurance companies are increasingly leveraging external data sources to supplement “traditional” data and applying analytical tools based on artificial intelligence and machine learning to their risk assessment, underwriting and pricing decisions. They are also developing engagement platforms to deliver risk mitigation advice and services to policyholders. However, they are also facing a number of challenges, including limited access to skills and particularly the data and technology necessary to incorporate external data and advanced analytical tools. In some countries, insurance regulation and supervision also create impediments or disincentives for technology adoption, particularly as a result of restrictions on pricing that reduce the benefits of investing in new risk assessment capacities as well as emerging requirements related to digital security and outsourcing arrangements – which are sometimes applied more broadly across the economy.

Harnessing the benefits of technological developments to improve risk assessment and risk reduction advice and services may require insurance regulators and supervisors to adapt existing regulatory and supervisory frameworks to allow for the implementation of new approaches, while taking measures to continue to ensure that policyholders are sufficiently protected from unfair discrimination, breaches of their privacy and financial exclusion. The report provides a set of potential good practices for creating an an enabling environment that supports the adoption of technology in insurance and mitigates risks to consumers, by (i) addressing excessive restrictions and disincentives to applying new data sources and analytical techniques to underwriting and pricing ; (ii) reviewing restrictions to insurers’ ability to provide risk reduction advice and services to policyholders; (iii) supporting access to data and technology; (iv) establishing regulatory sandboxes or innovation hubs to support the introduction of new approaches, products and services with potential benefits for consumers; (v) monitoring and responding to financial exclusion; and (iv) building trust in the application of technology in insurance.

The insurance sector clearly has an important role to play in building consumer trust in how they use personal data and apply technology in making decisions on coverage eligibility, pricing and claims settlement. Governments can support consumer trust by ensuring the implementation of a legislative framework that protects data and privacy and limits unfair or unlawful discrimination, consistent with societal values. Insurance regulators and supervisors can support consumer trust by building financial literacy related to insurers’ obligations in protecting personal data and delivering fair outcomes, while ensuring appropriate consumer protections are in place.

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