SOUTH AFRICAN ACTUARIAL JOURNAL
SAAJ **23** (2023) 23–58
https://dx.doi.org/10.4314/saaj.v23i1.2

The contribution of insurers to systemic risk: A practical framework for regulators

By RD Rusconi, FJC Beyers and NM Walters

Submission date 27 April 2023
Acceptance date 8 November 2023

ABSTRACT
While insurers are not typically the most significant contributors to systemic risk, their actions and behaviour may materially contribute to such risk. This study considers the models that may be used to detect systemic risk originating in the insurance market and proposes a framework for identifying and classifying the sources of systemic risk attributable to insurers. It applies this framework to the insurance market in South Africa, in the process providing practical recommendations for consideration by all regulators.

JEL CLASSIFICATION
C19, C63, D62, G22, G28

KEYWORDS
Insurance, systemic risk, risk classification and modelling

CONTACT DETAILS
RD Rusconi, Department of Actuarial Science, University of Pretoria, Pretoria, South Africa
Email: robert.rusconi@up.ac.za; ORCID: 0000-0002-9566-5405
FJC Beyers, Department of Actuarial Science, University of Pretoria, Pretoria, South Africa
Email: conrad.beyers@up.ac.za; ORCID: 0000-0002-2870-4718
NM Walters, Department of Actuarial Science, University of Pretoria, Pretoria, South Africa
Email: nadine.walters@up.ac.za

1. INTRODUCTION

1.1 Systemic risk is the possibility of weakness of or contagion within the financial system, with potential spillover into the wider economy (Acharya et al., 2017; Bisias et al., 2012; Kessler, 2014; Weiß & Mühlnickel, 2014). Financial-sector regulators typically include among their objectives the goal of identifying and mitigating the potential for systemic risk (Brunnermeier et al., 2009; IMF, 2018; NTSA, 2011). South Africa's framework for regulating financial-sector entities is generally strong (IMF, 2022e), but exposure to systemic risk is nevertheless high (IMF, 2022c, e).

1.2 Insurers are generally regarded as unlikely to contribute as much to systemic risk as their banking counterparts, largely on the basis that insurers do not engage in peer-to-peer transactions to the same extent as banks (refer to the summary of the literature in Section 2). The potential for insurers to be systemically risky entities is nevertheless not immaterial (Baluch et al., 2011; Bierth et al., 2019; Cummins & Weiss, 2014; Eling & Pankoke, 2016; Schwarcz & Schwarcz, 2014, for example, refer to Section 2.3) and should be guarded against by regulators.

1.3 The South African Reserve Bank includes observations on the potential contribution by the insurance sector in its reviews of financial stability (see SARB, 2021b, 2022, for example). In the United Kingdom, a spike in government bond yields led to severe liquidity pressure on liability-driven investment arrangements, some of which were managed by insurers, triggering Bank of England intervention (Chen & Kemp, 2023; Financial Stability Committee, 2022; Pinter, 2023). These events, following shortly after the generally positive views of the IMF regarding the capacity of the insurance sector to absorb even large increases to interest rates (IMF, 2022a), serve to illuminate the systemic significance of insurance markets, as part of the wider non-bank financial sector.

1.4 This paper proposes an approach to identifying the sources of systemic risk arising in the insurance sector. The approach is based on a classification system that is developed from a survey of the available literature and examination of the corresponding frameworks proposed by others. It contributes to the literature on systemic risk attributable to insurers by proposing a practical approach to identifying the sources of such risk arising in insurers across the market. It applies this approach to the South African insurance environment by considering those sources of risk that have been acknowledged by several insurers and recommending regulatory action to detect the possibility of other sources of systemic risk across the framework.

1.5 Several quantitative approaches to assessing levels of systemic risk have been developed (see Section 3.4, in particular the literature summaries by Silva et al. (2017) and Ellis et al. (2022)). Practical constraints limit the effectiveness with which such approaches may be applied to insurers (refer to the considerations set out in Section 4.4). This study aims to provide pragmatic approaches to insurance regulators to mitigate these constraints.

 © ASSA licensed under CC 4.0

Improving the effectiveness of the available qualitative approaches for identifying the sources of systemic risk attributable to insurers contributes to a more robust understanding of the nature of this risk that might be supported by such modelling.

1.6 Section 2 describes the objectives-based approach to financial-sector regulation and summarises the literature on the question of the insurer contribution to systemic risk. It also describes South Africa's insurance market. Section 3 sets out the methodology underpinning the research. It describes the development of the framework proposed for identifying and classifying the sources of systemic risk attributable to insurers. It also summarises the financial models available for detecting such risk quantitatively and considers the appropriateness of these models to meeting regulatory objectives. Section 4 summarises the results of the analysis. It demonstrates how this framework may be utilised by describing a survey of South Africa's insurers to identify the extent to which some of these sources of risk have been acknowledged already. Section 5 concludes, setting out thoughts on potential supporting research.

2. BACKGROUND

The discussion in this section provides a foundation to the analysis that follows. It describes the widely adopted position of financial-sector regulators that their approach should be directed by a set of regulatory objectives, one of which should be to mitigate the impacts of systemic risk. It then turns to the question of whether insurers contribute materially to systemic risk and how they might do so. The section closes with a description of South Africa's insurance market.

2.1 Objectives-based financial-sector regulation

2.1.1 Financial-sector regulation has been subject to significant development over the last two or three decades (Atack, 2009; Black, 2004; FSA, 2006, 2007; Llewellyn, 1999). Some of these changes have been stimulated by contemporary events such as the 2007–09 financial upheaval. The crisis drew considerable attention to the challenges of systemic risk and the inadequacy of the regulatory response to it (Grochulski & Morrison, 2014; OECD, 2010; Schwarcz, 2014).

2.1.2 Several regulators have adopted an objectives-based model to determine their priorities, for instance, those in Australia, the United Kingdom, Singapore and South Africa (APRA, 2014; FSA, 2007; MAS, 2015; NTSA, 2011). Under this approach, regulators identify the objectives of their intervention in financial markets and determine the actions considered most effective at meeting these objectives, taking into account the risks that regulation seeks to mitigate (Armour et al., 2016; Baldwin & Black, 2016; Black & Baldwin, 2010, 2012; Knot, 2014; Michael et al., 2010; Sinha, 2012).[1]

2.1.3 The success or failure of this approach could prove highly significant to the financial sectors and wider economies of the countries served by such regulations. Financial

1. Refer to Rusconi (2020) for a summary of the primary reasons for employing an objectives-based regulatory framework.

markets are critically important to the economies they serve (Merton, 1995; OECD, 2010; World Bank, 2012), but they are also characteristically complex, fragile and changeable (ADB, 2017; Erskine, 2014; European Central Bank, 2012; Schmukler, 2004; Tagoe, 2016).

2.2 Defining systemic risk

A well-established objective in many markets is the prevention or mitigation of systemic risk (Brunnermeier et al., 2009; Carvajal et al., 2009; Grochulski & Morrison, 2014; IMF, 2013, 2014b, 2018). Achieving this objective calls for a strong understanding of the nature of the risk, its origins and its channels of propagation. It also requires sound comprehension of the way alternative forms of intervention might prevent the occurrence of this risk or mitigate its effects (Baldwin & Black, 2016; EIOPA, 2017, 2019a,b; OECD, 2010), helping regulators to understand which of their available actions might best meet their stated objectives.

Since one of the objectives of financial-sector regulation is to mitigate the impacts of systemic risk, defining this risk unambiguously is important. Several researchers have grappled with this problem, with limited success (Claessens, 2015; Eling & Pankoke, 2016; European Central Bank, 2010; Galati & Moessner, 2014; Hansen, 2013). A joint statement of the International Monetary Fund, Bank for International Settlements and Financial Stability Board to the G20 (IMF et al., 2009: 2) describes systemic risk as "a risk of disruption to financial services that is (i) caused by an impairment of all or parts of the financial system and (ii) has the potential to have serious negative consequences for the real economy."

The following characteristics might be considered to represent broad consensus on the attributes of systemic risk (Acharya et al., 2017; Bisias et al., 2012; Cummins & Weiss, 2014; De Bandt & Hartmann, 2000; Eling & Pankoke, 2016; Georg, 2011; Harrington, 2009; Kessler, 2014; Nier et al., 2007; Safa et al., 2013; Weiß & Mühlnickel, 2014): (1) preconditions of widespread market connectedness or interdependence, (2) substantial loss of confidence leading to economic losses, (3) extensive adverse impacts on financial entities and (4) market failure, often resulting in considerable adverse impact on the wider economy. Underpinning this paper is the view that regulators should strive to understand the dynamics of systemic risk in their markets and to enhance their ability to detect any warning signs that such risk may be rising.

2.3 Insurer contribution to systemic risk

2.3.1 The discussion turns next to the question of whether insurers, individually or collectively, contribute substantially to systemic risk.[2]

2.3.2 It is widely accepted that the contribution to systemic risk by insurers is generally weaker than the corresponding contribution by banks. The primary reasons for this are that insurers are less likely to provide and demand financial support from peers and insurers

2. Eling & Pankoke (2016) provide a thorough meta-analysis of the literature concerned with the contribution of insurers to systemic risk. Refer to Rusconi (2020) for a more detailed consideration of the contribution by insurers to systemic risk with particular application to South Africa.

 © ASSA licensed under CC 4.0

typically retain on their balance sheets, hence transparently report, potentially risky financial activities (Baluch et al., 2011; Bierth et al., 2019; Billio et al., 2012; Bobtcheff et al., 2019; Eling & Pankoke, 2016; Kaserer & Klein, 2019; Kessler, 2014; Van Lelyveld et al., 2019).

2.3.3 Several other reasons for this position may be added to these. Insurers are generally well regulated (Cummins & Weiss, 2014). Claims are typically dependent on random events rather than on customer behaviour (Baluch et al., 2011; Cummins & Weiss, 2014; Kessler, 2014) and are payable over an extended period (Cummins & Weiss, 2014; IAIS, 2011; Kessler, 2014; Trichet, 2005). Premiums are largely payable in advance (Cummins & Weiss, 2014; Kessler, 2014; Trichet, 2005). Fees on lapses mitigate the risk of customer runs attributable to deteriorating confidence (Kessler, 2014). Product substitutability is generally high (Cummins & Weiss, 2013, 2014), business lines are separable and entity risks are typically idiosyncratic and uncorrelated (IAIS, 2011). Inter-connectedness between insurers is low (Baluch et al., 2011; Cummins & Weiss, 2013; Grace et al., 2013; IAIS, 2011; Kessler, 2014; Trichet, 2005), risk transfer is typically hierarchical, not peer-based (Baluch et al., 2011; Besar et al., 2011; IAIS, 2011), external funding is available (Berry-Stölzle et al., 2014) and reinsurance bankruptcy can be absorbed (Park & Xie, 2014; Van Lelyveld et al., 2019). Insurer wind-up is generally a lengthy, orderly process (IAIS, 2009, 2010) because the liabilities in specific business lines can be isolated for sale or running down (IAIS, 2011). Finally, the insurance industry is more robust to economic adversity, in contrast to the corresponding experience of the banking industry (Berry-Stölzle et al., 2014).

2.3.4 Notwithstanding these mitigating factors, the contribution to systemic risk by insurers is potentially significant (Baluch et al., 2011; Bierth et al., 2019; Cummins & Weiss, 2014; Schwarcz & Schwarcz, 2014) and should not be ignored. This contribution, furthermore, may be exacerbated by the attributes, business activities or behaviour of insurers (Baluch et al., 2011; Bobtcheff et al., 2019; Cummins & Weiss, 2014; EIOPA, 2017; Eling & Pankoke, 2016; Koijen & Yogo, 2017; Weiß & Mühlnickel, 2014). These attributes, activities and behaviour represent the focus of this research, considering both the literature (Section 3) and evidence from the market (Section 4).

2.3.5 Furthermore, even if insurers do not originate systemic risk, they may propagate or magnify it, typically through collective reactions or decisions (EIOPA, 2017; IAIS, 2019). These might include the sale of assets that intensify market movements and contribute to volatility, transfers of losses to other market participants or the interruption of a critical function, in this case the insurance service, in the process exacerbating distress elsewhere in the economy (IAIS, 2019).

2.3.6 Insurers that form part of a financial group are generally more likely to contribute to systemic risk, particularly if one or more banks are also members of the group (Baluch et al., 2011; Hauton & Héam, 2015). Insurers are also impacted by their customers. They may contribute to systemic risk through the behaviour of policyholders, which is linked to the state of the economy or the condition of other financial institutions (Barsotti et al., 2016; Klein, 2012; Russell et al., 2013).

2.3.7 For the purpose of managing systemic risk, regulators must take care not to depend on even soundly-established micro-prudential regulatory methods. These methods

focus considerable attention on idiosyncratic risk at regulated entities, but may contribute to behavioural herding that could paradoxically increase systemic risk (Al-Darwish et al., 2011; Floreani, 2013; Rae et al., 2017; Swarup, 2012). Furthermore, the pursuit of diversification at entity level, encouraged by micro-prudential regulatory methods, could contribute to systemic risk (Acharya, 2009; Allen & Carletti, 2006; Checkley, 2009; Ibragimov et al., 2011; Wagner, 2010).

2.3.8 In summary, though insurance is typically less systemically risky than banking, regulators should be aware that insurers can indeed contribute to systemic risk. They may originate systemic risk through their attributes or activities. They may contribute to the propagation of systemic risk through their collective reactions to adverse events. They may exacerbate systemic risk through their links to other financial-sector entities, particularly banks.

2.3.9 Finally, scope remains for quantitative assessment of the respective contributions to systemic risk by individual entities (Acharya et al., 2012, 2017; Adams et al., 2014; Adrian & Brunnermeier, 2016; Brownlees & Engle, 2017; Bui et al., 2017; Fong et al., 2009; Gauthier et al., 2012; Giglio, 2016; Hautsch et al., 2015; Huang et al., 2012; Sedunov, 2016; Zhang et al., 2015), taking care to understand the drivers and transmission channels of systemic risk (EIOPA, 2017). However, attention should be given to the effectiveness with which the methods used to assess banks could be applied to insurers. This also forms part of the assessment described in this paper (see Section 3.4 and its application in Section 4.4).

2.4 South Africa's insurance market

2.4.1 South Africa's financial sector is large and sophisticated (IMF, 2014a, 2022e) with significant assets assessed against gross domestic product (IMF, 2014a). It is also complex, however, and concentrated, with high levels of inter-connectedness between banks and other financial institutions (IMF, 2008, 2014a, 2022e). Prudential regulation of financial-sector entities falls under the responsibility of the Prudential Authority, a division of the South African Reserve Bank (SARB). The Prudential Authority acknowledges explicitly its responsibility to identify and mitigate potential contributions to systemic risk, as part of the SARB and in partnership with the market-conduct regulator, the Financial Sector Conduct Authority (Prudential Authority, 2021).

2.4.2 The insurance sector is similarly large and complex, but it is also competitive, with a diverse range of business models (IMF, 2022c). Assets in life insurers (also termed long-term insurers) amount to some two-thirds of annual gross domestic product (Prudential Authority, 2019; Rusconi, 2020) and the non-life (short-term) insurance market is large and competitive (KPMG, 2022; Rusconi, 2020). The insurance industry is generally well regulated, implementing several significant recent enhancements (IMF, 2022c,e), has high levels of solvency (IMF, 2022c) and weathered the storm of the COVID pandemic relatively well (IMF, 2022e).

2.4.3 International observers have nevertheless noted several systemic risks related to South Africa's insurance sector. Among them are: considerable inter-connectedness of financial entitles (IMF, 2022c), dependence by banks on the liquidity provided by non-

bank institutions (IMF, 2022e), large equity holdings by insurers (IMF, 2022c), high rates of lapses and surrenders by policyholders (IMF, 2022c), high dependence on the accuracy of the assumptions underlying the modelling of idiosyncratic risk in insurers (IMF, 2022c) and, together with other financial institutions, relatively high holdings of sovereign debt (IMF, 2022d). The IMF notes as well concerns regarding inadequate transparency of the Financial Stability Committee (IMF, 2022e, f) and the potentially adverse impacts of systemic governance weaknesses uncovered in the public- and private sectors (IMF, 2022b).

3. DESCRIPTIVE FRAMEWORK

3.1 Introductory comment

3.1.1 The literature exploring the nature of systemic risk and the manner of its propagation (see Section 2) suggests that the contribution of banks to systemic risk is generally greater than that of insurers. By the nature of the financial interactions between entities, the banking system both propagates and absorbs risk. Insurers typically do not operate in this manner. They absorb risk from their customers, but they redistribute this risk in a hierarchical structure, commonly through reinsurers. They are required to hold capital that is more than sufficient to back this risk and they typically retain all of their risk on their balance sheets.

3.1.2 The insurer contribution to systemic risk, however, is not immaterial, as summarised in Section 2 and discussed in more detail in this section. As regulated entities do not have the same economic incentives to mitigate externalities as they do to manage the risks that would impact their businesses directly (Schwarcz, 2008), regulators have the responsibility to mitigate systemic risk arising from these entities. In order to do this, they should seek to understand the nature of the contribution by insurers to systemic risk, through their attributes, business activities or behaviour, in the process identifying and mitigating this contribution to systemic risk. This is the subject of this article.

3.1.3 A survey of the literature exploring the contribution of insurers to systemic risk was undertaken. This utilised available literature reviews (notably (Cummins & Weiss, 2014; Eling & Pankoke, 2016), but original sources were scrutinised to ensure a sound understanding of the identified risk. The primary difficulty encountered was making sense of these risks by classifying them in a coherent form. The discussion that follows describes efforts to understand qualitatively the nature of this contribution and considers existing approaches to classifying these risks. It then proposes an alternative system of classification that could enhance the effectiveness by regulators of the management of systemic risk originating at or propagated by insurers. The final part of this section describes the corresponding quantitative methods available for assessing these risks and considers some of the difficulties of these methods.

3.2 Qualitative analysis: existing models

3.2.1 The European Insurance and Occupational Pensions Authority (EIOPA, 2017) suggests that systemic risk events and their impacts should be considered in two broad ways. Systemic risk may be introduced to markets directly, typically because of the failure of a significant insurer or group of insurers. This may be referred to as an entity-based source.

Alternatively, it may be indirect, activity-based or behaviour-based, under which the risks triggered by an outside set of events are propagated through the system by insurers either through their activities or through their reaction to events or the actions of others.

3.2.2 Entity-based risks are managed through existing micro-prudential approaches that are designed to identify and mitigate weaknesses in the risk-management systems of individual insurers. Several researchers have questioned the effectiveness of existing largely micro-prudential approaches for identifying systemic risks, in some cases arguing that these approaches stimulate herding behaviour that magnifies systemic risk (Al-Darwish et al., 2011; Floreani, 2013; Rae et al., 2017; Swarup, 2012). This, however, is only one part of the EIOPA (2017) approach.

3.2.3 Examples of indirect activity-based sources identified by EIOPA (2017) include financial guarantees to customers, securities lending and derivative trading not concerned with hedging risk. Widespread use of strategies such as these should be a signal to regulators of elevated levels of systemic risk. Behaviour-based sources of risk under the EIOPA (2017) framework include (1) collective behaviour, like fire sales or herding, that may sharpen movements in market prices, (2) imprudent risk-taking or concentration of assets or liabilities, and (3) inadequate provisioning or under-pricing, typically under pressure from competitors. Adding to systemic tendency, these behaviours may be linked to market conditions like elevated competition, a search for yield or other asset-side herding behaviour, and moral hazard problems such as the too-big-to-fail risk.

3.2.4 The EIOPA (2017) model focuses not just on the sources of systemic risk, but the channels of transmission. These channels serve to amplify the propagation of systemic risk through financial markets. Such channels include linkages to banks and other financial institutions, asset liquidation risks and the use of bank-like products such as investment guarantees and options embedded in insurance products.

3.2.5 An effort was made to allocate all of the insurance-related risks identified in the literature to the EIOPA framework by identifying a type (entity, activity or behaviour) and nature (driver or transmitter). This proved difficult. Some risks impact insurers but originate outside of the insurance industry. Climate change, which impacts asset prices and insurance liabilities, is an example of such a risk. These risks could be excluded from the framework. Alternatively, to capture risks like this, the EIOPA framework could be modified to include, under the type, an impact, and, under the nature, a contributor. In other cases, choosing the most appropriate type or nature was difficult. Though a mapping of all of the risks identified in the literature (refer to Table 3 in Appendix B) to the modified EIOPA framework was completed, the consistency and reliability of the approach was considered unsatisfactory.

3.2.6 The International Association of Insurance Supervisors (IAIS) utilises a similar model, considering the origination and propagation of risks separately (IAIS, 2019). It identifies the primary sources of systemic risk in the insurance industry and the channels through which this risk may be transmitted to the wider economy. The most significant sources noted by the IAIS are (1) liquidity risk, (2) exposure to economic factors and to counterparties and (3) the effects of limited substitutability of essential products or services of one or more insurers. The transmission channels considered by the IAIS include (1) depressed

 © ASSA licensed under CC 4.0

asset values resulting from fire sales, (2) economic impacts, through direct holdings in other financial entities or correlated experience with other institutions and (3) the interruption of critical functions.

3.2.7 An attempt was made to allocation each of the risks identified in the literature to the categories proposed by the IAIS, but this also proved challenging. In this case, the main problem experienced was that the IAIS categories are designed to incorporate the most significant systemic risks originated in or transmitted through the insurance industry. This made it inappropriate for the purpose of allocating a complete set of risks to these categories as several of the identified risks did not suit any of the available categories.

3.2.8 In view of the difficulties in allocating the identified risks to the categories proposed by either EIOPA or IAIS, an alternative classification system was developed.

3.3 Qualitative analysis: identifying and classifying insurance risks

The discussion that follows describes efforts to identify and classify the sources of systemic risk arising in or propagated by the insurance industry. This is undertaken through (1) a review of the literature to identify such sources and (2) an approach to classifying them into categories that would assist in the process of identifying any additional sources of or contributors to systemic risk.

3.3.1 Overall approach

3.3.1.1 Classification takes place in two stages. The first of these results from a survey of the literature and results in a broad set of categories. The output of this approach is set out in Table 3 in Appendix B. The second represents a more concise categorisation which is used to organise risks identified in annual reports by South African insurers. This is described in the next part of the paper, Section 4.

3.3.1.2 In the assessment of the sources of systemic risk attributable to insurers, no distinction is made between origination and transmission, primarily because of the overlap between the factors respectively impacting origination and transmission. Furthermore, no attempt is made to prioritise these factors. The intention, rather, is to assist the insurance regulator by providing a framework for identifying such factors. With this in mind, the approach aims to be collectively exhaustive, by exploring possibilities across as a wide front as possible, and mutually exclusive, by allocating factors to distinct categories.

3.3.2 Sources utilised

3.3.2.1 The sources considered include academic literature and publications by regulators, like the SARB, or regulatory umbrella organisations, such as the IAIS. Sources of systemic risk identified by international or regional bodies like the IAIS or EIOPA are considered sufficiently broad for general application, but locally identified risks should be reviewed as part of a study of country-specific sources of systemic risk. This explains the inclusion of sources identified by the SARB. In most cases, these add descriptive detail to risks already noted in the literature without materially adding to the list. They are also typically mirrored by the corresponding sources of risk identified by insurers, as described in Section 4.

© ASSA licensed under CC 4.0

3.3.2.2 Meta-analysis is also utilised, referring to the corresponding literature reviews of authors such as Eling & Pankoke (2016) and Cummins & Weiss (2014). All references to the potential sources of systemic risk attributable to insurers, or factors exacerbating the transmission of systemic risk are noted. Efforts to evaluate the significance of a risk are not captured on the basis of the subjectivity of approach. For the same reason, the frequency with which risks are mentioned is not recorded, the main difficulty in this case being the variations in wording that make it difficult to establish whether different risks are identified or the same risk repeated.

3.3.3 Approach to classifying systemic risks

3.3.3.1 As described in Section 3.2, difficulties were experienced in arranging and classifying the risks identified in the literature using available classification models and it was considered better to develop an alternative approach, with typical regulator approaches to identifying risks in mind. The approach proposed aims to assist regulators by aligning with existing methods for managing and mitigating insurance risk, categorising these risks first by balance sheet sector and then by the type of risk.

3.3.3.2 There are disadvantages to developing an approach similar to existing methods, the most important of which is that these methods are typically developed for micro-prudential purposes. Concerns are expressed by several researchers that the tendency of existing regulatory approaches to focus on idiosyncratic insurer-specific risk, not systemic risk, can exacerbate problems of systemic risk (Al-Darwish et al., 2011; Floreani, 2013; Ibragimov et al., 2011; Rae et al., 2017; Swarup, 2012; Wagner, 2010). This is mitigated by limiting the risks included in the framework to those identified as potentially systemic by credible sources in the literature. Significant overlap of these risks with the corresponding set of idiosyncratic risks is nevertheless likely, as many risks with potentially systemic attributes are also specific to individual insurers and could be identified and mitigated by these insurers.

3.3.3.3 The advantage of the proposed approach is that it is practical, fitting in with the existing framework and assisting regulators to extend that framework to identify and mitigate risks that may be systemic in their impacts.

3.3.4 Categories selected

3.3.4.1 Risk categories are chosen on two levels: that part of the balance sheet most impacted by the risk and the broad form that the risk takes. Under the first of these, five alternatives are used. These are assets, liabilities, asset-liability management (ALM), solvency and a general category. The first two are used respectively to classify risks that operate primarily to affect the assets or liabilities of an insurer. The investment of assets and its impact on investment returns is an example of the first type and concentration of insured risks of the second. The ALM category is used for risks that affect the balance between assets and liabilities. For example, an excessive reliability on short-term funding in the context of long-term liabilities can introduce or exacerbate a mismatch of assets to liabilities. Solvency is used to capture risks that most directly impact the financial viability of the insurer. The

 © ASSA licensed under CC 4.0

general category is used to capture risks that do not readily fall into other categories, typically covering risks of a strategic nature.

3.3.4.2 The second level of risk categories considers the broad type of risk: concentration of risk, a mismatch of the risk to its mitigation strategy, poor quality in product or investment, strategic risks, operational risks and general risks that do not fall into another category.

3.3.4.3 This approach aims to achieve objectives of collective exhaustion and mutual exclusivity most effectively, but it is affected by subjectivity. The meaning of researchers in characterising a risk could be misinterpreted. Two writers referring to the same risk may use different words, or the same terminology may be applied to risks that are actually distinct in their attributes. Subtle differences in wording can lead to misinterpretation regarding the nature of a risk or its application to different parts of a balance sheet. Some writers describe a risk in broad terms and others apply it more precisely to a specific area.

3.3.4.4 Consider the example of the substitutability of products, that is the breadth with which a particular offering is available across the market. This is identified by some writers in general terms (Cummins & Weiss, 2014; IAIS, 2018), while others note the impact of poor substitutability on industry capacity (IAIS, 2011) or consider the issue in specific classes of business (IAIS, 2019). It is at least clear that this is a risk concerned with concentration of liabilities. In other instances, it is not obvious whether a risk is more concerned with assets, in the case of structured securities, say, or ALM. For example, risks related to embedded investment guarantees in long-term insurance products may be allocated to liabilities, ALM or solvency. The broad approach employed in instances of doubt is to allocate risks first to assets or liabilities, then to ALM and then to solvency or to general risks.

3.3.4.5 Notwithstanding these concerns, the framework is regarded as helpful to regulators as an approach to categorise risks and to find areas of risk that have not yet been identified. Not all combinations of the categories used at the two levels are populated with identified risks, but these combinations could be used by regulators to identify possibilities not hitherto considered.

3.3.5 Allocating risks to categories

3.3.5.1 Classification is undertaken in two stages. The first stage aims for collective exhaustion at the risk of some overlap or confusion of categories. This is used to classify the risks attributable to insurers that are identified in the literature. The second targets mutual exclusion by limiting the possibility of incorrectly allocating the risks identified by insurers. This is used to assess the risks reported by insurers themselves.

3.3.5.2 First, examples identified in the literature are classified broadly, keeping separate risks that may have distinct attributes. This potentially overstates the number of distinct categories of risk, but it allows others to interpret these categories as they wish, perhaps consolidating them or reorganising them to suit their purposes. This information is summarised in Table 3 in Appendix B.

3.3.5.3 Second, categories that appear similar are consolidated for the purposes of categorising risks identified by South African insurers, the results of which are shown in

© ASSA licensed under CC 4.0

Figure 1 and discussed in Section 4. This consolidation makes it easier to allocate these risks on a consistent basis. This process is also prone to subjectivity, as judgement is required on appropriate consolidation of the categories identified in the literature. The number of categories, 50 in total, is small enough to facilitate reasonable classification of risks identified through the market survey, but sufficiently large to distinguish appropriately between these risks and hence between the corresponding strategies to mitigate them.

3.3.5.4 The process of classifying risks and consolidating them into a more concise set of categories was completed prior to considering the evidence for each of the identified risk types, described in Section 4.

3.4 Quantitative analysis

3.4.1 Significant research has been undertaken to quantify the impacts of poor market conditions on individual entities and, in turn, the extent to which the collapse of individual companies might affect their peers and the broader market. Such work is hampered by the absence of consensus on what constitutes systemic risk (see Section 2.2) but it does encourage the use of a wide range of approaches, helpfully assessed and classified by Silva et al. (2017) and Ellis et al. (2022).

3.4.2 A summary of several studies of quantitative methods for assessing systemic risk is provided in Table 4 in Appendix B, drawing on the classification system proposed by Ellis et al. (2022). Measures of solvency include SRISK, the capital shortfall of an entity conditional on a crisis (Acharya et al., 2012; Brownlees & Engle, 2017) and Delta CoVaR, the marginal change in the value-at-risk of the system conditional on the distress of an entity (Adams et al., 2014; Adrian & Brunnermeier, 2016). While SRISK explores the possibility of market impacts on an entity and Delta CoVaR the corresponding impacts that an entity may have on the market, not all methods seek evidence of direction of effect. Alternative approaches include models of joint probabilities of default (Segoviano & Goodhart, 2009), Granger causality studies (Billio et al., 2012) and a variety of network models (Hautsch et al., 2015; Lee, 2013; Martinez-Jaramillo et al., 2015; Poledna et al., 2015).

3.4.3 The methods also have different data requirements. With the exception of Lee (2013), all of the studies listed in Table 4 utilise quoted market data, either stock returns or credit default swap (CDS) prices. Several of them also use accounting information, which is typically available at significantly lower frequency than the market data, calling for a blended approach to data from different sources. Refer to Adrian & Brunnermeier (2016) for a thorough explanation of the challenges involved.

3.4.4 On the whole, not a great deal of attention has been given to quantitative studies of systemic risk involving insurers. Exceptions to this include Weiß & Mühlnickel (2014), who report evidence that insurers materially contributed to instability of the financial system in the 2007–09 crisis, and Leukes & Odei-Mensah (2019), who include insurers alongside other financial-market entities in their study of systemic risk in South Africa.

3.4.5 While the continued use of such modelling in the insurance sphere is encouraged, its challenges should not be understated. First, market prices are not necessarily representative of the insurer. This would be the case where the group holding company rather

 © ASSA licensed under CC 4.0

than the insurer itself is listed on the stock exchange. Second, not all countries have sufficient depth of CDS markets to enable these methods to be used with reliability: South Africa suffers this difficulty. Third, book values are typically available infrequently and are often delayed.[3] Fourth, some methods call for comparison of a single entity with the market as a whole. Data challenges are often particularly acute for smaller entities. Though they do not contribute a great deal to aggregate market figures, these entities often bring unusual features to the market, so it can be difficult to claim that the market is adequately represented if smaller entities are not included in the available data. Both the market and accounting data of these entities are likely to be more difficult to obtain with accuracy than for their larger counterparts.

3.4.6 While some of these problems could apply to all financial-sector entities, they could be particularly acute for insurers. In South Africa, for example, while monthly bank accounting figures are centrally published in standard format with a delay of a few weeks, no such equivalent information is available on insurers. This means that information would need to be manually extracted from published reports, which are available quarterly at best and may be subject to inconsistency of definition and interpretation.[4]

3.4.7 The appropriateness of quantitative methods to analysing the contribution of South Africa's insurance industry to systemic risk is considered in Section 4.4, the last part of the discussion that follows.

4. APPLICATION TO SOUTH AFRICAN INSURERS

The discussion turns now to the application of the method of classifying insurance-related systemic risk to South Africa's marketplace, supported by the summary of the market set out in Section 2.4. This starts with a description of the analytical approach. It is followed by a discussion of the findings and consideration of the regulatory methodology that may be utilised in response to poorly-reported risks. The discussion closes with a reflection of the potential for quantitative methods in this environment.

4.1 Analytical approach

4.1.1 Section 3.3 describes the process of consolidating the broad system for classifying the sources of systemic risk attributable to insurers into a more manageable set of risks arranged into two types of categories. The first of these is that part of the balance sheet

3 The authors recently conducted an assessment of the relationship between the adverse experience of South African banks and the market as a whole. Monthly accounting data was used and quantile regression methods were employed, in line with the Delta CoVaR method of Adrian & Brunnermeier (2016), but using the accounting data only, not the market data in addition. Detecting stable patterns in the tails of the distribution on the basis of monthly banking data proved challenging.

4 In such instances, the regulatory authority typically has information of better quality than is publicly available. The Prudential Authority requires all registered insurers to submit returns on a standard format, which facilitates the extraction and analysis of industry data. This was required monthly during the economic difficulties associated with the COVID pandemic in 2020 and 2021, but the frequency with which these must be submitted has since reverted to quarterly.

© ASSA licensed under CC 4.0

most affected by the risk. The second is the broad form that the risk takes. The discussion that follows explains how evidence for the existence of each of these risks may be identified from within the insurance industry.

4.1.2 Entities quoted on the Johannesburg Stock Exchange publish annual reports meeting listing requirements. These reports include a description of the most significant risks that the entities are exposed to. In the interest of transparency, some companies issue several reports covering the listed entity and its subsidiaries. In some instances, unlisted entities publish similarly comprehensive reports. The analysis summarised in this discussion and in Figure 1 covers the last five years' reports of the seven financial groups that include the five largest life insurers by assets (Deloitte, 2022; Prudential Authority, 2022a) and the five most significant non-life insurers by premium volume (KPMG, 2022; Prudential Authority, 2022c). The value of assets of these groups (Deloitte, 2022; Hollard, 2021a; Outsurance, 2021) amounts to some 89 percent of industry assets (Prudential Authority, 2022b).[5] The groups included in this analysis are, in alphabetical order, Discovery, Hollard, Liberty, Momentum Metropolitan, Old Mutual, Outsurance and Sanlam. Not all of the group entities issue separate reports for their life and non-life subsidiaries but, in most cases, the corresponding group reports identify risks relevant to these subsidiaries. Some 78 reports are included in the study, listed in Appendix A. Though all the annual reports and financial statements issued in the last five years were studied, in several cases the risks noted in these reports do not vary significantly from year to year.

4.1.3 Figure 1 maps the risks reported by South African insurers to the framework of systemic risks described in Section 3. Each of the risks identified in published reports is allocated to one of the categories. The reported or implied significance of each risk is not captured, either in terms of its likelihood or potential financial impact. There were several reasons for this, the most important of which is that the reports typically do not disclose this information. Even if some of them did, it is not considered possible to capture this data on a consistent, objective basis. Multiple mentions of the same risk type are also not captured, whether these occur in a single report or repeatedly over several years, again on the basis that it is difficult to do so without introducing an element of subjectivity.

4.1.4 As noted in Section 3.3.3 significant overlap with idiosyncratic risks is expected. Insurers are more likely to be focused on idiosyncratic risks, for their own purposes, then their systemic counterparts. Allocating the identified risks to categories identified in the literature as potentially systemic, however, allows the regulator to map the potential for systemic risk using these reports as one source of information.

4.1.5 Other risks of subjectivity remain, notably in the interpretation of the text and allocation of the risk to the available categories. Some risks are also less likely to be disclosed by insurers, even if they exist. This may be because insurers are typically focused on idiosyncratic risks rather than those with systemic qualities or because the risks disclosed are those more likely to be of interest to readers of the report, among them the regulator. It may

5 Hollard and Outsurance assets are for June not December, but contribute a small proportion to the total. The sources are listed in Appendix A.

 © ASSA licensed under CC 4.0

also reflect internal blind spots. Insurers are unlikely, for example, to identify and disclose economic exposure through speculative derivatives or risks associated with governance inadequacy. Both of these require an element of judgement and are difficult to describe dispassionately. Ambiguous disclosure could be detrimental. Transparent communication in matters such as these should nevertheless exist between the entity and the regulatory authority. This paper hopes to facilitate regulatory identification of such matters.

4.1.6 The resulting output (see Figure 1) is a scatter plot showing the extent to which risks falling into each of the categories are disclosed by insurers and their group holding companies in their financial reports. Summaries of the frequencies with which risks are reported that fall respectively into each balance sheet category and risk type are shown in Table 1 and Table 2 and discussed below.

4.2 Discussion of findings

4.2.1 The bottom rows of Tables 1 and 2 show the overall frequency with which risks falling into the identified sub-categories are reported for each type of company. This frequency, averaging 0.28 across all entities, is highest for holding companies (0.33), followed by long-term insurers (0.28) and short-term insurers (0.21). This is consistent with the expectation that holding companies have a broader perspective on risks that could be systemic in nature and that systemic risk is more likely to originate in or be propagated by long-term insurers than by their short-term counterparts (Park & Xie, 2014, for example).

TABLE 1. Insurer risk identification by balance sheet category
The table shows the frequency with which risks of each balance sheet category are reported in the annual financial statements and supporting published documents of entities of different type. ALM refers to asset-liability management.

	Holding companies	Long-term insurers	Short-term insurers	Average
Assets	0.45	0.19	0.16	0.28
Liabilities	0.33	0.35	0.23	0.30
ALM	0.38	0.31	0.25	0.32
Solvency	0.14	0.25	0.21	0.20
General	0.20	0.00	0.00	0.08
Average	0.33	0.28	0.21	0.28

4.2.2 Table 1 indicates that risks concerning the allocation of assets, which includes asset-liability management, and risks of a general nature are most frequently disclosed and managed at holding-company level, where strategic decisions are more likely than at the level of the subsidiary. In contrast, risks focused on insurance liabilities and on solvency are more frequently noted at the level of the insurance licence, where the attention to these issues is likely to be more acute. The differences between long-term and short-term insurers are greatest for those risks impacting liabilities, solvency and asset-liability

© ASSA licensed under CC 4.0

Balance sheet element	Risk type	Risk form
Assets	**Concentration**	Economic, policy and governance impacts on assets
		Impacts of climate change on asset values
		Interconnected stock market performance
		Investment in banks and the real economy or direct banking business
	Quality	Counterparty exposures
		Investment through unregulated subsidiaries
		Non-traditional investment activities
		Complex structured securities, CDSs and others
Liabilities	**Concentration**	Catastrophe risk
		Impacts on climate change on liaibilities
		Correlated product classes
		Limited substitutability and capacity: general
		Substitutability limitations: class-specific concerns
		Exposure to social issues and the broader economy
		Insurer concentration and interconnectedness
		Reinsurance with limited risk transfer
	Mismatch	Products with guarantees and embedded options
		Savings and investment in long-term insurance
		Policyholder lapses and surrenders
	Quality	Product complexity
		Bank-like product design
	Strategic	Distribution through banks
		Credit protection and economic exposure
		Exposure to burden of disease and economic impacts
		Exposure to fraudulent activity
		Insurer provides critical function with few substitutes
		Third-party asset management
	Operational	Cyber risk
ALM	**Mismatch**	Asset lending and associated liquidity risk
		Liquidity risks attributable to constrained funding, asset volatility or derivative exposure
		Reliance on short-term financing
		High exposure to equity investments
		Maturity mismatches
		Economic exposure attributable to speculative derivatives
	Quality	Counterparty exposure, particularly from reinsurance
		Alternative risk transfer, banking, hedge fund and synthetic investments
		Property management risk
	Strategic	Business model risks and interconnectedness
		Non-core activities and unusual exposures
		Insurance-linked securities
Solvency	**Concentration**	Risk exposures attributable to links with reinsurers
		Losses tranfered to other participants
	Mismatch	Leverage
	Quality	Funding structures
	Strategic	Unduly rapid growth
	Operational	Inadequate pricing and provisioning
		Operational liquidity risk and limited fungibility within groups
General	**General**	Policy and regulation not geared towards reducing systemic risk
		Panic run possible

FIGURE 1. Systemic risks identified for large South African insurers

The figure (1) synthesises the risk forms identified in the literature and set out in Table 3, (2) indicates those risks reported by seven South African insurance groups and their subsidiaries and (3) summarises the proposed mitigation strategy for those reported with poor frequency (normal text) or not identified at all (bold text). Background to the analysis is available in Section 4. The numbers in the table denote the

SARB	Total	Grp	LTI	STI	Group A Grp	Group A LTI	Group A STI	B Grp	B LTI	B STI	C LTI	D Grp	E Grp	F Grp	F LTI	F STI	G STI	Mitigation
	9	5	2	2														
	3	3																Scrutiny of impacts and potential concentration of risk
	1	1																Stress tests and capital buffers
	4	3	1															
	10	4	3	3														
																		Regulatory scrutiny and focus on group risk
																		Regulatory analytics and detailed probes
	2	2																Analysis of derivative holdings and their purpose
	9	3	3	3														
	5	4		1														
	4		2	2														
																		Concentration studies and care over barriers to entry
																		Focused market-sector analysis
	9	5	1	3														
	2	1	1															Concentration and interdependency studies
	2		1	1														Registration of financial reinsurance schemes, with monitoring
	6	3	3															
	5	1	4															
	8	3	4	1														
	1		1															Market conduct focus
																		Product definition and control measures
	3	1	1	1														
	12	5	3	4														
	6	3	2	1														
	1		1															Focus on operational risk management
																		Class-by-class identification of potential for concentration
																		Minimum governance standards
	6	4	1	1														
	2	2																Standard regulatory reporting
	9	3	3	3														
																		Liquidity modelling and occasional focused studies
	13	5	4	4														
	2	2																Liquidity modelling and stress tests
																		Liquidity modelling, regulatory disclosure and special studies
	11	4	4	3														
	4	2	1	1														
	7	3	3	1														
	1	1																Occasional focus on strategic risk management
	1	1																Systematic disclosure framework covering assets and liabilities
																		Identification and assessment
	1	1																Reinsurer solvency and analysis of concentration risks
	1		1															Assessment of inward reinsurance arrangements
	1		1															Microprudential tools and shock testing
	3	1	1	1														
	1	1																Scenario testing and focus on identified insurers
	3		1	2														
	8	2	3	3														
	2	2																Increasing regulatory focus on systemic risk
	1	1																Scenerio testing and care over product design

number of entities identifying each risk as applicable to them. Sources are as follows: 'Grp' indicates the group or holding company, 'LTI' a long-term insurer and 'STI' a short-term insurer. The reports assessed are listed in Section A of the Appendix. Not all entities publish group reports and only some of them have both long- and short-term insurers in the group.

management. This is consistent with the higher likelihood of a duration mismatch between assets and liabilities at long-term insurers than at their short-term counterparts.

4.2.3 Similar patterns are observed concerning the frequency with which risks are identified by category, shown in Table 2. Groups more frequently report on concentration-, strategic- and general risks than their insurance subsidiaries, consistent with the high-level perspective of these entities. Long-term insurers note risks of mismatching more often than their short-term counterparts, in line with the duration-based complexity of both their assets and their liabilities. Both holding companies and long-term insurers report risks of quality with relatively high frequency. These risks typically concern counterparty risks, alternative risk transfer, property management risk and product complexity. Short-term insurers identify operational risk more frequently than their long-term and holding-company counterparts. Though this is based on a sample cluster of risks, it is consistent with the generally higher operational intensity of short-term insurers and the competitiveness of their pricing in many product categories.

TABLE 2. Insurer risk identification by risk type
The table shows the frequency with which risks of each broad type are reported in the annual financial statements and supporting published documents of insurers and their holding companies.

	Holding companies	Long-term insurers	Short-term insurers	Average
Concentration	0.37	0.21	0.21	0.27
Mismatch	0.38	0.48	0.20	0.35
Quality	0.32	0.33	0.23	0.29
Strategic	0.24	0.18	0.15	0.19
Operational	0.40	0.42	0.50	0.44
General	0.20	0.00	0.00	0.08
Average	0.33	0.28	0.21	0.28

4.2.4 The discussion turns now to the frequency with which risks in each sub-category are reported (refer to the blue and green columns in Figure 1) and the overlap with those risks identified by the SARB in its financial stability reviews (refer to the column labelled ‘SARB’). Those risks most consistently noted by insurers include exposure to counterparties, including reinsurers, to stock market volatility and to risks concerned with uncertainty in social and economic conditions and government policy. Several insurers also identify catastrophe risk, lapses and surrenders by policyholders and liquidity risk as potentially significant contributors to adverse experience.

4.2.5 While some overlap of these risks with those noted by the SARB in its focus on systemic risk exists, such overlap is not particularly strong. The SARB, for example, has not identified counterparty risk or equity exposure as material systemic risks in its financial stability reports of the last few years, perhaps on the basis that it regards these

 © ASSA licensed under CC 4.0

risks as broadly under control. Furthermore, some of the risks noted by the SARB have not been identified by insurers with high frequency. These include the impacts of climate change, insurer concentration and exposure to fraudulent activity. This may indicate that they are limited to pockets of insurers. It may instead illustrate the difference in perspective between the regulator, which is concerned about systemic risk, and the regulated entities that have a limited incentive to manage risks whose impacts could be widely felt but might not directly impact the entities themselves (Schwarcz, 2008). Climate change and insurer concentration are examples of such risks.

4.3 Risks infrequently reported by insurers

4.3.1 The focus of the discussion turns now to those risks of a systemic nature that are infrequently identified by insurers, or not at all. The possibility of bias in the source data is acknowledged. Insurers and their holding companies are unlikely to report risks judged likely to have little impact on their operations or financial positions, even if these risks have potential systemic effects. Their absence from the annual financial reports of the largest insurers and their holding companies cannot be construed either as poor identification by these entities or that the risk is not relevant to the South African environment.

4.3.2 No instances were found, for example, of insurers identifying the risks associated with investment through unregulated subsidiaries or any non-traditional investment activities. There are good reasons for this. In the first instance, if insurers were using unregulated subsidiaries to channel investment, the status of such entities as unregulated would most likely not be highlighted in annual reports. Insurers are required to submit detailed charts of group organisational structures to the regulator, however, facilitating the identification of such subsidiaries outside of the public domain. This is consistent with regulatory focus on group risk. In the second instance, the term 'non-traditional' is subjective. Several insurers disclose investment in derivative structures to match their liabilities. Whether this match is perfect or whether some of these derivative arrangements are motivated by the pursuit of return rather than the management of risk is difficult to determine but would also be expected to form part of regulatory scrutiny.

4.3.3 In each case of risk sub-categories with no reporting or sparse reporting by insurers, further analysis is warranted to determine the likelihood that the risk exists and the extent of its potential impact on the financial system. This is most appropriately carried out by the regulator, in discussion with the insurers. Brief thoughts regarding the approach to each of these risks are indicated in the right-most column of Figure 1, in bold text where no instances of the risk are reported. With reference to the examples mentioned in the previous paragraph, for instance, the regulator is in a strong position to scrutinise group structures and probe the investment activity of insurers, using standardised reporting information and supporting this with more detailed investigation where appropriate. These examples call for detailed analysis at insurer- or group level.

4.3.4 Some risks require investigation that is technically complex or must be carried out across the industry. A few examples are considered in the discussion that follows. Investigation of insurer concentration is relatively straightforward where it is limited to

the proportion of assets or premium income attributable to the largest insurers, but product substitutability concerns require a more nuanced and detailed understanding that may prove beyond the means of the analysis of the standardised annual or quarterly regulatory insurance returns. Investigation of reinsurance arrangements with limited transfer of risk, or product complexity or of bank-like products offered by insurers all require technical knowledge and judgement. Expertise in governance and risk management is required to assess the risks of inadequacy in leadership or the effectiveness with which board policies are drafted and implemented.

4.3.5 Different approaches may be required at group level, where the respective attributes of distinct types of entities in the group may be considered, along with the potential for a contribution to systemic risk arising from interaction between these entities. A useful start to this process could be to consider whether, for each of the risk sub-types listed in this framework, the potential for risk magnification may exist as a result of attributes of the group and its relationships.

4.3.6 Most of the interaction and correspondence between the regulator and the entities that it oversees is not in the public domain. The summarised findings of this interaction, however, are frequently published in order to enhance awareness and influence behaviour. The categories and sub-categories used in this study to describe the types of systemic risks that might originate at or be propagated by insurers are designed to assist regulators to identify and manage these risks and to publicise the extent to which it is doing so. It should link this explicitly to its regulatory objectives.

4.3.7 Through their micro-prudential oversight, regulators expect to have a strong understanding of the idiosyncratic risk profile of supervised entities. The approach proposed aims to assist regulators to convert this insight into an analysis of the potential for these risks to become systemic in nature. It is hoped that this framework would assist South Africa's Prudential Authority and regulators in other jurisdictions not only to identify and manage systemic risk in their insurance markets but also to plan their resourcing requirements. How they might respond to risks needs to be appropriate to the circumstances. Identified instances of systemic risk call for case-specific responses, some of which need to be coordinated across entities. Such interventions may range from requirements of entities to mitigate specified risks or improve solvency levels to industry-wide initiatives to raise organisational resilience to uncertainty.

4.4 Quantitative analysis in practice

4.4.1 Some of the models used to assess the contribution of banks and insurers to systemic risk are summarised in Section 3.4. The most significant limitations of these models and some of the challenges concerning the data that they require are also considered in that discussion.

4.4.2 Notwithstanding these limitations, ongoing quantitative analysis of the systemic risk indicators and the drivers of systemic risk should be undertaken. The regulatory authority is typically in the strongest position to model systemic risk on the basis that it has the best access to the information required to do so. Where such information is desirable,

 © ASSA licensed under CC 4.0

but not currently available, consideration should be given to requesting regulated entities to submit this to the regulator. Where quarterly reports are submitted under the existing regulatory framework, for example, consideration should be given to the need for monthly information, possibly with backdated information to establish a history. For the purposes of this analysis, a significantly simplified version of the standard reporting template may be sufficient.

4.4.3 It is recommended that consideration be given to the appropriateness of several alternative models, such as Delta CoVaR, SRISK, Marginal Expected Shortfall and Systemic Expected Shortfall. Where alternative methods are possible, under each of these models, these should be actively investigated, preferably by constructing several of these alternatives and studying the reasons for differences in the results. Consideration of the detail underlying the models is likely to prove more helpful to an understanding of systemic risk than a blind acceptance of the outputs from just one model.

4.4.4 In time, the insights gained from this process could be shared with industry participants, with invitation to comment, potentially justifying the need for more frequent or more detailed information.

5. CONCLUDING COMMENTS

5.1 Identifying and mitigating instances of systemic risk in the financial sector are priorities for regulatory authorities around the world. It is broadly agreed that banking contributes to systemic risk by virtue of the inter-linkages between entities. The nature of the corresponding contribution by insurers is not as obvious. This article proposes a framework for classifying the sources of systemic risk attributable to insurers. The thorough approach to classification aims also to improve detection and identification of risk sources. It applies this framework to the insurance market in South Africa, in the process providing practical recommendations for consideration by all regulators.

5.2 While several approaches have been developed for assessing quantitatively the contribution to systemic risk by individual entities, practical constraints inhibit the application of quantitative methods to insurers, particularly in countries like South Africa with data limitations. Regulators are encouraged to explore the merit of these methods and to call for the data required to support this exploration. The framework presented herein aims to assist regulators to build a coherent understanding of the potential for systemic risk of various kinds arising from the insurers that fall under its responsibility, in turn contributing to efforts to develop supporting quantitative methods.

5.3 The discussion concludes with possibilities for further research. Possibilities for further exploration of a qualitative nature include the following. First, deeper engagement with insurers could be considered to understand their risk profiles in more detail. This might be conducted through structured interviews or an analysis of their management accounts or product ranges. Second, the risk sub-types defined in the literature and classified in two stages in this study could be more precisely defined, perhaps with the attributes of insurers

or their activities that regulators should look out for to identify evidence for each risk. Third, further study of insurance groups could be conducted in order to apply the methodology proposed in this paper to complex entities of various kinds. Fourth, cross-country studies could be considered that aim to identify systemic risks that are similar across jurisdictions or distinct to particular markets, in the process assisting in the development of appropriate responses to regulators. Finally, engagement with regulators might be considered, across countries or through regulatory associations, to gain insight into their perspective on the risks most commonly encountered and the most effective corresponding mitigating actions.

5.4 Several avenues could also be considered for further research of a quantitative nature. A detailed assessment of the alternative approaches that may be used for modelling in a particular country could be carried out. This could take into account the nature of the risks that characterise the insurance market in that country and the type and accuracy of data available. The models considered in this paper typically have several components. Consideration of the insights available from each of these components might be assessed and described.

5.5 The question of whether insurers might contribute to systemic risk is not a simple one. It is nevertheless a question that deserves the consideration of financial-sector regulators within the framework of their regulatory objectives. This paper aims to provide a practical framework within which regulators might identify and categorise the sources of systemic risk arising in insurers with a view to monitoring and mitigating such risk.

STATEMENTS AND DECLARATIONS

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The authors have no financial or non-financial interests directly or indirectly related to the work submitted for publication. The information utilised and generated during the study described in this paper is available from the corresponding author on request. Comments received from anonymous reviewers of the draft submitted to the *South African Actuarial Journal* are gratefully acknowledged.

 © ASSA licensed under CC 4.0

REFERENCES

Acharya, VV (2009). A theory of systemic risk and design of prudential bank regulation. In: *Journal of Financial Stability* 5, 224–55

Acharya, VV, Biggs, J, Hanh, L, Richardson, M & Ryan, S (2011). Systemic risk and the regulation of insurance companies. In: *Regulating Wall Street – The Dodd-Frank Act and the New Architecture of Global Finance*. Ed. by Acharya, VV, Coley, TF, Richardson, M & Walter, I. Hoboken, NJ: John Wiley & Sons, 241–301

Acharya, VV, Engle, RF & Richardson, M (2012). Capital shortfall: A new approach to ranking and regulating systemic risks. In: *American Economic Review* **102**(3), 59–64

Acharya, VV, Pedersen, LH, Philippon, T & Richardson, M (2010). *Measuring systemic risk*. Working Paper. Federal Reserve Bank of Cleveland

Acharya, VV, Pedersen, LH, Philippon, T & Richardson, M (2017). Measuring systemic risk. In: *The Review of Financial Studies* **30**(1), 2–47

Acharya, VV & Richardson, M (2014). Is the insurance industry systemically risky? In: *Modernizing Insurance Regulation*. Ed. by Biggs, JH & Richardson, M. 1st ed. Hoboken, NJ: John Wiley & Sons, 151–79

Adams, Z, Füss, R & Gropp, R (2014). Spillover effects among financial institutions: A state-dependent sensitivity Value-at-Risk approach. In: *Journal of Financial and Quantitative Analysis* **49**(3), 575–98

ADB (2017). *Asian Economic Integration Report*. Asian Development Bank

Adrian, T & Brunnermeier, MK (2016). CoVaR. In: *American Economic Review* **106**(7), 1705–41

Aikman, D, Alessandri, P, Eklund, B, Gai, P, Kapadia, S, Martin, E, Mora, N, Sterne, G & Willison, M (2011). Funding liquidity risk in a quantitative model of systemic stability. In: *Financial Stability, Monetary Policy, and Central Banking*. Ed. by Alfaro, R. Vol. 15. Central Banking, Analysis, and Economic Policies Book Series. Central Bank of Chile. Chap. 12, 371–410

Al-Darwish, A, Hafeman, M, Impavido, G, Kemp, M & O'Malley, P (2011). *Possible unintended consequences of Basel III and Solvency II*. Working Paper WP/11/187. International Monetary Fund

Allen, F & Carletti, E (2006). Credit risk transfer and contagion. In: *Journal of Monetary Economics* 55, 89–111

APRA (2014). Annual Report 2014. Australian Prudential Regulation Authority

Armour, J, Awrey, D, Davies, P, Enriques, L, Gordon, JN, Mayer, C & Payne, J. (2016). The goals and strategies of financial regulation. In: *Principles of Financial Regulation.* Ed. by Armour, J et al. 51–79. doi: 10.1093/acprof:oso/9780198786474.003.0003

Atack, J (2009). Financial innovation and crises: The view backwards from Northern Rock. In: *The Origins and Development of Financial Markets and Institutions: From the Seventeenth Century to the Present*. Ed. by Atack, J & Neal, L. Cambridge University Press

Baldwin, R & Black, J (2016). Driving priorities in risk-based regulation: What's the problem? In: *Journal of Law and Society* **43**(4), 565–95

Baluch, F, Mutenga, S & Parsons, C (2011). Insurance, systemic risk and the financial crisis. In: *The Geneva Papers* 36, 126–63

Baranoff, E (2012). An analysis of the AIG case: Understanding systemic risk and its relation to insurance. In: *Journal of Insurance Regulation; Kansas City* **31**(1), 243–70

© ASSA licensed under CC 4.0

Barsotti, F, Milhaud, X & Salhi, Y (2016). Lapse risk in life insurance: Correlation and contagion effects among policyholders' behaviors. In: *Insurance: Mathematics and Economics* 71, 317–31

Berry-Stölzle, TR, Nini, GP & Wende, S (2014). External financing in the life insurance industry: Evidence from the financial crisis. In: *Journal of Risk and Insurance* **81**(3), 529–62

Besar, Systemic risk and the interconnectedness between banks and insurers: An econometric analysis. In: *Journal of Risk and Insurance* **81**(3), 623–52

Chen, R & Kemp, E (2023). *Lessons from the United Kingdom's Liability-Driven Investment (LDI) Crisis*. Selected Issues Paper SIP/2023/049. International Monetary Fund

Claessens, S (2015). An overview of macroprudential policy tools. In: *Annual Review of Financial Economics* 7, 397–422

Cummins, JD & MA Weiss (2009). Convergence of insurance and financial markets: Hybrid and securitized risk-transfer solutions. In: *Journal of Risk and Insurance* **76**(3), 493–554

—— (2013). *Systemic risk and regulation of the US insurance industry*. Working Paper. Temple University, Philadelphia

—— (2014). Systemic risk and the US insurance sector. In: *Journal of Risk and Insurance* **81**(3), 489–527

De Bandt, O & Hartmann, P (2000). *Systemic risk: A survey*. Working Paper No. 35. European Central Bank

Deloitte (2022). Africa Insurance Outlook 2022: Navigating the insurance landscape. Deloitte South Africa

EIOPA (2017). The interplay of financial intermediaries and its impact on monetary analysis. European Insurance and Occupational Pensions Authority, Publications Office of the European Union

—— (2019a). 2020 Review of Solvency II. European Insurance and Occupational Pensions Authority, Publications Office of the European Union

—— (2019b). Consultation paper on the opinion on the 2020 review of Solvency II. European Insurance and Occupational Pensions Authority, Publications Office of the European Union

Eling, M & Pankoke, DA (2016). Systemic risk in the insurance sector: A review and directions for future research. In: *Risk Management and Insurance Review* **19**(2), 249–84

Ellis, S, Sharma, S & Brzeszczyński, J (2022). Systemic risk measures and regulatory challenges. In: *Journal of Financial Stability* 61, 100960

Erskine, A (2014). Regulating the Australian financial system. The funding Australia's future project. Australian Centre for Financial Studies

European Central Bank (2010). Macro-prudential policy objectives and tools. *Financial Stability Review*, 129–37

— (2012). The interplay of financial intermediaries and its impact on monetary analysis. *Monthly Bulletin*, 59–73

Financial Stability Committee (2022). *Financial Stability Report: December 2022*. Bank of England.

Floreani, A (2013). Risk measures and capital requirements: A critique of the Solvency II approach. In: *The Geneva Papers* 38, 189–212

Fong, T, Fung, L, Lam, L & Yu, I-W (2009). *Measuring the interdependence of banks in Hong Kong*. Working Paper 19/2009. Hong Kong Monetary Authority

FSA (2006). *A guide to market failure analysis and high level cost benefit analysis*. Financial Services Authority

— (2007). *Principles-based regulation: Focusing on the outcomes that matter*. Financial Services Authority

Galati, G & Moessner, R (2014). *What do we know about the effects of macroprudential policy?* DNB Working Paper No. 440. DeNederlandscheBank

Gauthier, C, Lehar, A & Souissi, M (2012). Macroprudential capital requirements and systemic risk. In: *Journal of Financial Intermediation* 21, 594–618

Geneva Association (2010a). *An account of the Geneva Association's ongoing dialogue on systemic risk with regulators and policymakers*. Special Report of The Geneva Association Systemic Risk Working Group

—— (2010b). *Systemic risk in insurance: An analysis of insurance and financial stability*. Special Report of The Geneva Association Systemic Risk Working Group

—— (2011). *Variable annuities with guarantees and use of hedging*

Georg, C (2011). *Basel III and systemic risk regulation – what way forward?* Working Papers on Global Financial Markets No. 17. Universität Jena und Universität Halle-Wittenberg

Giglio, S (2016). *Credit default swap spreads and systemic financial risk*. Working Paper Series No. 15

Grace, MF, Rauch, J & Wende, S (2013). *Systemic risk and interconnectedness in the financial industry: Implications on regulation of financial conglomerates*. Working Paper. Georgia State University, Atlanta

Grochulski, B & Morrison, W (2014). *Understanding market failure in the 2007–08 Crisis*. Economic Brief 14-12. Federal Reserve Bank of Richmond

Hansen, LP (2013). *Challenges in identifying and measuring systemic risk*. BFI Working Paper Series No. 2012-012. Becker Friedman Institute for Research in Economics, University of Chicago

Harrington, SE (2009). The financial crisis, systemic risk, and the future of insurance regulation. In: *Journal of Risk and Insurance* **76**(4), 785–819

Hauton, G & Héam, J (2015). Interconnectedness of financial conglomerates. In: *Risk* 3, 139–63

Hautsch, N, Schaumburg, J & Schienle, M (2015). Financial network systemic risk contributions. In: *Review of Finance* **19**(2), 685–738

Huang, X, Zhou, H & Zhu, H (2012). Systemic risk contributions. In: *Journal of Financial Services Research* 42, 55–83

IAIS (2009). *Systemic risk and the insurance sector*. International Association of Insurance Supervisors

—— (2010). *Position statement on key financial stability issues*. International Association of Insurance Supervisors

—— (2011). *Insurance and financial stability*. International Association of Insurance Supervisors

—— (2012a). *Globally systemically important insurers: Proposed assessment methodology*. International Association of Insurance Supervisors

—— (2012b). *Reinsurance and Financial Stability*. International Association of Insurance Supervisors

—— (2018). *Holistic framework for systemic risk in the insurance sector, public consultation document*. International Association of Insurance Supervisors

—— (2019). *Holistic Framework for systemic risk in the insurance sector*. International Association of Insurance Supervisors

© ASSA licensed under CC 4.0

Ibragimov, R, Jaffee, D & Walden, J (2011). Diversification disasters. In: *Journal of Financial Economics* 99, 333–48

IMF (2008). *South Africa: Financial system stability assessment*. Country Report No. 08/349, including report on the observance of standards and codes on the following topic: Securities Regulation. International Monetary Fund

—— (2009). *Global financial stability report: Responding to the financial crisis and measuring systemic risks*. International Monetary Fund

—— (2013). *Key aspects of macroprudential policy*. International Monetary Fund

—— (2014a). *South Africa financial system stability assessment*. Country Report No. 14/340. International Monetary Fund

—— (2014b). *Staff guidance note on macroprudential policy*. International Monetary Fund

—— (2018). *The IMF's annual macroprudential policy survey – objectives, design and country responses*. International Monetary Fund

—— (2022a). *Detailed assessment of observance of insurance core principles issued by the International Association of Insurance Supervisors*. United Kingdom Country Report No. 22/109, Financial Sector Assessment Program. International Monetary Fund

—— (2022b). *South Africa, 2021 Article IV Consultation – Press release; staff report; and statement by the Executive Director for South Africa*. Country Report No. 22/37. International Monetary Fund

—— (2022c). *South Africa financial sector assessment program: Technical note on insurance sector – regulation and supervision*. Country Report No. 22/185. International Monetary Fund

—— (2022d). *South Africa financial sector assessment program: Technical note on systemic risk oversight and macroprudential policy*. Country Report No. 22/186. International Monetary Fund

—— (2022e). *South Africa financial system stability assessment*. Country Report No. 22/39. International Monetary Fund

—— (2022f). *South Africa: Selected issues*. Country Report No. 22/38. International Monetary Fund

IMF et al. (2009). *Guidance to assess the systemic importance of financial institutions, markets and instruments: Initial considerations, report to the G-20 Finance Ministers and Central Bank Governors*. International Monetary Fund, the Bank for International Settlements, and the Secretariat of the Financial Stability Board

Jobst, AA (2014). Systemic risk in the insurance sector: A review of current assessment approaches. In: *The Geneva Papers* 39, 440–70

Kaserer, C & Klein, C (2019). Systemic risk in financial markets: How systemically important are insurers? In: *Journal of Risk and Insurance* **86**(3), 729–59

Kessler, D (2014). Why (re)insurance is not systemic. In: *Journal of Risk and Insurance* **81**(3), 477–87

Klein, RW (2012). Principles for insurance regulation: An evaluation of current practices and potential reforms. In: *The Geneva Papers* 37, 175–99

—— (2013). Insurance market regulation: Catastrophe risk, competition and systemic risk. In: *Handbook of Insurance*. Ed. by G Dionne., 2nd ed. New York: Springer, 909–39

Knot, K (2014). Governance of macroeconomic policy. Macroprudential policies: Implementation and interactions, *Financial Stability Review*. Banque de France

Koijen, RSJ & Yogo, M (2017). *Risk of life insurers: Recent trends and transmission mechanisms*. Working Paper No. 23365. National Bureau of Economic Research

 © ASSA licensed under CC 4.0

KPMG (2022). The South African insurance industry survey 2022. KPMG South Africa

Lee, SH (2013). Systemic liquidity shortages and interbank network structures. In: *Journal of Financial Stability* **9**(1), 1–12

Leukes, C & Odei-Mensah, J (2019). Systemic risk contribution of financial institutions in South Africa. In: *African Review of Economics and Finance* **11**(2), 188–218

Llewellyn, DT (1999). The economic rationale for financial regulation. Occasional Paper Series No. 1. Financial Services Authority

Martinez-Jaramillo, S, Alexandrova-Kabadjova, B, Bravo-Benitez B & Solórzano-Margain JP (2015). An empirical study of the Mexican banking system's network and its implications for systemic risk. In: *Journal of Economic Dynamics & Control,* 20, 70–81

MAS (2015). Objectives and principles of financial supervision in Singapore. April, 2004, revised in September 2015. Monetary Authority of Singapore

Merton, RC (1995). A functional perspective of financial intermediation. In: *Financial Management* **24**(2), 23–41

Michael, B, Goo, S & Osaulenko, S (2010). Does objectives-based financial regulation imply a rethink of legislatively mandated economic regulation? A literature review. In: *Journal of Legislation* **46**(2), 245–75

Neale, FR, Drake, PP, Schorno, P & Semaan, E (2012). *Insurance and interconnectedness in the financial services industry*. Working Paper. UNC Charlotte

Nier, E, Yang, J, Yorulmazer, T & Alentorn, A (2007). Network models and financial stability. In: *Journal of Economic Dynamics and Control* 31, 2033–60

NTSA (2011). *A safer financial sector to serve South Africa better*. Policy Document. National Treasury, Government of South Africa

OECD (2010). *Policy framework for effective and efficient financial regulation: General guidance and high-level checklist*. Organisation for Economic Cooperation and Development Publishing, Paris

Park, SC & Xie, X (2014). Reinsurance and systemic risk: The impact of reinsurer downgrading on property-casualty insurers. In: *Journal of Risk and Insurance* **81**(3), 587–622

Pinter, G (2023). *An anatomy of the 2022 gilt market crisis*. Staff Working Paper No. 1,019. Bank of England

Poledna, S, Molina-Borboa, JL, Martínez-Jaramillo, S, van der Leij, M & Thurner, S (2015). The multi-layer network nature of systemic risk and its implications for the costs of financial crises. In: *Journal of Financial Stability* 20, 70–81

Prudential Authority (2019). Annual Report 2018/19. Prudential Authority, South African Reserve Bank

—— (2021). *Regulatory strategy 2021–2024*. Prudential Authority, South African Reserve Bank

—— (2022a). *2021 Life insurance industry experience*. Prudential Authority, South African Reserve Bank

—— (2022b). Annual Report 2021/22. Prudential Authority, South African Reserve Bank

—— (2022c). *Non-life industry experience 2022*. Prudential Authority, South African Reserve Bank.

Radice, MP (2010). *Assessing the potential for systemic risks in the insurance sector: Considerations on insurance in Switzerland*. Working Paper June/2010. FINMA: Swiss Financial Market Supervisory Authority

Rae, RA, Barrett, R, Brooks, D, Chotai, MA, Pelkiewicz, AJ & Wang, C (2017). *A review of Solvency II: Has it met its objectives?* Solvency II Working Party. Institute and Faculty of Actuaries

Rusconi, RD (2020). The contribution of South Africa's insurers to systemic risk: Thoughts for policymakers. In: *South African Actuarial Journal,* 20, 149–210

Russell, DT, Fier, SG, Carson, JM and Dumm, RE (2013). An empirical analysis of life insurance policy surrender activity. In: *Journal of Insurance Issues* **36**(1), 35–57

Safa, MF, Hassan, MK & Maroney, NC (2013). AIG's announcements, Fed's innovation, contagion and systemic risk in the financial industries. In: *Applied Financial Economics* **23**(6), 1337–48

SARB (2017a). *Financial Stability Review 2017: First Edition*. South African Reserve Bank

—— (2017b). *Financial Stability Review 2017: Second Edition*. South African Reserve Bank

—— (2018a). *Financial Stability Review 2018: First Edition*. South African Reserve Bank

—— (2018b). *Financial Stability Review 2018: Second Edition*. South African Reserve Bank

—— (2019). *Financial Stability Review 2019: Second Edition*. South African Reserve Bank

—— (2020a). *Financial Stability Review 2020: First Edition*. South African Reserve Bank

—— (2020b). *Financial Stability Review 2020: Second Edition*. South African Reserve Bank

—— (2021a). *Financial Stability Review 2021: First Edition*. South African Reserve Bank

—— (2021b). *Financial Stability Review 2021: Second Edition*. South African Reserve Bank

—— (2022). *Financial Stability Review 2022: First Edition*. South African Reserve Bank.

Schmukler, S (2004). *Benefits and risks of financial globalization: Challenges for developing countries*. Development Research Group. The World Bank

Schwarcz, D & Schwarcz, SL (2014). Regulating systemic risk in insurance. In: *University of Chicago Law Review* 81, 1569–640

Schwarcz, SL (2008). Systemic risk. In: *Georgetown Law Journal,* 97, 193–248

—— (2014). Systematic regulation of systemic risk. In: *Wisconsin Law Review* 2019, 1–53

Sedunov, J (2016). What is the systemic risk exposure of financial institutions? In: *Journal of Financial Stability* 24, 71–87

Segoviano, MA & Goodhart, C (2009). *Banking Stability Measures*. Working Paper 09/04. International Monetary Fund

Silva, W, Herbert, R & Vinicius, AS (2017). An analysis of the literature on systemic financial risk: A survey. In: *Journal of Financial Stability* 28, 91–114

Sinha, A (2012). *Financial Sector Regulation and Implications for Growth*. BIS Papers No. 62. Bank for International Settlements

Swarup, A (2012). A well-intentioned folly: The macroeconomic implications of Solvency II. In:. *Economic Affairs* **32**(3), 17–23

Tagoe, NA (2016). The emerging role of financial intermediaries in the financial market of Ghana. In: *Business and Economics Journal* **7**(4), 1000253

Trichet, JC (2005). Financial stability and the insurance sector. In: *Geneva Papers on Risk and Insurance – Issues and Practice* 30, 65–71

Van Lelyveld, I, Liedorp, F & Kampman, M (2019). An empirical assessment of reinsurance risk. In: *Journal of Financial Stability* 7, 191–203

Wagner, W (2010). A note on the appropriate choice of risk measures in the solvency assessment of insurance companies. In: *Journal of Risk Finance* **15**(2), 110–30

 © ASSA licensed under CC 4.0

Weiß, GNF & Mühlnickel, J (2014). Why do some insurers become systemically relevant? In: *Journal of Financial Stability* 13, 95–117

Wong, A & Fong, T (2010). *Analysing Interconnectivity Among Economies*. Working Paper 03/2010. Hong Kong Monetary Authority

World Bank (2012). *Rethinking the Role of the State in Finance*. Global Financial Development Report 2013. The World Bank

Zhang, Q, Vallascas, F, Keasey, K & Cai, CX (2015). Are market-based measures of global systemic importance of financial institutions useful to regulators and supervisors? In: *Journal of Money, Credit and Banking* **47**(7), 1403–42

© ASSA licensed under CC 4.0

APPENDIX A
List of financial reports consulted

Discovery (2018a). *Annual Financial Statements for the year ended 30 June 2018*, Discovery Limited
Discovery (2018b). *Integrated Annual Report for the year ended 30 June 2018*, Discovery Limited
Discovery (2019a). *Annual Financial Statements for the year ended 30 June 2019*, Discovery Limited
Discovery (2019b). *Integrated Annual Report for the year ended 30 June 2019*, Discovery Limited
Discovery (2020a). *Annual Financial Statements for the year ended 30 June 2020*, Discovery Limited
Discovery (2020b). *Integrated Annual Report for the year ended 30 June 2020*, Discovery Limited
Discovery (2021a). *Annual Financial Statements for the year ended 30 June 2021*, Discovery Limited
Discovery (2021b). *Integrated Annual Report for the year ended 30 June 2021*, Discovery Limited
Discovery (2022a). *Annual Financial Statements for the year ended 30 June 2022*, Discovery Limited
Discovery (2022b). *Integrated Annual Report for the year ended 30 June 2022*, Discovery Limited
Hollard (2017a). *Audited consolidated annual financial statements for the year ended 30 June 2017*, The Hollard Insurance Company Limited
Hollard (2018a). *Audited consolidated annual financial statements for the year ended 30 June 2018*, The Hollard Insurance Company Limited
Hollard (2019a). *Audited consolidated annual financial statements for the year ended 30 June 2019*, The Hollard Insurance Company Limited
Hollard (2020a). *Audited consolidated annual financial statements for the year ended 30 June 2020*, The Hollard Insurance Company Limited
Hollard (2021a). *Audited consolidated annual financial statements for the year ended 30 June 2021*, The Hollard Insurance Company Limited
Hollard Life (2017b). *Audited consolidated annual financial statements for the year ended 30 June 2017*, Hollard Life Insurance Company Limited
Hollard Life (2018b). *Audited consolidated annual financial statements for the year ended 30 June 2018*, Hollard Life Insurance Company Limited
Hollard Life (2019b). *Audited consolidated annual financial statements for the year ended 30 June 2019*, Hollard Life Insurance Company Limited
Hollard Life (2020b). *Audited consolidated annual financial statements for the year ended 30 June 2020*, Hollard Life Insurance Company Limited
Hollard Life (2021b). *Audited consolidated annual financial statements for the year ended 30 June 2021*, Hollard Life Insurance Company Limited
Hollard Specialist (2019c). *Audited consolidated annual financial statements for the year ended 30 June 2019*, Hollard Specialist Insurance Company Limited
Hollard Specialist (2020c). *Audited consolidated annual financial statements for the year ended 30 June 2020*, Hollard Specialist Insurance Company Limited
Hollard Specialist (2021c). *Audited consolidated annual financial statements for the year ended 30 June 2021*, Hollard Specialist Insurance Company Limited
Liberty (2018a). *Annual Financial Statements for the year ended 31 December 2017*, Liberty Holdings Limited

 © ASSA licensed under CC 4.0

Liberty (2018b). *Group and Company annual financial statements for the year ended 31 December 2017*, Liberty Group Limited

Liberty (2018c). *Integrated report for the year ended 31 December 2017*, Liberty Holdings Limited

Liberty (2019a). *Annual Financial Statements for the year ended 31 December 2018*, Liberty Holdings Limited

Liberty (2019b). *Group and Company annual financial statements for the year ended 31 December 2018*, Liberty Group Limited

Liberty (2020a). *Annual Financial Statements for the year ended 31 December 2019*, Liberty Holdings Limited

Liberty (2020b). *Group and Company annual financial statements for the year ended 31 December 2019*, Liberty Group Limited

Liberty (2021a). *Annual Report for the year ended 31 December 2020*, Liberty Holdings Limited

Liberty (2021b). *Annual Financial Statements for the year ended 31 December 2020*, Liberty Holdings Limited

Liberty (2022a). *Annual Report for the year ended 31 December 2021*, Liberty Holdings

Liberty (2022b). *Annual Financial Statements for the year ended 31 December 2021*, Liberty Group Limited

Liberty (2022c). *Annual Financial Statements for the year ended 31 December 2021*, Liberty Holdings Limited

MMI Holdings (2017). *Advancing MMI's Strategy: Financial Results 2017*, MMI Holdings Group

MMI Holdings (2018). *Reset and Grow: Results for the year ended June 2018*, MMI Holdings Group

Momentum (2019). *Summary of Financial Information: Audited results for the year ended June 2019*, Momentum Metropolitan

Momentum (2020). *Group Annual Financial Statements: Audited results for the year ended June 2020*, Momentum Metropolitan

Momentum (2021a). *Group Annual Financial Statements: Audited results for the year ended June 2021*, Momentum Metropolitan

Momentum (2021b). *Integrated report 2021*, Momentum Metropolitan

Momentum (2022a). *Group Annual Financial Statements: Audited results for the year ended June 2022*, Momentum Metropolitan

Momentum (2022b). *Integrated report 2022*, Momentum Metropolitan

Old Mutual (2020). *Integrated Report 2019*, Old Mutual Limited

Old Mutual (2021). *Integrated Report 2020*, Old Mutual Limited

Old Mutual (2019a). *Integrated Report 2018*, Old Mutual Limited

Old Mutual (2019b). *Annual Financial Statements for the year ended 31 December 2018*, Old Mutual Limited

Old Mutual (2022a). *Annual Financial Statements, consolidated and separate, for the year ended 31 December 2021*

Old Mutual (2022b). *Integrated Report 2021*, Old Mutual Limited

OMI (2018). *Annual Report 2017*, Old Mutual Insure Limited

OMI (2019). *Annual Report 2018*, Old Mutual Insure Limited

OMI (2020). *Annual Report 2019*, Old Mutual Insure Limited

© ASSA licensed under CC 4.0

OMI (2021). *Annual Report 2020*, Old Mutual Insure Limited
OMI (2022). *Annual Report 2021*, Old Mutual Insure Limited
OMLACSA (2018). *Separate and Consolidated Annual Financial Statements for the year ended 31 December 2017*, Old Mutual Life Assurance Company (South Africa) Ltd
OMLACSA (2019). *Annual Financial Statements for the year ended 31 December 2018*, Old Mutual Life Assurance Company (South Africa) Ltd
OUTsurance (2017). *Annual report 2017*, OUTsurance Holdings Limited
OUTsurance (2018). *Annual report 2018*, OUTsurance Holdings Limited
OUTsurance (2019). *Annual report 2019*, OUTsurance Holdings Limited
OUTsurance (2020). *Annual report 2020*, OUTsurance Holdings Limited
OUTsurance (2021). *Annual report 2021*, OUTsurance Holdings Limited
Sanlam (2018a). *Integrated Report 2017*, Sanlam
Sanlam (2018b). *Audited Annual Results 2017*, Sanlam
Sanlam (2019a). *Integrated Report 2018*, Sanlam
Sanlam (2019b). *Audited Annual Results 2018*, Sanlam
Sanlam (2020a). *Integrated Report 2019*, Sanlam
Sanlam (2020b). *Audited Annual Results 2019*, Sanlam
Sanlam (2021a). *Integrated Report 2020*, Sanlam
Sanlam (2021b). *Audited Annual Results 2020*, Sanlam
Sanlam (2022a). *Integrated Report 2021*, Sanlam
Sanlam (2022b). *Audited Annual Results 2021*, Sanlam
Sanlam Life (2018). *Annual Financial Statements 2017*, Sanlam Life Insurance Limited
Sanlam Life (2019). *Annual Financial Statements 2018*, Sanlam Life Insurance Limited
Sanlam Life (2020). *Annual Financial Statements 2019*, Sanlam Life Insurance Limited
Sanlam Life (2021). *Annual Financial Statements 2020*, Sanlam Life Insurance Limited
Sanlam Life (2022). *Annual Financial Statements 2021*, Sanlam Life Insurance Limited
Santam (2021). *Annual Financial Statements 2020*, Santam
Santam (2022). *Annual Financial Statements 2021*, Santam

 © ASSA licensed under CC 4.0

APPENDIX B
Supporting information

TABLE 3. High-level classification of insurer contributions to systemic risk

Balance sheet element	Risk type	Detail and references
Assets	Concentration	Climate change and impact on asset prices (SARB, 2019) Exposure through investments (IAIS, 2011) Exposure to policy and governance (SARB, 2020a) Exposure to the economy (SARB, 2020a) Impact of investment returns on insurers (SARB, 2020b) Increasingly interconnected stock market performance (Acharya et al., 2010, 2011; Baluch et al., 2011; Bierth et al., 2019; Billio et al., 2012; Cummins & Weiss, 2013; Schwarcz & Schwarcz, 2014) Investment in banks and the real economy (SARB, 2017a, 2020a)
	Quality	Structured securities: liquidity and systemic impacts (Baluch et al., 2011; Baranoff, 2012; Chen et al., 2013; Cummins & Weiss, 2013, 2014; Geneva Association, 2010b; Klein, 2013; Trichet, 2005) Counterparty exposures (assets) (IAIS, 2018) Exploiting unregulated subsidiaries and information asymmetries (Acharya et al., 2011; Baranoff, 2012; Harrington, 2009; IAIS, 2011) Investing in complex structured securities (Cummins & Weiss, 2014) Non-traditional activities drive systemic risk (Cummins & Weiss, 2013; Neale et al., 2012)
Liabilities	Concentration	Catastrophe risk (Park & Xie, 2014) Impact of climate change on liabilities (SARB, 2020a) Correlated product classes (IAIS, 2011) Export credit insurance (poor substitutability) (IAIS, 2019) Exposure to business interruption claims (SARB, 2021b) Exposure to civil unrest (SARB, 2021b) Exposure to the economy (SARB, 2017b) Industry-loss warranties (IAIS, 2012b) Insurer concentration (SARB, 2020a, 2021b) Insurer interconnectedness (SARB, 2018b) Poor substitutability (Cummins & Weiss, 2014; IAIS, 2018) Poor substitutability and capacity concerns (IAIS, 2011) Poor substitutability: marine and aviation classes (IAIS, 2019) Poor substitutability: mortgage insurance class (IAIS, 2019) Reinsurance with limited or no risk transfer (IAIS, 2011)
	Mismatch	Annuities with options and guarantees (Cummins & Weiss, 2013) Embedded options (early surrender, liquidity risk) (IAIS, 2019) Financial guarantees: liquidity impacts (Cummins & Weiss, 2013, 2014; Geneva Association, 2010b; IAIS, 2011) Fixed-benefit guarantees (macro-economic exposure) (IAIS, 2019

© ASSA licensed under CC 4.0

Balance sheet element	Risk type	Detail and references
Liabilities (continued)	Mismatch (continued)	Guarantee funds (Cummins & Weiss, 2014) Guaranteed returns on saving products (IAIS, 2018) Guarantees without matching (IAIS, 2018) Policyholder lapses and surrenders (SARB, 2018a, 2020a,b) Products with guarantees (Geneva Association, 2011) Providing financial guarantees (Cummins & Weiss, 2014) Saving and investment in long-term insurance (IAIS, 2011)
	Quality	Complexity (Cummins & Weiss, 2014) Complexity (low for non-life insurers) (Park & Xie, 2014) Product design more like banks (IAIS, 2011)
	Strategic	Bancassurance (IAIS, 2011) Credit protection and associated macro-economic exposure (IAIS, 2019) Exposure to burden of disease and economic impacts (SARB, 2021a) Exposure to business interruption claims (SARB, 2020b) Exposure to fraudulent activity (SARB, 2021b) Functions critical to the financial sector (IAIS, 2018) Insurance provides critical function with few substitutes (IAIS, 2019) Third-party asset management (IAIS, 2011)
	Operational	Cyber risk (IAIS, 2018)
ALM	Mismatch	Asset lending (Acharya et al., 2011; Besar et al., 2011; Cummins & Weiss, 2014; IAIS, 2018) Asset lending: liquidity risk (IAIS, 2018) Asset liquidation (IAIS, 2018) Constraining funding or liquidity (exposure channel) (IAIS, 2019) Contributing to asset volatility (asset liquidation) (IAIS, 2019) Derivatives (liquidity risk) (IAIS, 2018, 2019) Exacerbating market movements (asset liquidation) (IAIS, 2019) Excessive reliance on short-term financing (Cummins & Weiss, 2014) High equity levels in life insurance (Chen et al., 2013; Harrington, 2009; IMF, 2009) Liquidity risks (Cummins & Weiss, 2014) Liquidity: backing liquid liabilities with illiquid assets (IAIS, 2018) Maturity mismatches (Cummins & Weiss, 2014) Securities lending (liquidity risk) (IAIS, 2019) Short-term funding potentially leading to fire sales (Acharya et al., 2011; Besar et al., 2011; Geneva Association, 2010a,b; Jobst, 2014; Schwarcz & Schwarcz, 2014) Speculative derivatives (macro-economic exposure) (IAIS, 2019) Counterparty exposures (reinsurers) (IAIS, 2019)
	Quality	Alternative risk transfer (Cummins & Weiss, 2009; IAIS, 2011) Asset concentration (counterparty exposure) (IAIS, 2019) Banking and hedge fund activities (IAIS, 2011) Derivatives (liquidity risk) (IAIS, 2011) Lending interaction (counterparty exposure) (IAIS, 2019)

 © ASSA licensed under CC 4.0

Balance sheet element	Risk type	Detail and references
ALM (continued)	Quality (continued)	Property management (IAIS, 2011) Synthetic investment portfolios (IAIS, 2011) Business model: mix of risks (IAIS, 2011)
	Strategic	Growth in non-core activities (Baluch et al., 2011) Insurance-linked securities (IAIS, 2011) Interconnectedness of various types (Cummins & Weiss, 2014) Size of exposures (Cummins & Weiss, 2014) Hierarchical link to reinsurers insufficient (IAIS, 2012a; Park & Xie, 2014)
Solvency	Concentration	Transferring losses to other participants (exposure channel) (IAIS, 2019) Leverage (IMF, 2009)
	Mismatch	Funding structure (IMF, 2009)
	Quality	Rapid growth (IAIS, 2011)
	Strategic	Deficient provisioning and inadequate pricing (IAIS, 2011)
	Operational	Limited fungibility within insurance groups (Baranoff, 2012; Radice, 2010) Under-reserving or under-pricing (IAIS, 2018) Government policy and regulation (Cummins & Weiss, 2014)
General	General	Interconnectedness higher than previously thought (Acharya et al., 2010; Billio et al., 2012) Life insurance more concentrated (IAIS, 2011) Panic run possible (Acharya & Richardson, 2014) Regulation: not primarily to reduce systemic risk (IAIS, 2011) Regulation: disadvantages of convergence (IAIS, 2011) Inadequate governance (IMF, 2022b)

© ASSA licensed under CC 4.0

TABLE 4. Selection of approaches to modelling systemic risk

Ellis type*	Summary of approach	Contagion direction	Data sources
Capital	Propensity to be under-capitalised when the system is under-capitalised (Acharya et al., 2010)	Market to entity	Book & market
	Capital shortfall of a company conditional on a market crisis (Acharya et al., 2012)	Market to entity	Book & market
	State-dependent sensitivity VaR to show dependence on state of financial markets (Adams et al., 2014)	Entity to market	Market
	Impact of entity distress on the value at risk of the financial system (Adrian & Brunnermeier, 2016)	Entity to market	Book & market
	Capital shortfall of a company conditional on a market crisis (Brownlees & Engle, 2017)	Market to entity	Book & market
	Joint probability of default: system tail risk, based on CDS data (Segoviano & Goodhart, 2009)	No direction implied	Market
	Various approaches to study insurance contribution to systemic risk (Weiß & Mühlnickel, 2014)	Several approaches	Book & market
	Based on sovereign CDS in Asia-Pacific, shows interconnectedness between countries (Wong & Fong, 2010)	Entity to market	Market
Contagion	Econometric connectedness on principal component analysis and Granger causality networks (Billio et al., 2012)	Between entities	Market
	Granger causality between banks and insurers using market and CDS prices (Chen et al., 2013)	Between entities	Market
Early warning	Granger causality between market returns of entities (Billio et al., 2012)	Between entities	Market
	Systemic risk metrics derived from CDS prices (Giglio, 2016)	No direction implied	Market
	Price of insurance against financial distress using CDS and equity price co-movements (Huang et al., 2012)	Entity to market	Market
Liquidity	Impact of shocks on individual banks and the system using Bayesian VaR (Aikman et al., 2011)	Market to entity	Book & market
	Several approaches to marginal impact of liquidity shortfall on market statistics (Jobst, 2014)	Entity to market	Book & market
Liquidity / Network	Liquidity shortages due to bank inter-connectedness: six network structures (Lee, 2013)	Between entities	Simulated
Network	Time-varying marginal effect of firm's VaR on system VaR, allowing for system interdependence (Hautsch et al., 2015)	Entity to market	Book & market
	Study of dynamics of interbank exposures and payment system networks (Martinez-Jaramillo et al., 2015)	Between entities	Book & market
	Quantify contribution to systemic risk from four distinct types of financial exposure (Poledna et al., 2015)	Between entities	Book & market

* The Ellis type follows the classification system proposed by Ellis et al.(2022). The acronym VaR in the summary of approach denotes Value at Risk. Contagion direction describes the nature of the relationship between individual entities and the market as a whole that the modelling aims to demonstrate. Market information is from quoted stock-price or CDS data and book values are obtained from accounting information.

 © ASSA licensed under CC 4.0