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Exploratory Analysis of Solvency Regulations in the Three Main Latin American Insurance Markets

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Abstract

Purpose – This paper analyses the suitability of different regulatory systems for the solvency of insurance companies.

Theoretical framework – The insurance sector is in the midst of a global process of change. There are different systems and each of them faces insolvency in a different way, although they all provide optimal capital with which to deal with undesirable situations. This study focuses on Latin America, where the sector is becoming increasingly important. Brazil, Mexico and Argentina are the most relevant countries in terms of annual premium volume.

Design/methodology/approach – This paper uses the structure designed by Cummins et al. (1994) to check whether the regulations are suitable for reducing the number of insolvencies.

Findings – The review of the regulations in these countries shows that they have all been reformed, following the trend in the insurance sector over the last decade, although the degree of legislative development is greater in some than in others. The involvement of the system must take place at two levels: on the part of the insurer, with the periodic self-assessment of risks; and on the part of the regulator, with the periodic review of the system as a whole.

Practical & social implications of research – This paper contributes to the literature by proposing the lines of work necessary for the globalisation of insurance sector regulation in Latin America.

Originality/value – The main conclusion is that regulatory systems must increase their qualitative approach to risk management, not only in the number of calculations but also by increasing governance, transparency and risk control.

Keywords: Insurance supervision, capital requirements, risk management, solvency, insurance stability.

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1 Introduction

Insurance consists of the transfer of risk of loss in exchange for a premium payment, so that when a loss occurs, this loss is compensated. The collected premiums must be properly managed in order to guarantee compensation payments as well as the solvency of insurance companies; this ensures that insurers will meet both foreseen and unforeseen payment obligations. In view of this, governments establish legislative frameworks to guarantee policyholders' rights, which provide the policyholders with security and require insurance companies to have sufficient capital to absorb the variability of the business, thus guaranteeing their solvency.

Since the 1990s, there has been a shift from a rule-based approach that measures solvency in a static way to a principle-based, risk-based capital approach that measures solvency dynamically (Eling & Holzmüller, 2008; Garayeta & De la Peña, 2017; Fung et al., 2018). This process has been promoted by the International Association of Insurance Supervisors (2015).

Research has been conducted on the predictive ability of solvency models (Meyricke & Sherris, 2014; Fung et al., 2018), and on the minimum capital needed to reduce insolvencies (Park & Tokutsune, 2013). Based on how the models incorporate capital into management, the literature proposes the following classification (Table 1):

Regardless of how countries implement it, the purpose of any insurance regulation is to prevent insurer failure and increase risk diversification (Krivokapic et al., 2017). Cummins et al. (1994) established a theoretical framework with seven hypotheses to analyse insurance regulation and its ability to predict insolvencies. They applied it to Risk-Based Capital, the regulation in force in the United States of America. Theirs is the only existing theoretical framework available to analyse in an insurance regulation the degree of risk measurement and management and its ability to reduce insurer failure. Doff (2008) applied these seven hypotheses to Solvency II, the regulation in force in the European Union (EU), and Holzmüller (2009) extended them to eleven and applied them to Risk-Based Capital, Solvency II and the Swiss Solvency Test, the regulation in force in Switzerland. Other authors have adapted these hypotheses to the latest regulatory changes introduced by Solvency II in the EU and have applied them to the three regulations involved, in addition to others. Such is the case of Garayeta & De la Peña (2017), who apply them to Solvency Margin Ratios, the regulation in force in Japan, and Fung et al. (2018), who apply them to the China Risk-Oriented Solvency System, the regulation in force in China. However, these eleven hypotheses have never been applied to one or more countries in Latin America, an insurance market made up of some thirty countries that differ in their cultural, economic, legal and geographical characteristics.

Therefore, this paper's main objective is to carry out an exploratory analysis of the solvency regulation of the main Latin American insurance markets to determine their degree of development and whether there are significant differences between these markets. The secondary objectives are to identify not only the differences and similarities between the solvency systems but also the areas that should be improved in order to increase the markets' capacity to predict insolvencies.

This paper's contributions are mainly twofold. The first, methodological contribution lies in it being the first to analyse the solvency regulations of Brazil, Mexico and Argentina using the Cummins et al. (1994) and Holzmüller's (2009) eleven hypotheses. The second, practical contribution lies in determining the degree of development of these regulations (indicating their potential for improvement) and comparing them by identifying their differences and similarities.

According to the data provided by Swiss Re. (2019), Latin American insurance businesses generated a premium volume of 167,888 billion United States

Table 1
Regulatory solvency models

	PRINCIPLE-BASED MODELS	RULE-BASED MODELS
Definition	• Responsibility delegated to each company (Eling & Holzmüller, 2008).	• Detailed set of rules (Klein, 2011)
Feature	• Freedom and flexibility	• No option to change
Capital requirements and risk management	• Integrated	• Non-integrated

Source: Own elaboration.

dollars (USD) in 2017. This volume of business exceeds that of the entire African continent and Oceania but not of North America or Europe. In terms of business volume, Brazil, Mexico and Argentina are the three most important countries. Their premiums account for 75% of the total premiums generated in 2017 in LA, of which Brazil represents 50% (Graph 1). The analysis of these countries provides a complete picture of the insurance sector in LA, since the remaining premium volume (25%) is highly fragmented among the other thirty or so countries that make up the region.

This paper is structured as follows. The second section describes the evolution and current status of the models analysed. The methodology is then developed by using Cummins et al. (1994) and Holzmüller's (2009) eleven hypotheses. These allow for a qualitative analysis of country-specific regulations. The fourth section details the results obtained and the fifth and sixth sections discuss those results and draw conclusions.

2 Insurance in Latin America

The pension market's decline and stagnation in recent years is characteristic of the sector in LA (Graph 2).

In the period from 2004 to 2011 there was initially an increase in diversification, both geographically and in terms of product type. The data show that the Latin American market operates at two speeds (Swiss Re., 2019). In 2012 and 2013, there was a slowdown in the main global insurance markets, which was more pronounced in LA. In 2014, life premiums decreased by 2.1% in Brazil and did not grow in the other countries (Swiss Re., 2006). In 2014 and 2015, the lack of investor confidence and fiscal austerity policies in Brazil were reflected in the insurance market with a sharp fall in premium volumes and a decline of growth in Mexico and Argentina (Swiss Re., 2014). Nevertheless, Brazil maintains its leadership position with 62% of premium volume in life insurance.

Graph 1. Insurance business in LA

Source: Data from Swiss Re, 2019 (own elaboration)

2.1 Brazil

Brazil's insurance market has the largest volume of business in LA (Graph 2), generating more than 50% of premiums in LA during the period from 2004 to 2018. The volume of collected premiums is very even between life and non-life business, although slightly more is collected in the former. In 2017, Brazil ranked 12th globally for premium volume, but it dropped to 16th position the following year, accounting for 1.4% of global premium volume in 2018 (Swiss Re., 2019).

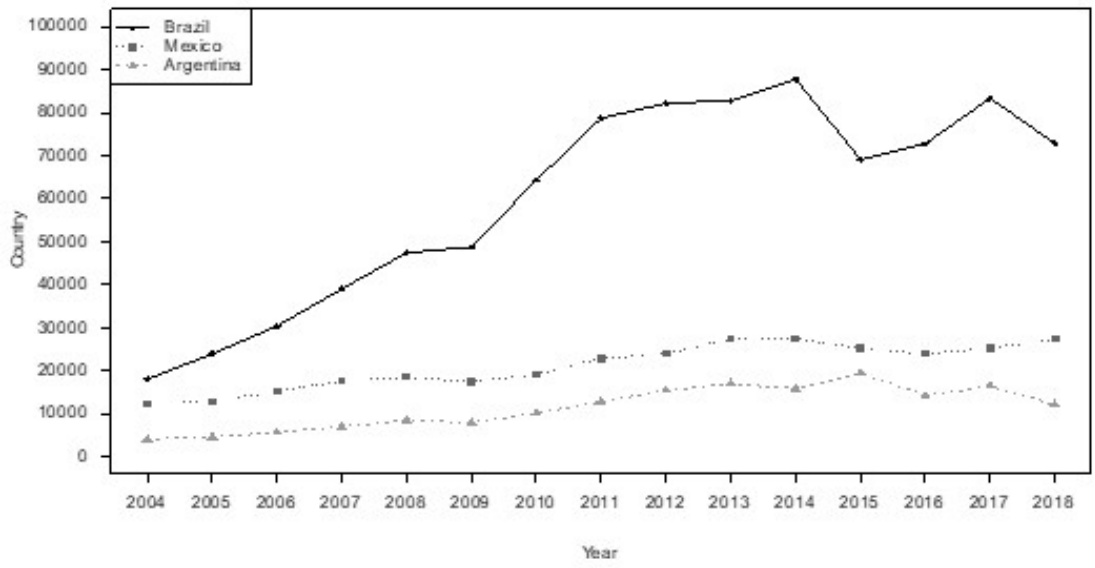
The entity in charge of insurance supervision in Brazil is the Superintendence of Private Insurance (SUSEP) (Curvello et al., 2018). One of the first times this body addressed the issue of insurance company solvency was in 2013 (Brasil, 2015), when the minimum capital required for a company to carry out insurance activities was addressed. It is now established that a company must have a base capital consisting of a fixed part of 1,200,000 Brazilian real (USD 272,982) and a variable part, which depends on the region of the country and the minimum capital (Melgarejo, 2004; Brasil, 2015).

The legislation makes it mandatory to have a solvency regularisation plan and sets the timeframe for implementation (Brasil, 2015; Curvello et al., 2018).

2.2 Mexico

In 2017, Mexico ranked 26th globally for premium volume and it generated USD 25,293 million, representing 15% of the Latin American market, which was 5.8% more than the previous year. Mexico now ranks 20th globally and, unlike Brazil, non-life premiums are more prevalent than life premiums (Swiss Re., 2019).

The National Insurance and Bonding Commission (*Comisión Nacional de Seguro y Fianzas* - CNSF) is the



Graph 2. Evolution of total premium volume (USD million) of the three main markets in LA
Source: Data from Swiss Re, 2019 (own elaboration)

competent body for issuing insurance market laws. In 2004, solvency was included in the inspection and supervision regulations, but mainly referred to accounting and the internal control of insurance companies. The CNSF is responsible for monitoring insurance companies' financial stability and solvency (México, 2018).

Institutions have to regularly assess their overall funding needs; information, both quantitative and qualitative; and risk tolerance limits. Investment and technical reserve requirements are also established (Braun et al., 2017). The legislation also permits the use of internal models to determine capital requirements, subject to prior approval. The required capital must be covered by eligible own funds, which must be invested in accordance with prudence, diversification, liquidity and profitability requirements (México, 2018).

2.3. Argentina

Argentina is ranked third for premium volume in the Latin American market with USD 16,435 million, an increase of 15% compared to 2016 (Swiss Re, 2019). The non-life insurance branch is experiencing the greatest development, ranking second in LA and accounting for 0.23% of premiums worldwide in 2018.

The body in charge of insurance supervision in Argentina is the *Superintendencia de Seguros de la Nación* (SSN). There is currently a regulation that establishes the requirements to be met by agents participating in the insurance market (Argentina, 2018).

The Argentine system bases insurer solvency on whether an insurer can demonstrate that it has enough capital to meet its obligations. In addition, investments must be in line with financial stability (Braun et al., 2017) and ensure company continuity (Noman et al., 2018). All this is carried out under the SSN's supervision.

The Argentine system is rule-based and solvency assessments are mainly accomplished by using accounting indicators, which is far removed from global risk management (International Association of Insurance Supervisors, 2015; Mapfre, 2018). This system is similar to the previous European Solvency I system.

3 Methodology

Modelling the solvency status of an insurer involves considering many factors, not all of which can be measured quantitatively (European Commission, 2004).

Cummins et al. (1994) established a qualitative model based on seven hypotheses that are testable by analysing insurance solvency regulation and focusing on risk assessment and insolvency detection.

The use of this qualitative model is justified because, to date, it is the only existing model for analysing a regulatory system in its entirety and assessing its ability to reduce and predict insurer insolvency. It analyses, from the supervisor's point of view, how insurers measure and

manage their risks. There is no other methodology for analysing solvency in an exploratory way.

This qualitative methodology was used by Doff in 2008 to analyse Solvency II. Holzmüller (2009) extended it by adding four assumptions in order to adapt it to the complexity of products and changes in markets, insurer structures and risks. The latter author applies it to Risk-Based Capital, Solvency II and the Swiss Solvency Test, focusing on the possibility of dynamic changes and market capital. Other authors have adapted these hypotheses to the latest regulatory changes introduced by Solvency II in the EU and have applied them to the three regulations involved and others. Garayeta and De la Peña (2017) apply the model to Solvency Margin Ratios (Japan) and Fung et al. (2018) apply it to the China Risk-Oriented Solvency System.

The qualitative model used in this paper is the European model, as it is the most common one in the insurance sector (Holzmüller, 2009). It contains the eleven criteria, which will be tested as hypotheses.

The hypotheses of this model are then tested and assigned a value of 1 if they are fulfilled and 0 otherwise. According to the Cummins methodology, each criterion has requirements to be fulfilled, which in this work will be used as if they were items to be fulfilled. If an item is addressed in the legislation or there is a formula to measure it, a value of 1 will be set and 0 otherwise. All items will be averaged out and given the same degree of importance. If the average is less than 0.5, the hypothesis is not fulfilled, whereas if the value obtained is greater than or equal to 0.5, the hypothesis is considered as being fulfilled. We will follow the methodology established by Doff (2008) and Holzmüller (2009).

> H1: The risk-based capital formula provides sufficient incentives for weak firms to reduce their risk exposure.

Rule-based regulation is simple and less risk-oriented (Doff, 2008). Therefore, an insurance supervisor sets minimum capital requirements that are public and that insurers must meet to avoid intervention, providing an incentive to hold capital commensurate with risk (Doff, 2008; Noman et al., 2018). Setting capital requirements allows for early intervention as well as the creation of an efficient and stable structure. Therefore, the hypothesis is fulfilled if a country's regulation:

> i. Rehabilitates weak insurers.
>
> ii. Ensures the orderly liquidation of insurers that are unable to do so.
>
> iii. Limits insurers that are at risk of insolvency from acquiring risks.

> H2: The risk-based capital formula reflects the main types of risk.

Regulation that identifies the types of risk and the sensitivity to them allows for the detection of weak insurers (Santomil & González, 2020) and reduces the possibilities of arbitrage in the system, so the hypothesis is satisfied if:

> i. Internal controls are in place that, together with adequate governance, reduce failures. Insolvencies are often due to a combination of several risks (Park & Tokutsune, 2013), so the regulation identifies the main risks to which an insurer is exposed that are individually or jointly responsible for its insolvency (Park & Tokutsune, 2013); it establishes internal controls and promotes appropriate governance in order to reduce failures.
>
> ii. Risk sensitivity reflects the differences between various insurers (Holzmüller, 2009). However, the regulation should not set excessive requirements for small insurers so that they are not discriminated against and driven out of the market, which would ultimately harm supply and market freedom (Van Rossum, 2005; Liu et al., 2019).

> H3: The weight of each risk is proportional to its impact.

The hypothesis is fulfilled if:

> i. The regulation promotes an approach where the weight of risk is commensurate with its importance (Doff, 2008). Risks must be calibrated appropriately (Holzmüller, 2009) and each insurer's casuistry must be considered (Cummins et al., 1994).
>
> ii. The probability of insurer insolvency must be calculated using a consistent risk measure (Artzner et al., 1999) and the parameters must be estimated correctly to avoid distortions (Doff, 2008).

iii. The structure of interdependencies between risks is appropriate and can be developed using internal models (Holzmüller, 2009).

H4: The system significantly identifies insurers that generate the highest insolvency costs.

Insolvencies in the insurance sector are caused by one or more shocks to assets, liabilities or both (Eling et al., 2007), although historically insolvencies have focused attention on liabilities as they are more frequent in weakly capitalised insurers (Park & Tokutsune, 2013). Similarly, small insurer insolvencies tend to be more frequent, but those of large insurers generate higher costs to the economy (Liu et al., 2019). The hypothesis therefore holds if the regulation can reduce the failures of insurers that pose a systemic risk (Doff, 2008; Cummins et al., 1994).

H5: The formula must reflect the economic values of assets and liabilities.

An insurer's accounting balance sheet differs greatly from an economic balance sheet. The calculation of technical provisions and minimum allowable capital must be done using the economic value of assets and liabilities because book values can provide biased results (Holzmüller, 2009; Krivokapic et al., 2017; Curvello et al., 2018). The International Financial Reporting Standard (IFRS) uses economic value, so compliance with the assumption leads to convergence with it especially for liabilities (International Accounting Standards Board, 2017).

H6: The measurement system prevents inaccurate reporting and other forms of insurer manipulation.

Supervisory and control regulation focuses on the security of policyholders and beneficiaries, while accounting regulation should avoid inaccurate information (Gatzert & Heidinger, 2020) without neglecting qualitative characteristics. A supervisor must have access to accurate and relevant information that enables insolvencies to be anticipated (Noman et al., 2018). The hypothesis is therefore fulfilled if:

i. The accuracy of information is ensured by having instruments that detect and sanction fraud (Cummins et al., 1994), including on-site assessments (Doff, 2008).

ii. Sanctions are clearly defined and known to all other actors (Holzmüller, 2009).

H7: The formula avoids complexity.

This hypothesis is complex because the regulation should encourage risk management and reduce insolvency costs (Doff, 2008). Thus, there are two extremes (Table 2):

The insurance industry is complex by nature. However, a formula's level of complexity must, on the one hand, be appropriate and encourage overall risk management and, on the other hand, not make premiums more expensive or reduce innovation (Van Rossum, 2005). In this respect, it should be borne in mind that there may be simple formulas underlying complex calculations (Klein & Wang, 2007).

Internal models, however, are more risk appropriate and are incorporated into an insurer's management (Klein & Wang, 2007; Linder & Ronkainen, 2004; Scherer & Stahl, 2021), but they are complex and costly (Eling et al., 2007). While complexity is to some extent necessary, it must be at an appropriate level and there must be a comprehensive approach to risks.

H8: The structure is adequate to anticipate economic shocks and manage systemic risk.

Systemic risk has been primarily associated with the banking sector, but globalisation has increased its importance in the insurance sector (Laas & Siegel, 2017).

Table 2
Main features of the calculation formula

	SIMPLE FORMULA	COMPLEX FORMULA
In favour	• **Easy to explain, understand and use.**	• **Improved prediction** (Holzmüller, 2009)
Against	• Does not capture all the information (Trainar, 2006). • Does not observe inefficiencies in transparency (Butt, 2007).	• Cost to insurer and regulator (Holzmüller, 2009) • Difficult to analyse (Cummins et al., 1994): - the management of the company - the effect on capital and the market

Source: Own elaboration.

A lack of regulation fosters systemic risk (Holzmüller, 2009), although the use of the same model leads to the same response to similar events, thereby increasing systemic risk.

Internal models are a systemic risk reduction tool (Nebel, 2004). Such models relate risk to an insurer's own experience and risk profile, and they are therefore the basis for risk assessment and risk management (Santomil & González, 2020; Vesa et al., 2007).

H9: The regulation carries out an evaluation of management processes.

This hypothesis requires:

i. A structure and tools to enable a regulator to detect insolvency situations and causes at an early stage. There needs to be some indicator to prevent capital shortfalls.

ii. The conducting of qualitative analyses (Park & Tokutsune, 2013), which can be effective in detecting various factors. On the one hand, there are factors that cause insolvency, such as a lack of management experience, incorrect business plans (Arora, 2018; Holzmüller, 2009; Park & Tokutsune, 2013), poor management or exposure to strategic risk (Doff, 2008). On the other hand, there are factors that prevent it, such as internal controls or expert advice (Arora, 2018).

iii. Regulators having supervisory and monitoring tools in addition to setting capital requirements (International Association of Insurance Supervisors, 2015).

H10: The system is flexible and adaptable to change.

This hypothesis examines whether:

i. The market moves faster than regulation so that misalignments can occur and affect policyholders (Holzmüller, 2009). A system with high solvency standards may drive more insurers out of the market than is necessary (Eling et al., 2007), reducing the number of institutions in the market and changing its structure from atomised to centralised.

ii. The market's degree of competitiveness. When agents have more power, they tend to limit regulation. In contrast, highly regulated markets allow for high competitiveness and individual agents have less power (Fung et al., 2018).

H11: Systems increase market discipline and transparency.

Regulation should include market discipline and not be limited to capital to ensure solvency (Gatzert & Heidinger, 2020). This requires increased transparency, which provides information that allows insurers to be assessed (Eling et al., 2007), so that:

i) These systems comply with regulation and maintain an appropriate level of risk.

ii) The market is more efficient and information asymmetries are reduced.

The methodology used in this research consists of an exploratory analysis of Brazil, Mexico and Argentina's legislation on the supervision and control of insurance companies in order to assess these countries' regulatory development. For this purpose, a qualitative model was used, based on Cummins et al. (1994) and Holzmüller's (2009) eleven hypotheses, which determine the degree of performance of each country's regulatory solvency system in comparison with the European Solvency II model. The aspects analysed are a system's quantitative management (H1, H2, H3, H5, H7 and H10), its qualitative management (H6 and H9), its transparency and use of market discipline (H11), as well as its ability to detect insurer failures and, if they occur, to reduce their costs (H4 and H8).

4 The exploratory analysis results and hypotheses testing

4.1 The exploratory analysis results

The exploratory analysis results on the impact of the Brazilian, Mexican and Argentine regulations on insurance companies' solvency are summarised in Table 3.

Table 3
Summary of solvency regulation

System	Brazil	Mexico	Argentina
1. General information			
1.1. Country of application	Brazil MCR (minimum capital requirement)	Mexico SCR (solvency capital requirement)	Argentina
1.2. Year of introduction	2015	2016	2014 (last reform, although solvency is not addressed)
1.3. Main pillars	Quantitative and qualitative requirements regarding investment characteristics	Quantitative and qualitative requirements to be reviewed by the supervisor, public disclosure	Quantitative and slightly qualitative requirements
1.4. Regulated companies	Insurance and reinsurance companies	Insurance and reinsurance companies	Insurance and reinsurance companies
1.5. Consideration of management risk	No	Slight	No
1.6. Public information requirements	Yes, but for administrations	Yes	Yes
2. Definition of required capital			
2.1. Typology of the model	Static factors + dynamic solvency assessment	Static factors + dynamic solvency assessment	Static factors
2.2. Rule-based/Principle-based	Principle-based	Principle-based	Rule-based
2.3. Balance sheet orientation	Yes	Yes	Yes
2.4. Time horizon	3 months	1 year	1 year
2.5. Measurement of risk/ calibration	VaR 99%	VaR 99.5%	-
2.6. Operational risk	Yes	Yes	-
2.7. Catastrophic risk	No	Yes, as part of the liabilities at risk	-
2.8 Internal models	No	Yes	-
3. Definition of available capital			
3.1. Definition based on market or book values	Economic values	Market-consistent values	Book values
3.2. Classification of available capital	Not stated	Yes (3 levels)	-
3.3. Consideration of off-balance sheet items	No	Yes, as part of the risks	-
4. Intervention			
4.1. Levels of intervention			-
4.2. Transparency of sanctions	Yes. Deadlines are set but no sanctions	Yes, established	No

Source: Own elaboration.

4.2 Hypotheses testing

The hypotheses of the qualitative model are tested by assigning them a value of 0 if they are rejected and 1 if they are accepted. Next, the evidence that allows the hypotheses to be accepted or rejected is presented, as well as the situation in which the analysed regulations are found. Using text mining, a value of 1 is assigned to the evidence that contributes to the acceptance of the hypothesis and 0 is assigned to the evidence that does not. The hypothesis is rejected (0 value) if the average of the evidence is less than 0.5 and accepted (value of 1) if it is greater than or equal to 0.5. For this purpose, it is assumed that all evidence is of equal importance for the acceptance or rejection of the hypothesis, so that all evidence for the same hypothesis has the same weighting.

H1:

Brazil leads the Latin American insurance market in terms of premium volume but not in terms of solvency measurement. Its system is in transition to a principle-based system, so it adheres to H1 but does not fully satisfy it (Mapfre, 2018). It includes the largest risks but

could improve its risk adequacy, as internal models are not addressed (Scherer & Stahl, 2021).

The Mexican solvency capital requirement (SCR) generally complies with H1 because it is principle-based, risk-sensitive and strives to move away from the rule-based system. However, the SCR does not consider that there are risks whose measurement requires a more complex approach, and its risk sensitivity can be improved as some calculations use accounting concepts (México, 2018). Another drawback is that the system is based on modules where the SCR increases with premiums and not with risks, which implies a failure of H1 because higher premiums do not necessarily lead to higher risk exposure.

Argentina has a system with a basic risk quantification, which is similar to the Solvency I system that the European Union used in the past (Mapfre, 2018). The system is rule-based, calculations are carried out with accounting rather than economic values, and the system does not contemplate the use of internal models. Therefore, the risk management approach is not comprehensive and is far removed from H1.

Most systems use the value-at-risk (VaR) risk measurement, with the exception of the Argentine regulation, which does not require a measure as it is rule-based. Brazil uses a confidence level of 99% (Chan & Marques, 2017), while Mexico uses 99.5% (México, 2018).

Regarding the typology of the regulatory solvency system, Argentina uses a formula-based system, which is a feature to be improved; Brazil and Mexico use risk-oriented systems.

The above evidence confirms that the hypothesis is accepted in the Brazilian and Mexican systems, while it is rejected in the Argentine one.

H2:

The Mexican model's approach to risk includes six main risks (insurance technical, financial, pension, counterparty, operational and probable maximum loss). The Brazilian model again lags behind the Mexican model because it only includes four main risks (operational, underwriting, credit and market), although it uses an accounting basis and does not consider catastrophic risks.

The Argentine system mentions six main risks (insurance, market, credit, liquidity, operational and money laundering) that an adequate risk management system should contemplate (Argentina, 2018), but either it does not develop them further or its formulas are excessively static.

Operational risk is mentioned in all three systems. However, the Argentine system only considers it as part of an adequate risk management system. The Mexican system integrates it into a risk management system. Only the Brazilian system uses a formula, based on premiums and provisions, which is similar to that of Solvency II. There is consequently room for improvement, at least in the first two systems.

As for catastrophic risk, Mexico includes it but Brazil makes no reference to its implementation. Liquidity risk is different from solvency risk and many systems only mention it. The Mexican model includes liquidity risk as part of the SCR to be calculated, whereas the Argentine and Brazilian systems only mention it; however, none of the systems establish the calculation method.

Therefore, the above evidence indicates that the hypothesis is accepted for the regulation of Brazil and Mexico and rejected for Argentina.

H3:

Risks are often interdependent. The Brazilian model considers the correlation between risks and between some sub-risks, although it does not consider the correlation between these risks and operational risk. The Mexican system considers the correlations between the different risks, but the value of these correlations is not detailed in the regulation, which is an aspect that needs to be improved. The Argentine model is static and requires neither calibration nor risk measures.

The time horizon used for most calculations in Mexico is one year. In Brazil, for some calculations, it is three months (Chan & Marques, 2017). In Argentina it ranges from 12 to 36 months, depending on the calculation.

Therefore, the hypothesis is accepted in the Mexican and Brazilian systems but not in the Argentine system.

H4:

The Brazilian and Mexican models are principle-based, so risks are represented by probability measures, and the VaR risk measure is used to determine capital requirements (Chan & Marques, 2017; México, 2018). The Argentine model is a rule-based system and uses book values, so there is a higher possibility of bankruptcies that generate high costs for the economy.

The regulation in Mexico allows for the development of internal models, subject to prior authorisation by the Commission; however, Brazil and Argentina do not consider them, although in the latter some authors suggest that they should be addressed (Chan & Marques, 2017).

The Brazilian system states that cash flows should consider an insurer's size, although it does not indicate how to do so (Brasil, 2015), while the Argentine system does not differentiate between large and small companies.

The evidence indicates that the hypothesis is only accepted in the case of Brazil and Mexico.

H5:

Brazil and Mexico have recently implemented market-consistent solvency models so that valuations are mainly carried out using economic values. However, the Argentine model makes no reference to the use of market values. Therefore, the evidence indicates that H5 is accepted in the regulations of the first two countries and rejected in the latter.

In addition, there are intangible assets in the insurance sector that must be considered when analysing an insurer's risk and solvency. There is no doubt that some off-balance sheet items are not captured, although, for example, Mexico attempts to include them in its models (México, 2018). It was not observed that the other systems address this section, which supports the statement in the previous paragraph.

H6:

The Brazilian and Mexican models are principle-based systems, but this is not the case for Argentina's regulatory system. Brazil mentions internal controls that are mainly focused on monitoring the accounting–auditing part (Brasil, 2015) but does not expressly mention corporate governance. Mexico's model addresses corporate governance and establishes criteria for sanctions and levels of intervention. However, these levels are unspecified and should be further developed. The Argentine system only establishes corporate governance principles.

Thus, the evidence indicates that the hypothesis is rejected in the Argentine and Brazilian cases because neither the monitoring system nor corporate governance is developed.

H7:

Following their respective reforms, the Brazilian and Mexican systems are not rule-based, and although the MCR and SCR formulas are more complex, they are still simple enough to adhere to the hypothesis. The risk measure used by these systems is VaR, which is simpler than tail value at risk (TVaR). In addition, the Mexican system establishes the obligation to publish the information used for the SCR calculation, so it can be cross-checked.

The Argentine system establishes the calculation by regulation, without capturing representative risk information or using stochastic methodologies, although it is the simplest of the three.

As for internal models, Mexico allows their development, Brazil does not do so yet and Argentina does not even contemplate them.

The evidence indicates that the hypothesis is accepted in the cases of the Brazilian and Mexican regulations.

H8:

The Mexican model is based on internal principles and models, whereby capital requirements are determined based on insurers' experience and risk profile. It also reduces the possibility of contagion by allowing each insurer to use its own model, which (although not explicitly addressed in the system) reduces exposure to systemic risk (Laas & Siegel, 2017).

The Brazilian model does not address internal models but uses a principle-based system focused on risk adequacy (Brasil, 2015) that allows it some resilience to shocks. Argentina should transform its system to a principle-based, risk-oriented system that allows the use of internal models to reduce its exposure to systemic risk and improvement with regard to this hypothesis.

Therefore, the hypothesis is accepted for the Mexican regulation and rejected for Brazil and Argentina.

H9:

The regulation in Brazil addresses an insurer's internal control, but its focus is on accounting rather than the overall analysis of corporate governance. It requires managers to be experts in insurance matters (Arora, 2018) and emphasises actuarial expertise. The Mexican regulation addresses corporate governance and external actuarial advice. To obtain the advice the regulation establishes a disciplinary regime and experience requirements for specify types of work, without elaborating on how such work will be assessed. The Argentine regulation establishes the principles of corporate governance but does not elaborate on them, so they are still to be developed.

Furthermore, it does not establish requirements for the work to be performed by insurance experts, nor does it address the consequences of malpractice by those involved in risk management (Argentina, 2018).

Therefore, the above evidence indicates that the hypothesis is only accepted in the case of Mexico.

H10:

The political process of approval and/or implementation of a regulation, the number of actors involved in it, and the geographical area of a country, which may involve the participation of local authorities, are factors that hinder a regulation's flexibility and its speed of implementation. These factors are fully or partially present in Brazil, Mexico and Argentina and may affect the acceptance or rejection of the hypothesis, which will ultimately depend on the degree of centralisation of the legislative process.

Mexico's transition to the current model began in the 1990s, which highlights the complexity of its implementation and questions its flexibility. Brazil and Mexico's systems are principle-based and allow for some changes in amounts and/or parameters—changing their structure, however, would require a longer process. Argentina's system does not allow for changes in the way minimum capital is determined.

All this evidence leads to the rejection of the hypothesis in all three systems.

H11:

The Brazilian system currently does not address internal models or corporate governance, although management promotes adequate governance, and there is an obligation to report to SUSEP, although it is true that its dissemination is not fully detailed. The Mexican model aims for efficient risk management based on principles, it promotes internal model development and it establishes public disclosure of certain data. The Argentine model addresses internal control, for which an annual programme is required, and tasks are detailed; however, market discipline, transparency and information dissemination are still pending issues.

The evidence indicates that the hypothesis is only accepted in the case of Mexico.

5 Discussion

The hypotheses of Cummins et al. (1994) and Holzmüller (2009) provide the qualitative baseline analysis of solvency regulations. In the previous section this paper analysed Argentina, Brazil and Mexico's regulatory systems, hypothesis by hypothesis, and it also assessed the state of these systems and the reforms they should undertake to improve the insurance sector's solvency.

The joint analysis of the hypotheses (Table 4) shows that the most developed system is the Mexican one, which adheres to all the hypotheses except for the tenth, which is largely due to the fact that it is closer to the path set by Solvency II. In this sense, it would be advisable for the Mexican regulator to improve the system's capacity to adapt to emerging risks such as, for example, cyber, climate or geopolitical risks (Eling & Holzmüller, 2008), which are expected to increase in relevance in the coming years. Despite being the market

Table 4
Summary of hypotheses

Hypothesis	Brazil	Mexico	Argentina
1. Provides appropriate incentives	1	1	0
2. Risk-sensitive formula	1	1	0
3. Well calibrated formula	1	1	0
4. Identification of high insolvency costs	1	1	0
5. Economic values considered	1	1	0
6. Avoids inaccurate information	0	1	0
7. Simple formula	1	1	0
8. Crisis-responsive structure	0	1	0
9. Assessment of the management system	0	1	0
10. Flexibility to adapt	1	0	0
11. Strength of management and market transparency	0	1	0

Source: Own elaboration.

in LA with the largest volume of premiums, Brazil does not adhere to five of the eleven scenarios. The Brazilian regulator should improve the adaptability of the system (hypothesis 10), qualitative risk management (hypotheses 6 and 9), disclosure of information and use of market discipline (hypothesis 11), which would allow it to increase transparency (Gatzert & Heidinger, 2020), and the ability to detect insurer failures and reduce their costs (hypothesis 8). The Argentine system does not fulfil any of the hypotheses and can therefore improve both quantitative and qualitative risk management, transparency and the use of market discipline, and its ability to detect insurer failures and reduce their costs. This is because the system measures solvency primarily on a static and retrospective basis (Doff, 2008), and the regulator should therefore initiate a reform process with the aim of implementing a new system to address risks in an appropriate manner.

The Mexican system is inspired by Solvency II and, like the Chinese system and the Swiss Solvency Test II, it is characterised by a high number of accepted assumptions (Doff, 2008, 2016; Fung et al., 2018; Garayeta & De la Peña, 2017; Holzmüller 2009). The Argentine system is inspired by Risk-Based Capital and Solvency I and, like the Japanese system, it is characterised by a low or zero number of accepted assumptions (Cummins et al., 1994; Fung et al., 2018; Garayeta & De la Peña, 2017; Holzmüller, 2009). The Brazilian system is in transition from a system inspired by Risk-Based Capital and/or Solvency I to one inspired by Solvency II and the Swiss Solvency Test II and therefore needs to improve to meet the assumptions indicated in the previous paragraph.

The entry into force of Solvency II in January 2016 has been a milestone not only for the European Union insurance market that has had to implement it, but also for numerous regulators in other geographical areas. These have taken this regulation as a reference to transform their generally static, retrospective and rule-based regulatory systems into dynamic, risk-based, forward-looking ones, taking into account the characteristics of their insurance markets and their degree of risk aversion, in order to improve the prediction and management of insolvencies and to encourage insurers to manage their business using the enterprise risk management (ERM) techniques that have been developed in recent decades. In the last five years, therefore, the activity of most insurance markets has focused on the process of discussing and/or initiating the necessary reforms to their regulatory systems, or on their implementation and the analysis of results. All these processes have been delayed by the COVID-19 pandemic. For example, in the case of the European Union, the results of the implementation of Solvency II are being analysed and two debates have been initiated. The first is on the process of reviewing and, if necessary, amending Solvency II (European Commission 2021a, 2021b, 2021c). The second is on the measurement and management of systemic risk in the insurance market and macro-prudential management tools (European Insurance and Occupational Pensions Authority, 2017, 2018b, 2018c), many of which were introduced in Solvency II.

The objectives of insurance regulation are primarily to protect policyholders and beneficiaries, to identify and reduce the number of insolvencies, to reduce the total cost to an economy of insolvencies of insurers operating in that economy, to increase the efficiency of the insurance market, to reduce information asymmetries between players in the insurance market and to align their interests by setting appropriate incentives to do so.

The fulfilment of these objectives depends on the degree of development of the regulation, which depends on the acceptance of the eleven hypotheses of Cummins et al. (1994) and Holzmüller (2009). The rejection of these hypotheses highlights the weaknesses of regulations and the reforms that regulators should undertake to improve them.

One of the most analysed objectives in the literature relates to the cost of insurer insolvency. Although the number and cost of insurer insolvencies is lower than that of other financial institutions such as banks, it is notable and attracts the attention of academics, practitioners and regulators (European Insurance and Occupational Pensions Authority, 2018a). More developed systems allow for more bankruptcies to be predicted earlier and in greater numbers, and their proper management reduces the cost to policyholders, beneficiaries and, ultimately, governments and taxpayers. Conversely, the number and cost of insolvencies is higher in systems with more weaknesses (Eling et al., 2007). In order to address these weaknesses, many regulators (Garayeta et al., 2022) have undertaken or plan to undertake the necessary reforms to implement, in whole or in part, systems that allow for a dynamic and prospective assessment of solvency (Braun et al., 2017; Chan & Marques, 2017; Gavira-Durón et al., 2022).

6 Conclusions

This paper details an exploratory analysis of the regulation of the main Latin American insurance markets to determine their degree of development, the differences and similarities between the systems and their room for improvement. To this end, Brazil, Mexico and Argentina's solvency regulations were analysed using Cummins et al. (1994) and Holzmüller's (2009) theoretical framework and by testing their eleven hypotheses. It is the first time that this methodology has been used to assess Latin American solvency.

The result of this exploratory analysis shows that, although the systems analysed have similarities between them, they also have significant differences (Table 3) and different degrees of development (Table 4). Therefore, the degree of development of the different LA insurance markets was determined and it is concluded that there are significant differences between them, thus fulfilling the main objective of the study.

Table 3 summarises the regulations of the main insurance markets in LA, showing the differences and similarities between these regulations, thus fulfilling the first secondary objective.

Using the information in Tables 3 and 4, it is concluded that the regulations in Brazil and Argentina need to be reformed in order to develop their risk management systems, and the discussion section indicates the aspects that need to be improved in these regulations and which reforms regulators should undertake in the short and medium term in order to increase their capacity to predict insolvencies, and which are therefore of interest to them.

The Brazilian regulator should improve risk identification, use internal models, promote corporate governance and establish and publish sanctions. The Argentine regulator should undertake a comprehensive and in-depth review of its regulatory system, which has many weaknesses—including the fact that it is a static, rule-based system that uses book values and therefore lacks calibration and risk measures. It does not provide for the use of internal models, nor does it adequately develop risks, corporate governance principles, market discipline, transparency and disclosure. This may lead to non-risk-sensitive capital requirements as well as to the failure to provide for insurer insolvency, which, if a contagion effect occurs, may increase the country's exposure to systemic risk. Therefore, we identified the regulations that need to be reformed to increase their ability to predict insolvencies, identifying the specific areas that can be improved, thus fulfilling the second secondary objective.

In addition to regulators, this work may be of interest to: i) policyholders, whether they belong to the public or private sector (companies or families), since the insolvency of their insurers could affect the collection of their claims; ii) insurers, because the implementation of this type of reform entails significant consumption of material, immaterial and human resources that need to be managed over several years; and iii) academics who are interested in the insurance sector, risk management, insolvency prediction and regulation, especially in LA.

This paper's main limitation is the number of countries considered, which is limited to three of the thirty or so countries that make up the region. However, these countries account for 75% of the total premiums generated by LA in 2017, so the paper's conclusions can be extrapolated to the rest of the region.

Future lines of research should focus on extending the exploratory analysis of solvency regulation, not only geographically (including representative Latin American countries which have this type of regulation) but also normatively, by analysing the rules that tend to develop this regulation by branch (life and non-life) or by risk type.

References

Argentina. Superintendencia de Seguros de la Nación – SSN. (2018). *Reglamento General de la Actividad Aseguradora. Resolución reglamentaria de la ley 20.091*. Poder Ejecutivo Nacional.

ARORA, P. (2018). Financially linked independent directors and bankruptcy reemergence: The role of director effort. *Journal of Management*, *44*(7), 2665-2689. http://dx.doi.org/10.1177/0149206316648384.

ARTZNER, P., DELBAEN, F., EBER, J. M., & HEATH, D. (1999). Coherent measures of risk. *Mathematical Finance*, *9*(3), 203-228. http://dx.doi.org/10.1111/1467-9965.00068.

Brasil. Conselho Nacional de Seguros Privados – CNSP. (2015). *Resolução CNSP nº 321, de 2015*. Diário Oficial da República Federativa do Brasil.

BRAUN, A., SCHMEISER, H., & SCHREIBER, F. (2017). Portfolio optimization under Solvency II: Implicit constraints imposed by the market risk standard formula.

The Journal of Risk and Insurance, *84*(1), 177-207. http://dx.doi.org/10.1111/jori.12077.

BUTT, M. (2007). Insurance, finance, solvency ii and financial market interaction. *The Geneva Papers on Risk and Insurance. Issues and Practice*, *32*(1), 42-45. http://dx.doi.org/10.1057/palgrave.gpp.2510115.

CHAN, B. L., & MARQUES, F. T. (2017). Impacts of the regulatory model for market risk capital: Application in a special savings company, an insurance company, and a pension fund. *Revista Contabilidade & Finanças*, *28*(75), 465-477. http://dx.doi.org/10.1590/1808-057x201703840.

CUMMINS, J. D., HARRINGTON, S., & NIEHAUS, G. (1994). An economic overview of risk-based capital requirements for the property–liability insurance industry. *Journal of Insurance Regulation*, *11*(4), 427-447.

CURVELLO, R. D. S. S., RODRIGUES, A., & MACEDO, M. A. D. S. (2018). Loss reserve error in the Brazilian insurance market: Empirical evidence of the response to economic and tax regulations. *Revista Brasileira de Gestão de Negócios*, *20*(4), 550-572. http://dx.doi.org/10.7819/rbgn.v0i0.2942.

DOFF, R. (2008). A critical analysis of the Solvency II Proposals. *The Geneva Papers on Risk and Insurance. Issues and Practice*, *33*(2), 193-206. http://dx.doi.org/10.1057/gpp.2008.2.

DOFF, R. (2016). The final Solvency II Framework: Will it be effective? *The Geneva Papers on Risk and Insurance. Issues and Practice*, *41*(4), 587-607. http://dx.doi.org/10.1057/gpp.2016.4.

ELING, M., & HOLZMÜLLER, I. (2008). An overview and comparison of risk-based capital standards. *Journal of Insurance Regulation*, *26*(4), 31-60.

ELING, M., SCHMEISER, H., & SCHMIT, J. T. (2007). The Solvency II process: Overview and critical analysis. *Risk Management & Insurance Review*, *10*(1), 69-85. http://dx.doi.org/10.1111/j.1540-6296.2007.00106.x.

European Commission – EC. (2004). *The Draft Second wave calls for Advice from CEIOPS and Stakeholder Consultation on Solvency II, Markt/2515/04* (Working Paper, 2004-10-11). Brussels.

European Commission – EC. (2021a). *Communication from the Commission to the European Parliament and the Council on the review of the EU prudential framework for insurers and reinsurers in the context of the EU's post pandemic recovery COM/2021/580*. Brussels.

European Commission – EC. (2021b). *Proposal for a directive of the European Parliament and of the Council amending directive 2009/138/EC as regards proportionality, quality of supervision, reporting, long-term guarantee measures, macro-prudential tools, sustainability risks, group and cross-border supervision. 2021/0295/COD*. Brussels.

European Commission – EC. (2021c). *Proposal for a directive of the European Parliament and of the Council establishing a framework for the recovery and resolution of insurance and reinsurance undertakings and amending directives 2002/47/EC, 2004/25/EC, 2009/138/EC, (EU) 2017/1132 and regulations (EU) no 1094/2010 and (EU) no 648/2012. 2021/0296/COD*. Brussels.

European Insurance and Occupational Pensions Authority – EIOPA. (2017). *Systemic risk and macroprudential policy in insurance.* Publications Office of the European Union. https://www.eiopa.europa.eu/sites/default/files/publications/pdfs/003systemic_risk_and_macroprudential_policy_in_insurance.pdf

European Insurance and Occupational Pensions Authority – EIOPA. (2018a). *Failures and near misses in insurance: Overview of the causes and early identification*. Publications Office of the European Union https://www.eiopa.europa.eu/sites/default/files/publications/reports/eiopa-bos-21-394-failures-and-near-misses-database-report.pdf

European Insurance and Occupational Pensions Authority – EIOPA. (2018b). *Solvency II tools with macroprudential impact.* Publications Office of the European Union https://www.eiopa.europa.eu/sites/default/files/publications/pdfs/solvency_ii_tools_with_macroprudential_impact_0.pdf

European Insurance and Occupational Pensions Authority – EIOPA. (2018c). *Other potential macroprudential tools and measures to enhance the current framework*. Publications Office of the European Union https://www.eiopa.europa.eu/sites/default/files/publications/pdfs/eiopa_other_potential_macroprudential_tools_0.pdf

FUNG, D. W. H., JOU, D., SHAO, A. J., & YEH, J. J. H. (2018). The China risk-oriented solvency system: A comparative assessment with other risk-based supervisory frameworks. *The Geneva Papers on Risk and Insurance. Issues and Practice*, *43*(1), 16-36. http://dx.doi.org/10.1057/s41288-017-0046-3.

GARAYETA, A., & DE LA PEÑA, J. I. (2017). Looking for a global standard of solvency for the insurance industry: Pros and cons in three systems. *Transformations in Business & Economics*, *16*(2), 55-75.

GARAYETA, A., DE LA PEÑA, J. I., & TRIGO, E. (2022). Towards a global solvency model in the insurance market: A qualitative analysis. *Sustainability*, *14*(11), 6465. http://dx.doi.org/10.3390/su14116465.

GATZERT, N., & HEIDINGER, D. (2020). An empirical analysis of market reactions to the first Solvency and Financial Condition Reports in the European insurance industry. *The Journal of Risk and Insurance*, *87*(2), 407-436. http://dx.doi.org/10.1111/jori.12287.

GAVIRA-DURÓN, N., MAYORGA-SERNA, D., & BAGATELLA-OSORIO, A. (2022). The financial impact of the implementation of Solvency II on the Mexican insurance sector. *The Geneva Papers on Risk and Insurance. Issues and Practice*, *47*(2), 349-374. http://dx.doi.org/10.1057/s41288-020-00196-1.

HOLZMÜLLER, I. (2009). The United States RBC Standards, Solvency II and the Swiss Solvency Test: A comparative assessment. *The Geneva Papers on Risk and Insurance. Issues and Practice*, *34*(1), 56-77. http://dx.doi.org/10.1057/gpp.2008.43.

International Accounting Standards Board – IASB. (2017). *International finance reporting standards 17 insurance contracts*. IASB.

International Association of Insurance Supervisors – IAIS. (2015). *Insurance core principle & risk management and internal controls, amended November 2015*. IAIS.

KLEIN, R. W. (2011). Principles for insurance regulation: An evaluation of current practices and potential reforms. *The Geneva Papers on Risk and Insurance. Issues and Practice*, *37*(1), 175-199. http://dx.doi.org/10.1057/gpp.2011.9.

KLEIN, R. W., & WANG, S. (2007). Catastrophe risk financing in the US and the EU: A comparative analysis of alternative regulatory approaches. *The Journal of Risk and Insurance*, *76*(3), 607-637. http://dx.doi.org/10.1111/j.1539-6975.2009.01308.x.

KRIVOKAPIC, R., NJEGOMIR, V., & STOJIC, D. (2017). Effects of corporate diversification on firm performance: Evidence from the Serbian insurance industry. *Economic research-. Ekonomska Istrazivanja*, *30*, 1224-1236. http://dx.doi.org/10.1080/1331677X.2017.1340175.

LAAS, D., & SIEGEL, C. F. (2017). Basel III versus Solvency II: An analysis of regulatory consistency under the New Capital Standards. *The Journal of Risk and Insurance*, *84*(4), 1231-1267. http://dx.doi.org/10.1111/jori.12154.

LINDER, U., & RONKAINEN, V. (2004). Solvency II: Towards a new insurance supervisory system in the EU. *Scandinavian Actuarial Journal*, *104*(6), 462-474. http://dx.doi.org/10.1080/03461230410000574.

LIU, S., JIA, R., ZHAO, Y., & SUN, Q. (2019). Global consistent or market-oriented? A quantitative assessment of RBC standards, solvency II, and C-ROSS. *Pacific-Basin Finance Journal*, *57*, 101073. http://dx.doi.org/10.1016/j.pacfin.2018.10.002.

Mapfre. (2018). *Regímenes de regulación de solvencia en seguros. Un análisis del proceso de avance hacia regulaciones basadas en riesgos*. Servicio de Estudios Mapfre.

MELGAREJO, J. (2004). *El margen de solvencia de las entidades aseguradoras en Iberoamérica.* Servicio de Estudios Mapfre

México. Comisión Nacional de Seguros y Fianzas – CNSF. (2018). *Ley de instituciones de seguros y de fianzas, compilada hasta el 22 de julio de 2018*. Congreso de la Unión.

MEYRICKE, R., & SHERRIS, M. (2014). Longevity risk, cost of capital and hedging for life insurers under Solvency II. *Insurance, Mathematics & Economics*, *55*, 147-155. http://dx.doi.org/10.1016/j.insmatheco.2014.01.010.

NEBEL, R. (2004). Regulations as a source of systemic risk: The need for economic impact analysis. *The Geneva Papers on Risk and Insurance. Issues and Practice*, *29*(2), 273-283. http://dx.doi.org/10.1111/j.1468-0440.2004.00287.x.

NOMAN, A. H. M., GEE, C. S., & ISA, C. R. (2018). Does bank regulation matter on the relationship between competition and financial stability? Evidence from Southeast Asian countries. *Pacific-Basin Finance Journal*, *48*, 144-161. http://dx.doi.org/10.1016/j.pacfin.2018.02.001.

PARK, S. C., & TOKUTSUNE, Y. (2013). Do Japanese policyholders care about insurers' credit quality? *The Geneva Papers on Risk and Insurance. Issues and Practice*, *38*(1), 1-21. http://dx.doi.org/10.1057/gpp.2012.32.

SANTOMIL, P. D., & GONZÁLEZ, L. O. (2020). Enterprise risk management and Solvency II: The system of governance and the Own Risk and Solvency Assessment. *The Journal of Risk Finance*, *21*(4), 317-332. http://dx.doi.org/10.1108/JRF-09-2019-0183.

SCHERER, M., & STAHL, G. (2021). The standard formula of Solvency II: A critical discussion. *European Actuarial Journal*, *11*(1), 3-20. http://dx.doi.org/10.1007/s13385-020-00252-z.

Swiss Re. (2006). *World insurance in 2005: Moderate premium growth, attractive profitability* (Sigma No.5/2006). Sigma. https://cncpanama.org/phocadownload/Biblioteca%20Digital%20CNC/2.%20Biblioteca/Seguros/Seguro_Mundial_Swiss_RE_2005.pdf

Swiss Re. (2014). *World insurance in 2013: Steering towards recovery* (Sigma, No 3/2014). Sigma. https://www.swissre.com/institute/research/sigma-research/World-insurance-series.html

Swiss Re. (2019). *World insurance in 2019: The great pivot east continues.* Sigma. https://www.swissre.com/institute/research/sigma-research/World-insurance-series.html

TRAINAR, P. (2006). The challenge of solvency reform for European insurers. *The Geneva Papers on Risk and Insurance. Issues and Practice*, *31*(1), 169-185. http://dx.doi.org/10.1057/palgrave.gpp.2510066.

VAN ROSSUM, A. (2005). Regulation and insurance economics. *The Geneva Papers on Risk and Insurance. Issues and Practice*, *30*(1), 156-177. http://dx.doi.org/10.1057/palgrave.gpp.2510005.

VESA, R., LASSE, K., & RAOUL, B. (2007). Topical modelling issues in Solvency II. *Scandinavian Actuarial Journal*, *2007*(2), 135-146. http://dx.doi.org/10.1080/03461230701257098.

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