Economic crisis and determinants of solvency in the insurance sector: new evidence from Spain

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Abstract

This paper analyzes the factors that determine the solvency of the insurance companies operating in Spain. The selected time span, from 2008 to 2015, encompasses a period of economic instability characterized by record low interest rates and low or even negative economic growth. Using a dynamic panel data model, we conclude that actual solvency margins are positively related to profitability, underwriting risk, and a mutual-type organization but inversely related to size, reinsurance use, longer-tailed business, and life insurance specialization. We also find that less concentrated markets and the context of an economic crisis decrease solvency margins.

Keywords: Insurance; solvency; capitalization; economic crisis; European financial system.

JEL classification: G22; G28; G32; G33.

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1. Introduction

Given their crucial role in the financial system, insurers have received increasing attention from researchers and regulators since the financial crisis of 2008 (Dhaene *et al.*, 2017). Similar to the banking system, the insurance industry mobilizes savings and invests part of them in nonfinancial sectors of the economy, making it an important provider of the investments needed for economic growth. In fact, in 2016, European insurers generated total premium income of 1,189 billion euros (31.1 percent of the global market share) with 10,112 billion euros invested in the economy, making this industry the largest institutional investor in this area (Insurance Europe, 2018b). Moreover, the insurance sector plays a relevant role in terms of financial stability by acting as a conduit for households and firms to transfer risks to entities that are better suited to handle them.

Traditionally, insurance companies have been regarded as posing potentially lower systemic risks than the banking sector because they are less exposed to liquidity risk. That the average maturity of insurer liabilities are longer than that of their assets makes insurance companies much less vulnerable to 'runs'. In addition, insurers are not as strongly interconnected through the interbank market and payment systems as banks are (Trichet, 2005). However, from the perspective of financial stability, the increasing interactions among the insurance sector, financial markets, and other financial intermediaries call into question the traditional approach that considers insurance an activity with low systemic risk. Billio *et al.* (2012) find that hedge funds, banks, broker/dealers, and insurance companies have become closely interrelated, likely increasing the level of systemic risk in the finance and insurance industries through a complex and time-varying network of relationships.[1]

Insurer capitalization is an important element to consider regarding the stability of the financial system. The European Union (EU) is aware of this element and has established a new regulation on solvency for insurance companies, known as Solvency II. This regulation has replaced 28 national regimes with a single set of risk-based capital requirements and advanced risk-management principles.[2] However, although adequate

[1] Weiß and Mühlnickel (2014) conclude that several insurers contributed significantly to the instability of the U.S. financial sector during the recent financial crisis. In the same vein, Bierth *et al.* (2015) find that the contribution of insurers to the fragility of the financial system peaked in the crisis. See Trichet (2005) for a good description of the linkages between the banking and the insurance sector.

[2] The Solvency II Directive (Directive 2009/138/EC [recast]), which came into force in January 2016, was adopted in November 2009 and amended by Directive 2014/51/EU of the Parliament and the Council of Europe of 16 April 2014 (the so-called "Omnibus II Directive").

capital requirements are necessary to protect customers, excessive solvency margins could increase the costs of some products (e.g., guaranteed savings products) and may even restrict the ability of insurers to allocate capital to long-term investments (Insurance Europe, 2018a).[3] As stated by Cummins *et al.* (1999), the accuracy of the solvency regulation system is essential not only to avoid insolvencies but also to reduce unnecessary regulatory costs on financially sound insurers.

This paper aims to contribute to the ongoing debate surrounding insurer solvency in Europe by analyzing the factors (firm-specific and macro) that determine the actual solvency margin of insurance companies operating in Spain during 2008–2015. To conduct this analysis, we use a comprehensive dataset of 202 firms (1,537 observations) that represents approximately 94 percent of the premiums in the Spanish insurance sector. Because social benefit institutions and reinsurance specialists have singular characteristics that may affect solvency, we limit our analysis to stock and mutual insurers. The selected timespan, from 2008 to 2015, encompasses a period of economic instability with a prolonged situation of record low interest rates and low or even negative economic growth.

We focus on Spain as an interesting case study: Spain is among the top ten European countries by asset volume and gross premiums written (EIOPA, 2017). Some additional background information is required to better understand the Spanish insurance sector. By the end of 2017, insurance penetration, i.e., the relationship between premiums and gross domestic product (GDP), was 5.45 percent. Total investment by insurance companies amounted to 292.064 billion euros, representing a 1.4 percent increase over 2016. The return on equity (ROE) in the industry maintained the upward trend initiated in 2015, with an ROE of 12.03 percent or 1.3 percentage points higher than in 2016. Likewise, profitability measured in terms of return on assets (ROA) showed a slight increase to 1.6 percent (MAPFRE Economic Research, 2018). The Spanish insurance industry is mainly governed by rules originated in the EU, particularly the Solvency II Directive, whereas supervision is carried out by the Directorate General of Insurance and Pension Funds

[3] This can happen if calibrations are unnecessarily conservative or because the wrong risks are being measured.

(*Dirección General de Seguros y Fondos de Pensiones*) (DGSFP), an administrative body within the Ministry of Economy and Business.[4,5]

Our results show that actual solvency margins in Spain are directly and significantly related to profitability, underwriting risk, and a mutual-type organization. However, company size, the use of reinsurance, a longer-tailed business, and life specialization seem to reduce insurers' capitalization. We also find that less concentrated markets and the context of an economic crisis (with a declining GDP) decrease solvency margins. Portfolio risk and interest rates are found not to be significant in our model. Because the European Commission has expressed its intention to review the methods, assumptions, and standard parameters used in Solvency II, those findings may have broad implications for supervisors concerned about benchmarking and validating this new regulatory framework. These implications are even stronger if we consider that approximately 90 percent of insurers operating in Spain had capital buffers of up to 50 percent higher than the minimum requirements, which brings to light the fact that regulators could have been requiring far less capital than demanded by the market under the former supervisory regime (i.e., Solvency I).

Our analysis complements the literature along different dimensions. First, there is little empirical evidence on the determinants of insurers' solvency in the context of an economic crisis. Although the insurance sector has shown stronger resistance to the recent financial crisis than the banking sector, the volatility of the financial markets, a prolonged situation of record low interest rates, and a scenario of low or even negative economic growth (with high unemployment rates) have had widespread effects in most countries, especially those in the euro area. Second, by using actual solvency margins (roughly defined as available capital divided by total assets) instead of solvency ratios (actual solvency margins divided by required solvency margins) as the main proxy of insurer solvency, our findings would not be affected by regulatory requirements.[6] Finally, we use the system-generalized method of moments (system-GMM) estimator developed by

[4] The main laws and regulations that have been brought into force to implement the Solvency II Directive are Act 20/2015 of 14 July for ordination, supervision, and solvency of insurance and reinsurance undertakings (LOSSEAR) and Royal Decree 1060/2015 of 20 November, which approves the regulations for ordination, supervision, and solvency of insurance and reinsurance undertakings (ROSSEAR). Both became effective on 1 January 2016.

[5] See MAPFRE Economic Research (2018) for an in-depth understanding of the Spanish insurance market.

[6] de Haan and Kakes (2010) find that the levels of insurers' actual solvency margins during the pre-Solvency II period 1995–2005 in the Dutch insurance industry are related to their risk characteristics and not to regulatory solvency requirements. Consequently, they conclude that the vast majority of insurers hold much more capital than required, i.e., non-risk-based capital requirements are not binding.

Arellano and Bover (1995) and Blundell and Bond (1998) for dynamic panel data models. Only very few papers on the determinants of solvency in the insurance industry have used this new methodology that allows us to control for endogeneity and for unobserved heterogeneity (e.g., Rubio-Misas and Fernández-Moreno, 2017).[7]

This paper is structured as follows. Section 2 reviews the most significant studies and presents our research hypotheses. Section 3 describes the data and methodology employed in the empirical research. Section 4 presents and discusses the results obtained. Section 5 summarizes the results and draws conclusions.

2. Theoretical background and hypotheses

Indicators of insurer solvency are mostly defined in terms of capitalization: as previously mentioned, we use as a proxy for the insurer's solvency the actual solvency margin, which is calculated as available capital divided by total assets.[8] Therefore, we adopt capital structure theories as a starting point to formulate most of our hypotheses. Two main theories may influence the capital structure of insurers.[9] Trade-off theory states that the main benefit of holding a capital buffer is that it may help the insurer avoid the cost of financial distress when there are relevant losses in the portfolio, whereas the main advantage of using financial debt is a reduction in taxes.[10] Moreover, financial debt may be pitted against technical provisions in the different trade-offs that define the capital structure of insurance companies (Dhaene *et al.*, 2017). Reducing financial debt to

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[7] Rubio-Misas and Fernández-Moreno (2017) analyze the effect of cost frontier efficiency, reinsurance use, organizational form, and premium growth on solvency ratios (defined as actual solvency margins divided by required solvency margins) of Spanish insurers from 2005 to 2012.

[8] The actual solvency margin is calculated by dividing the insurer's solvency margin (according to Spanish legislation) by its total assets. Spanish rules state that the solvency margin corresponds to the assets of the insurer, free of all foreseeable liabilities, less any intangible items. In general, this margin consists of share capital (or, in the case of mutual companies, initial guarantee fund), reserves (including hidden reserves arising out of the undervaluation of assets or overvaluation of liabilities), undistributed profits, members' accounts, cumulative preferential shares, and subordinated loans. The intangible assets (e.g., copyrights, licenses, trademarks, own shares) must be subtracted from the total of the net asset items.

[9] There is little consensus on how firms choose their capital structure although much has been written since the irrelevance proposition of Modigliani and Miller (1958). The choice between equity and financial debt is likely to be even more complex in insurance companies than in industrial firms due to their particular business model. First, insurers have an inverted production cycle (they receive a premium upfront). Second, the role of the customer and the financier are merged in an insurance company since policyholders finance the firm through premium payments. In the case of mutual insurance firms, policyholders are owners as well. Third, regulation requires insurers to invest in a portfolio of financial securities to meet policyholders' future claims, and technical provisions account for the largest share of insurers' liabilities. As a result, the use of financial debt in insurance companies is reduced, and the main emphasis of capital structure decisions will be equity versus technical provisions (see Dahene *et al.* 2017 for an excellent discussion).

[10] The trade-off theory states that firms pursue an optimal target debt ratio by balancing the corporate tax advantages of leverage against the costs of possible financial distress (e.g., Bradley *et al.*, 1984; Myers, 2001).

increase provisions when keeping all else fixed has the benefit of creating more insurance business for the same investment in the securities portfolio. In addition, the extra provisions are usually tax deductible (Bradford and Logue, 1999). Jensen and Meckling (1976) introduce 'agency costs' as another potential source of costs and benefits to consider when firms are choosing the optimal capital structure. Insurers are subject to two main sources of agency costs: owner-policyholder and owner-manager conflicts of interest. Based on this, the optimal capital structure of an insurance company may depend on the dominant type of conflict, whereas lower capitalization mitigates the owner-manager conflict and higher capitalization reduces the owner-policyholder conflict (de Haan and Kakes, 2010). In contrast, the pecking order theory of financing (Myers and Majluf, 1984) states that information asymmetries between managers and investors make external financing costlier than internal financing. As a result, firms may prefer financing through internal funds and debt rather than issuing new equity.[11] We should, however, consider some particular issues in insurance companies. First, insurers mainly invest in financial securities because they are not required to finance important amounts of inventories or accounting receivables; therefore, we might expect fewer financial deficits than in industrial firms, other things being equal (Dhaene *et al.*, 2017). Second, because insurers are subject to asymmetric information in liabilities (Zhang *et al.*, 2009), and financial debt is subordinated to policyholder claims, this debt may be considered risky by investors. Consequently, the pecking order theory in insurance companies also predicts little use of financial debt, making these firms highly dependent on internal funds.

Factors influencing insurer capitalization can be classified into two main groups. The first group includes determinants specific to each insurance company, such as size, profitability, reinsurance use, risk profile of the asset portfolio, underwriting risk, long-tailed business, organizational form, and specialization. Most of these determinants are a result of decisions made by managers. The second group of determinants comprises factors relating insurers' capital to the industry structure and to the macroeconomic environment, such as industry concentration, interest rates, and economic growth.

2.1. Size

[11] For industrial firms, the resulting 'pecking order' in managers' preferences for financing is as follows: they first use retained earnings, followed by 'safe' debt, then they move on to risky debt and, finally, issue equity. Consequently, according to this theory, there is not an optimal target debt–equity ratio, and firms' capital structure is the result of the accumulation of past financial deficits (Shyam-Sunder and Myers, 1999; Myers, 2001).

Sharpe and Stadnik (2007) find that financially distressed insurers are typically small in size. Because the average losses for a larger pool of policyholders may be more easily predictable, larger insurance firms may have lower default probabilities with the same amount of capital (de Haan and Kakes, 2010). Additionally, larger insurers may need less capital than smaller firms because they normally benefit from economies of scale and scope and have lower financing costs (Bouzouita and Young, 1998; Adams *et al.*, 2003, Caporale *et al.*, 2017). Previous studies by Cummins and Nini (2002), Carayannopoulos and Kelly (2004), de Haan and Kakes (2010), and Cheng and Weiss (2013), among others, find that size is negatively and significantly related to insurer capitalization.

Consequently, we formulate the following hypothesis:

Hypothesis 1. *There is a negative relationship between size and actual solvency margin.*

We use the natural logarithm of total assets to account for the effect of size on the insurer's actual solvency margin.

2.2. Profitability

The empirical literature on insurance firms concludes that higher profitability contributes to higher levels of capitalization and lower probabilities of insolvency (see, e.g., Sharpe and Stadnik, 2007; Kleffner and Lee, 2009; Shim, 2010; Rauch and Wende, 2015; Caporale *et al.*, 2017; among others). Shim (2010) finds that, consistent with the pecking order theory, profitability plays a significant role in determining an insurer's ability to increase capital (i.e., insurers seem to rely heavily on retained earnings due to costly external financing caused by asymmetric information). Rauch and Wende (2015) state that an insurer's profitability positively influences the company's equity and solvency because premium and investment income exceeds claims and other expenses. In the same vein, Caporale *et al.* (2017) report that highly profitable insurers are less likely to become insolvent because they manage expenses effectively and can set competitive premium rates.

Therefore, we test the following relationship:

Hypothesis 2. *There is a positive relationship between profitability and the actual solvency margin.*

We divide profits after tax by total assets to examine the influence of profitability on the margin.

2.3 Reinsurance

According to the renting capital hypothesis, reinsurance serves as a substitute for equity because the cost of renting capital from reinsurers may be lower than the cost of issuing extra equity (Shiu, 2011; Dhaene *et al.*, 2017).[12] That reinsurance allows insurers to transfer part of its risk to third parties results in more predictable future losses and, consequently, a reduction in its capital reserves (Caporale *et al.*, 2017). Moreover, reinsurance enables primary insurers to have sufficient risk capacity for planning and pricing new business lines (Upreti and Adams, 2015). Nevertheless, although reinsurance is widely used by insurance firms to reduce capital requirements, it exposes them to counterparty risk (Caporale *et al.*, 2017), potentially resulting in insurers with higher probabilities of default. Nevertheless, most of the empirical evidence shows an inverse relationship between the use of reinsurance and the insurer's capitalization (see, e.g., Cummins and Nini, 2002; Carayannopoulos and Kelly, 2004, Shiu, 2011; Cheng and Weiss, 2013; Mankaï and Belgacem, 2016; among others).[13]

We formulate the following hypothesis to be tested:

Hypothesis 3. *There is a negative relationship between the use of reinsurance by the insurer and its actual solvency margin.*

We use the ratio of reinsurance premiums paid to total premiums earned to analyze the effect of reinsurance on the solvency margin.

2.4. Risk profile of the asset portfolio

Most studies report a positive relationship between the risk of the asset portfolio and capitalization for insurance companies (Cummins and Sommer, 1996; Cummins and Nini, 2002; Baranoff and Sager, 2002; Mankäi and Belgacem, 2016; Rauch and Wende, 2015; among others). Cheng and Weiss (2013) provide several reasons to explain this positive relationship. First, higher capital may help insurers prevent financial distress costs. Second, insurers will raise capital to offset policyholders' awareness of insolvency when increasing risk taking. Third, agency costs also lead to a positive relationship

[12] The reinsurer receives a percentage of the annual premia written from primary insurers in return for sharing in the losses of the insurance portfolio. Depending on their purpose, reinsurance arrangements can take many specific forms (Berger *et al.*, 1992). In liability insurance, the reinsurer agrees to cover losses in excess of a specified limit (Patrik, 1990). This type of reinsurance is an important mechanism for risk diversification.

[13] Adams (1996) shows that reinsurance is associated with more leveraged insurers. Therefore, it may imply a two-sided interaction between reinsurance and leverage.

between risk and capital if managers compensate for increases in risk by holding higher capital buffers.

We therefore derive the following hypothesis:

Hypothesis 4. *There is a positive relationship between portfolio risk and the actual solvency margin.*

We choose the share of equity securities in total assets to measure the effect of investment risk on insurer solvency.[14]

2.5. Underwriting risk

Underwriting risk captures the risk on the insurance portfolio (de Haan and Kakes, 2010), reflecting the amount and types of business that the insurer underwrites each year (Cheng and Weiss, 2013). Therefore, although asset risk mainly accounts for the risk of bond defaults and stock price fluctuations (i.e., the investment portfolio), underwriting risk refers to the risk that loss payments will be greater than the expected losses allowed for in the premiums charged to policyholders (Cummins and Sommer, 1996). Following a similar reasoning to the line applied in the asset risk hypothesis, we might again expect a positive relationship between underwriting risk and insurer capitalization. Empirical literature corroborates this positive association (see, e.g., Cheng and Weiss, 2013; Hu and Yu, 2014; among others).

Consequently, we formulate the following testable hypothesis:

Hypothesis 5. *There is a positive relationship between underwriting risk and actual solvency margin.*

Similar to de Haan and Kakes (2010), we proxy underwriting risk by the standard deviation over the sample period of the loss ratio, defined as incurred losses divided by premiums earned net of reinsurance.

2.6. Long-tailed business

Long-tail lines of insurance (i.e., with a higher time lag between the policy issuance and the payment of the claims) may have a negative effect on insurer solvency because they tend to generate less income from underwriting than shorter-tail lines (de Haan and Kakes, 2010). In addition, a longer-tailed business implies that managers control

[14] Stocks and real estate assets expose insurers to more volatility risk than fixed-income investments (Cummins and Nini, 2002).

policyholder funds for longer periods, which gives these managers higher chances of squandering these funds (Carayannopoulos and Kelly, 2004). Consequently, owner-manager conflicts may be more severe in these firms, resulting in higher agency costs. Owners could mitigate this type of conflict by reducing capital and increasing leverage (Cummins and Nini, 2002).

Therefore, we hypothesize a negative effect of long-tailed business on solvency.

Hypothesis 6. *There is a negative relationship between long-tailed businesses and actual solvency margins.*

Following Cummins and Nini (2002), we use the ratio of technical provisions (i.e., loss reserves) over incurred losses to test the effect of the time lag between the issuance and payment of claims. Higher ratios indicate a longer-tailed business.

2.7. Organizational form

Ownership structure is another possible determinant of an insurer's solvency margins. Based on agency costs, we might expect that mutual insurance companies will hold less capital than stock companies because mutual firms control owner-policyholder conflicts (Carayannopoulos and Kelly, 2004).[15] However, mutual insurers are likely to find it more difficult to raise capital; therefore, pecking order theory predicts that they will have a stronger tendency to accumulate capital (de Haan and Kakes, 2010).[16] The empirical literature mostly finds evidence that the existence of a mutual organization contributes to higher capital ratios and, thus, higher actual solvency margins (Cummins and Sommer, 1996; Cummins and Nini, 2002; Harrington and Niehaus, 2002; de Haan and Kakes, 2010; Cheng and Weiss, 2013; Rauch and Wende, 2015).

Considering this, we test the following hypothesis:

Hypothesis 7. *Mutual insurers have higher actual solvency margins than stock companies.*

We account for the ownership structure of the firm using a dummy variable that takes the value of 1 for mutual insurers and 0 for stock companies.

2.8. Specialization

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[15] In mutual insurance companies, policyholders are also owners of the firm.

[16] Mutual insurers have less access to financial markets than stock companies, and they basically raise equity capital by retaining earnings.

Investment activities, operations, and liabilities' maturities notably differ between life and nonlife segments of the insurance industry (Rubio-Misas and Fernández-Moreno, 2017). Although life insurance companies function as financial intermediaries, nonlife insurers operate as 'risk takers' (Chen and Wong, 2004). Nonlife insurers are considered riskier than life insurance companies, not only because of the uncertainty of claim payments but also on account of the difficulty in predicting threats (Gründl *et al.*, 2016).

Since we might expect that insurers involved in less risky lines of business hold less capital, we establish the following hypothesis:

Hypothesis 8. *Life specialized insurers have lower actual solvency margins than nonlife specialized insurers.*

We test the effect of the line of business on the actual solvency margin using a dummy variable that takes the value of 1 if the written premiums of the company during that year are 50 percent or higher in the life insurance sector and 0 otherwise.

2.9. Industry concentration

Most of the literature analyzing the relationship between concentration and financial stability has focused on the banking industry, reporting two contrary hypotheses (see, e.g., Baselga-Pascual *et al.*, 2015). The 'concentration-stability' view states that a concentrated industry with few large firms is more stable because large firms are likely to earn more profits due to market power. These profitable firms have the ability to increase capital, thus increasing their solvency. However, the 'concentration-fragility' view asserts that a more concentrated industry is more vulnerable to financial fragility because the 'too-big-to-fail' protective mechanism may lead to excessive risk-taking by managers, thus negatively affecting the solvency of companies. Only a few recent studies analyze this relationship in the insurance sector, also with contradictory results. Although Cummins *et al.* (2017) report a positive relationship between concentration and soundness in European life insurance firms, Altuntas and Rauch (2017) and Shim (2017) conclude that higher market concentration is associated with lower financial stability in the insurance sector, providing empirical support for the "concentration-fragility view".

Thus, we propose the following contradictory hypotheses:[17]

[17] All studies analyzed use the Z-score to measure financial stability. Thus, we construct our hypotheses assuming that capital and financial soundness are positively related.

Hypothesis 9a. *There is a positive relationship between industry concentration and actual solvency margin.*

Hypothesis 9b. *There is a negative relationship between industry concentration and actual solvency margin.*

We measure industry concentration using a Herfindahl–Hirschman index calculated as the sum of the squares of all insurers' market shares in terms of total assets (in percentage). An index greater than 1,800 suggests a highly concentrated market whereas an index lower than 1,000 indicates an unconcentrated market.

2.10. Interest rates

The existent literature on the impact of interest rates on insurer solvency is also ambiguous (see, e.g., Cheng and Weiss, 2012; Shim, 2017; among others). These contradictory findings could be due to two opposing effects of interest rates. Higher interest rates increase the yields of insurer account portfolios and thus may have a positive impact on its solvency but also may negatively affect insurer capitalization due to the decreasing market value of fixed-income assets (Rubio-Misas and Fernández-Moreno, 2017).

Again, we formulate two testable hypotheses:

Hypothesis 10a. *There is a positive relationship between interest rates and actual solvency margin.*

Hypothesis 10b. *There is a negative relationship between interest rates and actual solvency margin.*

We use the interest rate of the main refinancing operations (MRO) of the European Central Bank (ECB) as our proxy for interest rates. This rate is one of main instruments of the monetary policy in the euro area.

2.11. Economic growth

Previous studies on banking solvency have demonstrated the positive influence of economic growth on capital. Banks use an expansionary macroeconomic environment to accumulate capital (Laeven and Majnoni, 2003; Schaeck and Cihák, 2012). Moreover, defaults on bank loans during recessions increase and generate higher losses that are charged against bank capital (Brewer III *et al.,* 2008). Nevertheless, some of the banking literature also concludes that certain institutions may behave in an excessively lax manner during upturns because they do not properly consider the cyclical nature of output and, therefore, tend to underestimate risks (e.g., Ayuso *et al.* (2004) find that capital buffers were countercyclical in Spain during 1986–2000). Although the literature on the effect of economic growth on insurer solvency is still scarce, it seems obvious that general economic conditions are also likely to affect insurer capitalization because raising capital may be easier in a relatively strong economy (Cummins and Sommer, 1996).

Consequently, we formulate the following hypothesis:

Hypothesis 11. *There is a positive relationship between economic growth and the actual solvency margin.*

We use the growth rate of the Spanish GDP to examine this relationship.

Table 1 summarizes the hypotheses and variables considered in the current study. Data are mainly obtained from the database maintained by the Spanish regulatory authority, the DGSFP.[18]

[INSERT TABLE 1 ABOUT HERE]

3. Empirical tests

3.1 Sample selection

Our sample consists of 202 insurance companies operating in Spain during 2008–2015. As previously stated, we limit our analysis to stock and mutual insurers because social benefit institutions and reinsurance specialists have singular characteristics that may affect solvency. We only chose those companies in the DGSFP database that have information for all of the variables analyzed over at least five consecutive years during the period considered. This is a required condition for the implementation of the system-GMM estimator (to test for the absence of second-order serial correlation). We use unconsolidated financial statements, thereby reducing the possibility of introducing aggregation bias in the results. Merged insurers are also considered separate firms before the merger and a single company afterward. Finally, to ensure that the analysis is not affected by potential measurement errors and misreporting, we remove from the sample those firms that present abnormal ratios or extreme values. After completing this filtering, we obtain a final dataset consisting of an unbalanced panel with 1,537 observations (see Table 2).

[INSERT TABLE 2 ABOUT HERE]

[18] The database is available at http://www.dgsfp.mineco.es/sector/balancesycuentas.asp

3.2. Methodology

The firm-specific factors that influence insurer solvency may be endogenous. For instance, insurers with a higher capital ratio could have incentives to invest more in shares (de Haan and Kakes, 2010). In the same vein, the insurer's current capital structure may affect the utilization of reinsurance (Shiu, 2011). Furthermore, not all the factors that may influence solvency margins are easy to measure or identify in an equation (e.g., managerial ability). If the influence of the so-called unobserved heterogeneity is not considered, one could observe correlations between some of the coefficients of the explanatory variables and the error terms that bias these coefficients. Finally, the persistence of capital ratios has been previously documented in the literature (e.g., Rubio-Misas and Fernández-Moreno, 2017).

To address all these concerns, we use the system-GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998) for dynamic panel data models. As proposed by Windmeijer (2005), we employ the two-step estimation procedure with finite-sample corrected standard errors, which provides less biased coefficient estimates and more accurate standard errors. We treat insurer characteristics (except their organizational form) as endogenous variables by using suitable instruments for both the equation in levels and the equation in differences. Industry concentration and macroeconomic variables are considered as strictly exogenous. We verify the validity of the instruments by using a Hansen J-test for overidentifying restrictions.

Our baseline equation is as follows:

$$Y_{i,t} = \alpha + \delta \cdot Y_{i,t-1} + \beta \cdot FS_{i,t} + \gamma \cdot M_t + \varepsilon_{i,t} \tag{1}$$

where Y denotes the variable used to measure the solvency of insurer i in year t (i.e., the actual solvency margin);[19] $Y_{i,t-1}$ represents its lagged value; δ measures the speed of adjustment (a value of δ close to 0 implies that insurer solvency is characterized by a high speed of adjustment, whereas a value close to 1 indicates a very slow adjustment); $FS_{i,t}$ and M_t denote, respectively, the firm-specific and industry and macroeconomic variables considered in our study, and β and γ are vectors of coefficient estimates. Finally, $\varepsilon_{i,t}$ is the disturbance term that contains the unobserved insurer-specific effect (η_i) and the idiosyncratic error ($v_{i,t}$).

[19] We take natural logarithms to control for the skewness exhibited by the original variable.

4. Results

4.1. Determinants of actual solvency margins in Spain

Table 3 sets out an initial outline of the Spanish insurance industry from 2008 to 2015. The actual solvency margin decreased by 8 percent from 2008 to 2013, when it reached a minimum value. Although the solvency margin increased from then up to 2015, probably caused by the start of the economic recovery in Spain and/or the necessary adjustments before the entry into force of Solvency II in 2016, it did not recuperate its value from 2008. Nevertheless, the mean value of the actual solvency margin for the full period is in line with that reported by de Haan and Kakes (2010), who examined the Dutch insurance industry in a precrisis period (1995–2005). Mean size values decreased steadily during the sample timespan. Insurers' profitability remained mostly unchanged, with slight signs of improvement following 2012. The use of reinsurance was stable, although with a mean value of only 11.5 percent during the period analyzed. Competitive markets and low investment returns have forced insurers to retain more risk on their balance sheets as they became increasingly price sensitive and developed their risk management capabilities over time (EIOPA, 2016). Portfolio risk accounted for less than 7 percent and increased in the last three years, especially in 2014 and 2015. Although the Spanish insurance sector's investment portfolio is mostly made up of fixed-income investments, the decline in interest rates may be pushing insurers to invest in riskier assets in search of higher returns. Moreover, the transition to the Solvency II regulatory framework might have been driving this reallocation of investments. Underwriting risk mean values are also similar to those found in other European countries (e.g., de Haan and Kakes, 2010). In contrast, technical provisions are approximately 3 times the amount of the incurred losses, with the time lag between issuance and payment of claims remaining stable. The dummy variables show that approximately 15 percent of the sample are mutual insurers (85 percent stock companies) and approximately 30 percent of the sample observations correspond to life specialized insurers (70 percent nonlife specialized companies). Regarding industry and macroeconomic variables, Table 3 reports an increase in the concentration of the Spanish insurance sector according to the evolution of company size over the sample period. Finally, macroeconomic variables show a deterioration of the economic situation in Spain after the 2007–2008 global financial crisis, with negative economic growth and a low interest rate environment.

[INSERT TABLE 3 ABOUT HERE]

Table 4 reports the results of the empirical estimation of Equation (1) using the system-GMM estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998). The dynamic character of the model specification is confirmed by the high levels of significance of the lagged dependent variables. The higher values of δ indicate strong persistence, i.e., that the adjustment of the actual solvency margin is very slow.

[INSERT TABLE 4 ABOUT HERE]

We validate our first hypothesis (H1), in which we anticipated a positive relationship between the insurer's size and its actual solvency margin based on the literature, and found that larger insurance firms require relatively less capital due to more predictable losses and because they benefit from economies of scale and scope as well as lower financing costs (Bouzouita and Young, 1998; Adams *et al.*, 2003; de Haan and Kakes, 2010; Caporale *et al.*, 2017). According to previous studies (e.g., Shim, 2010), a positive relationship between profitability and capitalization may be expected, consistent with pecking order theory. Our results corroborate this hypothesis (H2): the higher the profitability, the higher the capitalization. This finding indicates that insurers seem to rely on retained earnings due to costly external financing caused by asymmetric information. We also report that greater use of reinsurance may negatively affect insurers' capitalization, i.e., higher levels of reinsurance result in lower actual solvency margins (H3). By transferring part of their risk to third parties, reinsurance allows primary insurers to reduce their capital reserves, acting thus as contingent capital. Reinsurance use also mitigates solvency risk and enables companies to increase their capacity to underwrite new businesses (Mankaï and Belgacem, 2016). Portfolio risk is statistically insignificant in both specifications (H4). However, we find a positive relationship between underwriting risk and actual solvency margins, supported by the high levels of significance for the standard deviation of the loss ratio in the equation. This result confirms our hypothesis that insurers facing higher risk in their insurance portfolio tend to be relatively more capitalized (H5), a statement broadly agreed on in the literature (e.g., Cheng and Weiss, 2013). Similarly, a longer time lag between policy issuance and claims payment is shown to reduce actual solvency margins (H6). As previously stated, long-tail lines of insurance may have a negative effect on insurer solvency because they tend to generate less income from underwriting than shorter-tail lines (de Haan and Kakes, 2010). Moreover, based on agency costs, long-tailed businesses may be more levered to discourage managers from taking actions that are contrary to the interests of policyholders

(Cummins and Nini, 2002). Mutual insurers appear to be more capitalized compared with stock companies (H7), in agreement with other authors (e.g., Cheng and Weiss, 2013). This finding may be explained in accordance with the pecking order theory, which predicts that mutual insurers are likely to find it more difficult to raise capital and, therefore, have a stronger tendency to accumulate capital. The insurer's specialization is another possible determinant of solvency margins (H8). As we expected, life specialized insurers would hold less capital than nonlife specialized insurance companies because the latter are considered riskier given the uncertainty of claim payments and the difficulty of predicting threats (Gründl *et al.*, 2016).

Industry concentration has a positive relationship with solvency, corroborating H9a, which states that a more concentrated the sector is associated with higher insurer capitalization. Concentrated markets may enhance profits due to market power, thus increasing actual solvency margins. This finding coincides with the recent empirical evidence provided by Cummins *et al.* (2017), who report higher financial soundness of European life insurance firms in more concentrated markets. Among the macroeconomic variables, interest rates are found not to be significant in our model (H10). Thus, the low interest rate environment in Spain during the sample period might not have affected the capitalization of the insurance sector. However, we find that actual solvency margins are positively related to economic growth (H11), exhibiting a clear cyclical behavior. During recessions, lower profits are charged against capital. Moreover, raising capital may be more difficult in a relatively weak economy (Cummins and Sommer, 1996).

4.2. Robustness checks

We subject our findings to a number of robustness tests. First, following Altuntas *et al.* (2015) and Rubio-Misas and Fernández-Moreno (2017), among others, all quantitative firm-specific variables are winsorized at the 1 percent and 99 percent level to minimize the influence of potential outliers. As expected, the results do not differ from those previously obtained.[20,21]

Second, in Table 5, we re-estimate our equation by changing some of the variables used as regressors. The model in column (1) includes the square of the logarithm of total assets to address a potential nonlinear relationship between size and solvency. Both linear

[20] Most of the results hold when the variables are winsorized at different levels, such as 2.5 percent and 97.5 percent, and 5 percent and 95 percent.
[21] We do not report these results because of space limitations. However, they are available from the authors on request.

and quadratic terms significantly enter the regression, which suggests an exponential relationship between insurer size and capitalization. The model in column (2) considers ROE instead of ROA as our profitability measure. Both sign and statistical significance are not affected, corroborating a positive relationship between profitability and actual solvency margin. We also consider the fixed-income investments to total assets ratio as the portfolio risk measure (model in column (3)), although, as previously reported for the equity securities to total assets ratio, this variable is not found to be significant. Finally, because unemployment has been recognized as an important factor in the recent economic crisis in Spain, in the model in column (4), we replace the GDP growth rate with the unemployment rate as a proxy for economic growth. As expected, higher unemployment rates imply lower solvency margins, thus confirming a cyclical behavior of the insurance industry.

[INSERT TABLE 5 ABOUT HERE]

Third, because factors that influence insurer solvency may be affected by their specialization (life versus nonlife), we now remove from the baseline sample insurers who specialize in the life segment.[22] Table 6 shows that the results obtained when the sample includes only nonlife specialized insurers do not differ substantially from those obtained previously for the entire sample.

[INSERT TABLE 6 ABOUT HERE]

Finally, we consider an alternative measure of solvency. Table 7 reports the results of our empirical estimation when the solvency ratio and not the actual solvency margin is used as the dependent variable. Although different measures of capitalization are often used in the literature as indicators of the financial soundness of the company (Baranoff and Sager, 2002; Cummins and Nini, 2002; Carayannopoulos and Kelly, 2004; Shim, 2010; Mankaï and Belgacem, 2016; among others), some studies recently use the solvency ratio as an alternative measure of insurer financial strength (see, e.g., Berry-Stölze *et al.*, 2010; Rauch and Wende, 2015; Rubio-Misas and Fernández-Moreno, 2017). The solvency ratio, defined as the ratio of the actual solvency margin to the required

[22] To avoid the small-sample downward bias in the dynamic panel data setting when the system-GMM estimator is developed (see Roodman, 2009), we do not apply our model to the life insurance segment (the reduced sample includes only 449 observations).

solvency margin, must be equal to or greater than 1.[23] Therefore, this measure compares the insurer's capital reserves with its regulatory capital requirements, allowing for the identification of potentially weak capital positions that could require intervention by supervisor (Rubio-Misas and Fernández-Moreno, 2017). Solvency ratios are usually substantially higher than 1 because insurers maintain large capital buffers to reduce their risk of insolvency.[24] Figure 1 shows the distribution of the solvency ratio for insurers operating in Spain from 2008 to 2015. The median takes values slightly higher than 3, indicating that approximately 50 percent of the insurers have more than three times the amount of capital required for the period analyzed. Moreover, the 10th percentile line shows that approximately 90 percent of companies have capital buffers up to 50 percent higher than the minimum requirements. These ratios, which are in line with those found in other European countries (e.g., de Haan and Kakes (2010) for Dutch companies and Rauch and Wende (2015) for the German insurance sector), bring to light the fact that supervisors could have been requiring far less capital than demanded by some stakeholders (ratings agencies, investment analysts, shareholders, policyholders, and others). Table 7 shows that the results obtained for the solvency ratio do not differ substantially from those obtained previously for the actual solvency margin; most of the explanatory variables retain both their signs and statistical significance. The high levels of significance for the lagged variables also indicate strong persistence in the solvency ratios, confirming the dynamic character of the model specification. Solvency ratios are positively related to insurers' profitability and underwriting risk, whereas long-tail lines of insurance may have a negative effect on the ratio. However, size and reinsurance use both lose their statistical significance. This result suggests that, although these variables may affect insurer capitalization, they might be not related to higher capital buffers (possibly because they also influence minimum regulatory capital requirements). In line with the previously reported results for the actual solvency margin, portfolio risk is not found to be significant. Mutual insurers have larger solvency ratios compared with stock

[23] The required solvency margin is different for life and non-life insurance segments. In general, for non-life insurance undertakings, the minimum regulatory solvency margin is equal to the higher of the results obtained by applying two methods: one based on the annual amount of premiums and the other based on the average burden of claims for the last 3 years. The required solvency margin for life insurance is obtained by adding a percentage of the mathematical reserves to an amount based on the positive capital at risk.

[24] With the entry into force of the Solvency II EU Directive, European insurers are required to assess all types of risk to which they are exposed and to manage those risks more effectively. Therefore, a key difference with the previous regulation is that this new framework is more risk-based, that is, solvency requirements are primarily driven by insurers' risk profiles rather than their performance in past years (de Haan and Kakes, 2010).

companies, in agreement with other authors (e.g., Rauch and Wende, 2015). However, we now find that an insurer's specialization is not a determinant of the solvency ratio (recall that the required solvency margin is different for life and nonlife insurance segments). As previously reported in the actual solvency margin equation, industry concentration shows a positive relationship with the solvency ratio. We also find that solvency ratios exhibit cyclical behavior that is positively related to economic growth. Finally, although the low interest rate environment in Spain during the sample period may not have affected the capitalization of the insurance sector, it could have negatively affected solvency ratios.

[INSERT TABLE 7 & FIGURE 1 ABOUT HERE]

5. Summary and conclusions

This paper contributes to the debate about insurer solvency in Europe by analyzing the factors (firm-specific and macro) that determine the actual solvency margin of a large sample of insurance companies operating in Spain. The selected timespan, from 2008 to 2015, encompasses a period of economic instability characterized by record low interest rates and low or even negative economic growth. The applied methodology relies on the system-GMM estimator, developed by Arellano and Bover (1995) and Blundell and Bond (1998), which has only recently been used in a few studies on the determinants of insurer solvency (e.g., Rubio-Misas and Fernández-Moreno, 2017).

Policymakers and supervisors may benefit from our findings since the European Commission has recently expressed its intention to review methods, assumptions and parameters used in Solvency II. We report that actual solvency margins are directly and significantly related to profitability, underwriting risk, and a mutual-type organization. However, insurers' size, the use of reinsurance, a longer-tailed business, and a life specialization seem to reduce their capitalization. We also find that less concentrated markets and a context of economic crisis (with a falling GDP) decrease solvency margins. Portfolio risk and interest rates are found not to be significant in our model. We apply different robustness tests, first by minimizing the influence of potential outliers by winsorizing all quantitative firm-specific variables. Furthermore, we re-estimate the baseline equation using alternative regressors. We also use a reduced sample that only includes insurers specialized in the nonlife segment. All these tests yield results that are consistent with those reported in the baseline model, thus proving their robustness. As a final robustness check, we consider the solvency ratio as an alternative measure of insurer financial strength. We report that approximately 90 percent of insurers operating in Spain have capital buffers of up to 50 percent higher than the minimum requirements, which brings to light the fact that supervisors could have been requiring far less capital than demanded by the market under the former supervisory regime (i.e., Solvency I). Both size and reinsurance use lose their statistical significance, suggesting that although these variables may affect insurer capitalization, they might not be related to higher capital buffers. We also show that insurers' specialization is not a determinant of solvency ratios. Finally, although the low interest rate environment in Spain during the sample period might not have affected the capitalization of the insurance sector, it could have negatively affected solvency ratios.

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Table 1
Hypotheses and variables used in the analysis

Hypotheses and Expected signs	**Variables**	**Definition**	**Data Source**
	Actual solvency margin	Solvency margin (according to Spanish legislation) divided by total assets	Authors' calculation using DGSFP data
H1 (-)	Size	Natural log of total assets	Authors' calculation using DGSFP data
H2 (+)	Profitability	Profits after tax divided by total assets	Authors' calculation using DGSFP data
H3 (-)	Reinsurance	Reinsurance premiums paid divided by total premiums earned	Authors' calculation using DGSFP data
H4 (+)	Portfolio risk	Equity securities in the asset portfolio divided by total assets	Authors' calculation using DGSFP data
H5 (+)	Underwriting risk	Standard deviation over sample period of loss ratio, defined as incurred losses divided by premiums earned net of reinsurance	Authors' calculation using DGSFP data
H6 (-)	Long-tailed business	Technical provisions (loss reserves) divided by incurred losses	Authors' calculation using DGSFP data
H7 (+)	Mutual	Dummy variable that takes the value of 1 for mutual companies and 0 otherwise	Authors' calculation using DGSFP data
H8 (-)	Life insurance	Dummy variable that takes value of 1 if the written premiums of the company in that year are 50 percent or higher in the life insurance sector and 0 otherwise	Authors' calculation using DGSFP data
H9a (+), H9b (-)	Industry concentration	Herfindahl–Hirschman index calculated as the sum of the squares of all insurance companies' market shares in terms of premiums written (in percentage)	Authors' calculation using DGSFP data
H10a (+), H10b (-)	Interest	Interest rate on the MRO of the ECB	ECB
H11 (+)	Economic growth	Annual real GDP growth rate	Eurostat

Table 2
Number of observations in the sample

Year	Mutual insurers	Stock insurers	Total
2008	29	159	188
2009	29	163	192
2010	30	168	198
2011	30	172	202
2012	30	172	202
2013	30	166	196
2014	29	158	187
2015	29	143	172
	236	1,301	1,537

Table 3
Descriptive statistics for the Spanish insurance sector (2008–2015)

	Actual solvency margin	*Firm-specific variables* Size	Profitability	Reinsurance	Portfolio risk	Underwriting risk	Long-tailed business	Mutual	Life insurance	*Industry and macroeconomic variables* Industry concentration	Interest	Economic growth
2008												
Mean	0.409	18.608	0.023	0.116	0.056	0.873	3.036	0.154	0.282	291.656	0.025	0.011
Standard Deviation	(0.433)	(2.337)	(0.058)	(0.186)	(0.101)	(0.553)	(5.823)	(0.362)	(0.451)			
2009												
Mean	0.406	18.660	0.023	0.119	0.066	0.838	2.877	0.151	0.292	272.936	0.010	-0.036
Standard Deviation	(0.403)	(2.328)	(0.050)	(0.194)	(0.123)	(0.545)	(2.660)	(0.359)	(0.456)			
2010												
Mean	0.395	18.670	0.021	0.116	0.054	0.795	2.890	0.152	0.293	271.408	0.010	0.000
Standard Deviation	(0.374)	(2.295)	(0.057)	(0.194)	(0.092)	(0.466)	(2.899)	(0.359)	(0.456)			
2011												
Mean	0.384	18.713	0.023	0.110	0.047	0.802	2.970	0.149	0.297	296.040	0.010	-0.010
Standard Deviation	(0.341)	(2.270)	(0.068)	(0.184)	(0.076)	(0.613)	(3.141)	(0.356)	(0.458)			
2012												
Mean	0.387	18.764	0.023	0.103	0.053	0.883	2.935	0.149	0.297	313.130	0.008	-0.029
Standard Deviation	(0.327)	(2.265)	(0.064)	(0.176)	(0.088)	(0.804)	(2.970)	(0.356)	(0.458)			
2013												
Mean	0.376	18.845	0.026	0.114	0.067	0.964	3.056	0.153	0.301	329.115	0.003	-0.017
Standard Deviation	(0.292)	(2.250)	(0.052)	(0.204)	(0.109)	(0.869)	(3.037)	(0.361)	(0.460)			
2014												
Mean	0.383	18.917	0.027	0.123	0.090	1.089	3.061	0.155	0.294	330.835	0.001	0.014
Standard Deviation	(0.291)	(2.277)	(0.040)	(0.217)	(0.143)	(1.953)	(2.845)	(0.363)	(0.457)			
2015												
Mean	0.390	19.013	0.027	0.118	0.097	0.952	3.214	0.169	0.279	422.944	0.001	0.034
Standard Deviation	(0.288)	(2.281)	(0.044)	(0.194)	(0.146)	(0.874)	(2.978)	(0.375)	(0.450)			
2008-2015												
Mean	0.391	18.770	0.024	0.115	0.066	0.897	3.387	0.154	0.292	314.343	0.008	-0.005
Standard Deviation	(0.347)	(2.286)	(0.055)	(0.193)	(0.112)	(0.942)	(3.091)	(0.361)	(0.455)	(44.055)	(0.007)	(0.022)
Median	0.308	18.620	0.020	0.033	0.023	0.754	2.110	0.000	0.000	296.040	0.010	-0.010
Number of obs.	1,537	1,537	1,537	1,537	1,537	1,537	1,537	1,537	1,537	1,537	1,537	1,537

Notes: This table reports the main descriptive statistics for the variables used in the study during the period analyzed (2008–2015) and the evolution of the mean and standard deviation values (in parentheses) from 2008 to 2015. The sample comprises 202 insurance companies (1,537 observations). See Table 1 for a description of the variables.

Table 4
Determinants of the actual solvency margin in the Spanish insurance sector

Variables	(1) Actual solvency margin	(2) Actual solvency margin
Lagged dependent	0.802***	0.812***
	(0.039)	(0.038)
Size	-0.037***	-0.035***
	(0.013)	(0.013)
Profitability	0.862***	0.908***
	(0.204)	(0.203)
Reinsurance	-0.129*	-0.129*
	(0.077)	(0.077)
Portfolio risk	-0.033	-0.030
	(0.070)	(0.077)
Underwriting risk	0.038***	0.038***
	(0.011)	(0.010)
Long-tailed business	-0.000**	-0.000**
	(0.000)	(0.000)
Mutual	0.065**	0.055**
	(0.027)	(0.027)
Life insurance	-0.290***	-0.277***
	(0.081)	(0.081)
Industry concentration	0.001***	0.000***
	(0.000)	(0.000)
Interest	1.384	
	(1.931)	
Economic growth	1.369***	
	(0.365)	
Constant	0.263	0.279
	(0.214)	(0.208)
Year dummies	No	Yes
z_1	178.28 (10, 201)	151.39 (8, 201)
z_2	9.11 (2, 201)	6.00 (7, 201)
m_1	-4.90	-4.85
m_2	-0.57	-0.61
Hansen	190.42 (206)	193.65 (209)
Number of obs.	1,537	1,537
Number of firms	202	202

Notes: This table presents the determinants of the actual solvency margin in the Spanish insurance sector during the period 2008–2015 using the system-GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). See Table 1 for a description of the variables. The dependent variable is included in logarithmic form. The model in column (2) includes year dummies instead of macroeconomic variables. Except for *Mutual, Industry concentration, Interest*, *Economic growth,* and *Year dummies*, all variables are considered endogenous in our model. We report heteroskedasticity-consistent asymptotic standard errors in parentheses, and significance levels are indicated as follows: ***= significance at the 1 percent level; **= significance at the 5 percent level; and *= significance at the 10 percent level. z_1 and z_2 are Wald tests of the joint significance of the reported coefficients for the nondummy and the dummy explanatory variables, respectively, asymptotically distributed as F under the null hypothesis of no significance, with degrees of freedom in parentheses. m_i is a serial correlation test of order i using residuals in first differences, asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation. *Hansen* is a test of the overidentifying restrictions, asymptotically distributed as χ^2 under the null hypothesis of no correlation between the instruments and the error term, with degrees of freedom in parentheses.

Table 5
Robustness checks (I): alternative explanatory variables

Variables	(1) Actual solvency margin	(2) Actual solvency margin	(3) Actual solvency margin	(4) Actual solvency margin
Lagged dependent	0.778***	0.812***	0.803***	0.798***
	(0.038)	(0.037)	(0.039)	(0.039)
Size	-0.318**	-0.041***	-0.031***	-0.037***
	(0.138)	(0.013)	(0.013)	(0.013)
$Size^2$	***0.007****			
	(0.004)			
Profitability	0.817***	***0.221*****	0.923***	0.911***
	(0.192)	***(0.084)***	(0.212)	(0.219)
Reinsurance	-0.141*	-0.155**	-0.120*	-0.135*
	(0.079)	(0.078)	(0.071)	(0.080)
Portfolio risk	-0.003	-0.031	***0.149***	-0.021
	(0.069)	(0.076)	***(0.093)***	(0.077)
Underwriting risk	0.039***	0.040***	0.037***	0.039***
	(0.011)	(0.012)	(0.010)	(0.011)
Long-tailed business	-0.000**	-0.000**	-0.000**	-0.000*
	(0.000)	(0.000)	(0.000)	(0.000)
Mutual	0.071**	0.059**	0.059**	0.067**
	(0.034)	(0.028)	(0.027)	(0.028)
Life insurance	-0.304***	-0.308***	-0.271***	-0.296***
	(0.076)	(0.077)	(0.082)	(0.082)
Industry concentration	0.001***	0.001***	0.001***	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
Interest	1.608	1.848	1.419	1.454
	(1.970)	(1.957)	(1.880)	(2.367)
Economic growth	1.393***	1.415***	1.419***	***-0.411****
	(0.348)	(0.355)	(0.358)	***(0.203)***
Constant	2.822**	0.346	0.144	0.255
	(1.301)	(0.224)	(0.204)	(0.210)
Year dummies	No	No	No	No
z_1	175.29 (11, 201)	190.90 (10, 201)	160.35 (10, 201)	165.15 (10, 201)
z_2	10.53 (2, 201)	9.59 (2, 201)	7.36 (2, 201)	9.08 (2, 201)
m_1	-4.90	-4.90	-4.90	-4.85
m_2	-0.60	-0.58	-0.51	-0.79
Hansen	196.06 (233)	192.12 (206)	197.23 (206)	192.92 (206)
Number of obs.	1,537	1,537	1,537	1,537
Number of firms	202	202	202	202

Notes: This table presents the results for our baseline equation after changing some of the explanatory variables. The model in column (1) includes *$Size^2$* (the square of *Size*). The model in column (2) considers ROE in place of ROA as a proxy for *Profitability*. The model in column (3) considers fixed-income investments divided by total assets in place of the equity securities to total assets ratio as a proxy for *Portfolio risk*. The model in column (4) considers the unemployment rate in place of the GDP growth rate as a proxy for *Economic growth*. Regressions use the system-GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). See Table 1 for a description of the variables. The dependent variable is included in logarithmic form. Except for *Mutual, Industry concentration, Interest,* and *Economic growth*, all variables are considered endogenous in our model. We report heteroskedasticity-consistent asymptotic standard errors in parentheses, and significance levels are indicated as follows: ***= significance at the 1 percent level; **= significance at the 5 percent level; and *= significance at the 10 percent level. z_1 and z_2 are Wald tests of the joint significance of the reported coefficients for the non-dummy and the dummy explanatory variables, respectively, asymptotically distributed as *F* under the null hypothesis of no significance, with degrees of freedom in parentheses. m_i is a serial correlation test of order *i* using residuals in first differences, asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation. *Hansen* is a test of the overidentifying restrictions, asymptotically distributed as χ^2 under the null hypothesis of no correlation between the instruments and the error term, with degrees of freedom in parentheses.

Table 6

Robustness checks (II): including only nonlife specialized insurers

Variables	(1) Actual solvency margin	(2) Actual solvency margin
Lagged dependent	0.793***	0.796***
	(0.043)	(0.042)
Size	-0.043***	-0.044***
	(0.013)	(0.013)
Profitability	0.409***	0.420***
	(0.151)	(0.146)
Reinsurance	-0.240***	-0.225***
	(0.091)	(0.085)
Portfolio risk	-0.040	-0.052
	(0.065)	(0.063)
Underwriting risk	0.073**	0.066**
	(0.029)	(0.030)
Long-tailed business	-0.000**	-0.000*
	(0.000)	(0.000)
Mutual	0.095***	0.091***
	(0.031)	(0.031)
Industry concentration	0.000*	0.001***
	(0.000)	(0.000)
Interest	-3.010	
	(1.914)	
Economic growth	0.660*	
	(0.369)	
Constant	0.560	0.490
	(0.211)	(0.199)
Year dummies	No	Yes
z_1	578.60 (9, 144)	396.70 (8, 144)
z_2	9.05 (1, 144)	2.84 (6, 144)
m_1	-4.26	-4.28
m_2	0.27	0.33
Hansen	139.00 (188)	137.02 (191)
Number of obs.	1,088	1,088
Number of firms	145	145

Notes: This table presents the determinants of the actual solvency margin for nonlife specialized insurers operating in Spain during 2008–2015. We consider that an insurer is specialized in the nonlife segment when the written premiums of the company are higher than 50 percent in this sector for that year. See Table 1 for a description of the variables. The dependent variable is included in logarithmic form. We use the system-GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). The model in column (2) includes year dummies instead of macroeconomic variables. Except for *Mutual, Industry concentration, Interest*, *Economic growth*, and *Year dummies*, all variables are considered endogenous in our model. We report heteroskedasticity-consistent asymptotic standard errors in parentheses, and significance levels are indicated as follows: ***= significance at the 1 percent level; **= significance at the 5 percent level; and *= significance at the 10 percent level. z_1 and z_2 are Wald tests of the joint significance of the reported coefficients for the nondummy and the dummy explanatory variables, respectively, asymptotically distributed as *F* under the null hypothesis of no significance, with degrees of freedom in parentheses. m_i is a serial correlation test of order *i* using residuals in first differences, asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation. *Hansen* is a test of the overidentifying restrictions, asymptotically distributed as χ^2 under the null hypothesis of no correlation between the instruments and the error term, with degrees of freedom in parentheses.

Table 7
Robustness checks (III): alternative proxy of solvency

Variables	(1) Solvency ratio	(2) Solvency ratio
Lagged dependent	0.727***	0.739***
	(0.062)	(0.059)
Size	-0.001	-0.001
	(0.016)	(0.015)
Profitability	1.273**	1.320**
	(0.536)	(0.517)
Reinsurance	0.073	0.076
	(0.155)	(0.154)
Portfolio risk	0.131	0.131
	(0.162)	(0.163)
Underwriting risk	0.034**	0.034**
	(0.013)	(0.013)
Long-tailed business	-0.000**	-0.000**
	(0.000)	(0.000)
Mutual	0.212***	0.198***
	(0.067)	(0.064)
Life insurance	-0.107	-0.099
	(0.071)	(0.073)
Industry concentration	0.000*	0.000**
	(0.000)	(0.000)
Interest	7.962***	
	(3.029)	
Economic growth	1.905***	
	(0.458)	
Constant	0.201	0.096
	(0.340)	(0.292)
Year dummies	No	Yes
z_1	136.71 (10, 201)	163.10 (8, 201)
z_2	6.00 (2, 201)	8.24 (7, 201)
m_1	-2.88	-2.87
m_2	0.52	0.42
Hansen	196.33 (206)	198.45 (209)
Number of obs.	1,537	1,537
Number of firms	202	202

Notes: This table presents the determinants of the solvency ratio (defined as the actual solvency margin divided by the required solvency margin) in the Spanish insurance sector during the period 2008–2015 using the system-GMM estimator developed by Arellano and Bover (1995) and Blundell and Bond (1998). See Table 1 for a description of the variables. The dependent variable is included in logarithmic form. The model in column (2) includes year dummies instead of macroeconomic variables. Except for *Mutual, Industry concentration, Interest*, *Economic growth,* and *Year dummies*, all variables are considered endogenous in our model. We report heteroskedasticity-consistent asymptotic standard errors in parentheses, and significance levels are indicated as follows: ***= significance at the 1 percent level; **= significance at the 5 percent level; and *= significance at the 10 percent level. z_1 and z_2 are Wald tests of the joint significance of the reported coefficients for the nondummy and the dummy explanatory variables, respectively, asymptotically distributed as *F* under the null hypothesis of no significance, with degrees of freedom in parentheses. m_i is a serial correlation test of order *i* using residuals in first differences, asymptotically distributed as N(0,1) under the null hypothesis of no serial correlation. *Hansen* is a test of overidentifying restrictions, asymptotically distributed as χ^2 under the null hypothesis of no correlation between the instruments and the error term, with degrees of freedom in parentheses.

Figure 1
Distribution of solvency ratio in the Spanish insurance sector