Received: 10 October 2022 | Accepted: 30 April 2023
DOI: 10.52898/ijif.2023.5

ORIGINAL ARTICLE

THE FACTORS INFLUENCING SOLVENCY RATIO OF INSURERS IN THE EUROPEAN COUNTRIES

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Abstract
This paper analyzes the impacts of selected financial variables on the solvency values of 918 insurance companies from 36 European countries for the period 2017-2021. The solvency indicators used in this paper are the equity-to-assets ratio, debt-to-assets ratio, and debt-to-equity ratio, respectively, which are obtained from the balance sheets of the companies. As independent variables, return on assets, liquidity level, firm size, conservation ratio, and the COVID-19 pandemic are employed. Panel two-stage least squares (2SLS) regression analysis is utilized as a solution methodology. As a result of the analysis, a strong and negative association is found between company size and solvency values. Significant linkages are found between the other independent variables, such as return on assets, liquidity, and conservation rates, and the solvency variables. Moreover, it is observed that the COVID-19 epidemic has a negative effect on the solvency factors.

Keywords
Solvency, insurance, insurance level variables, COVID-19 pandemic, 2SLS

JEL Classification
G22, G32.

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1. INTRODUCTION

In developing countries, insurance companies, as well as banks, play critical roles both in establishing the stability of the financial system and in ensuring the sustainable development of countries (Çamlıbel, 2021; Işık, 2021).

Solvency is an important numeric factor that enables insurance companies or other financial companies to control their ability to continue their operations and fulfill their financial obligations in the long term. If insurance companies fail to meet their obligations in the long run, they face the risk of bankruptcy. The solvency factor also expresses the capital adequacy problem for insurance companies.

Araichi & Almulhim (2021) stated that consistency in the determination of solvency capital for insurance companies is a fundamental issue for actuaries and other stockholders. Insurance companies undertake downside risks while carrying out their activities. Additionally, they are known as companies that have the capital to pay their future debts while fulfilling their stated obligations to policyholders in return for the policies they sell.

Munari, Weber, & Wilhelmy (2021) explained that insurance companies and some financial companies operating in financial markets are subject to certain regulatory factors. In many financial regulations, the main purpose is to protect parties, such as depositors, policyholders, and other counterparties, against future financial problems. Corporate governance, reporting and transparency plans implemented by each company operating for commercial purposes are the cornerstones of its activities. However, capital regulation processes are equally important activities. Companies engaged in financial activities should define the minimum capital they should hold for future financial risks. Companies that fail in this competence are followed by authorized bodies and their activities can be taken under control when necessary. Financial companies are required to comply with solvency capital requirements, which define a minimum level for their current net asset value. Firms that do not meet these requirements are subject to audit interventions.

According to Liu et al. (2019), insurance solvency can be calculated according to premium volume-based standards in most insurance markets in the past years. Over time, it has become a transition from basic computing standards to risk-based standards. With these risk-based calculations, it reached a turning point in January 2016, and risk-based solvency regulations entered into force in the European Union (EU) and China. Therefore, the leading countries and regions of the insurance market, like the USA, EU1, and China, all have solvency regulations that are risk-based and have the basic standard of solvency capital requirements.

In this paper, the effects of some intra-company financial variables (i.e., profitability, liquidity, firm size, and conversation ratio) and the COVID-19 pandemic on the selected solvency variables of the insurance companies operating in the European insurance market are investigated. Literature related to the study subject is given, hypotheses for the regression equation are given, and some previous studies are given to support the hypotheses. Solvency values are obtained by proportioning the variables in the balance sheets of insurance companies. The values obtained as a result of the analysis are compared by looking at the previous studies. The values obtained from the study are interpreted financially in terms of insurance companies.

The contribution of this article to the literature can be summarized as follows.

- This study was performed on a large sample of 36 European countries.
- Data from 918 insurance companies operating in more than one insurance branch are employed for this study.
- In the study, the 2SLS estimator is utilized to solve the problem of endogeneity between the variables.
- This study is based on the most recent data (i.e., 2017-2021) from insurance companies.
- This study also controls for the impact of the COVID-19 pandemic crisis on solvency ratios.

2. LITERATURE REVIEW

There are various articles in the literature regarding the effect of solvency on insurance companies. The majority of these articles are about calculating solvency and examining the factors that affect it. Some recent studies on solvency are as follows.

Munroe et al. (2015) provide a precise statistical improvement of the risk metrics required to complement the Solvency II obligations for possible internal models for insurers' long-term liabilities and reserve risk. The suggested model is new, as it is not based on the proxy principle of proportionality. With the solution method based on the traceable simulation method, it provides sufficient capital needed to return the current economic balance sheet to the fair value of the debts in case of economic distress in the first following calendar year.

Alm, J. (2016) calculated the solvency capital requirement using the data obtained from the annual reports of the four major non-life insurance companies operating in Sweden. It aimed to find the marginal distributions of losses and the dependence between losses in the five largest business lines (LoBs) in order to build models for solvency capital requirement calculation. As a result of the study, they found that the dependency between the five largest business lines was weaker than assumed in the Solvency II standard formula. He also discussed under which conditions it would be better to use different formulas instead of standard formulas for the calculation of solvency capital by decision-makers in insurance companies.

Christiansen and Fahrenwaldt (2016) defined the underlying risk sources, solvency level, and time dynamics, which are thought to affect the solvency capital, which is an important determinant of life insurance contracts, using a back-and-forth solution system. They stated that by doing this, it would cause additional dissociation in total solvency according to different risk sources and times. It was stated that decomposition emerged as an intuitive tool for examining risk sensitivities. They studied forward-backward systems through linear partial differential equations and a Monte Carlo method based on Malliavin algebra.

Rubio-Misas and Fernández-Moreno (2017) examined the factors influencing the regulatory solvency ratio of Spanish insurance companies using the two-step system GMM model between 2005 and 2012. As a result of the study, it was seen that the use of reinsurance, premium growth, the form of stock insurers, and cost cap efficiency adversely affected the regulatory solvency ratio. Firm-level characteristics that affect the regulatory solvency ratio are stated to be strong in crisis and non-crisis periods. In addition, the effect of cost cap efficiency on the regulatory solvency ratio is greater for shareholders than for stocks.

Shao et al. (2017) performed a comprehensive evaluation including solvency capital requirements, premiums, and reserve variables were analyzed for the evaluation of long-term care insurance policies using daily living activities and US data. In the continuation of the study, independent policies, long-term care social insurance policies, life care salaries and shared long-term care insurance were compared in terms of net premium cost and solvency capital. By using Thiele's differential equation, which is the solution method, net premiums and the best estimated reserves are determined for basic long-term care insurance policies. It is shown how the costs and risks of long-term care insurance products are reduced with the determined maximum benefit period.

Coppola et al. (2018) stated that in the case of longevity risk, Solvency II's solvency capital requirements include distortions and inconsistencies resulting from the unchanged longevity shock compared to age and time assumed by the relevant regulatory model. To remedy this problem, they constructed a rotating window affine stochastic model, revealing the temporal nature of time-mortality included as the driver of the longevity shock. As a result of the study, it has been shown that the longevity shock can be eliminated, and the profile of the determined risk contractor can be reflected by allowing the required level of equity.

Nguyen & Vo (2020) investigated the association between the adoption of Enterprise Risk Management (ERM) and solvency for listed insurers in the European Union, according to the solution

results, controlling the endogeneity problem, it was stated that there was a decrease in the solvency levels of the insurers adopting ERM, and as a result of this situation, financial vulnerabilities could be triggered by the impact of unexpected shocks. Firm-specific variables such as leverage ratio, ROA, composite ratio and business type were found to significantly increase the solvency of EU-operated insurers, but the impact of firm size and age was found to be insignificant. According to the results obtained from the study, it is stated that insurers adopting ERM have common features such as higher performance, higher leverage, larger size and more diverse businesses. It has also been noted that market demand is an important factor in ERM adoption and insurance solvency.

Gatzert & Heidinger (2020) empirically analyzed market responses to initial solvency and financial position reports for all publicly traded insurance companies in the European Union, according to an English-language report based on a case study in their study. Regression analysis and text mining were used as methods and the key figures and textual attributes that were most important to investors were investigated. According to the results obtained from the study, it has been determined that the important figures mentioned in the solvency and financial status reports are more important than the textual features.

Moreno et al. (2020) analyzed the drivers that determine the solvency of insurance companies operating in the Spanish insurance sector. In the selected time period from 2008 to 2015, adverse events such as economic instability expressed by low or negative economic growth and record low interest rates occurred in the country. In their study using dynamic panel data resolution, a cross-type organization concluded that actual solvency margins were positively correlated with profitability and underwriting risk, but negatively correlated with reinsurance use, size, and longer term business and life insurance expertise. However, less concentrated markets and an economic crisis environment have been found to reduce solvency margins.

In their study, Ryu and Yu (2020) re-examined the determinants of hybrid bond issuances of insurance companies. In addition, the effects of issuers and issues that have an impact on financial solvency are analyzed. In the logistic regression analysis, it was seen that the probability of issuing bonds increases when the net income is higher, and the risk-based capital ratio is lower. At the end of the study, it was determined that the risk of bankruptcy decreased when the bonds were issued to foreign creditors.

Rödel et al. (2021) focused on financial guarantees in the life insurance products involved in their articles. In their study, they examined the two main types of interest rate guarantees offered as guarantees to customers in life insurance, the term guarantee and the stereotype guarantee. In order to obtain all probability distributions of forward solvency ratios, the model framework is limited to two sources of risk. In this way, the correct evaluation of the liabilities in the market and more consistent results in calculations are obtained. At the same time, thanks to the model used, the effect of different interest rate guarantees on future solvency can be analyzed in detail. As a result of the study, they stated that the type of interest guarantee has a significant effect on the solvency of the company in the long run.

Mukhtarov et al. (2022) examined the information content of the disclosures of solvency and earnings information of European insurance companies within the scope of Solvency I and Solvency II regulations. In their study, they used a sample of 571 data from 46 insurance companies in the period of 2012-2018. Within the scope of solvency, they found that although investors found the unexpected earnings informative, they did not find the unexpected solvency ratio. Unexpected earnings and solvency ratios, which are important for investors, are to be evaluated within the scope of Solvency II. Based on the variance decomposition method, it has been stated that within the scope of Solvency II, investor attention partially moves from earnings information to solvency information. In their conclusion, they found that the disclosed solvency ratios cover information about value within the risk-based Solvency II, and that the requirements under this framework direct investor attention to solvency data and distract from the earnings of European insurance companies.

Huggenberger & Albrecht (2022) reviewed the benefits of the risk pool created by stock insurance

companies for policyholders according to different standards of solvency. According to the result obtained using the second-order stochastic dominance method, they stated that if the equity is proportional to the premiums written, the benefit of the policyholders who do not like risk increases in proportion to the size of the pool. On the other hand, it is stated that an increase in pool size may reduce policyholders' own benefits if equity is calculated using the value-at-risk method. They have shown that if the constraint from excessive queue risk is covered by the pool, an infrastructure calculated by the value-at-risk will benefit risk-averse policyholders if there is augmentation of the pool with more risk. Through their work, they will contribute to the design of solvency standards and enable them to see the potential disadvantages of risk-based capital needs for policyholders.

Alokla et al. (2022) examined the drivers influencing the solvency of takaful insurance companies operating in Malaysian economies and members of the Gulf Cooperation Council and aimed to contribute to the literature. The main purpose of the study is to reveal a deeper understanding of the factors affecting the solvency of takaful firms. In the study, it was stated that the size of the firm and the attorney's fees caused a decrease in the solvency of 52 tekaful firms, as a result of the analysis made using the data between the periods of 2011-2016. As a result, it was stated that the attorney fee percentages should be followed. Some variables that are not related to solvency are specified. These variables are the return on assets, risk holding and investment income ratios as well as other explanatory variables. In the continuation of the analysis, it has been determined that there are significant differences between the takaful companies operating in Malaysia and the Gulf Cooperation Council member companies of the Gulf Cooperation countries. This situation is understood by the different stages of financial development.

González et al. (2022) investigated whether the degree of Enterprise Risk Management (ERM) implementation affects the performance of insurance companies under Solvency II. Based on the responses from the chief risk officers (i.e., CROs) of 44 insurance companies in Spain, one of the EU's largest insurance markets, they created a composite ERM index containing 76 variables. According to the results obtained, it has been seen that the higher the value is obtained according to the degree and quality obtained based on the ERM application, the better the return on equity and the return on assets adjusted for risk. On the other hand, it has been determined that the applied risk management performance standards are higher and more stable. It was also stated that the models created for Solvency II would penalize small companies and offset the costs associated with improvements in management.

Araichi & Almulhim (2021) aimed to create an appropriate model for the damage amounts by using the multivariate dependency factor between the risks. In order to do this, the hanging copula method was employed to capture the interdependence of the multivariate risk distributions including the five business lines. If the dependency structure is uncertain, this leads to different levels of capital. In cases of uncertain dependency structures, fuzzy solution methods are suggested. Based on the findings obtained from the study, a high solvency capital requirement arises according to the independence status if the multivariate dependency structure is considered. In addition, the Solvency Capital Requirement level is decided according to the degree of dependency between the risks.

When the above-mentioned literature is examined, the following gaps in the previous literature have been identified.

- It has been observed that there are a limited number of studies covering all European countries on solvency for insurance companies.
- The number of studies covering all insurance companies operating in all insurance branches in European countries is limited.
- The number of studies using the 2SLS method is not sufficient to solve the problem of endogeneity between variables related to the study subject.
- Previous studies did not consider the impact of the COVID-19 pandemic on the solvency ratio.

3. OVERVIEW OF THE EUROPEAN INSURANCE INDUSTRY

When we look at the sector report of the European insurance sector for 2021 prepared by the European Insurance and Occupational Pension Agency, the following information has been obtained.[1]

3.1. Life Business Sector

Looking at the countries operating in the field of life insurance, an increase is observed in the total gross written premiums. At the line-of-business level, index- and unit-linked businesses saw the highest increase. Life businesses decreased by more than 15% in both Liechtenstein and Slovakia.

On the concentration indicator, which is the measure of the market share of gross written premiums on a national basis, and is expressed as the 3, 5 and 10 largest premium writers, it is seen that Estonia, Iceland, Lithuania, Latvia and Malta have 3 undertaking concentrations over 80%. And it has been observed that the least concentrated market is Germany, in particular, Ireland, Italy, Spain and France.

According to the aggregate gross written premiums and the variation by country, an increase in Gross Written Premium is observed for the vast majority of countries. The largest percentage increases are seen in Norway and Portugal. The distribution of the change in gross written premiums for each country, Portugal has the highest median growth rate, followed by Liechtenstein.

However, the Czech Republic and Slovenia have a median growth rate of 0% or below 0%. In the reinsurance activities for each business line operating in the insurance sector, it is seen that the most reinsurance is made in the non-life insurance sector in annuities. The health insurance sector and the index and unit-linked insurance areas follow respectively. In terms of the gross written premium per capita, Luxembourg has by far the largest gross written premium per capita, followed by Liechtenstein and then Ireland. Here, the lowest value is found in Bulgaria and followed by Romania.

3.2. Non-Life Business Sector

In the non-life insurance sector, an increase in total gross written premium is observed in 2021 for most of the countries. Maritime, aviation and transportation are the business lines with the highest increase in reinsurance activities. In only 2 countries, the median combined rate of 100% or higher is observed for France and Romania. Credit and suretyship are the most frequently recurring business lines.

Looking at the concentration in the non-life sector, Latvia and Lithuania have 3 undertaking concentrations of over 90%. France has the least concentration market, followed by Germany, Spain and Cyprus. At the aggregate gross written premiums and the variation by country, for the vast majority of countries, growth in gross written premium is observed in 2021. In 2021, only the Slovak and Swedish non-life insurance markets contracted in gross written premiums.

Poland had the second-highest median growth, at 12%, while Romania had the highest median growth, at 13%, according to the distribution of the change in gross written premiums for each nation. The lowest growth seen at the median level is realized in Cyprus and Greece with 2%. The combined ratio per country, shows that the highest Combined ratio at Median level is found in Romania with 106%, while Malta has the lowest rate with 73%.

According to the claims ratio per country, the countries with the highest median claims ratio are France and Iceland with 74%. Malta has the lowest median rate of 34%. According to the expense ratio per country, the country with the highest median expense ratio is Romania with 57%. At the lowest median level, Luxembourg had 13%.

[1] file:///Users/pcya/Downloads/European-Insurance-Overview-Report-EIOPA-2022.html

3.3. Solvency and Capitalization

When we look at the country distributions, it has been observed that the median solvency capital ratio coverage values for all countries in Europe are over 150%. It has also been observed that the median minimum capital ratio coverage values are over 250%. For equities, it has been stated that at least 80% Tier 1 unlimited equity should be included, valid in each country.

Considering the distribution ratio of solvency capital by type of commitment, the median value ratio of all commitment ratios is 210% and the 25th percentile is over 160%. Looking at the solvency capital ratio by country, Germany has the highest solvency capital ratio with a median value of 293% and a lower quarter of over 206%. Iceland has the lowest median ratio at 156%. Finland has the highest median minimum capital ratio coverage at 877%. Romania is the only country with a median value less than 300%.

4. METHODOLOGY

The methodology section consists of data, variables, and hypothesis development sub-sections.

4.1. Data

The dependent and independent variables used in the analysis are obtained from the financial statements of the companies. The data of 918 companies operating in the insurance sector from 36 European countries between 2017 and 2021 is used in the study. These data were obtained from the Refinitiv Eikon.

4.2. Variables

Four insurance-specific independent variables like return on assets, liquidity, firm size, and conservation ratio are employed as independent variables. As dependent variables, three alternative solvency ratios are taken into account. In addition, the COVID-19 epidemic, which also influences the insurance industry, is added to the regression model as a dummy variable to control for the impact of this crisis. The expected sign of coefficients of variables such as conservation ratio and COVID-19 should be negative. The variables utilized for this study are demonstrated in Table 1.

Total Debt to Total Assets Ratio

Ilham (2019) expressed the variable known as the Debt-Asset Ratio or debt ratio is the solvency ratio used to measure the proportion of a company's debt-financed assets rather than its own use of equity.

The debt ratio is a unit of measure that compares all a company's financial liabilities with its total assets, specifically used to measure the company's risk of default or bankruptcy in the future. If at any time the operations of the company are stopped and it goes bankrupt, companies whose assets total more than their debts can meet their financial obligations. In other words, the less debt the company has, the more likely it is to continue its activities and fulfill its obligations.[2]

Rahman (2017) when the debt-to-assets ratio rises, this will lead to an increase in the financing costs of companies. Otherwise, there is a risk that companies with debts more than their assets will not be able to fulfill their financial obligations. Debt-Asset ratio takes values <1, =1 and >1. The value that investors and company managers want is that the debt ratio is less than <1.

[2] https://www.wallstreetprep.com/knowledge/debt-ratio/

Equity Ratio (Total Equity to Total Assets Ratio)

The equity-to-asset ratio is the ratio that indicates what percentage of a company's assets are owned by investors or shareholders. This ratio also determines how much of the company's assets are unleveraged and can come under the control of debtors in the event of bankruptcy.

The higher the value of the equity-to-asset ratio, the less leverage the company uses. A lower leverage ratio means that a greater proportion of the company's assets belong to the company and its shareholders. While the general consensus is that an equity-to-asset ratio of 100% is ideal, a lower equity-to-asset ratio does not mean that the situation is bad for companies.[3]

Total Debt to Equity

Efendi (2019) implied that the debt-to-equity ratio is the solvency ratio used by most companies to understand how much of the debt-financed capital companies use. Sawir (2014) explained that the debt-equity ratio is the solvency capital ratio, which reveals the debt and equity ratio at the stage of meeting the institutional need for funds and shows the company's ability to meet its obligations above its own capital. The higher this ratio, the more efficient the company is to pay interest and the higher the chance of getting a loan.

Table 1.
Variables Definitions

Variable	Measure	Notation	Expected sign
Dependent variables			
Solvency ratio_1	The ratio of total debts to total assets	DA	
Solvency ratio_2	The ratio of total equity to total assets	EA	
Solvency ratio_3	The ratio of total debt to equity	DE	
Independent variables			
Return on assets	Net profit/total assets	ROA	+/-
Liquidity level	Cash & cash equivalents/total assets	LIQ	+/-
Firm size	Natural logarithm of total assets	Ln_ta	+/-
Conservation ratio	Net premiums earned to net premiums written	CON	-
Covid-19 crisis	It takes the value 1 in 2020 and 2021, 0 in other years.	COVID-19	-

4.2.1 Hypotheses Development

In accordance with the purpose of the study, the following hypotheses have been produced when the theoretical and practical studies performed in the past are investigated.

For the ROA-solvency ratio association:

The high ROA ratio, the more profit the firm will earn. Companies that make a profit may want to borrow more money. If it borrows more, its solvency risk increases and a positive relationship between ROA and solvency is expected. If firms utilize their profits for investment, since profits will increase even more, the risk of solvency will decrease and there will be a negative relationship between ROA and solvency. Therefore, there could be a positive and negative relationship between ROA and solvency. Weihan (2022) found a significant and positive relationship between the ratio of debts to equity and the size of the company. In addition, a significant and negative relationship was found between the ratio of debts to equity and ROA. Baloch et al. (2015) found a significant and negative

[3] file:///Users/pcya/Downloads/European-Insurance-Overview-Report-EIOPA-2022.html

relationship between the ratio of debts to assets and the size of the firm.

For the liquidity-solvency ratio association

Firms with increased liquidity have higher credibility as their reputation in the market will increase. Thus, companies can borrow more money. If firms are more indebted, their solvency values increase, and if solvency increases, a positive relationship between solvency and liquidity is expected. On the other hand, companies with high liquidity hold money for speculation and tend to invest in different areas. In this case, the solvency decreases and a negative association between the solvency and the liquidity could be expected. Hence, there can be a positive and inverse linkage between liquidity and solvency. Consequently, Novokmet & Marinović (2016) found a negative result between solvency and liquidity in one model and a positive result between solvency and liquidity in the other model.

For the firm size-solvency ratio association

As companies grow, they specialize in what they do, and as a result, they reduce their costs in their operations. In this case, their profits increase, and then their solvency ratios decrease. In this case a negative relationship between firm size and solvency ratio is expected. On the other hand, as firms grow, bureaucracy increases within the firm and increasing bureaucracy costs subsequently increase borrowing. In this case, solvency increases and a positive relationship between solvency and firm size could be expected. That is, there can be a negative or positive link between firm size and the solvency ratio. Ahmed (2021) found a significant positive connection between the ratio of solvency and the size of the company. Yeo (2016), using the FGLS regression method, found a significant negative relationship with company size.

For the conservation-solvency ratio association

Theoretically, it could be expected that there is a negative relationship between the conservation rate and solvency.

For the COVID-19 pandemic-solvency ratio association

Theoretically, the COVID-19 pandemic-solvency ratio association is expected to be negative.

4.3. Models

In this part of the study, panel data regression model employed in the study is explained. In addition, the literature on previous studies using this model is included. The strengths and weaknesses of the model are mentioned below.

4.3.1. Two-stage least square

The OLS method, which is used in most statistical studies, produces inconsistent and biased results for the parameters of the regression model since it does not take into account the cross-section units and the time effects. It also does not take into account the issue of endogeneity regarding the variables. Endogeneity is one of the most critical issues to be considered in corporate finance studies. Thus, in order to overcome the endogeneity problem, it is observed that the 2SLS estimator is employed in lots of prior studies in the literature. In addition, Baranoff and Sager (2002) conducted a study dealing with the fact that the autoregressive 2SLS method provides a correction for autocorrelation in simultaneous equations through instrumental variables. According to Abrevaya, Hausman, Khan (2010)

when the endogeneity problem is not corrected in econometric models, it leads to prediction errors. When the model is formed correctly, the two-stage least squares method (2SLS) makes consistent estimations for linear models without the need to make parametric assumptions for error distortions. However, the 2SLS model is not suitable to be used in nonlinear models because it cannot be predicted consistently. As said by Hu and Yu (2014); and Cummins and Sommer (1996), the traditional 2SLS method is a regression estimator that can be used to reduce the endogeneity problem and to make consistent estimations. Land, Deane (1992) explained that the 2SLS regression method is more effective than the maximum likelihood method in terms of estimation and calculation, and numerical estimates are obtained in terms of statistical efficiency. According to Oczkowski and Farrell (1998), it can be said that the higher the correlation between the scale variables and the tools, the more efficient the estimator is asymptotically. Wooldridge (1997) said that the asymptotic normality and consistency of the 2SLS estimator yield useful results when the unknown form of the variance matrix is adjusted for its heteroskedasticity. The 2SLS method is preferred because of its strong standard errors and simplicity.

The models used for this study is as follows.

$$\text{Model-1: } (\text{DA})_{\text{it}} = \alpha_0 + + \sum_{j=1}^{4} (\text{ISFV})_{\text{it}}\, \beta_{\text{j}} + COVID - 19_t + \varepsilon_{\text{it}} \quad (1)$$

$$\text{Model-2: } (\text{EA})_{\text{it}} = \alpha_0 + + \sum_{j=1}^{4} (\text{ISFV})_{\text{it}}\, \beta_{\text{j}} + COVID - 19_t + \varepsilon_{\text{it}} \quad (2)$$

$$\text{Model-3: } (\text{DE})_{\text{it}} = \alpha_0 + + \sum_{j=1}^{4} (\text{ISFV})_{\text{it}}\, \beta_{\text{j}} + COVID - 19_t + \varepsilon_{\text{it}} \quad (3)$$

Where DA is the debt-to-asset ratio of insurer in year t, EA is the equity-to-total-assets ratio of insurer in year t, and ED is the equity-to-debt ratio of insurer in year t; α_0 and β_{j} are coefficients to be estimated. ISVF is a set of insurance specific financial variables. COVID-19 is a dummy variable that take value of 1 for the years 2019-2021, and ε_{it} is error term of the model.

Looking at Table 2, The deviation of the standard deviations from the mean in terms of solvency variables indicates that there are significant differences between insurers.

Table 2.
Summary Statistics

	Mean	Std. Dev.	Min	Max	N
EA	.07	.176	-.972	.975	3400
DA	.006	.032	.0001	.891	3145
DE	305.929	23526.664	-25603.223	1855083	3529
ROA	-.008	.277	-9.218	16.301	5227
LIQ	.06	.084	.0102	.994	5227
Ln_ta	16.552	2.837	8.311	27.762	4875
CON	.954	3.916	-168.85	188.1	4774
COVID-19	.346	.476	0	1	5227

When the correlation matrix in Table 3 is examined, it is observed that the correlation coefficients calculated for the independent variable pairs are below 0.42, indicating that multi-collinearity is not a significant problem for the regression models.

Table 3.
Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) EA	1.000							
(2) DA	-0.029	1.000						
(3) DE	0.474	-0.007	1.000					
(4) ROA	0.411	-0.007	0.153	1.000				
(5) LIQ	0.229	-0.254	0.070	0.095	1.000			
(6) Ln_ta	0.458	0.035	0.294	0.254	0.039	1.000		
(7) CON	-0.063	-0.207	-0.002	-0.135	0.022	-0.040	1.000	
(8)COVID-19	0.073	-0.322	0.043	0.195	0.039	0.080	0.117	1.000

4.3.2. Estimation Results

When we look at Model-I in Table 4, there is a significant relationship between lagged EA, DA, and DE, and dependent variables, which shows that past solvency variables are a significant determinant of current solvency variables.

From Table 4, ROA, liquidity, firm size, and conservation variables are significant determinants of the EA variable.

From Table 4, it is determined that the effects of the dummy variable measuring pandemic crisis and firm size on the DA variable are negative and significant. In their studies, Muhammad and Shah (2014) found a strong and negative relationship between the DA and ROA. Ahmed (2021) found a significant and positive relationship between firm size and DA. He also found a significant negative relationship between the DA variable and ROA. Yeo (2016) found no significant relationships between DA and firm size and found a negative relationship between DA and ROA according to the generalized linear model result. But, according to the results obtained from the cross-sectional time series FGLS regression model, there are significant negative relationships between DA and firm size and ROA.

Looking at Table 4, ROA, liquidity, firm size, and conservation variables are significant determinants of the DE variable. These findings reveal that the determinants of the DE model are similar to those of EA model. Muhammad, Shah (2014) found a negative relationship between DE and ROA and Fitrianti et al. (2021) found there was a significant and negative relationship between DE and ROA. Molla (2019) found a significant and negative relationship between DE and ROA. Ahmed (2021) found a significant positive relationship between DE and Ln_ta. Also, Yeo (2016) found a significant and negative relationship between the DE ratio and ROA.

Table 4.
Estimated Results of the 2SLS

	(1) Equity-to-Assets	(2) Debt-to-Assets	(3) Debt-to-Equity
L.EA	0.980***		
	(0.00771)		
L.DA		0.921***	
		(0.0124)	
L.DE			-0.0000651***
			(0.0000132)
ROA	-0.154**	-0.000786	27.40**
	(0.0659)	(0.000474)	(8.166)
LIQ	0.0329***	-0.00173	-76.67*
	(0.0112)	(0.000924)	(35.81)
Ln_ta	-0.000798**	-0.000638**	-5.310**
	(0.000316)	(0.000174)	(1.577)
CON	-0.00223***	0.00000500	0.793**
	(0.000461)	(0.0000184)	(0.265)
COVID-19	-0.00201	-0.00197**	-16.49
	(0.00180)	(0.000540)	(12.01)
Constant	0.0261***	-0.00882*	-65.33*
	(0.00542)	(0.00334)	(28.87)
Number of Observation	3399	4776	4776
Number of Firms	918	918	918
F-test	203.19***	163.37***	187.09***

Note: Standard errors are in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Conclusion

Solvency is an important performance indicator that is controlled especially for insurance companies to continue their activities. Solvency is not a single ratio but is also achieved using multiple balance sheet and income statement variables. Solvency is expressed as the ability to meet obligations in the long run. Insurance companies have to reach the numerical values where the solvency ratios are required.

When the results obtained from this study are examined, it is seen that the most effective variable on solvency is the size of the company (Ln_ta). This variable shows whether the insurers benefit from the advantages arising from economies of scale in the market in which they operate. If insurers benefit from economies of scale, a negative relationship can be expected between firm size and solvency. As seen Table 4, there exist a significant and negative relationship between solvency and Ln_ta, which indicates that insurance companies benefit from economies of scale. In other words, as insurers grow in terms of total assets, the solvency ratio they hold tends to decrease.

At the same time, ROA, LIQ and CON variables, which are other critical variables for the solvency of insurers. According to the results of this study, the policy recommendations of the study are as follows. Considering the significant effects of financial variables on solvency, it indicates that managers should consider these variables in order to control the solvency.

For future studies, other solution methods that prioritize endogeneity can be used, for example, the system and difference GMM methods. In addition to the financial ratios used in the study, different performance variables can be used. The sample used in the study can be expanded. The time period in which the data is used can be chosen wider.

As for the limitations of the study:

• The subject of study covers only European countries. It is not binding for insurance companies operating in other countries.

• The time interval subject to analysis is narrow.

• In the study, only one solution method which deals with endogeneity is used.

• Since the study deals with insurance branches operating in more than one field, comments cannot be made for a single insurance field.

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How to cite this article: Akgül, Y. (2023). The factors influencing solvency ratio of insurers in the European countries. *International Journal of Insurance and Finance, 3*(1), 43-56. https://doi.org/10.52898/ijif.2023.5