# THE IMPACT OF REINSURANCE FOR INSURANCE COMPANIES

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## Abstract

The study provides empirical evidence for the effect of reinsurance on solvency, profitability, and taxes of primary insurers. Our main finding is that primary insurers increasing in the use of reinsurance exhibit lower capital ratios. This impact involves the segments of health insurance, composite insurance, title insurance, and non-life insurance. Our interpretation is that reinsurance and capital can be seen as substitutes for improving solvency. This implies that, by sharing their risk with reinsurers, primary insurers can benefit from a relief on capital. Additional outcomes display an important relationship between demand and supply of reinsurance at the firm level, as we observe that, growing in the used reinsurance; primary insurers are more prone to providing reinsurance to other firms.

**Keywords:** Reinsurance, Insurers, Solvency, Profitability, Taxes

## 1. INTRODUCTION

Insurance companies purchase reinsurance to protect themselves against the risks of losses above certain thresholds. Although reinsurance is a major risk and capital management tool available to insurers, it seems to be hardly known outside the insurance sector. The empirical evidence suggests that the purchase of reinsurance introduces substantial changes to several characteristics of insurers, besides their risk profile. The goal of this article is to document the effect that utilized reinsurance has on solvency, profitability, and taxes of insurers. Arguably, if reinsurance mitigates risk-taking, then we expect that reinsurance impacts the solvency of insurers (Nissim, 2010; Kuschel et al., 2011). At the same time we predict that reinsurance influences the firm performance, as the consequence of price changes or the effect on solvency Berger et al. (1992). Finally, we consider taxes, in order to explore the hypothesis that corporate tax burdens are sensitive to reinsurance (Powell and Sommer, 2007; Adams et al., 2008).

We examine a large sample of insurers from the United States. The main finding is that reinsurance relates negatively to firm solvency, as measured by capital ratios. In addition, the data reveal that the use of reinsurance enhances the supply of reinsurance to other firms.

We bring the following contributions to the existing literature. The majority of the previous articles considers firm solvency, profitability and taxes in a separate way, whereas we consider the three aspects jointly. This allows making conclusions on whether reinsurance affects one aspect more strongly than the others. We disentangle the outcomes across insurance segments, thereby we distinguish from the earlier works that focus on single segments of insurance (Powell and Sommer, 2007; Lee and Lee, 2012). In respect to other cross-sectional studies instead, we show results for quite a huger sample, as we look at the horizon 2009-2017 and include the total number of 17,868 firm-year observations. For example, Pasiouras and Gaganis (2013) have a sample made by 4,321 observations for life and non-life insurers during the period 2005-2007. De Haan and Kakes (2010) uses data from about 350 Dutch insurers during the period 1995-2005, and some regressions are based on panels counting less than 700 observations. As a matter of fact, the research activity on the insurance business suffers often from the lack of extensive datasets. We argue that the relatively huge sample at our disposal can improve the robustness of the insights that we draw out of the empirical outcomes. Finally, to the best of our knowledge we are the first article displaying evidence for the correlation at the company level between used reinsurance and supplied reinsurance. Therefore, we point out important effects arising from reinsurance that will deserve additional analyses and theoretical thoughts from future research.

The article proceeds as follows. Section 3 reviews the literature more closely related to this article. Section 3 introduces the sample and defines the main variables for the analysis. Section formulates hypotheses that relate insurers' solvency, profitability, and taxes, to the amount of reinsurance used by the same firms. Section 5 tests these hypotheses on empirical data. Section 6 analyzes the supply of reinsurance. Section 7 concludes.

## 2. LITERATURE REVIEW

Several articles analyze the purchase of reinsurance from the perspective of risk management, focusing on reinsurance as a tool for risk mitigation. Among others, see for example Borch (1968), Doherty and Tinic (1981), Tapiero and Zuckerman (1981), Louberge (1983), Samson and Thomas (1983), Blazenko (1986), Eden and Kahane (1988), Hoerger et al. (1990), Mayers and Smith Jr. (1990), Berger et al. (1992), Garven and Louberge (1996), Cummins and Mahul (2003), Garven and Lamm-Tennant (2003), Cole and McCullough (2006), Froot (2007), Powell and Sommer (2007), Mankai and Belgacem (2016), and Surminski (2018)[1]. Recently, Altuntas et al. (2018) provides an interesting of overview on the usage of reinsurance across countries, assessing the importance of country-level and firm- level factors in explaining the purchase of reinsurance. While the previous articles deal mainly with traditional reinsurance with unaffiliated reinsurers, Koijen and Yogo (2016) examine reinsurance transactions within the same group, in the framework of so-called "shadow insurance."

This article analyzes the effect of reinsurance on solvency, profitability, and taxes of insurers. The interaction between reinsurance and solvency is discussed for example in the articles of Berger et al. (1992), Garven and Lamm-Tennant (2003), De Haan and Kakes (2010), Nissim (2010), and Kuschel et al. (2011). In respect to the link with performance, for example Cole and McCullough (2006), Garven and Grace (2007), and Lee and Lee (2012) show that the interplay between reinsurance and profitability is statistically impor- tant. In contrast, Choi (2010) and Choi and Elyasiani (2011) document that reinsurance reduces growth and efficiency. Finally, the hypothesis that reinsurance policies depend from corporate taxation was advanced, among others, by Smith and Stulz (1985), Powell and Sommer (2007), and Adams et al. (2008).

## 3. SAMPLE AND VARIABLES

### 3.1. The sample

We source the data for the analysis from Orbis Bank Focus. We focus on insurance companies from the United States classified as "active," and obtain the annual accounting-based information for the years 2009 to 2017. Active firms exclude companies that are defined alternatively as: under receivership, active but with no longer accounts on Orbis Bank Focus, bankrupted, dissolved, and in liquidation. The sample counts in total 17,868 firm-year observations. Table 1 shows the breakdown of the sample by segments of insurance. Our firms belong to the following segments: composite insurance, health insurance, life insurance, title insurance, and non-life insurance. The sample is made in a larger share by non-life insurers. However, as we look at the total assets under management, composite insurance and life insurance are the segments that cover the largest amount of assets within the sample.

**Table 1.** Business specialization of United States insurance firms (2009-2017)

| *Insurance segment* | *N* | *N (%)* | *Total assets (000$)* | *Total assets (%)* |
|---|---|---|---|---|
| Composite | 311 | 1.74% | 23,700,000 | 48.48% |
| Health | 2,584 | 14.46% | 1,336,485 | 2.73% |
| Life | 3,418 | 19.13% | 19,400,000 | 39.68% |
| Title | 90 | 0.50% | 1,368,599 | 2.80% |
| Non-life | 11,465 | 64.16% | 3,083,483 | 6.31% |
| Total | 17,868 | 100% | 48,888,567 | 100% |

### 3.3. Variables

Table 2 displays descriptive statistics for the variables that we use in the analysis.

REINS USED is the ratio of reinsurers' share of technical provisions over total assets. CAPITAL is the sum of equity capital and surplus divided by total assets. CAPITAL2 is the sum of equity capital and surplus divided by total earned premiums. ROA is the ratio of net income to total assets. ROE is the ratio of net income to total equity. PROFIT MARGIN is the ratio of net income to total revenue.

TAXES is the difference between pre-tax profit and profit net of taxes, divided by pre-tax profits. LOG ASSETS is the natural logarithm of total assets.

The variable REINS USED is an indicator for the reinsurance used by the company, as it normalizes the reinsurers' share of technical provisions over total assets. Technical provisions are the amounts set aside to fulfill obligations to policyholders. Setting technical provisions implies the estimation of loss reserves, and the attempt to give reliable insights into future claims emergence by means of different actuarial techniques[2].

The variable CAPITAL divides the sum of equity capital and surplus by total assets.

CAPITAL captures the solvency of the firm. Insurers with a high level of CAPITAL would be relatively solvent, as they hold sufficient resources to fully cover their obligations. For robustness, we test also the ratio of capital and surplus over total earned premiums (CAPITAL2).

We construct the variable ROA by taking the ratio of net income to total assets. In addition, we divide net income to total equity (ROE) and to total revenue (PROFIT MARGIN), ROA, ROE, and PROFIT MARGIN account for the company profitability.

As we consider taxes, we take the difference between pre-tax profit and profit net of taxes, in

[1] For an overview of reinsurance from the point of view of the actuarial science, we refer to the book of Albrecher et al. (2017)

[2] Empirical articles have implemented a variety of measures for the usage of reinsurance. For example, De Haan and Kakes (2010) compute the proportion of reinsurance premiums paid over total premiums earned. Garven and Lamm-Tennant (2003) and Lee and Lee (2012) assess the usage of reinsurance with a variable that divides the total reinsurance ceded by gross premiums written.

respect to pre-tax profit (TAXES). TAXES increases with the tax burden of the firm, because the number tells whether a huge share of profits is eroded by taxes.

**Table 2**. Summary statistics

| *Variable* | *N* | *Mean* | *Std. Dev.* | *Min* | *Max.* |
|---|---|---|---|---|---|
| REINS USED | 17,868 | 0.019 | 0.041 | -0.021 | 0.624 |
| CAPITAL | 17,868 | 0.405 | 0.199 | 0.028 | 1.000 |
| CAPITAL2 | 17,868 | 1.361 | 1.300 | 0.081 | 6.419 |
| ROA | 17,868 | 0.032 | 0.069 | -0.270 | 0.471 |
| ROE | 17,510 | 0.081 | 0.147 | -0.531 | 0.617 |
| PROFIT MARGIN | 17,765 | 0.077 | 0.364 | -9.162 | 8.118 |
| TAXES | 17,868 | 0.188 | 0.370 | -2.607 | 2.612 |
| TOTAL ASSETS (000$) | 17,868 | 6,297,850 | 30,400,000 | 547 | 702,000,000 |
| LOG ASSETS | 17,868 | 12.833 | 2.275 | 6.304 | 20.370 |

*Note: REINS USED is the ratio of reinsurers' share of technical provisions over total assets. CAPITAL is the sum of equity capital and surplus divided by total assets. CAPITAL2 is the sum of equity capital and surplus divided by total earned premiums. ROA is the ratio of net income to total assets. ROE is the ratio of net income to total equity. PROFIT MARGIN is the ratio of net income to total revenue. TAXES is the difference between pre-tax profit and profit net of taxes, divided by pre-tax profits. LOG ASSETS is the natural logarithm of total assets.*

In order to dig more deeply into the composition of the sample, Table 3 reports statistics by segment of insurance. This decomposition reveals interesting differences. For example, non-life insurers utilize reinsurance in a larger measure than the other companies. This evidence confirms the findings of Baur and Breutel-O'Donoghue (2004), who document the usage of reinsurance worldwide during 1990-2003. Nissim (2010) argues that reinsurance is used extensively in property and casualty insurance, while it is less common in life and health insurance. This is primarily due to the fact that reinsurance exhibits significant limitations as a risk transfer mechanism in respect to longevity risk. The systematic nature of longevity risk implies that reinsurance treaties covering this risk are usually expensive. In addition, many life insurance companies are reluctant to buy long-term reinsurance coverage because of substantial credit risk. The numbers in Table 3 confirm these views, as we can see that REINS USED is close to zero for life insurers, whereas over the whole sample the average REINS USED is 1.9 percent. We notice that health insurers exhibit quire high indicators for both solvency and profitability. For all variables, the Kruskal-Wallis equality-of-populations rank test rejects the null hypothesis that the populations identified by the insurance segments are the same at any level below 0.1 percent.

**Table 3.** Descriptive statistics across segments of insurance

| | *Composite* | *Health* | *Life* | *Title* | *Non-life* | *Total* | *Kruskal-Wallis test* |
|---|---|---|---|---|---|---|---|
| REINS USED | 0.019 | 0.013 | 0.006 | 0.001 | 0.024 | 0.019 | 1741.389*** |
| CAPITAL | 0.379 | 0.513 | 0.213 | 0.428 | 0.438 | 0.405 | 4183.397*** |
| CAPITAL2 | 0.556 | 0.338 | 1.135 | 0.390 | 1.691 | 1.361 | 6335.787*** |
| ROA | 0.045 | 0.068 | 0.019 | 0.074 | 0.027 | 0.032 | 981.789*** |
| ROE | 0.135 | 0.120 | 0.100 | 0.180 | 0.640 | 0.081 | 489.094*** |
| PROFIT MARGIN | 0.047 | 0.028 | 0.080 | 0.057 | 0.088 | 0.077 | 455.654*** |
| TAXES | 0.242 | 0.214 | 0.177 | 0.169 | 0.184 | 0.188 | 75.534*** |
| TOTAL ASSETS (000$) | 23,700,000 | 1,336,485 | 19,400,000 | 1,368,599 | 3,083,483 | 48,888,567 | 1422.440*** |

*Note: REINS USED is the ratio of reinsurers' share of technical provisions over total assets. CAPITAL is the sum of equity capital and surplus divided by total assets. CAPITAL2 is the sum of equity capital and surplus divided by total earned premiums. ROA is the ratio of net income to total assets. ROE is the ratio of net income to total equity. PROFIT MARGIN is the ratio of net income to total revenue. TAXES is the difference between pre-tax profit and profit net of taxes, divided by pre-tax profits. The Kruskal-Wallis rank test verifies the null hypothesis that the sub-samples are taken from the same sample. Under the null hypothesis, the statistics is distributed as a $\chi 2$. * p<0.05, ** p<0.01, *** p<0.001*

## 4. WORKING HYPOTHESES

In this section we formulate three working hypotheses that relate the insurer solvency, profitability, and taxation to the reinsurance utilized by the same firm.

We begin the discussion by treating solvency. The purpose of reinsurance is primarily to transfer risk from cedant to reinsurer, therefore we expect that the ability of the cedant to remain solvent should increase after sharing part of its risk with the reinsurer. In general, capital ratios should serve as measures for the assessment of capital adequacy. In fact, the discipline that applies to insurers across countries, dictates solvency standards based on capital measures. However, there is no clear evidence whether the usage of reinsurance would bring changes to capital levels of insurers. The correlation between reinsurance and capital is negative if capital and reinsurance act as substitutes for enhancing solvency, i.e. reinsurance allows achieving a given level of insolvency risk with lower capitalization (Berger et al., 1992; Garven and Lamm-Tennant, 2003; Powell and Sommer, 2007; De Haan and Kakes, 2010)[3]. In contrast, the correlation is positive if reinsurance reduces the strain on regulatory capital both by reducing exposure and increasing surplus Nissim (2010). For example, Kuschel et al. (2011) suggests that different reinsurance programs end up to increase the solvency of European insurers, as supported by trends in the regulatory capital requirements. To summarize, we develop the following hypothesis:

[3] Shiu (2011) finds that insurers with higher reinsurance dependence tend to have a higher level of debt.

*$H_1$: The effect of used reinsurance on solvency: if the solvency of insurers increases with the level of used reinsurance, to the extent that reinsurance and capital can be seen as substitutes, we should observe a negative effect of REINS USED on CAP- ITAL and CAPITAL2.*

In contrast, if reinsurance is a complement for capital in order to enhance solvency, the effect of REINS USED on CAPITAL and CAPITAL2 should be positive.

The second aspect we consider is profitability. The literature discusses whether the usage of reinsurance carries substantial costs, to the point that it leads to higher prices and/or lower profits. It remains an open issue whether reinsurance interferes with the insurer performance.

For example, some articles illustrate that reinsurance reduces growth (Choi, 2010) and efficiency Choi and Elyasiani (2011), leading to a bad performance of investments Shiu (2011). Lee and Lee (2012) contend that reinsurance costs are substantially high, to the point that insurers could perform much better if they will not cede their premiums to reinsurers.

In contrast, the findings of Berger et al. (1992), Cole and McCullough (2006), Garven and Grace (2007), and Lee and Lee (2012), suggest that reinsurance increases profitability, in accordance to the argument advanced by Jean-Baptiste and Santomero (2000). Finally, Choi and Weiss (2005) show that the empirical link between profitability and reinsurance is not significant in statistical terms[4]. The above discussion is summarized with the following hypothesis.

*$H_2$: The effect of used reinsurance on profitability: If reinsurance is expensive to the extent that it has an impact on the cedant profitability, we should observe a negative effect of REINS USED on profitability, as captured by ROA, ROE, and PROFIT MARGIN.*

In contrast, if reinsurance improves the cost efficiency of insurers, we should observe a positive effect of REINS USED on profitability, as captured by ROA, ROE, and PROFIT MARGIN.

Finally, we consider the corporate taxation. There are two main arguments that relate reinsurance to taxes. The first argument was advanced by (Smith and Stulz, 1985), who argue that buying reinsurance allows firm to lower the volatility of their pre-tax earnings, ultimately decreasing expected tax liabilities. By the same token, Garven and Louberge (1996) develop a model predicting that firms buy reinsurance to achieve the optimal allocation of tax shield benefits. Garven and Lamm-Tennant (2003) hypothesize that the demand for reinsurance is greater for firms which concentrate their investments in tax favored assets, because the purchase of reinsurance reduces the probability of bearing large unexpected losses, so that firms would be able to fully recognize tax shields. Nonetheless, the data analyzed by Garven and Lamm-Tennant (2003) do not offer strong support to this hypothesis. In contrast, Powell and Sommer (2007) develop the argument further, and exam multi-firm corporations by separating demand for internal versus external reinsurance. The authors maintain that firms would be able to internalize the tax benefits from tax-favored assets, under the hypothesis that intra-group reinsurance costs less than external reinsurance, even if the cost of external reinsurance is greater than the expected tax savings.

The second argument linking reinsurance to taxes says that reinsurance enhances the level of taxable income by means of reinsurance commissions Adiel (1996). This view is corroborated by the findings in Adams et al. (2008), showing that UK life insurers raise their use of reinsurance when they are subject to low marginal tax rates. In conclusion, our working hypothesis states as follows.

*$H_3$: The effect of used reinsurance on taxation: if reinsurance reduces the income volatility of insurers to the extent that reduces corporate taxes, we should observe a negative effect of REINS USED on TAXES.*

In contrast, if reinsurance enhances the level of taxable income, we should observe a positive effect of REINS USED on TAXES.

## 5. RESULTS FOR THE EFFECT OF USED REINSURANCE ON INSURER SOLVENCY, PROFITABILITY, AND TAXES

For every firm *i* at time *t*, the following regression models estimate the effect of reinsurance on firm-specific characteristics:

$$Insurer\ characteristics_{i,t} = a + \beta \times REINS\ USED_{i,t} + \Theta \times Controls_{i,t} + \upsilon_i + \tau_t + E_{i,t} \quad (1)$$

where the insurer-specific characteristics that we consider are solvency, profitability, and taxation as captured by CAPITAL, CAPITAL2, ROA, ROE, PROFIT MARGIN, and TAXES. $\Theta$ is the vector of coefficients for the control variables of the regressions. All models control for size effects with the inclusion of the logarithm of total assets (LOG ASSETS). In the equations for CAPITAL and CAPITAL2 we include a measure for profitability, while in the regressions for the profitability indicators we control for capital levels. We estimate the equations using panel data techniques that include fixed effects. On this purpose, in 1 the terms $\upsilon_i$ and $\tau_t$ denote respectively two dummies that capture time and firm fixed effects[5]. $E_{i,t}$ is an error term. Standard errors are clustered at the firm level to control for within firm correlation.

Table 5 displays results from the estimates of (1). The effect of REINS USED is negative for both CAPITAL and CAPITAL2. In light of Hypothesis 1, the sign is consistent with the argument that reinsurance and capital can be seen as substitutes for enhancing solvency. Thus, by deploying reinsurance, firms would be able to mitigate their risk, to the point that they can save of capital levels. The effect of REINS USED on profitability is negative as well, and statistically relevant for the variables

[4] Some articles investigate to what extent the level of profitability determines the decision of the firm to buy reinsurance. For example, Cole and McCullough (2006) display that high levels of profitability induce firms to reduce the use of reinsurance, in accordance to the argument of Adams et al. (2008).

[5] Notice that, using fixed effects we assume that something within the entity may impact or bias the predictor or the outcome variables and we need to control for this. This reflects in the assumption of certain correlation between the error term and the predictor variables or each sample entity. Fixed effects should remove the effect of those time-invariant characteristics so we can assess the net effect of the predictors on the outcome variable. Another important assumption of the fixed effects model is that those time- invariant characteristics are unique to the individual and should not be correlated with other individual characteristics.

ROA and ROE. Hypothesis 2 would suggest that the huge costs of reinsurance result into impaired performances. Finally, reinsurance does not changes tax burdens, as the coefficient of REINS USED for TAXES is weak in magnitude as well as in statistical significance.

**Table 4.** The effect of used reinsurance on insurer solvency, profitability, and taxes

| | *(1) CAPITAL* | *(2) CAPITAL2* | *(3) ROA* | *(4) ROE* | *(5) PROFIT MARGIN* | *(6) TAXES* |
|---|---|---|---|---|---|---|
| REINS USED | -0.524*** (0.0765) | -51.87 (26.86) | -0.0756* (0.0325) | -0.166* (0.0773) | 0.0169 (0.0997) | -0.248 (0.168) |
| LOG ASSETS | -0.0776*** (0.00753) | -39.34 (0.0075) | 0.0196*** (0.00371) | 0.0401** (1.385) | 0.0451 (0.0261) | 0.00766 (0.0150) |
| ROA | 0.338*** (0.0185) | 10.76 (22.89) | | | | 0.0872 (0.0524) |
| CAPITAL | | | 0.217*** (0.0136) | 0.326*** (4.592) | 0.308*** (0.0280) | -0.0974 (0.0571) |
| N | 17,868 | 17,868 | 17,868 | 17,510 | 17,765 | 17,868 |
| R2 | 0.205 | 0.001 | 0.086 | 0.046 | 0.006 | 0.004 |

*Note: CAPITAL is the sum of equity capital and surplus divided by total assets. CAPITAL2 is the sum of equity capital and surplus divided by total earned premiums. ROA is the ratio of net income to total assets. ROE is the ratio of net income to total equity. PROFIT MARGIN is the ratio of net income to total revenue. TAXES is the difference between pre-tax profit and profit net of taxes, divided by pre-tax profits. REINS USED is the ratio of reinsurers' share of technical provisions over total assets. LOG ASSETS is the natural logarithm of total assets. All models include in the set of regressors a constant term. Standard errors are clustered at the firm level and are reported in parentheses. * p<0.05, ** p<0.01, *** p<0.001*

We acknowledge that a certain degree of endogeneity may affect the outcomes in Table 5. In particular, this would happen if our variable of interest REINS USED is strongly driven by the firm characteristics included in the right-hand side of the equations. Although the usage of fixed effects is often seen as one way to attenuate the concern of potential endogeneity, in order to dig more deeply in the issue of multicollinearity, Table 5 calculates the variance inflated factors (VIFs) for the equations of Table 5 where the impact of REINS USED is statistically significant.

**Table 5.** Variance inflation factors (VIFs) of the equation models estimated for CAPITAL, ROA, and ROE

| | *CAPITAL* | | *ROA* | | *ROE* | |
|---|---|---|---|---|---|---|
| Insurer features | VIF | 1/VIF | VIF | 1/VIF | VIF | 1/VIF |
| REINS USED | 1.02 | 0.984 | 1.02 | 0.977 | 1.02 | 0.977 |
| LOG ASSETS | 1.01 | 0.987 | 1.34 | 0.746 | 1.34 | 0.746 |
| ROA | 1.01 | 0.986 | - | - | - | _ |
| CAPITAL | - | - | 1.34 | 0.748 | 1.34 | 0.748 |
| Mean VIF | 1.62 | | 1.68 | | 1.68 | |

*Note: CAPITAL is the sum of equity capital and surplus divided by total assets income to total assets. ROE is the ratio of net income to total equity. REINS USED is the ratio of reinsurers' share of technical provisions over total assets. LOG ASSETS is the natural logarithm of total assets. The variance inflation factors (VIFs) for the time dummies are not reported, for brevity.*

Researchers often use the rule of thumb that a VIF equal to ten indicates multicollinearity (Marquaridt, 1970; Mason et al., 2003). Based on the values computed in Table 5, we can alleviate further the suspect that multicollinearity contaminates severely the quality of our baseline regression outcomes.

According to Table 3, our firms make use of reinsurance in a different measure depending on their insurance segment. Therefore, we question whether the results in the table would be different across segments. For this purpose, we create three dummy variables that identify respectively health, life, and non-health/life insurers, and name the variables as H, L, and NHL. The non-health/life insurers include composite insurance, title insurance and non-life insurance. We estimate the regressions in (5) adding the interaction term of REINS USED with the three dummies. This allows disentangling the impact of reinsurance across the three segments:

$$\begin{aligned}\text{Insurer characteristics}_{i,t} &= a + \beta \times REINS\ USED_{i,t} \\ &+ Dummy\ insurance\ segment \\ &+ \Theta \times Controls_{i,t} + \upsilon_i + \tau_t \\ &+ E_{i,t}\end{aligned} \quad (2)$$

The insurer-specific characteristics are captured by CAPITAL, CAPITAL2, ROA, ROE, PROFIT MARGIN, and TAXES. The set of controls, $\upsilon_i$, $\tau_t$ and $E_{i,t}$ have the same interpretation as in 1. The dummy variables indicating the insurance segment are H, L, and NHL. Table 6 reports the outcomes from 2. We observe the stronger effects for health insurers. A marginal increase of REINS USED leads to a significant decrease in solvency and profitability. A strong negative effect on capital reveals also for non-health/life insurers. The effect on taxes, that was not relevant in Table 5, is now significantly negative for life insurers. That is, life insurers that make increasing use of reinsurance, bear lower tax burdens. Hypothesis 3 explains this pattern by saying that reinsurance diminishes taxes by reducing the income volatility. Decomposing reinsurance effects across segments leads to the conclusion that the impact on solvency is relatively persistent across segments, as the sensitivity of capital to reinsurance remains significant for both life and non-health/life insurers, in accordance to the argument that these firms benefit from reinsurance through the relief on capital.

**Table 6.** Interaction of used reinsurance with dummies for health, life and non-health/life insurers

| | | *(1) CAPITAL* | *(2) CAPITAL2* | *(3) ROA* | *(4) ROE* | *(5) PROFIT MARGIN* | *(6) TAXES* |
|---|---|---|---|---|---|---|---|
| REINS USED | × L | -0.334 | -39.24 | -0.0271 | -0.0334 | 0.941 | -0.841* |
| | | (0.258) | (41.09) | (0.167) | (0.290) | (0.756) | (0.413) |
| REINS USED | × H | -0.611** | -25.55 | -0.261** | -0.579 ** | -0.112 | 0.0226 |
| | | (0.228) | (51.07) | (0.0919) | (0.239) | (0.0957) | (0.430) |
| REINS USED | × NHL | -0.510*** | -65.25 | -0.000309 | -0.0299 | -0.0523 | -0.297 |
| | | (0.0475) | (39.56) | (0.0299) | (0.0733) | (0.114) | (0.171) |
| LOG ASSETS | | -0.0775*** | -39.34 | 0.0195*** | 0.0396** | 0.0454 | 0.00928 |
| | | (0.00750) | (25.87) | (0.00377) | (0.00765) | (0.0262) | (0.0148) |
| ROA | | 0.337*** | 11.22 | | | | |
| | | (0.0186) | (22.87) | | | | |
| CAPITAL | | | | 0.216*** | 0.321*** | 0.305*** | -0.0753 |
| | | | | (0.0138) | (0.0284) | (0.0719) | (0.0539) |
| N | | 17,868 | 17,868 | 17,868 | 17,510 | 17,765 | 17,868 |
| R2 | × L | 0.205 | 0.001 | 0.089 | 0.048 | 0.006 | 0.004 |

*Note: CAPITAL is the sum of equity capital and surplus divided by total assets. CAPITAL2 is the sum of equity capital and surplus divided by total earned premiums. ROA is the ratio of net income to total assets. ROE is the ratio of net income to total equity. PROFIT MARGIN is the ratio of net income to total revenue. TAXES is the difference between pre-tax profit and profit net of taxes, divided by pre-tax profits. REINS USED is the ratio of reinsurers' share of technical provisions over total assets. H is a dummy variable identifying health insurers. L is a dummy variable identifying life insurers. NHL is a dummy variable identifying non-health/life insurers, i.e. the segments of composite insurance, title insurance and non-life insurance. LOG ASSETS is the natural logarithm of total assets. All models include in the set of regressors a constant term. Standard errors are clustered at the firm level and are reported in parentheses. * p<0.05, ** p<0.01, *** p<0.001*

## 6. RESULTS FOR THE EFFECT OF USED REINSURANCE ON INSURER SUPPLIED REINSURANCE

In this section we study in more depth the case of firms that, besides demanding reinsurance for their own, they also provide reinsurance to other firms. In fact, a primary insurer is allowed to supply reinsurance, by accepting indirect business from another insurance company in form of assumed premiums.

As we want to construct a variable capturing the supply of reinsurance, we exploit the information reported on the company profit and loss account. Specifically, the variable REINS SUPPLIED computes the difference between gross and net premiums written, and divides this number by gross premiums written. Gross premiums written include both written premiums charged to policyholders (also called direct written premiums) and assumed reinsurance premiums from insurance companies. Net written premiums instead are gross premiums written minus ceded reinsurance premiums. Hence, by taking the difference between gross and net premiums written we have an approximation for the share of premiums that the firm accepts as reinsurer, i.e. the premiums ceded to same firm. A high value of REINS SUPPLIED means that the firm is actively supplying reinsurance. Table 7 shows that non-life insurers tend to supply more frequently reinsurance than the other firms. This confirms our previous statement that, in general, reinsurance is a practice widely diffused in non-life insurance than in other segments. Nonetheless, we notice that, while life insurers tend almost not using reinsurance, they actively supply reinsurance[6].

**Table 7.** Average amount of supplied reinsurance across segments of insurance

| *Insurance segment* | *REINS SUPPLIED* |
|---|---|
| Composite | 0.091 |
| Health | 0.035 |
| Life | 0.245 |
| Title | 0.040 |
| Non-life | 0.397 |
| Total | 0.308 |
| Kruskal-Wallis test | 5716.317*** |

*Note: REINS SUPPLIED is the difference between gross premiums written and net premiums written, divided by gross premiums written. The Kruskal-Wallis rank test verifies the null hypothesis that the sub-samples are taken from the same sample. Under the null hypothesis, the statistics is distributed as a $\chi 2$. * p<0.05, ** p<0.01, *** p<0.001*

For every firm $i$ of the sample, we study the interplay between used reinsurance and supplied reinsurance. With panel data techniques, we conduct a regression of REINS SUPPLIED on REINS USED, in accordance to the following regression model:

$$\text{REINS SUPPLIED}_{i,t} = a + \beta \times REINS\ USED_{i,t} + \Theta \times Controls_{i,t} + \upsilon_i + \tau_t + E_{i,t} \quad (3)$$

The set of controls $\upsilon_i$, $\tau_t$ and $E_{i,t}$ have the same interpretation as in 1 and 2. Table 8 displays that the coefficient on REINS USED is strongly positive and significant. We interpret this finding with the argument that, by obtaining reinsurance our firms are able to mitigate their underwriting and solvency risks, thereby improving the capability to supply indemnity coverage for the risks ceded from other firms through reinsurance contracts.

## 7. CONCLUSIONS

The article analyzes a sample of insurers from the United States and provides empirical evidence for the effect of reinsurance on solvency, profitability, and taxes of insurers. In statistical terms, the impact of reinsurance is observed to be more important for solvency, than for profitability and taxes. In fact, the outcomes suggest that insurers' capital decreases in the amount of utilized reinsurance. We interpret this

[6] The high value of REINS SUPPLIED for life insurers could be seen in line with the trend in the life reinsurance market documented at https://www.rgare.com/knowledge-center/media/articles/global-life-reinsurance-industry-a-brief-overview

pattern to be in line with the hypothesis that reinsurance can substitute capital for improving the solvency of insurers. Additional outcomes show that insurers are more prone to supplying reinsurance to other firms as they receive growing amounts of reinsurance for their own.

We argue that this article provides results that could be of particular interest for regulators, as they seek to establish adequate capital requirements for insurers. To the future research activity instead, we leave the task of making the message of this article much stronger by providing additional empirical support, for example analyzing other countries besides the United States. In fact, we acknowledge that the research on reinsurance faces often the lack of huge and informative data-sets where to perform in-depth analyses. Evidently, having longer time series of data could in some instances allow to implement techniques that treat more effectively the issue of potential endogeneity. For example, exploring changes in the regulation over time is often seen as one tool that helps to discard endogeneity. Finally, we encourage additional theoretical research in this field that should work to provide a more solid basis to the relationships that we document empirically.

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