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Non-linear Effects of Market Concentration on the Underwriting Profitability of the Non-life Insurance Sector in Europe

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Abstract

Recent studies argue that more attention needs to be paid to the insurance sector in analyses of the financial sector, as it may be a significant factor in maintaining overall financial stability. In this paper, we analyze the relationship between market concentration and the underwriting profitability of the non-life insurance sector. We find that an increasing level of concentration over time leads, on average, to an increase in underwriting profitability (as proxied by the loss ratio). At high levels of concentration, however, this effect reverses, with rising concentration reducing underwriting profitability. The convex (U-shaped) nature of this relationship implies that the strongest incentives for collusive behavior arise when concentration is lowest. Additionally, we show that during a period of lower rates, weaker interest returns are offset by stronger underwriting results. However, this effect seems to be conditional on a high level of concentration.

Abstrakt

Nedávné studie tvrdí, že v analýzách finančního sektoru je třeba věnovat více pozornosti pojišťovnictví, neboť může být významným faktorem pro udržování celkové finanční stability. V této práci analyzujeme vztah mezi koncentrací trhu a ziskovostí upisování v neživotním pojištění. Zjišťujeme, že v čase rostoucí koncentrace v průměru vede ke zvýšení ziskovosti upisování (aproximované škodním poměrem). Při vysokých úrovních koncentrace je však tento efekt opačný a rostoucí koncentrace ziskovost upisování snižuje. Konvexní křivka ve tvaru U, která tento vztah vyjadřuje, implikuje, že motivace ke koluznímu jednání je nejsilnější při nejnižší koncentraci. Dále ukazujeme, že během období nižších úrokových sazeb jsou slabší úrokové výnosy kompenzovány silnější ziskovostí upisování. Tento efekt se však jeví jako podmíněný vysokou úrovní koncentrace.

JEL Codes: C33, G22, G23.
Keywords: Concentration, insurance sector, loss ratio, low interest rates, underwriting profitability.

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1. Introduction

The role of life and non-life insurance companies in maintaining financial stability, though growing in importance in the financial sector, receives less attention than that of the banking sector and stock markets. Recent studies, such as Liu et al. (2016), Ruiz (2018), and Hodula et al. (2021), however, argue that more attention needs to be paid to the insurance sector in analyses of the financial sector and in the implementation of macro-economic policy.

In our study, we focus primarily on the effect of industry concentration on the loss ratios of non-life insurance companies. The loss ratio can, with a reasonable degree of simplification, be understood as an important part (the inverse) of insurers (underwriting) profitability. We analyze a panel of 24 European OECD countries over the period 1997–2019 and examine the relationship between concentration rates and loss ratios using regression analysis methods. From the micro-data on insurance companies (ICs), we calculate several different measures of market concentration and determine whether it affects the loss ratio (and, in turn, underwriting profitability) in a given country and at a given time. At the same time, we examine whether this relationship is strictly linear and how it is influenced by other variables that characterize the insurance sector in a given country.

The period under review is of particular interest, because significant changes have taken place in the European insurance sector in recent years. First, there have been significant movements in the level of market concentration in the non-life insurance sector. While less developed (former communist) countries with less developed insurance sectors have deconcentrated the sector in recent decades, some developed countries have seen an increase in market concentration. Based on the trade share of the four largest ICs, the degree of concentration in less developed countries was 77.2% in 1997 but only 70.5% in 2019. Conversely, in developed countries, it was 48.22% in 1997 and 58.95% in 2019.

The second aspect of the period under review is the introduction of the Solvency II directive. The directive aims to improve the protection of policyholders and beneficiaries, enhance harmonization, introduce effective risk management, and ensure the financial stability of the insurance sector (EU, 2009). It is rather an empirical question whether this directive has affected developments in the insurance sector, because on the one hand the new capital requirements may have put some strain on the profitability of ICs, but on the other hand the obligatory categorization of risk in internal models may have motivated them to increase their reported profitability. Although it is not our primary interest, in this paper we will try to address the relationship between Solvency II and the loss ratio of the insurance sector.

The third aspect of the period under review consists in the post-GFC period, when most European countries experienced a low interest rate environment (LIRE). Not only banks, but also institutional investors face difficulties when rates are "low for long." This applies primarily to the life sector, but also partly to the non-life sector.[1] The profitability of the non-life sector is driven by both underwriting and investment performance. The liquid funds that the insurance sector collects from policyholders are largely invested in various types of assets, often corporate, government or other bonds. As interest rates fall, investments in these assets yield an even lower return. Investment

[1] In the life sector, problems emerge on both sides of the balance sheet. The liabilities of life insurance companies and pension funds rise when they discount them at a low market interest rate. Valuation gains on their assets, on the other hand, depend on the type of instrument. Generally, however, in an environment of low interest rates, the return on fixed-income investment instruments will decline, as they get rolled over at much lower coupons. All this constitutes a growing solvency threat (Van Riet, 2017).

income on invested cash flows can remain on the balance sheet for a couple of years and is an integral part of the non-life insurance business model (Fan et al., 2020).

Our study complements and extends the line of inquiry in the insurance sector in several ways. We combine two datasets – a micro-economic dataset on individual ICs and macro-economic data on the country level. This gives us the opportunity to analyze some of the trends in the insurance sector in more detail. We highlight four empirical findings.

First, we identify a non-linear relationship between market concentration and the loss ratio. Based on the ICs' micro-data, we show that the relationship between market concentration and the loss ratio turns from negative to positive at a certain point. With increasing concentration (lower competition) the loss ratio decreases, but at a certain point (the 75^{th} percentile of concentration) this relationship reverses. It appears that in a country where concentration is too high, the insurance sector may end up with a high loss ratio, which may be a risk to financial stability.

Second, we show that this non-linear relationship mainly concerns the non-life "Motor" and "Property" sub-sectors, which together account for about 80% of the entire non-life sector. We complement these findings with a description of possible differences in sub-sectors such as "Surety, Bond and Credit." This serves not only as one of many robustness tests, but also as a more detailed look at the non-life sector as a whole.

Third, we further investigate the impact of the LIRE and conclude that the unfavorable investment returns caused by low interest rates motivate ICs to offset those low yields with better underwriting results (reflected in the loss ratio). This happens substantially more in sectors where little competition prevails. This could mean that in such sectors, ICs pass on reduced investment returns to policyholders so that they can increase their underwriting results. We argue that although the non-life sector will not be affected by a period of low interest rates as strongly as the life sector, there may still be channels that influence the sector through low yields.

The rest of the paper is organized as follows. The second section describes existing research in the field of the insurance sector, focusing mainly on the literature on the impact of market concentration on profitability. The third section describes the data and the methodology of our research. The fourth section presents the main results of our baseline estimates. By examining the impact of market concentration and controls on the loss ratio, it lays the basis for a quantitative evaluation of the factors influencing the loss ratio. The fifth section develops several robustness checks via multivariate analysis and provides additional empirical support for the results in the previous section. The sixth section contains a more detailed analysis of the sub-sectors of the insurance sector. Finally, the seventh section concludes.

2. Literature Review

Empirical studies devoted to the analysis of the insurance sector have grown in number in recent years. These studies find a positive impact of insurance premiums on GDP growth (Arena, 2008; Haiss and Sümegi, 2008; Ruiz, 2018), interlinkages between the banking sector, the insurance industry, and economic growth (Pradhan et al., 2017), interlinkages between the banking sector, the insurance sector, and stock markets, and dynamic effects of the banking sector, the insurance sector, and stock markets on economic growth (Hou and Cheng, 2017). Other studies (Cummins and Weiss, 2014; Eling and Pankoke, 2016) investigate systemic risk in the insurance sector and the interconnectedness of the insurance sector with other financial institutions, arguing that the mechanisms for insurance group supervision should be strengthened. Eling and Pankoke (2016) conclude that the current literature indicates that policymakers and regulators need to closely analyze systemic risk, especially with respect to insurance activities.

Another stream of literature investigates the factors determining the supply and demand for both life and non-life insurance (Outreville, 1996; Feyen et al., 2011; Christophersen and Jakubik, 2014; Hodula et al., 2021). Beenstock et al. (1986) analyzed panel data for 10 industrialized countries over the period 1970–1981. They found that life insurance premiums positively correlate with life expectancy, the dependency ratio, interest rates, and income, but correlate negatively with social security coverage. Earlier studies investigated the determinants of insurance premiums on national markets, such as Cummins (1973) for the US, Diacon (1980) for the UK, and Outreville (1996) for France. More recent studies, such as Browne and Kim (1993), Outreville (1996), Beck and Webb (2003), and Li et al. (2007), also explore the life insurance market, while Feyen et al. (2011) and Christophersen and Jakubik (2014) investigate both the life and non-life markets. Those studies illustrate the benefit of analyzing life insurance demand on a cross-country basis, although some of them rely on a limited number of developed countries and do not include less developed (or post-communist) countries. The latter, however, are covered by more recent studies (Hodula et al., 2021). More detailed studies then analyze factors of the profitability of the insurance sector, mostly in less developed countries (Akotey et al., 2013; Boadi et al., 2013; Burca and Batrinca, 2014), but some studies also in developed countries (Greene and Segal, 2004; Pope and Ma, 2008; Dorofti and Jakubik, 2015).

Our paper is related to the second stream of literature analyzing the loss ratio of the insurance sector in the European countries of the OECD. It is closely related to studies on the demand for, and supply of, insurance products and to studies on the profitability of the insurance industry.

Despite the increasing number of papers studying the determinants of life and non-life insurance consumption, several issues remain unclear. For instance, the research into insurance premiums does not really answer the question of whether the volume of insurance premiums is optimal (or sufficient) for a given insurance sector in a given country (Emms, 2007). In practice, a situation may arise where GDP in a country grows along with insurance premiums, but at the same time the profitability of the insurance sector declines. This can happen if insurance claims grow faster than insurance premiums. In other words, if the analysis is to focus on the sustainability of the insurance sector and on the implications for financial stability, the relationship between insurance premiums and claims must be examined as well. This relationship between insurance premiums and claims is best described by the loss ratio. The loss ratio can simultaneously also be a good proxy for underwriting profitability.

The majority of studies analyzing the determinants of profitability or loss ratios in the financial sector focus on company-level data. These studies consider traditional risk factors such as leverage, a firm's growth rate, firm size, and liquidity to be important determinants (Bouzouita and Young, 1998; Adams et al., 2003; Frank and Goyal, 2009). In the insurance sector, however, it is not uncommon for country-level data to be analyzed as well (Beck and Webb, 2003; Li et al., 2007; Feyen et al., 2011; Christophersen and Jakubik, 2014). We follow this approach, analyzing country-level data for the European countries of the OECD. Similar samples of countries were investigated by Donni and Fecher (1997) (15 OECD countries, 1983–1991), Li et al. (2007) (30 OECD countries, 1993–2000), and Haiss and Sümegi (2008) (29 European countries, 1992–2005), but with a considerably different focus than ours.

2.1 The Loss Ratio in the Insurance Sector

The loss ratio is the ratio of losses to premiums earned. The losses in the loss ratio include insurance claims incurred, so it is also called the claim ratio (EIOPA, 2020).[2] The loss ratio is used to measure the total technical outflows associated with claim settlement activities. It can be employed to assess the (underwriting) profitability of insurance companies or the profitability of the insurance sector as a whole. A high loss ratio may indicate that the insurance sector is in financial distress (Kwon and Wolfrom, 2017). Epermanis and Harrington (2006) mention in this regard that the literature on insurer insolvencies and the insurance trade press emphasize that insolvencies often follow periods of poor underwriting results (i.e., high loss ratios).

Berger et al. (1992) use a variable defined as one minus the firm's economic loss ratio as a measure of underwriting profitability. They add that increases in the loss ratio reflect high losses relative to prices and that declines in the loss ratio can reflect substantial price increases (relative to loss amounts). The study uses company-level data and, besides other results, concludes that a higher Herfindahl index (fewer participants, lower competition) is associated with lower underwriting profitability of reinsurance companies. Similarly, Pope and Ma (2008) use the loss ratio as a measure of profitability in a way where their dependent variable is one minus the market average loss ratio of non-life lines. They suggest that this approach is the most suitable for measuring underwriting profitability. The study concludes that the level of competition, barriers to market entry, the price elasticity of demand, interest rates, and GDP growth determine the profitability of the non-life insurance sector.

In our study, we focus primarily on the effect of industry concentration on the loss ratio. The literature on this relationship in the insurance sector is scarce, so we also rely on literature from the banking sector.

2.2 The Relationship Between Industry Concentration and Profitability

Research on the relationship between the degree of competition and profitability has a long tradition in the banking sector (Bourke, 1989; Goddard et al., 2004; Petria et al., 2015), but the results are mixed and inconclusive. One stream of literature finds empirical evidence for the so-called Edwards–Heggestad–Mingo (EHM) hypothesis, which argues that with higher concentration and market power, the banking sector can increase its profitability. This is because it can better avoid risk and achieves economies of scale in operational expenditure (Edwards and Heggestad, 1973; Heggestad and Mingo, 1976). Another, more traditional hypothesis that supports a positive relationship between concentration and profitability is the structure–conduct–performance (SCP) hypothesis. The SCP hypothesis asserts that a positive relationship between profitability and concentration (a proxy for market power) reflects non-competitive pricing behavior. The higher the market concentration, the higher the profit, as a result of collusive behavior. Evidence for a positive association of concentration and profitability is provided, for instance, by Goddard et al. (2004) Park and Weber (2006), Mirzaei et al. (2013), and Khan et al. (2018).

Another strand of the literature, however, argues that lower competition, which translates into higher market concentration, actually reduces profitability. This may occur because non-price competition may be more intense in more concentrated markets and so bank profitability is lower (Le and Ngo, 2020). Another explanation is that higher competition (and lower concentration) forces banks to improve their management practices. The improvement in managerial practices then results in increased profitability (Athanasoglou et al., 2008). Also, managers in more concentrated markets

[2] An alternative is the combined ratio, defined as the sum of claims and expenses divided by premiums earned.

can more easily engage in expense-preference behavior, so bank costs in such markets are higher and profitability is lower (Edwards, 1977). Managers in concentrated markets may also invest in less risky assets (to enjoy the "quiet life"), thus earning lower returns (Heggestad, 1977). This negative relationship is shown by Chronopoulos et al. (2015), Petria et al. (2015), and Yuanita (2019) using firm-level data. To sum up, the evidence regarding the relationship between concentration and profitability in the banking sector is rather mixed and inconclusive (Gilbert, 1984; Berger, 1995; Berger et al., 2004).

The focus on concentration–profitability analysis and its relation to financial stability has led to investigation of this relationship in the insurance sector, where such research is much less common. Most studies find a positive relationship between concentration and profitability. This conclusion, in line with the structure–conduct–performance hypothesis (Yoshiro et al., 2006), is documented especially at the aggregate level (Njegomir and Stojić, 2011; Chidambaran et al., 1997; Cole et al., 2015), but also using firm-level data (Choi and Weiss, 2005).

Pope and Ma (2008), however, demonstrates that this usually strongly significant positive effect dies away with a rising level of liberalization. Their study leaves some aspects of this relationship unexplained, does not have a sufficiently complete dataset, and does not use some important control variables. Therefore, there is an opportunity for further research into this relationship. As some studies suggest (Shim, 2017; Altuntas and Rauch, 2017), the need for more research in this area is reinforced by the importance of the concentration–profitability relationship in the analysis of overall financial stability.

3. Methodology

In our empirical analysis, we use a panel regression model where the cross-section units are the European OECD countries (24 countries) and the time period is 1997–2019. Our primary focus is on the relationship between the concentration and the loss ratio of the insurance sector in the countries analyzed.

3.1 Methods

We specify a panel regression model as follows:

$$LossR_{it} = \alpha + \beta Concentr\_Ratio_{it} + \gamma \mathbf{X}_{it}^{'} + \mu_i + \tau_t + \varepsilon_{it}, \quad (1)$$

where the dependent variable $LossR_{it}$ is non-life ICs' gross loss ratio in a given country and year, $Concentr\_Ratio_{it}$ is the concentration ratio, calculated as the trade share of the four biggest ICs in a given country and year, and $\mathbf{X}_{it}^{'}$ is a row vector of financial and macro controls. We estimate all the models with a drift α. In addition, μ_i captures unobserved country-specific effects, τ_t captures time-specific effects (when needed), and ε_{it} is the error term.

When considering the descriptive statistics in the next section, we must also take into account that the relationship between concentration and the loss ratio/profitability may not be linear. Therefore, we test the non-linearity of this relation by quadratic approximation, where $Concentr\_Ratio_{it}$ enters the relation as both a linear and quadratic term:

$$LossR_{it} = \alpha + \beta Concentr\_Ratio_{it} + \omega Concentr\_Ratio_{it}^{2} + \gamma \mathbf{X}_{it}^{'} + \mu_i + \tau_t + \varepsilon_{it}. \quad (2)$$

Based on the previous eq. (1), we further hypothesize that the effects of changing the level of concentration might differ not just across countries, but across the quantiles of concentration as well. Therefore, we enrich our baseline specification with an interaction term that singles out the top quartile (75^{th} pct) of the distribution:

$$\begin{aligned} LossR_{it} = {} & \alpha + \beta Concentr\_Ratio_{it} + \phi 75Concentr_{it} + \psi Concentr\_Ratio_{it} * 75Concentr_{it} \\ & + \gamma \mathbf{X}_{it}^{'} + \mu_i + \tau_t + \varepsilon_{it}, \end{aligned} \tag{3}$$

where $75Concentr_{it}$ is a dummy variable taking a value of 1 if the concentration ratio is higher than the value for the 75^{th} percentile of concentration. At this point, based on our literature review, we have no presumption as to what effect higher or lower percentiles of concentration should have on the loss ratio. Therefore, in a similar logic, we test the 25^{th} percentile ($25Concentr_{it}$). These alternative specifications are motivated by the inconsistent empirical results reported by previous studies. Since we have a limited number of observations, we decided to examine the bottom and top quarter of the distribution as a tail. However, we recognize that when analyzing tails, it is more common to examine, for example, the 10^{th} and 90^{th} percentiles.

Our panel-data units (countries) differ substantially and systematically from one another in unobserved ways that affect the outcome of interest. We therefore use unit fixed effects, since they eliminate between-unit variation, producing an estimate of a variable's average effect within units over time (Allison, 2009). We use standard OLS with fixed effects (FE), with the fixed effects representing individual OECD countries (24 countries). To take care of other potential problems, in some regressions we also use time fixed effects, since the variables of interest exhibit substantial variability over time. We expect that our dataset may contain period-to-period shocks to the outcome variables that apply to all the units of the analysis equally. By employing time fixed effects, we deal with time-variant unobservables that are not unit-specific. Our model still shows the individual time trends of our variables, but only using the variations that are not common to all units. In our paper, we report results both with and without time fixed effects and compare them. By employing both unit and time fixed effects, we aim to reduce selection bias in the estimation of causal effects by eliminating large portions of variation thought to contain confounding factors.

3.2 Data

Our country-level data come from the AXCO database (the loss ratio and the penetration rate) and the OECD database (real GDP growth, financial sector leverage, and 3M interest rates). Our company-level data are sourced from the AXCO database (the market share of insurance companies in a given country and year). Data at the company level were converted to annual data at the country level, so that the concentration ratio $Concentr\_Ratio_{it}$ is calculated as the trade share of the four companies with the largest market share. As a robustness check, the same was done with the three and two largest companies on the market. Table 1 provides basic descriptive statistics of those variables.

The explained variable is the gross loss ratio, which measures the total technical outflows associated with claim settlement activities. It is defined as $LossR = \frac{ins.claims}{ins.premiums}$ and is calculated on gross premiums written. Data on the loss ratio was obtained from the AXCO database and covers the period 1997–2019, but individual data may be missing for some countries in some years. We also consider the loss ratio as a proxy for underwriting profitability. From this point of view, it would be better to examine the combined ratio, which, in addition to losses, includes other money flowing out of an insurance company in the form of dividends and expenses.

Table 1: Basic Descriptive Statistics

Statistic	N	Mean	St. Dev.	Min	Pct(25)	Pct(75)	Max
LossR	497	64.38	11.81	17.22	56.65	74.85	110.09
Penetr_Rate	523	1.78	0.50	0.00	1.45	2.17	4.51
GDP_R	523	2.40	3.28	−14.81	1.14	3.89	25.18
Fin_Lvrg	499	18.45	39.35	2.87	10.10	18.07	611.49
IR_3M	510	2.61	3.06	−0.78	0.22	4.26	19.90
SolvencyII	523	0.17	0.38	0	0	0	1
Concentr_Ratio	519	58.17	18.89	13.60	42.94	74.18	94.16

Note: The number of observations differs due to differences in data availability in the AXCO and OECD databases.

However, the data on the combined ratio is very limited and such a dataset would collectively consist of less than 100 observations for several countries. A fan chart describing the evolution of the gross loss ratio for the years and countries under review is given in Figure A1 in the Appendix.

Our baseline control variables are based on the previous literature (Pope and Ma, 2008; Cole et al., 2015; Hodula et al., 2021) and defined by vector $\mathbf{X}_{it}^{'} : \{Penetr\_Rate_{it}, GDP\_r_{it}, Fin\_Lvrg_{it}, IR\_3M_{it}, SolvencyII_{it}\}$. $Penetr\_Rate_{it}$ is the penetration rate, meaning insurance penetration, which is used as an indicator of the development of the insurance sector within a country and is calculated as the ratio of total insurance premiums to gross domestic product in a given year. The penetration rate is expected to have a negative impact, because more developed insurance markets are likely to use more complex and cost-effective practices while having more experience in managing underwriting profitability. The second control variable, GDP_r_{it}, is real GDP growth. We expect it to have a negative impact on the loss ratio (and a positive effect on underwriting profitability).

Fin_Lvrg_{it} is financial sector leverage (also known as the equity multiplier ratio or financial leverage). It is the ratio of the total financial assets of the banking sector to the market value of its equity, excluding investment fund shares. Banks engage in leverage by borrowing to acquire more assets, with the aim of increasing their return on equity. We take the leverage ratio as a proxy for the profitability achievable in the financial sector as a whole and suppose that higher leverage increases underwriting profitability (and reduces the loss ratio) in the insurance sector as well.[3] IR_3M_{it} is the three month inter-bank interest rate, which we expect to have a negative impact on the loss ratio. We assume that higher interest rates prevent a rise in the price level in the economy and hence a rise in insurance prices. If demand is sufficiently elastic, lower insurance premium prices increase the volume of insurance premiums and reduce the loss ratio. Interest rates therefore act on the loss ratio through pricing, and, as Doherty and Garven (1995) points out, insurance pricing models based on financial theory are unanimous in showing that insurance prices are inversely related to interest rates.

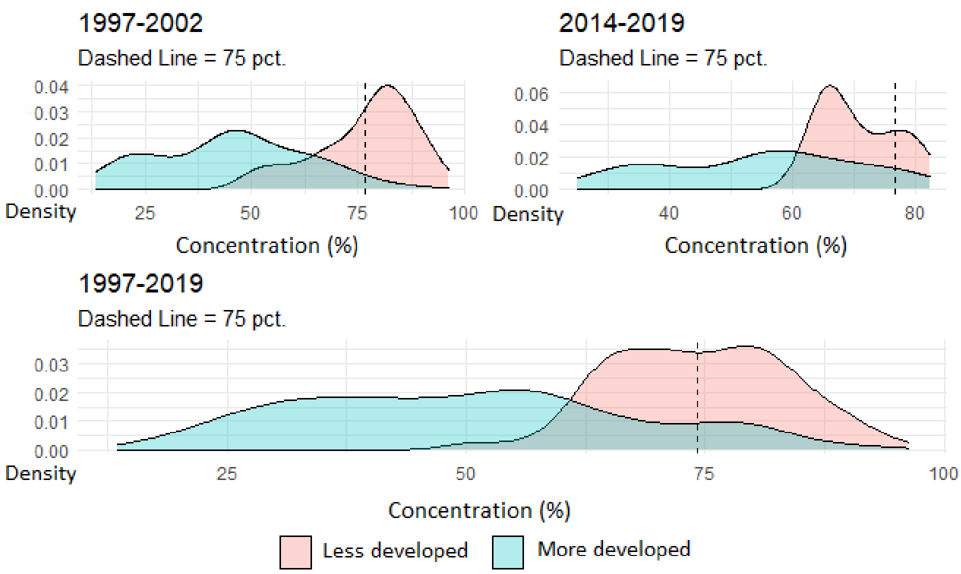
The last control variable is $SolvencyII_{it}$. The solvency framework consists of the Solvency II directive (2009/138/EC) and related implementing technical standards and delegated acts. The directive is in fact a risk-based capital regime and has been applied in European ICs since 2016. Article 12 of this directive states that ICs are required to review, at least annually, the cause and source of profit and loss for each major business unit. They must also demonstrate how the

[3] However, a higher leverage ratio may increase a financial institution's exposure to risk and cyclical downturns. From the financial stability point of view, the long-term solvency of a financial sector may be jeopardized if its leverage is too high and/or it experiences a sharp cyclical downturn.

categorization of risk chosen in the internal model explains the causes and sources of profits and losses. We might therefore expect these regulatory measures and controls to reduce the loss ratio so that it is not assessed as too high. This would mean that the relationship between the Solvency II variable and our dependent variable is negative. On the other hand, the directive imposes more precise capital requirements on ICs and also the obligation for ICs to identify eligible own funds to cover those requirements. These solvency capital requirements may put some strain on the reported profitability of ICs, and in that case the relationship between the Solvency II variable and the loss ratio would be positive.

Our primary variable of interest is $Concentr\_Ratio_{it}$, calculated from micro-data on individual European ICs. The concentration ratio is calculated as the sum of the trade shares of the four ICs with the highest absolute value of gross insurance premiums in the given country and year. Although we make no assumptions about the linearity of the relationship, we nevertheless assume that, in line with the structure–conduct–performance hypothesis (Yoshiro et al., 2006), the effect on profitability may be positive, so the loss ratio should decline with a rising level of concentration. The evolution of the concentration ratio in the years and countries studied is described by fan chart A1 in the Appendix. Figure 1 shows the distribution of the concentration ratio across our sample. The lower part of the figure shows the distribution in the whole period 1997–2019. The upper figures then show the first and last five years in the observed period. These distribution graphs show that less developed countries in Europe (with lower GDP and a lower penetration ratio) have a systematically higher rate of concentration of ICs. At the same time, however, they also show that this level of concentration decreases over time and begins to resemble that in more developed countries.

Figure 1: Market Concentration in Non-life Insurance Sector 1997–2019

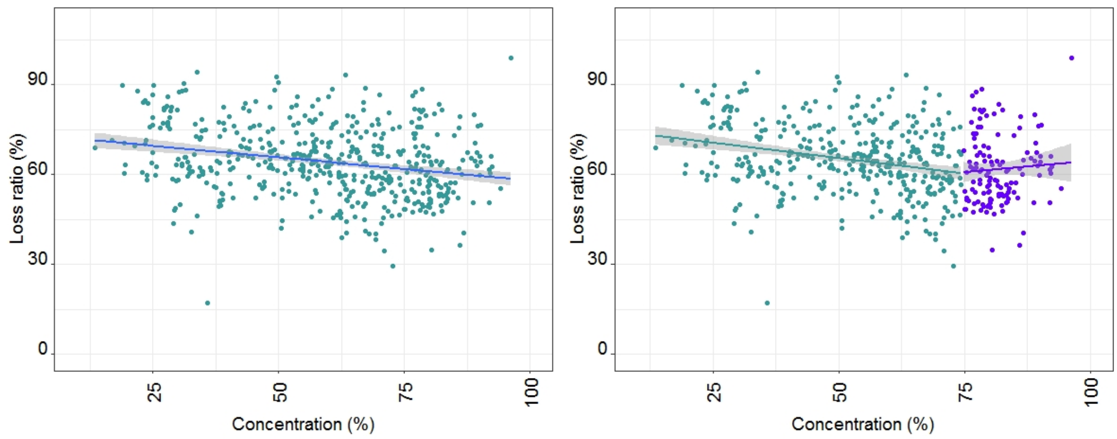


Source: Based and calculated on micro-data on individual insurance companies (AXCO database)

Figure 2 shows the relationship between the loss ratio and the concentration ratio of ICs. This simple correlation indicates a linear and negative relationship between these variables. This suggests that the structure–conduct–performance hypothesis could actually explain their relationship. However, the relationship between concentration and the loss ratio may not be linear throughout its course.

Figure 2 suggests a break for points with higher concentration levels. This is only a preliminary statement, as it is a mere correlation with no verification of causality[4] and no other control variables.

Figure 2: Relationship between Market Concentration and Loss Ratio



Note: The linear approximation method (LM function) is used to calculate the smoothed conditional means and fit the data. In the right panel, points up to and including the 75^{th} percentile are shown in green and points above the 75^{th} percentile are shown in purple.
Source: Axco and OECD databases (own calculations)

4. Baseline Estimates

Table 2 describes the results of the first set of regressions. Regression (1) shows the baseline model containing the control variables only. A higher penetration rate reduces the loss ratio, meaning that more developed insurance sectors are likely to manage their business better than less developed ones. We also see that higher real GDP growth, higher bank leverage, and the introduction of the Solvency II directive also reduce the loss ratio $LossR_{it}$.[5] Regression (2) shows the baseline model with the independent variable $Concentr\_Ratio_{it}$. The results indicate that a higher market concentration of the insurance sector reduces the loss ratio, meaning that sectors with lower competition achieve higher underwriting profitability. This finding is in line with the structure–conduct–performance hypothesis (Yoshiro et al., 2006).

Given that the previous empirical papers provide relatively inconsistent evidence, we consider a non-linear effect of the concentration ratio on the loss ratio in the third regression (3). Indeed, quadratic regression appears to explain this relationship better (a higher adjusted R-squared and a more significant coefficient on $Concentr\_Ratio_{it}$). The linear term of the quadratic function is

[4] Nevertheless, we can corroborate the causality between concentration and the loss ratio using a simple Granger non-causality test (Dumitrescu and Hurlin, 2012). The results show that the loss ratio is unequivocally affected by concentration (Z-stat. = 6.93), while the opposite causality is not significant (Z-stat. = 0.88). In general, we do not assume endogeneity in our paper, as this would imply that the loss ratio contemporaneously affects the concentration rate. If this inverse relationship between the concentration rate and the loss ratio were to exist, it would be more likely to be a long-run one.

[5] We also tested the variable representing real GDP growth in interaction with a dummy variable that takes the value of 1 for positive GDP growth and 0 for negative GDP growth. This allows us to control for whether changes in GDP have a different effect on the loss ratio in the upward and downward phases of the cycle. However, the results show that there is no statistically significant difference between the two positive and negative phases of the cycle. We do not report the results here, but they are available upon request.

negative and the quadratic is positive. That is, higher concentration reduces the loss ratio, but with a rising level of concentration this effect slowly turns around and from a certain point it is the opposite. As a result, we identify a simple convex relationship (a convex parabola). When plotting the graph using a simulated function based on fitted values from regression (3), it is revealed that the turning point at which the relationship starts to be positive is around (concentration) 74–75% (Figure 3).

Regression (4) shows that a higher concentration ratio increases the loss ratio significantly in less developed countries, but this effect is the opposite in more developed countries. However, given the distribution of concentration between more and less developed countries (Figure 1) this result may serve rather as additional support for the conclusion of a non-linear relationship form of the previous model. As another robustness check, in the next regression (5), we examine whether the effect of concentration differs according to its percentile. Based on the intuition derived from the simulated data of our quadratic function (Figure 3), we set the turning point at the 75^{th} percentile.[6]

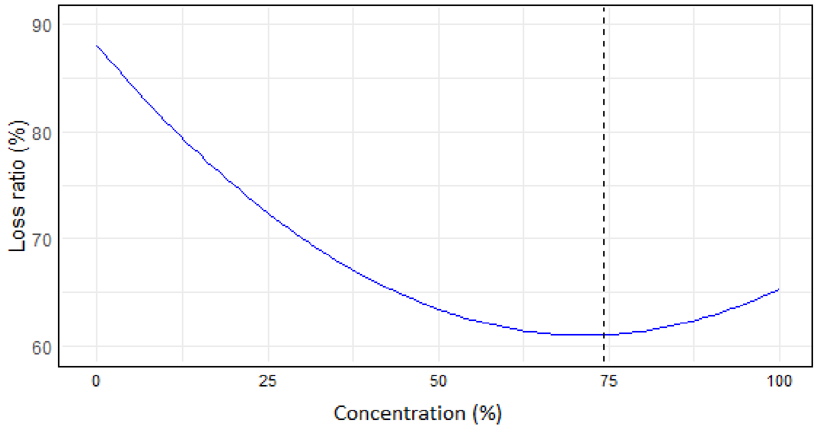
[6] We note that the 75^{th} percentile is simultaneously a concentration value of around 75% only by chance. We also tested a dummy for the 25^{th} percentile, but this proved insignificant in the regressions.

Table 2: Non-linear Relationship, Baseline Estimates

	Dependent variable: $LossR_{it}$				
	(1)	(2)	(3)	(4)	(5)
Penetr_Rate	−3.831**	−5.326**	−6.173***	−5.808***	−5.344**
	(1.800)	(2.227)	(2.149)	(2.044)	(2.140)
GDP_r	−0.299**	−0.326**	−0.375**	−0.342**	−0.386***
	(0.150)	(0.140)	(0.154)	(0.148)	(0.147)
Fin_Lvrg	−0.025***	−0.024***	−0.022***	−0.023***	−0.022***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
IR_3M	0.315	0.373	0.276	0.203	0.301
	(0.281)	(0.295)	(0.289)	(0.282)	(0.265)
SolvencyII	−3.188***	−2.694***	−2.231**	−2.328**	−2.182**
	(1.092)	(1.035)	(1.119)	(1.128)	(1.092)
Concentr_Ratio		−0.149**	−0.757**	−0.258***	−0.211***
		(0.069)	(0.322)	(0.087)	(0.076)
Concentr_Ratio^2			0.005*		
			(0.002)		
Concentr_Ratio*Less_Dvlp				0.441**	
				(0.178)	
75Concentr					−44.506**
					(19.335)
Concentr_Ratio*75Concentr					0.562**
					(0.246)
Cross-section dummies	Y	Y	Y	Y	Y
Time dummies	N	N	N	N	N
Observations	497	472	472	472	472
R^2	0.089	0.119	0.135	0.154	0.139
Adjusted R^2	0.035	0.061	0.076	0.097	0.079
F Statistic	8.006***	9.977***	9.848***	11.481***	8.900***
	(df = 5; 461)	(df = 6; 442)	(df = 7; 441)	(df = 7; 441)	(df = 8; 440)

Note: The numbers in parentheses are robust standard errors clustered at the country level. Symbols * denote statistical significance, where *p-value<0.1; **p-value<0.05; ***p-value<0.01. All models regress the loss ratio on the set of variables described in Section 3.2 used in the estimator (without time dummies). Model (1) contains the control variables only. Model (2) estimates the linear effect of concentration. Models (3)–(5) measure the non-linearity in the loss ratio – the concentration relationship when applying the quadratic function (3), the interaction term with less developed countries (4), and the interaction term with the dummy for the 75^{th} percentile (5).

Figure 3: Loss Ratio and Concentration Relationship, Simulated Data



Note: Dashed line – 75^{th} pct. We simulated the data by taking the results of regression (3) and substituting the average values for the independent variables into the regression. We added these to the constant, which is the average of the fixed effects. Then we calculated the relationship: $LossR_{it} = const - 0.757 * Concentr\_Ratio_{it} + 0.005 * Concentr\_Ratio_{it}^2$.
Source: AXCO and OECD databases

5. Robustness Checks

The first set of robustness tests is described in Table 3. There, we mainly introduce dynamics into the models and check for time-related fixed effects. The most important result of these regressions is that our conclusions about the non-linear effect of concentration ($Concentr\_Ratio_{it}$) on the loss ratio persist even after a series of these tests. The robustness of the model is also shown by the expected behavior of the control variables, which remain significant and with the expected effect, being only slightly "weakened" by the inclusion of additional regressors. At the same time, as the effect of having a lagged dependent variable is strongly significant in all models and the adjusted R-squared rises substantially, it seems that the loss ratio is indeed time-persistent and may be estimated by dynamic models.

The addition of dynamics and time-related fixed effects also reveals more about the effect of interest rates, IR_3M_{it}, on the loss ratio. This variable was found to be statistically insignificant in the basic regressions. In the first two regressions of Table 3, we show that IR_3M_{it} has a positive impact on the loss ratio. This is contrary to our assumptions, as we assumed that a higher interest rate reduces the loss ratio in the insurance sector. We therefore also look at different quartiles of 3M interest rates. European countries experienced an unusually long period of very low interest rates, at least in part of the period under review. This could have biased the regression results. Indeed, if we add an interaction term with a dummy variable that indicates a period of low rates (lower quartile), the results fit our assumptions much better (regressions (8) and (9)).[7]

The variable IR_3M_{it} adjusted for the effect of low rates indicates a negative relationship with the dependent variable $LossR_{it}$. As expected, higher interest rates reduce the loss ratio of insurance companies. However, the opposite sign in the case of the effect of low rates is quite surprising. It seems as if a further decline in rates during a period of low rates no longer causes a decline in

[7] The dummy for the lower quartile indicates all rates that are lower than 0.53%. This corresponds quite well to other empirical studies, which indicate rates below 0.5% as very low rates.

underwriting profitability, but on the contrary causes it to grow. We therefore return to this result more closely in the following sub-section.

Table 3: Robustness Checks I – Dynamics and Time Dummies, Low Interest Rate Environment

	Dependent variable: $LossR_{it}$			
	(6)	(7)	(8)	(9)
$LossR_{t-1}$	0.479^{***}	0.468^{***}	0.444^{***}	0.451^{***}
	(0.065)	(0.071)	(0.070)	(0.058)
Penetr_Rate	-3.490^{**}	-2.711^{**}	-3.915^{***}	-3.492^{***}
	(1.676)	(1.367)	(1.435)	(1.156)
GDP_r	-0.341^{***}	-0.253^{*}	-0.420^{**}	-0.402^{**}
	(0.112)	(0.142)	(0.176)	(0.172)
Fin_Lvrg	-0.009^{***}	-0.009^{***}	-0.008^{**}	-0.010^{***}
	(0.003)	(0.003)	(0.004)	(0.003)
IR_3M	0.244^{*}	0.255^{*}	-0.356^{***}	-0.422^{***}
	(0.134)	(0.137)	(0.119)	(0.131)
25IR_3M			0.915	0.126
			(1.124)	(1.139)
IR_3M*25IR_3M			2.628^{**}	3.645^{***}
			(1.298)	(1.357)
SolvencyII	−0.932			
	(0.713)			
Concentr_Ratio	-0.134^{***}	-0.151^{***}	−0.052	
	(0.043)	(0.046)	(0.033)	
75Concentr	-30.908^{***}	-39.710^{***}	-27.711^{***}	
	(8.215)	(7.948)	(9.635)	
Concentr_Ratio*75Concentr	0.390^{***}	0.503^{***}	0.344^{***}	
	(0.104)	(0.102)	(0.123)	
Cross-section dummies	Y	Y	Y	Y
Time dummies	N	Y	Y	Y
Observations	467	467	467	492
R^2	0.367	0.309	0.311	0.313
Adjusted R^2	0.320	0.220	0.218	0.228
F Statistic	27.909^{***}	12.571^{***}	18.524^{***}	28.383^{***}
	(df = 9; 434)	(df = 8; 420)	(df = 10; 411)	(df = 7; 437)

Note: The numbers in parentheses are robust standard errors clustered at the country level. Symbols * denote statistical significance, where *p-value<0.1; **p-value<0.05; ***p-value<0.01. All models regress the loss ratio on its lagged values and the set of variables described in Section 3.2 (with or without time dummies). Models (6) and (7) introduce dynamics into the baseline regressions. Models (8)–(9) investigate the non-linearity in the effect of the interest rate based on the interaction term with the dummy variable for a low interest rate environment.

Table 4 shows further robustness checks concerning $Concentr\_Ratio_{it}$. First of all, column 10 shows a regression that is run on a sample of more developed countries only and shows that the non-linear effect of concentration is not due to differences between more developed and less developed countries. In principle, we control for this through the penetration rate in the other regressions, but this approach is more straightforward and shows the robustness of our results. Columns 11 and 12 show regressions where the independent variable ($Concentr\_Ratio_{it}$) was calculated from micro-data as the trade share of, respectively, the two and three biggest insurance companies. The results are in line with our previous assertions. Column 13 then shows a regression where we replaced the simple concentration ratio with the skewness of the trade share of all insurance companies in the given country and year. Skewness measures the asymmetry of the probability distribution of the trade share about its mean. If the industry is more concentrated, the skew will be positive with a longer right tail. We see that even if we employ this indicator we can confirm that a high level of concentration (above the 75^{th} percentile) has a positive effect on the loss ratio, and that effect increases with increasing skewness of the trade share distribution to the right. The last column of Table 4 supports our hypothesis about the impact of low interest rates and shows the effect of the interest rate spread (the 10Y rate minus the 3M rate). If the spread is negative (interaction term $Spread\_IR_{it}*Negative\_Spread_{it}$), a further decrease in the spread leads to a decrease in the loss ratio (an increase in underwriting profitability).

Finally, we also tried to winsorize the dependent variable to allay concerns that the relationship between the concentration ratio and the loss ratio might be distorted by outliers that may occasionally be present in the gross loss ratio. Table B1 in appendix shows the results of the regressions. The dependent variable is winsorized at the 5^{th} and 95^{th} percentiles and then at the 1^{st} and 99^{th} percentiles. The results are still consistent with the previous statements about the non-linearity of the relationship between concentration and the loss ratio.

Table 4: Robustness Checks II – More Developed Countries, Concentration Measures, IR Spread

	Dependent variable: $LossR_{it}$				
	(10)	(11)	(12)	(13)	(14)
$LossR_{t-1}$	0.451^{***}	0.484^{***}	0.473^{***}	0.482^{***}	0.412^{***}
	(0.074)	(0.076)	(0.071)	(0.071)	(0.063)
Penetr_Rate	-3.006^{**}	-2.869^{*}	-2.835^{*}	-3.147^{**}	-3.909^{***}
	(1.229)	(1.647)	(1.573)	(1.435)	(1.235)
GDP_r	-0.040	-0.333^{**}	-0.329^{**}	-0.294^{*}	-0.408^{*}
	(0.111)	(0.151)	(0.151)	(0.158)	(0.228)
Fin_Lvrg	0.035	-0.009^{**}	-0.010^{***}	-0.008	-0.009^{*}
	(0.045)	(0.003)	(0.003)	(0.005)	(0.005)
Concentr_Ratio	-0.162^{**}				-0.062*
	(0.078)				(0.038)
Concentr_RatioII		-0.001^{*}			
		(0.0004)			
Concentr_RatioIII			-0.112^{**}		
			(0.055)		
75Concentr	-36.298^{**}	-13.765^{***}	-22.942^{***}		-16.086^{**}
	(15.093)	(4.096)	(8.019)		(7.292)
Concentr_Ratio*75Concentr	0.455^{**}				0.232^{**}
	(0.186)				(0.110)
Concentr_RatioII*75Concentr		0.002^{***}			
		(0.001)			
Concentr_RatioIII*75Concentr			0.333^{***}		
			(0.127)		
Concentr_skewness				-0.429	
				(0.637)	
75Skewness				-12.424^{**}	
				(5.959)	
Concentr_skewness*75Skewness				2.434^{*}	
				(1.284)	
Spread_IR					-0.207
					(0.266)
Negative_Spread					1.726^{*}
					(1.044)
Spread_IR*Negative_Spread					2.288^{**}
					(1.003)
Cross-section dummies	Y	Y	Y	Y	Y
Time dummies	Y	Y	Y	Y	Y
Observations	302	484	483	484	424
R^2	0.354	0.331	0.332	0.340	0.279
Adjusted R^2	0.300	0.251	0.251	0.260	0.173
F Statistic	17.567^{***}	30.507^{***}	30.547^{***}	31.685^{***}	14.266^{***}
	(df = 7; 252)	(df = 7; 431)	(df = 7; 430)	(df = 7; 431)	(df = 10; 369)

Note: The numbers in parentheses are robust standard errors clustered at the country level. Symbols denote statistical significance, where *p-value<0.1; **p-value<0.05; ***p-value<0.01. All models regress the loss ratio on its lagged values and the set of variables described in Section 3.2 used in the estimator (with time dummies). Model (10) represents the baseline specification estimated only on a sample of more developed countries. The other models are run on the whole sample, where (11) and (12) use the concentration ratio calculated as the trade share of the two and three biggest companies, respectively. In model (13), the concentration ratio is replaced by the skewness of the trade share of all insurance companies. Model (14) employs the interest rate spread instead of the simple interest rate.

5.1 The Role of the Low Interest Rate Environment

EIOPA's Financial Stability Reports – see, for example, EIOPA (2014b) – mention that the risk stemming from the prolonged period of low interest rates is the single most important risk insurers are facing. Galdeano and Aumente (2016) add that the protracted episode of low interest rates is undermining insurers' profits, particularly for entities that have underwritten life insurance with guaranteed long-term commitments. The severity of this erosion depends on whether the assets and liabilities are well matched in terms of duration. This situation is causing a shift in investment policy and in insurance companies' asset mixes toward equities and other higher-risk assets and lower-rated and longer-term fixed-income securities. Volatility in the equity markets, coupled with the prolonged episode of low interest rates, is increasing the uncertainty in the insurance market.

What is particularly important is that life insurers are also being forced to reconfigure and recalibrate their product ranges. They are reducing guaranteed interest rates and boosting other products such as unit-linked, risk life, and non-life policies (Galdeano and Aumente, 2016).[8] Similarly, EIOPA's stress test (EIOPA, 2014a) provides evidence that European insurers have responded to the period of low rates by diversifying into the non-life sector and asset management businesses, lowering guaranteed rates, and increasing the use of interest rate derivatives.

ECB (2016) states that non-life insurers are somewhat less affected by the low-yield environment, but they also face significant challenges. This is because non-life insurers have both liabilities and assets of lower duration and they are consequently less exposed to a prolonged period of low rates. On the other hand, low yields put downward pressure on investment margins, and most non-life insurance companies cope with this environment by focusing on underwriting discipline and cost optimization. As Galdeano and Aumente (2016) add, those non-life insurance companies that had been financing themselves from their investment income (as their underwriting results were negligible or even negative, typically in the motor sector) are also facing difficulties in light of low returns.

Fan et al. (2020) explains how the profitability of the non-life insurance sector (mainly in property and casualty insurance) is driven by both underwriting and investment performance. Investment income on invested cash flows can remain on the balance sheet for a couple of years and is an integral part of the non-life insurance business model. Their empirical analysis across the major markets from 1977 through 2017 shows a strong long-term relationship between the combined ratio in non-life insurance and nominal interest rates. They observe that during periods of lower rates, weaker investment returns need to be offset by stronger underwriting results. In normal circumstances, non-life insurers could improve their underwriting results through higher premiums (and a lower loss ratio), but they are often prevented from doing so by a competitive environment. As Fan et al. (2020) adds, in the recent competitive environment, insurers' pricing power has been limited, and they were not able to sufficiently offset low interest rates pre COVID-19.

Our analysis may directly challenge this statement by examining whether the downward effect of low rates on the loss ratio has been higher in countries and periods with higher industry concentration. Such a finding could mean that under unfavorable investment returns, insurers operating in a less competitive environment can better offset low yields by charging higher insurance premiums through higher insurance prices.

[8] As Galdeano and Aumente (2016) add, some entities have stopped selling annuities altogether on account of the substantial amount of capital that has to be put aside for these products under Solvency II.

Indeed, Table 5 shows that in countries and periods with higher industry concentration, the effect of low interest rates is much higher (see our interaction term IR_3M*25IR_3M). An environment of very low interest rates causes insurance companies to replace investment returns with improved underwriting results (among other effects; see Malovaná et al., 2020). We therefore observe a rapidly declining loss ratio (increasing underwriting profitability) in our sample of countries and periods where the level of competition is generally lower.

Table 5: Role of Low Interest Rate Environment – Low and High Concentration Countries

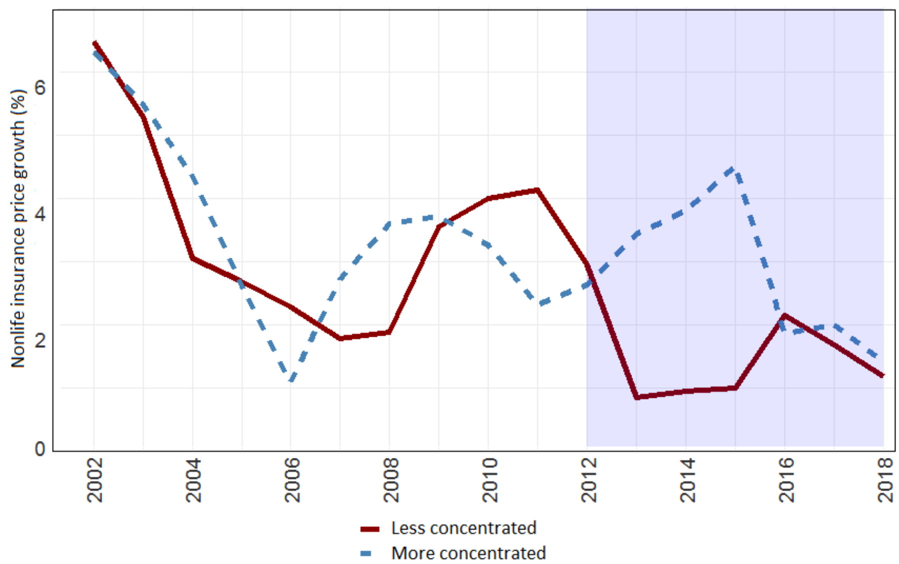
	Dependent variable: $LossR_{it}$		
	High concentration	Low concentration	Full sample
	(1)	(2)	(3)
$LossR_{t-1}$	0.290^{***}	0.444^{***}	0.453^{***}
	(0.065)	(0.065)	(0.065)
Penetr_Rate	-11.341^{***}	-4.070^{***}	-4.024^{***}
	(1.481)	(1.481)	(1.437)
GDP_r	-0.623^{***}	-0.231	-0.420^{**}
	(0.230)	(0.230)	(0.179)
Fin_Lvrg	-0.011^{***}	0.061^{***}	-0.011^{***}
	(0.002)	(0.002)	(0.004)
IR_3M	-0.696^{*}	-0.706^{*}	-0.563^{***}
	(0.398)	(0.398)	(0.155)
25IR_3M	-7.691^{***}	1.866^{*}	
	(1.124)	(1.124)	
IR_3M*25IR_3M	12.435^{***}	4.338^{*}	
	(2.485)	(2.485)	
75Concentr			-2.100^{***}
			(0.609)
IR_3M*75Concentr			0.309^{*}
			(0.181)
Cross-section dummies	Y	Y	Y
Time dummies	Y	Y	Y
Observations	112	322	464
R^2	0.378	0.295	0.310
Adjusted R^2	0.067	0.168	0.222
F Statistic	6.427^{***} (df = 7; 74)	16.257^{***} (df = 7; 272)	26.342^{***} (df = 7; 411)

Note: The numbers in parentheses are robust standard errors clustered at the country level. Symbols * denote statistical significance, where *p-value<0.1; **p-value<0.05; ***p-value<0.01. All models regress the loss ratio on its lagged values and the set of variables described in Section 3.2 used in the estimator (with time dummies). Models (1) and (2) investigate the interest rate effect in a low interest rate environment in sub-samples with high and low concentration, respectively. In model (3), this effect is estimated in the full sample using an interaction term with a dummy variable for the 75^{th} percentile of concentration.

Conversely, in countries with a high level of competition (lower industry concentration), this effect is weaker. Although 25IR_3M alone is relatively difficult to interpret, it suggests that if rates were exactly 0, this would lead to a significant increase in underwriting profitability for periods and countries with high concentration (whereas this is not observed for countries with low concentration). To confirm our estimates, we add a third column where the interest rate and the 75^{th} percentile of industry concentration interact. Once again, it turns out that with falling rates, underwriting profitability increases (the loss ratio decreases) if the insurance environment is less competitive (industry concentration is higher).

We cannot say with certainty that the decline in loss ratios in countries with high concentration is due to an increase in non-life insurance prices. In the Axco database, we only have data on premiums written as a volume of insurance. However, if we look at non-life insurance price growth from other sources (we use OECD data), we see that since most of the countries analyzed have experienced a period of low interest rates, this means relatively high insurance price growth for countries with high concentration ratios. In contrast, this price growth is not as strong for countries with lower levels of concentration (see Figure 4).

Figure 4: Insurance Price Growth in Less and More Concentrated Insurance Markets

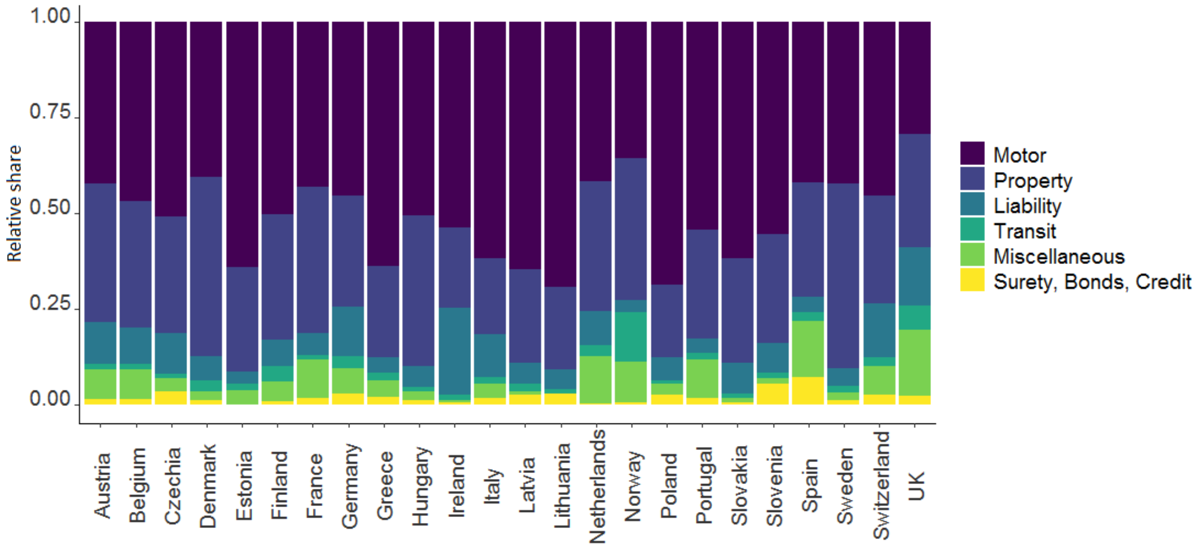


Note: Shaded area: the LIRE period. Similar to above, it is calculated as the period when the 3M interest rate in the countries analyzed fell below 0.5% (on average). We have complete data for developed countries only, and we exclude countries referred to as less developed here both because of a lack of data and because they could compromise the analysis (they have systematically higher levels of concentration – see above).

6. Analysis of Sub-sectors

In this section, we will focus in more detail on the individual sub-sectors of the non-life sector. The data is based on the AXCO database on non-life insurance companies. As previous research (Hodula et al., 2021) shows, different sub-sectors show different responses to (macro-)economic determinants, which may be reflected in the degree of impact of market concentration on the loss ratio. The relative importance of the sub-sectors considered ("Motor", "Property", "Surety, Bond, Credit", "Liability", "Transit", and "Miscellaneous") in the individual countries is demonstrated in Figure 5. The relative weight (importance) of a given sector in a given country is calculated as the volume of insurance premiums in 2017. In most countries, the "Motor" and "Property" sub-sectors make up about 80% of the total non-life sector. The "Surety, Bond, Credit" and "Transit" sub-sectors, on the contrary, have the smallest shares in the sector as a whole.

Figure 5: Relative Shares of Non-life Insurance Sub-sectors



Source: Axco Database

The detailed results on the sub-sectors are reported in the six columns of Table B2 in the Appendix. Above all, we again see an indication of a non-linear relationship between market concentration and the loss ratio. This means that the negative effect of concentration on the loss ratio gradually disappears and turns positive at a certain level of concentration. As in the previous case, we approximate this limit by the value of the 75^{th} percentile. Moreover, we can also presume that the relationship between market concentration and the loss ratio is convex. That said, this non-linear relationship applies only to "Motor", "Property", "Liability", and, at least partially, "Miscellaneous." Coincidentally, these are also the most important sub-sectors (by insurance premiums) in non-life insurance (see Figure 5). A graphical representation of this relationship is shown in Figure A2 in the Appendix.

We also see that the "Surety, Bond, Credit" and "Miscellaneous" sub-sectors behave pro-cyclically, i.e., that the loss ratio decreases in an increasing phase of the economic cycle and falls with a decline in GDP growth. In addition, the "Surety, Bond, Credit" sub-sector reacts strongly to the penetration rate in individual countries. The positive sign shows that with a growing role of insurance, the loss ratio in the financial products insurance sector increases. This probably pertains to developed countries, where the role of financial product insurance is larger. At the same time, this sector is very volatile and can thus cause insurance companies considerable losses. While the mean for the "Surety, Bond, Credit" sub-sector is 62.82 and those for "Motor" and "Property" are 71.29 and 59.03, respectively, the standard deviation for "Surety, Bond, Credit" is 140.34, while that for "Motor" is 13.32 and that for "Property" is 20.86.[9]

[9] We therefore winsorized the data (5^{th} and 95^{th} percentiles) for the "Surety, Bond, Credit" sub- sector before running the regressions. This reduced the standard deviation to 39.44.

7. Conclusion

This paper examines the relationship between market concentration and the loss ratio of non-life insurance companies in depth. It builds on some previous research papers (Bourke, 1989; Heggestad and Mingo, 1976; Petria et al., 2015; Yuanita, 2019) that have analyzed this relationship in the banking sector. Our analysis not only explains the relationship between market concentration and the loss ratio (which can be seen as a proxy for underwriting profitability), but also explores the non-linearity of this relationship, examines the differences between developed and less developed countries, and also employs different measures of market concentration. Using a data set covering 24 European OECD countries for the period 1997–2019, we highlight several facts that may be of interest to both academic researchers and policymakers. In our research, we use commonly available data from the OECD, the World Bank, and the IMF, as well as micro-data at the level of individual insurers provided by AXCO.

Our paper shows that an increasing degree of concentration over time and across countries leads to a decrease in the loss ratio, which, when simplified, implies an increase in the underwriting profitability of the insurance sector.[10] In general, concentration is higher in our sample of less developed countries (in terms of insurance sector development), but even when we control for insurance sector development in our regressions, this positive relationship still holds. This may imply some collusive behavior among large insurance companies and supports the structure–conduct –performance (SCP) hypothesis, which asserts that a positive relationship between profitability and concentration (a proxy for market power) reflects non-competitive pricing behavior. It may also, however, simply reflect the relationship between size and efficiency (larger ICs gain from economies of scale and other efficiency advantages, so more concentrated markets are inherently more profitable), as suggested by Chronopoulos et al. (2015).

In contrast to the current literature, we also examine the concentration–loss ratio relationship in terms of the level of concentration itself. We reveal that the widely accepted negative effect of concentration on the loss ratio (Choi and Weiss, 2005; Njegomir and Stojić, 2011; Cole et al., 2015) is, in fact, significantly non-linear. From the 75^{th} percentile of market concentration upward, the relationship reverses and higher concentration actually increases the loss ratio. This may occur because non-price competition is more intense in more concentrated markets and so insurance underwriting profitability is lower (Le and Ngo, 2020), or because too much concentration (and low competition) does not force ICs to improve their management practices and does not motivate them to increase their profits and market position. We confirm this non-linear relationship between market concentration and the loss ratio with a number of robustness tests. Additionally, we reveal that this effect is driven mainly by the motor, property, and liability sub-sectors.

From the policy perspective, the above results may point to a tricky position for the regulator. It may not be advantageous for the financial stability of the insurance sector to have only a few strong companies with large market shares or for the sector to become more concentrated over time. Although the literature sometimes states that countries with high concentration of insurance business have been more successful in developing insurance services (Outreville, 1996), this does not always seem to be the case. Our estimated non-linear relationship suggests that while insurers' gains from increasing their market position increase up to a certain point, the marginal gains from

[10] It is also worth taking into account in further research that higher profitability in a given sector does not automatically imply higher financial stability. Shim (2017) and Altuntas and Rauch (2017) show that despite having a positive effect on insurers' profits, higher concentration in the insurance sector is associated with lower stability of the financial sector.

this market position growth are likely to decline. Thus, the strongest incentives for collusive behavior arise when concentration is lowest.

Across our regressions, we also observe that higher GDP growth and the implementation of Solvency II reduce the loss ratio in our sample of countries. This pro-cyclical effect of GDP on the loss ratio, however, is not as straightforward as it might seem at first glance. If higher GDP growth leads to an increase in insurance premium growth (Hodula et al., 2021), it may also lead to a subsequent increase in insurance claim growth, and profitability may thus remain unaffected. Nevertheless, the literature suggests that this effect may be positive (Dorofti and Jakubik, 2015; Haiss and Sümegi, 2008). This is because economic growth has a direct impact on the disposable income of individuals, which translates into greater demand for insurance, even in the face of rising prices or less favorable terms. In other words, economic growth induces an improvement in market sentiment and contributes to non-life companies' performance. Also, as Dorofti and Jakubik (2015) argue, if a country's economy does not grow, a large or increasing number of insurance carriers would intensify the competition, resulting in reduced profits per unit.

Our analysis also shows that there is a relationship between low interest rates and the loss ratios of non-life insurance companies. According to our results, presumably weaker investment returns appear to be offset by stronger underwriting results during periods of low rates. We add that in normal circumstances, non-life insurance companies could improve their underwriting results through higher premiums (and lower loss ratios), but this is probably not always possible due to the high degree of competition. This conclusion is further supported by several robustness tests.

Our research reveals several new facts about the non-life insurance industry, particularly in relation to its loss ratio. Nevertheless, it is far from answering all the current and important questions concerning the insurance industry. In particular, due to a lack of data, it does not focus on the loss ratios of individual insurers, which could give more insight into the structural and micro-economic factors determining the profitability of the different business models of individual insurers. It should also be noted that due to data unavailability, we analyze the gross loss ratio, which also includes reinsurance. This gross loss ratio may be characterized by outliers caused by a sharp increase in claims due to natural catastrophes, for example. However, we also present winsorized regressions that partially address this problem. At the same time, our analysis of loss ratios only covers the non-life sector. This is mainly because it makes little sense to analyze indicators similar to loss ratios in the life sector, as life insurers typically have very large time gaps between insurance premium earnings and subsequent insurance claim payments. However, an analysis of the life sector is crucial given the period of very low interest rates (LIRE), which may be affecting the profitability of the life sector particularly strongly. We raise this issue with only a brief discussion of the reverberations that a period of low rates can have for the non-life sector.

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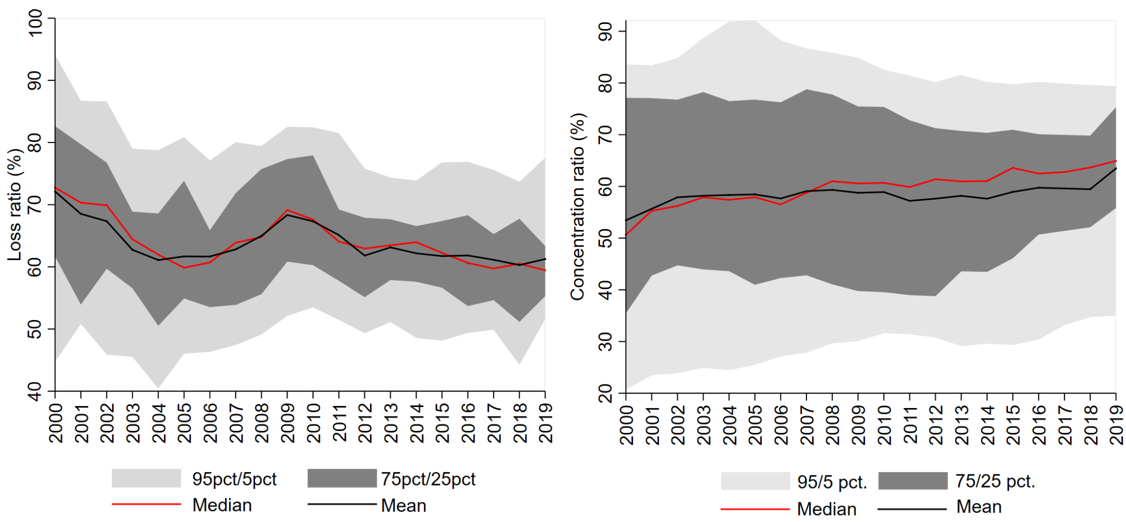
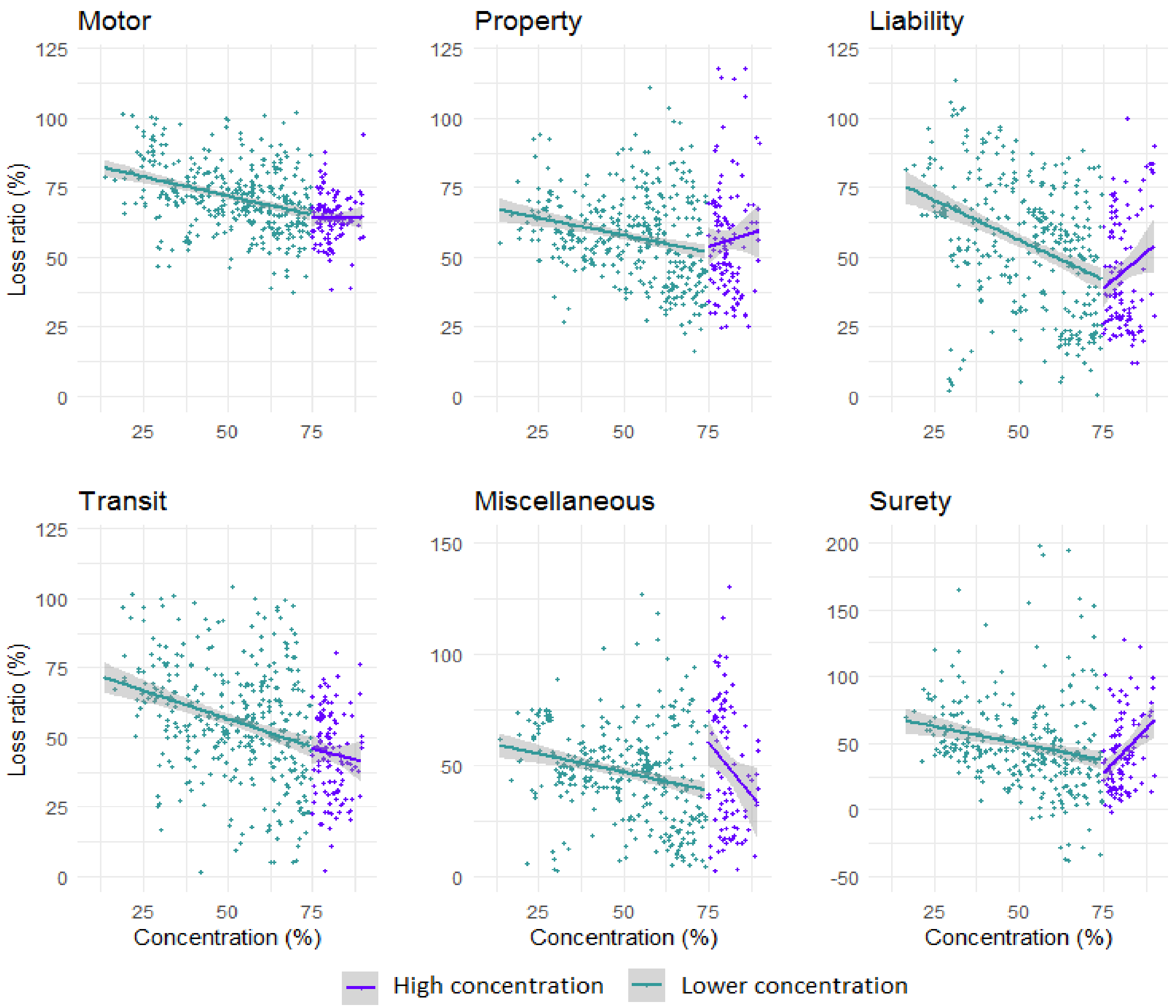
Appendix A: Non-life Loss Ratio and Concentration Ratio

Figure A1: Loss Ratio (left) and Concentration Ratio (right)



Source: Axco and OECD databases

Figure A2: Sub-sector Scatters – Concentration Ratio and Loss Ratio



Note: The linear approximation method (LM function) is used to calculate the smoothed conditional means and fit the data.
Source: Axco and OECD databases (own calculations)

Appendix B: Robustness Check Regressions

Table B1: Baseline Estimation with Winsorized Data

	Dependent variable: $LossR_{it}$		
	not winsorized (Table 3, reg.7)	(5,95) pct. wins.	(1,99) pct. wins.
	(1)	(2)	(3)
$Loss\_Ratio_{t-1}$	0.468^{***}	0.457^{***}	0.448^{***}
	(0.071)	(0.060)	(0.051)
Concentr_Ratio	-0.151^{***}	-0.105^{**}	-0.143^{**}
	(0.046)	(0.062)	(0.072)
75Concentr	-39.710^{***}	-16.767^{**}	-21.550^{***}
	(7.948)	(7.686)	(7.714)
Concentr_Ratio*75Concentr	0.503^{***}	0.212^{**}	0.278^{***}
	(0.102)	(0.103)	(0.103)
Controls	all included	all included	all included
Cross-section dummies	Y	Y	Y
Time dummies	Y	Y	Y
Observations	467	467	467
R^2	0.309	0.428	0.403
Adjusted R^2	0.220	0.356	0.332
F Statistic	12.571^{***} (df = 8; 420)	42.0997^{***} (df = 8; 420)	37.779^{***} (df = 8; 420)

Note: The numbers in parentheses are robust standard errors clustered at the country level. Symbols * denote statistical significance, where *p-value<0.1; **p-value<0.05; ***p-value<0.01. Both models regress the loss ratio on its lagged values and the set of variables described in Section 3.2 used in the estimator (with time dummies). The data are symmetrically winsorized at 5% (Model 2) and 1% (Model 3). For simplicity, we do not report results for controls.

Table B2: Analysis of Non-life Sub-sectors

	Dependent variable: $LossR_{it}$					
	Motor	Property	Surety, Bonds, Credit †	Liability	Transit	Miscellaneous
	(1)	(2)	(3)	(4)	(5)	(6)
$LossR_{t-1}$	0.531***	0.297***	0.262**	0.519***	0.711***	0.015
	(0.063)	(0.062)	(0.105)	(0.073)	(0.002)	(0.021)
Penetr_Rate	−3.185***	−5.204	16.337**	3.748	−8.959	−3.882
	(1.159)	(3.870)	(8.160)	(3.305)	(14.773)	(2.426)
GDP_r	0.006	−0.383	−1.928***	0.205	−3.475	−0.773**
	(0.172)	(0.377)	(0.613)	(0.182)	(2.978)	(0.331)
Fin_Lvrg	−0.013***	0.010	−0.006	−0.005	−0.055	0.036***
	(0.003)	(0.012)	(0.018)	(0.008)	(0.062)	(0.011)
IR_3M	−0.063	0.898**	−0.138	−0.212	1.296	0.487
	(0.142)	(0.369)	(0.528)	(0.259)	(1.126)	(0.783)
SolvencyII	−3.489***	1.712	−2.198	−0.869	1.288	2.134
	(1.173)	(1.627)	(5.392)	(2.087)	(3.246)	(3.620)
Concentr_Ratio	−0.108***	−0.145**	0.185	−0.322**	0.027	−0.376**
	(0.033)	(0.067)	(0.283)	(0.131)	(0.349)	(0.177)
75Concentr	−16.499**	−13.840**	−55.615	−20.558	170.643	8.595
	(7.356)	(61.626)	(94.992)	(34.973)	(217.677)	(76.485)
Conc._Ratio*75Conc.	0.204**	1.777**	0.470	0.293*	−2.288	0.023
	(0.093)	(0.807)	(1.236)	(0.154)	(2.845)	(0.933)
Cross-section dummies	Y	Y	Y	Y	Y	Y
Time dummies	Y	Y	Y	Y	Y	Y
Observations	464	459	399	421	453	417
R^2	0.468	0.274	0.208	0.376	0.534	0.082
Adjusted R^2	0.409	0.195	0.112	0.304	0.483	−0.024
F Statistic	15.950***	7.093***	4.444***	10.811***	22.235***	1.588**
	(df = 23; 417)	(df = 22; 413)	(df = 21; 355)	(df = 21; 376)	(df = 21; 408)	(df = 21; 373)

Note: The numbers in parentheses are robust standard errors clustered at the country level. Symbols * denote statistical significance, where *p-value<0.1; **p-value<0.05; ***p-value<0.01. All models regress the loss ratio on its lagged values and the set of variables described in Section 3.2 used in the estimator (with time dummies). Estimations (1)–(6) are run on sub-samples based on the type of sector. † Data for "Surety, Bonds, Credit" are winsorized at the 5^{th} and 95^{th} percentiles due to the high volatility of the loss ratio in this sector.

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