CIRRELT

CIRRELT-2025-41

Effect of inflation on insurers' main financial indicators with panel data in the US P&C insurance industry

Georges Dionne
Denise Desjardins

December 2025

Bureau de Montréal
Université de Montréal
C.P. 6128, succ. Centre-Ville
Montréal (Québec) H3C 3J7
Tél : 1-514-343-7575
Télécopie : 1-514-343-7121

Bureau de Québec
Université Laval,
2325, rue de la Terrasse
Pavillon Palasis-Prince, local 2415
Québec (Québec) G1V 0A6
Tél : 1-418-656-2073
Télécopie : 1-418-656-2624

Effect of inflation on insurers' main financial indicators with panel data in the US P&C insurance industry

Georges Dionne[1,2*], Denise Desjardins[2]

1. Interuniversity Research Centre on Enterprise Networks, Logistics and Transportation (CIRRELT)
2. Canada Research Chair in Risk Management and Finance Department, HEC Montréal

Abstract. We study the effect of inflation on P&C insurers with individual data. We use observed and forecasted measures of inflation. We compute forecasted rates of inflation from the Bayesian Vector Autoregression (BVAR) model under two different assumptions, the Gaussian distribution and the Student-t distribution. For the econometric estimations, we proceed with the Generalized Method of Moments (GMM). Overall, the findings indicate that insurers are responsive to forecasted inflation as well to realized inflation. Proactive strategies—particularly those based on long-term forecasts—appear to enhance profitability and stabilize operations, while short-term reactions to realized inflation are more defensive.

Keywords: Inflation rate; US P&C insurance industry; forecasted inflation; observed inflation; reinsurance demand; liquidity creation; ROA; GMM estimation model; BVAR model

Acknowledgments: Research financed by the SCOR Foundation for Science and SSHRC Canada. We thank Claire Boisvert, Akouété-Tognikin Fenou, and Mohamed Mnasri for their collaboration to this research.

* Corresponding author: georges.dionne@hec.ca

Dépôt légal – Bibliothèque et Archives nationales du Québec
Bibliothèque et Archives Canada, 2025

1 Introduction

Our goal is to study the effect of inflation on the insurance industry by using individual data on P&C insurers. Our data make it possible to investigate the causality links between *Liquidity creation ratio*, *Reinsurance demand*, *ROA*, and other important decision variables for insurers, along with their relationships with inflation in a dynamic panel where the number of observations is quite large, and the number of periods is moderately large.

Protecting against the risks associated with fluctuating inflation may become necessary for insurers. For example, unanticipated variations in inflation may increase claims volatility and total expenses without an increase in premiums in the short run, thus increasing the combined ratio. This will reduce the profitability of the underwriting business. Under competition, increasing premiums to recover the equilibrium profitability may be problematic for insurers. However, higher interest rates can generate higher investment results to compensate losses in underwriting activity in the long run.

We use observed and forecasted measures of inflation. We compute forecasted rates of inflation from the Bayesian Vector Autoregression (BVAR) model under two different distribution assumptions, the Gaussian distribution and the Student-*t* distribution. The Student-*t* distribution lets us capture the heavy-tailed data and skewness often observed in macroeconomic variables, particularly during periods of high volatility such as the 2007-2009 financial crisis and the COVID-19 pandemic. The Gaussian distribution is used to describe the multivariate normal distribution of the data. By incorporating forecasted inflation, the analysis aligns with the forward-looking nature of financial markets, which are driven by expectations rather than realized values.

For the econometric estimations, we proceed with the Generalized Method of Moments (GMM) with fixed effects. Since the study by Arellano and Bond (1991), the GMM procedure has become a standard method for estimating parameters with dynamic panel data. However, when the number of moment conditions is large, bias estimates can be obtained with the standard GMM estimation method, particularly when the autoregressive parameter of the dependent variable is close to unity (Blundell and Bond, 1998; Doran and Schmidt, 2006; Okui, 2009). We apply the GMM-FOD model to reduce potential bias estimates.

The rest of the paper is organized as follows. We present a literature review on the effect of inflation on the insurance sector in Section 2, along with a description of inflation during our period of analysis. Section 3 describes the main variables used in this research. The descriptive statistics are summarized in Section 4. Section 5 adds more structural analysis with the Generalized Method of Moments (GMM) model. Section 6 estimates the main relationships between the variables of our study with the GMM-FOD model. Section 7 illustrates the effect of inflation on *Reinsurance demand*, *Liquidity creation ratio*, and *ROA* in the P&C sector during the 1993-2023 period including the COVID-19 pandemic. Appendix F documents inflation results on six additional financial variables. Section 8 documents inflation results on six additional financial variables that are analysed in Appendix F. Section 9 summarizes the main results and concludes the study.

2 Economic inflation and literature review

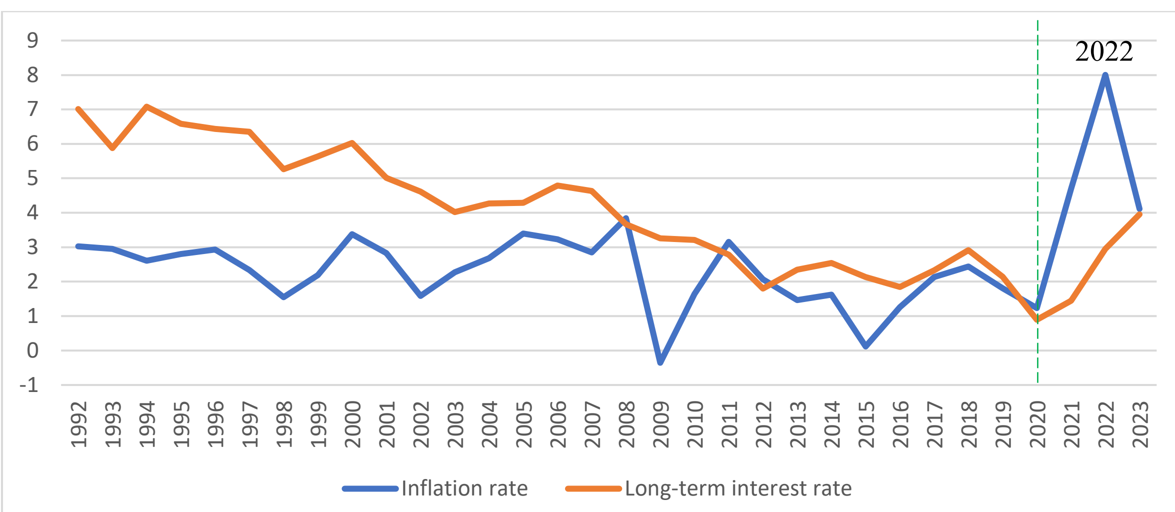
2.1 Measuring inflation

The price index most often used to measure inflation is the Consumer Price Index (CPI) of a large basket of goods and services (Bureau of Labor Statistics, BLS). For many years, the BLS has updated the index, and no significant bias has been documented in recent years. In this research, to analyze the effect of inflation variation, we use the *Inflation rate,* defined as the annual percentage change of the CPI.

2.2 Historical inflation rates in US

Understanding historical inflation is important. Stock and Watson (2007) argue that the changing economic conditions in recent decades have made it more difficult to accurately predict inflation. Figure 1 presents the trends of inflation rate from 1992 to 2023. Three other observations can be made from Figure 1. First, the *Inflation rate* reached historically low points in 2009 and 2015. It floated around 0 and 3.8% throughout the post-2000 period and before COVID-19. The second observation stems from the specific nature of the post-2000 period, marked by higher volatility. Finally, Figure 1 shows that inflation and the nominal rate of LT government bonds (10-year maturity) moved in the same direction over the entire period. We can clearly see that the reduction of inflation observed between 1992 and 2020 has led to a reduction in the interest rates on LT (10-year maturity) government bonds in which insurers invest significantly.

Figure 1: Trends in *Inflation rate*
and in the nominal rate of LT (10-year) government bonds, 1992 to 2023 period



Note: The *Inflation rate* is the percentage change of the Consumer Price Index (CPI).
Source: World Bank.

2.3 Causes of recent inflation

As observed in Figure 1, inflation was below 4% over the 1992-2020 period. The 2007-2009 financial crisis did not accentuate price variations significantly, although it affected financial markets. The COVID-19 crisis had a different pattern on price stability by creating shortages in many markets and inciting many governments to inject money in the economy. Following the recent COVID-19 pandemic, inflation has become an international growing concern, as observed in the recent data.

Bernanke and Blanchard (2025) analyze the causes of the post-COVID-19 inflation. They show that, for the US, the recent inflation period was explained by strong increases in the prices of food and energy. Supply disruptions in key sectors also caused inflation. Concomitantly, tightening labor supply contributed to wage inflation.

The US response to the COVID-19 pandemic included a series of federal intervention plans that caused roughly $5 trillion in US government spending. These programs fueled strong consumer and business demand, which affected labor markets in mid-2021 and early 2022, putting upward pressure on wages and prices.

In summary, rising commodity prices and supply chain disruptions were the principal triggers of the recent inflation. When these factors became less significant, labor market conditions and wage increases enhanced the main drivers of the rate of price increase.

2.4 Effect of inflation on the insurance industry

Masterson (1968) measures the impact of inflation on insurers by isolating components that are related to separate lines of business. He shows that during the 1966-1967 years, inflation did not have an isolated impact on insurers' performance.

During the 1951-1976 period, inflation had a negative correlation with underwriting profit margins and investment returns in the P&C insurance industry (D'Arcy, 1982). No significant correlation between underwriting profits and inflation was observed during the 1977-2006 period (Krivo, 2009). A positive relationship between T-Bill yields and inflation was estimated in both the 1951-1976 and 1977-2006 periods. In fact, D'Arcy (1982) recommends using T-Bills to immunize deteriorations in underwriting profit margins due to inflation.

Another potential impact of inflation is on the investment portfolio. An increase in interest rates reduces the value of fixed income holdings in the short run, which make up a significant proportion of investments for property-casualty insurers. Insurance investment returns were significantly negatively correlated with inflation during the period 1933-1981 (D'Arcy, 1982) and 1977-2006 (Krivo, 2009). In addition, stock returns were significantly negatively correlated with inflation during the period 1933-1981 (D'Arcy, 1982), although not during the 1977-2006 period (Krivo, 2009). This discrepancy may be due to the level of inflation and whether it was expected. If inflation rates were to increase sharply, the short-run impact on property-casualty insurers would be significant. Earnings from both underwriting and investments would be reduced, and policyholder surplus would decrease as a result of both increased liabilities and reduced asset values. In the long run, higher interest rates may become an important hedging financial instrument.

Lowe and Warren (2010) describe the negative impact of inflation on property-casualty insurers' claim costs, loss reserves and asset portfolios. They express concern that most recent actuaries, underwriters and claim staff have never experienced severe inflation, so could be slow to adapt to any change in the economic environment.

Social inflation is particular to insurance. It is defined as excessive growth in insurance settlements or excessive inflation in claims (Lynch and Moore, 2023; The Institutes, 2020; Pain, 2020; Badiel and Dionne, 2025). It has increased auto liability claims by more than 20 billion during the period 2010-2019 (Lynch and Moore, 2023). It is also important in other liability markets including medical malpractice (Wellington, 2023). It is difficult to separate social inflation from pure economic inflation. In this research, we assume that social inflation is included in the *Inflation rate*.

Insurers are also likely to experience adverse development on loss reserves if inflation increases. As explained in D'Arcy et al. (2009), loss reserves are commonly set based on the inherent assumption that the inflation experienced in the recent past will continue until these claims are closed. For some liability insurance lines, it can take a decade for losses to close.

The resurgence of inflation in 2021 was a surprise in insurance markets (Geneva Association, 2023). According to the report, the immediate impact of inflation on non-life insurers' earnings should be negative, primarily through rising future claims costs on current insurance policies and the need to protect loss reserves with more capital.

According to EIOPEA (2023), the key determinants of P&C insurers' welfare sensitivity to inflation and corresponding higher interest rates are the exposure to interest rate-sensitive assets, the relative duration of liabilities and the sensitivity of claims and expenses to inflation. Inflation may also have an impact on regulated capital. A decrease in the value of fixed income assets leads to a decrease in market risks, while an increase in exposure to future premiums might lead to a potential increase in underwriting risk. When assessing the impact of inflation on profitability, the time horizon needs to be considered. In the short run, the impact of inflation on profitability is typically negative, in particular for non-life insurers with a higher share of business in competitive lines of business such as liability insurance.

More recently, Dionne et al. (2025) analyzed the effect of inflation on the US insurance industry during the period 2013-2023 with aggregate data. They show that P&C insurers were significantly affected by inflation fluctuations, especially in periods of high inflation. The negative results on premiums, probably explained by a reduction in clients' purchasing power, caused a negative performance on insurers overall. The positive results on investments did not create a significant hedging effect in this sector. The life sector was less affected by inflation.

3 Data and variables

3.1 Data

We first focus on three important financial indicators: *Reinsurance demand*, *Liquidity creation ratio*, and *ROA* in the US property-casualty insurance industry. Other items of financial statements[1] are also analyzed in detail. We use data from the National Association of Insurance Commissioners' (NAIC) annual financial statements. Our data set is a panel of US P&C insurers. Our period of data ranges from 1992 to 2023, which gives us coverage of the 2007-2008 financial crisis, the 2001 recession, and the COVID-19 crisis. The year 1992 is used for lagged variables.

[1] *Premiums to Total assets*, *Losses incurred to Total assets*, *Net gain from operations to Total assets*, *Net investment income to Total assets*, *Net realized capital gains to Total assets*, and *Capital ratio*.

Several data exclusion criteria are applied. We first remove insurers with nonpositive total admissible assets and premiums. We exclude insurers reporting a value outside the 0 and 1 range for reinsurance demand. The observations are winsorized at the 1% and 99% levels to remove potential outliers. In order to estimate fixed-effect regressions with lagged variables, firms with only one year of observations are also removed. The resulting sample consists of 51,951 firm-year observations, from 3,163 P&C insurers. Insurers entered or left the market during the study period. We thus have an unbalanced panel to permit a comprehensive dynamic evaluation of inflation in the US P&C insurance industry.

3.2 Dependent variables

- Revenue and risk intensity

Reinsurance demand, *Premiums to Total assets*, and *Losses incurred to Total assets* are key metrics that measure an insurer's risk transfer activity, operational volume, and risk burden. We use *Reinsurance demand* (Reins) to quantify the extent to which an insurer relies on reinsurance. This metric is calculated as the sum of affiliated reinsurance ceded and non-affiliated reinsurance ceded, divided by the sum of direct business written and reinsurance assumed. *Reinsurance demand* reflects an insurer's capital management strategy and risk appetite—indicating how much risk is transferred to reinsurers versus retained on the insurer's own balance sheet.

Premiums to Total assets measures how intensively a company uses its asset base to generate underwriting revenue, providing insight into the operational scale relative to Total assets. *Losses incurred to Total assets* serves as a measure of the insurer's risk burden, indicating the proportion of claims costs incurred relative to its total assets. *Net gains from operations on Total assets* summarizes the results from underwriting business.

- Liquidity management

The *Liquidity creation ratio*, denoted as Liquid, measures an insurer's liquidity creation in the economy relative to its total admitted assets. It is calculated as LC/Total assets, where LC (liquidity creation) is defined in Table A1, Step 3. This ratio reflects the insurer's capacity to meet immediate and short-term obligations through the use of liquid assets, providing an important indicator of financial flexibility and short-term solvency. Usually, LC/Total assets is negative in insurance markets because insurers invest more in short-term assets than in long-term assets (Desjardins, et al., 2022).

- Profitability and returns

ROA (return on *Total assets*), *Net investment income on Total assets*, and *Net realized capital gains on Total assets* are key profitability metrics that measure the returns generated by an insurer's operations and investments relative to its total assets. These metrics focus on returns, providing valuable insights into an insurer's performance, operating efficiency, and financial strength, especially when comparing companies of different sizes.

Net investment income on Total assets and *Net realized capital gains on Total assets* both originate from the investment side and capture different sources of return: *Net investment income on Total assets* reflects income from interest, dividends, and rental income; *Net realized capital gains on Total assets* captures net profits from the sale of investments.

ROA serves as a broad indicator of an insurer's overall accounting profitability. It aggregates the effects of underwriting performance, investment results, and capital gains, offering a single accounting measure of return relative to assets. While generally more stable than other profitability measures, *ROA* is influenced by claims experience, pricing cycles, and investment market conditions. Capital on *Total assets* (*Capital ratio*) measures financial strength and capital adequacy. Together, these ratios help stakeholders evaluate how effectively an insurer converts its assets into profits.

Reinsurance demand and *Liquidity creation ratio* primarily address aspects of risk transfer and short-term solvency, rather than directly reflecting profitability. In contrast, *ROA* captures the overall financial outcome of an insurer's operations, investment income, and realized capital gains.

Table 1 summarizes the definitions and construction of each dependent variable and provides their respective symbols for reference.

Table 1: Dependent variables: definition, symbol, and construction

Variable name	Symbol	Variable definition	What it measures
Reinsurance demand	Reins	Affiliated reinsurance ceded + non-affiliated reinsurance ceded/direct business written plus reinsurance assumed	How much risk is transferred to reinsurers — capital and risk management tool
Liquidity creation ratio	Liquid	LC/Total assets	Ability to meet short-term obligations — liquidity health
ROA (return on *Total assets*)	*ROA*	Net income before dividends to policyholder, after capital tax and before all others federal and foreign income taxes/Total assets	Overall profitability relative to total assets — includes underwriting, investment income, capital gains, and other activities
Premiums on Total assets	Pe	Premiums earned on Total assets	Revenue from underwriting relative to total assets — a measure of operational intensity
Losses incurred on Total assets	Li	Claims incurred on Total assets	Measure the cost of claims relative to total assets, representing the insurer's operational risk burden. It includes claims already paid, claims reported but not yet settled, and estimates for claims incurred but not yet reported (IBNR).
Net gains from operations on Total assets	Nibdt	Net gains earned from operations on Total assets	The insurer's profit from core activities — combining underwriting results and net investment income but excluding

Variable name	Symbol	Variable definition	What it measures
			realized capital gains. It reflects net income before policyholder dividends, after capital taxes, and before all other federal and foreign income taxes, measured relative to total assets.
Net realized capital gains on Total assets	Rcg	Net earned capital gains on Total assets	The profit an insurance company records from selling or disposing of investments, such as stocks, bonds, or other assets. These gains or losses are recognized at the time of sale and are measured relative to the insurer's total assets.
Net investment income on Total assets	Ii	Net investment income earned on Total assets	The revenue an insurer earns from its investment portfolio, after deducting related expenses. It primarily consists of recurring earnings such as interest and dividends, measured relative to the insurer's total assets.
Capital ratio	Capital	Policyholders' surplus on Total assets	Measures the financial strength and capital cushion relative to assets. Measures the proportion of a company's total assets financed by shareholder equity and surplus, which is essentially the company's ownership stake in itself. A key indicator of a company's financial health and stability.

Note: This table presents the definitions of the dependent variables analyzed in this study.

3.3 *Inflation rate* measures[2]

The inflation measures used in this research consist of one observed annual *Inflation rate* and four forecasted rates generated at different horizons (t+1 and t+3) using Bayesian Vector Autoregression (BVAR) models. These BVAR models are based on two different assumptions:

- Gaussian distribution without stochastic volatility (F1-GAUSS, F3-GAUSS);
- Student-*t* distribution with stochastic volatility (F1-MST, F3-MST)

[2] See Mnasri et al. (2025) for a more detailed analysis of these inflation measures.

where F1 and F3 are for forecasted inflation at one- or three-year horizons, respectively. GAUSS is for Multivariate Gaussian distribution, and MST is for Multivariate Skew-*t* distribution.

The Student-*t* distribution captures the heavy-tailed data and skewness often observed in macroeconomic variables, particularly during periods of high volatility such as the 2007-2009 financial crisis and the COVID-19 pandemic. The Gaussian distribution is used to describe the multivariate normal distribution of data. By incorporating forecasted inflation, the analysis aligns with the forward-looking nature of financial markets, which are driven by expectations rather than realized values. Table 2 presents the different inflation measures used in this study.

Table 2: Inflation measures

Variable name	Symbol	Variable definition
Inflation rate	Observed inflation	Inflation rate measured by the variation of the Consumer Price Index (CPI) during a period of time, which is the average change in prices for a basket of goods and services over time.
One-year ahead GAUSS	F1-GAUSS	Measured as the average of the predicted *Inflation rate* with the Gaussian distribution for the quarters t+1 to t+4 minus the average of the observed *Inflation rate* during the last previous four quarters (quarters $t-3$ to t).
One-year ahead Student-t	F1-MST	Measured as the average of the predicted *Inflation rate* with the Skew-*t* distribution for the quarters t+1 to t+4 minus the average of the observed *Inflation rate* during the last previous four quarters (quarters $t-3$ to t).
Three-year ahead GAUSS	F3-GAUSS	Measured as the average of the predicted *Inflation rate* with the Gaussian distribution for the quarters t+9 to t+12 minus the average of the predicted *Inflation rate* during the quarters t+5 to t+8.
Three-year ahead Student-t	F3-MST	Measured as the average of the predicted *Inflation rate* with the Skew-*t* distribution for the quarters t+9 to t+12 minus the average of the predicted *Inflation rate* during the quarters t+5 to t+8.

Note: MST refers to the Bayesian VAR with a multivariate skew Student's *t* distribution with stochastic volatility for the innovations. GAUSS refers to the Bayesian VAR with a multivariate Gaussian distribution for the innovations.

F1 measures the expected change in inflation over the next 4 quarters (1 year ahead) compared to the most recent observed inflation over the past 4 quarters. This is forecast data vs. observed data comparison. It reflects how inflation is expected to evolve in the short term relative to current inflation trends, capturing near-term inflation shocks or changes in trend. F3 measures the expected change in inflation between two future periods: from year 3 (quarters t+9 to t+12) compared to year 2 (quarters t+5 to t+8). This is forecast data vs. forecast data comparison (all values are predicted). It reflects the anticipated change in the inflation trend between the medium to longer term. Table 3 summarizes the differences between the forecasted measures of inflation.

Table 3: Summary of the difference in forecasted measures

Feature	F1 (1-Year ahead)	F3 (3-Years ahead)
Compared to	Past observed inflation (last 4 quarters)	Future forecasted inflation (quarters t+5 to t+8)
Horizon	Short-term (next year)	Medium-to-long term (year 3 vs. year 2 ahead)
Measures	Near-term inflation pressure vs. recent past	Change in expected inflation trend over time
Input type	Forecast vs. actual *Inflation rate*	Forecast vs. forecast *Inflation rate*

Note: This table summarizes the differences between the forecasted measures of inflation.

We do not have information about the inflation measures used by each insurer. Our analysis compares different assumptions about potential information insurers may have used before the year t to make predictions on strategic variables in year t. As documented in Mnasri et al. (2025) statistics and forecasts on inflation are available to the markets such as the Survey of Professional Forecasters (SPF) and the Federal Reserve Bank of Cleveland model. These professional forecasters do not solely rely on models; they use their judgement extensively when forming forecasts. The two forecasters' predictions are compared to F1 and F3 in Mnasri et al. (2025).

3.4 Control variables

Control variables include standard variables analyzed in the literature on *Reinsurance demand*, *Liquidity creation ratio*, *ROA*, and other analyzed dependent variables (Cole and McCullough, 2006; Mayers and Smith, 1990; Garven and Lamm-Tennant, 2003; Winter, 1994; Sommer, 1996; Weiss and Chung, 2004; Powell and Sommer, 2007; Choi et al, 2013; Alhassan and Biekpe, 2019; Desjardins et al., 2022). Table 4 summarizes the definition and construction of each control variable and presents their symbols.

Table 4: Control variables: definition, symbol, and construction

Variable name	Symbol	Variable definition
Insurance leverage ratio	Insurance leverage	Direct business written to surplus
Geographical concentration in direct premium written	Geographical concentration	Herfindahl index defined as $\sum_{l=1}^{55}\left(\frac{PW_l}{TPW}\right)^2$ where PW_l is the value of direct premium written in each US state and TPW represent the insurer's total direct premiums written
Regulatory pressure	Regulatory pressure	Dummy variable equal to 1 if firm's net premium to surplus ratio ≥ 300%, 0 otherwise
Liabilities to liquid assets ratio	Liabilities	Dummy variable equal to 1 if firm's adjusted liabilities to liquid assets ratio ≥ 100%, 0 otherwise
Line of business concentration in direct premium written	Line concentration	Herfindahl index defined as $\sum_{l=1}^{22}\left(\frac{PW_l}{TPW}\right)^2$ where PW_l is the value of direct premiums written in each line of business in the insurers' annual statement and TPW represents the insurer's total direct premiums written
Reinsurance price	Reinsurance price	$\frac{Net\ premium\ written - exp - divp}{D \times losses\ incurred}$ where *exp* = Commissions, expenses paid and aggregate write-ins for deduction; *divp* = Dividend paid; *D* is the Discount factor used in Winter (1994) to calculate the economic loss ratio; Losses incurred is losses incurred in current year
Tax exemption investment income	Tax exemption	Bond interest exempt from federal taxes plus 70% of dividends received from common and preferred stock

Variable name	Symbol	Variable definition
Information asymmetry	Information asymmetry	Standard deviation of the firm's ROE over the last 5 years
2-yr loss development	Loss development	Estimated losses and loss expense incurred 2 years before current year and prior year scaled by policyholder's surplus
New York license	New York license	Dummy variable equal to 1 if firm is licensed in New York State, 0 otherwise
Cost of capital	Cost of capital	Average of positive ROE over the last 5 years
Firm size	Firm size	Logarithm of total admitted assets
Firm affiliated with a group	Group affiliation	Dummy variable equal to 1 if the insurer is affiliated with a group, 0 otherwise
Business mix concentration	Mix concentration	Herfindahl index of commercial lines short and long tails or personal and commercial lines

Note: This table presents the definitions of the control variables used in different regression models. Note that model specification can change from one dependent variable to another.

4 Descriptive statistics

Summary statistics for all insurers are shown in Table 5. To capture the variation of the different dependent variables by insurer size, we divide the sample of insurers into two classes:

1. Large insurers, whose total admitted assets are greater than $3 billion;
2. Small insurers, whose total admitted assets are less than $1 billion.

Summary statistics for all variables of large and small insurers are shown in tables A2 and A3 in Appendix A. Among the 51,951 insurer-year observations, large insurers account for 2,294 observations and small insurers for 45,909 observations. The sum of the two groups is not equal to 51,951 because we need lagged observations for the estimations, and insurers may change size categories over time.

Table 5 indicates that the mean value of *Reinsurance demand* is 37.3%, with a 28.6% standard deviation for all insurers. Small insurers seem to use larger amounts of reinsurance to mitigate risk.

On average, the *Reinsurance demand* for large insurers is 30.6%, and is 37.8% for small insurers, as tables A2 and A3 show. Large insurers control 65.3% of the premium earned in the industry and small insurers control 18.3% of the insurance activity. Medium insurers, not presented in this study, represent 16.4% of the industry.

Table 5: Summary statistics for all insurers, 1992-2023

Variable at time *t*	Obs	Mean	Median	Std	Min	Max
Reinsurance demand	51951	0.3732	0.3198	0.2863	0.0000	1.0000
Liquidity creation ratio	51951	-0.5158	-0.5175	0.2136	-3.2730	0.6358
ROA (return on assets)	51951	0.0289	0.0323	0.0773	-2.7319	2.6411
Premiums on Total assets	51951	0.3658	0.3313	0.2524	0.0000	13.8625
Losses incurred on Total assets	51951	0.2059	0.1765	0.1808	0.0000	12.0445
Net gain from operations on Total assets	51951	0.0289	0.0323	0.0773	-2.7319	2.6411
Net investment income to Total assets	51951	0.0311	0.0291	0.0232	-0.1567	2.1969
Net realized capital gains to Total assets	51951	0.0046	0.0009	0.0261	-1.1001	2.4636
Capital ratio	51951	0.4416	0.4015	0.1920	0.0000	1.0000
Insurance leverage ratio	51951	1.8951	1.1457	2.8564	0.0000	33.0000
Geographical concentration	51951	0.5818	0.5823	0.3859	0.0303	1.0000
Regulatory pressure	51951	0.0301	0.0000	0.1710	0.0000	1.0000
Liabilities	51951	0.1129	0.0000	0.3164	0.0000	1.0000
Line concentration	51951	0.5807	0.5181	0.2921	0.0991	1.0000
Reinsurance price	51951	3.7668	3.3591	2.2527	0.0000	12.0000
Tax exemption investment income	51951	0.2490	0.1875	0.2390	0.0000	1.0000
Information asymmetry	51951	0.1146	0.0743	0.1401	0.0020	1.1110
Year loss development	51951	-2.2992	-1.9458	18.8737	-73.7500	80.6200
New York license	51951	0.3202	0.0000	0.4666	0.0000	1.0000
Cost of capital	51951	0.0731	0.0727	0.1313	-0.4648	0.5280
Firm size	51951	18.2447	18.1755	2.0338	11.1758	26.6716
Group affiliation	51951	0.6610	1.0000	0.4734	0.0000	1.0000
Mix concentration	51951	0.6923	0.6409	0.2482	0.2505	1.0000

Note: Variables are defined in tables 1 and 4. Statistics are for the 1992-2023 period while the analyses are for the 1993-2023 period, due to the use of lagged observations.

The average *Liquidity creation ratio* is -51.6% for all insurers, indicating that insurers generate negative liquidity creation normalized by total admitted assets. Choi et al. (2013) and Alhassan and Biekpe (2019) obtained -47% and -45%, respectively. The average *Liquidity creation ratio* (standard deviation) is -51.8% (22%) for small insurers; whereas for large insurers, the ratio is -49.9% (15%), indicating that large insurers generate slightly more long-run liquidity creation in the economy than small insurers do. The respective standard deviations indicate, however, much more variability for small insurers.

The average *ROA* is 0.0289 overall, with large insurers achieving a higher average of 0.0376 compared to 0.0281 for small insurers. This disparity can be attributed to differences in size, scale, and operational efficiencies between large and small insurers. Large insurers benefit from economies of scale, which enable them to spread fixed costs, such as administrative expenses, over a broader base of assets or premiums, thereby improving efficiency and *ROA*. They also have better access to investment opportunities, and specialized expertise, allowing for higher returns on their investments and operations. Additionally, large insurers tend to maintain more diversified portfolios, both geographically and across various lines of business, which reduces risk and enhances stability.

On average, key financial metrics for US property-casualty insurers show the following values: *Premiums to Total assets* is 0.3658, *Losses incurred to Total assets* is 0.2059, *Net gain from operations* to Total ass*ets* is 0.0289, *Net investment income to Total assets* is 0.0311, *Net realized capital gains to Total assets* is 0.0046, and *Capital ratio* is 0.4416.

When broken down by company size, large insurers report lower *Premiums to Total assets* (0.2996) and *Losses incurred to Total assets* (0.1868), but higher *Net gain from operations to Total assets*

(0.0376), *Net investment income to Total assets* (0.0340), and *Net realized capital gains to Total assets* (0.0057) compared to the industry average.

In contrast, small insurers have higher *Premiums to Total assets* (0.3722) and *Losses incurred to Total assets* (0.2075), but lower *Net gain from operations to Total assets* (0.0281), *Net investment income to Total assets* (0.0310), and *Net realized capital gains to Total assets* (0.0045).

Notably, the median value for *Net realized capital gains to Total assets* is considerably lower for small insurers, at 0.0007, while it is much higher for large insurers, at 0.0021. This suggests that although the average capital gains performance appears similar, the distribution is more skewed for small insurers, with typical outcomes falling well below those of larger companies.

The *Capital ratio* variable indicates variations of capital and surplus among the different sizes of insurers. The *Capital ratio* for large insurers is 0.38, and is 0.45 for small insurers. Therefore, small insurers seems to maintain a higher level of capital than large insurers do, which affects liquidity creation because part of the surplus is assigned to illiquid liabilities.

The mean value of the *Insurance leverage* ratio for all insurers is 1.89, and ranges from 0 to 33. This ratio is, on average, 2.0 for small insurers, which is more than double that of large insurers (0.74). On average, small insurers exhibit higher *Concentration ratios* in geographical areas (0.6206 vs. 0.1978), insurance lines (0.5974 vs. 0.4151), and business mix (0.7021 vs. 0.5797) compared to large insurers. These higher concentration levels indicate less diversification, which increases risk and can lead to less stable returns.

Most large insurers are affiliated with a group (96%), compared with 62% of small insurers. Small insurers bear more risk in relation to policyholders' surplus than do large insurers; 3.2% of small insurers have net premiums written to policyholders' surplus greater than 300%, compared with 2.0% for large insurers. For large insurers, 30.2% have a liability to liquid asset ratio greater than 100%, versus only 9.7% for small insurers.

The mean for the two-year *Loss development ratio* is equal to -27.1% and -2.38 for large insurers and small insurers, respectively. The usual range for the two-year loss development ratio includes results below 20%. Only 27.1% of small insurers held a New York State license, compared with 79.8% of large insurers. Appendix D presents the correlation matrix of the nine key financial variables.

5 Analysis based on the generalized method of moments

5.1 Econometric model

We use a structural equations model to assess the reciprocal relationships between different dependent variables. To this end, we specify a dynamic panel data model that incorporates unobserved heterogeneity. For example, the lagged values of *Liquidity creation ratio* and *ROA* are included as key explanatory variables in the equation for *Reinsurance demand*.

This specification, where the parameters associated with lagged variables capture causal links that take time to materialize, is particularly suitable for our study. Insurers' strategic decisions, including inflation management, investments (liquidity creation) and reinsurance management, are typically made by the board of directors on an annual basis and may take several months to be fully implemented. As a result, these decisions are unlikely to have immediate effects within the same year. Therefore, we focus on annual lagged values of key variables to analyze the relationships between variables. Moreover, this model specification aligns well with Granger causality. We must emphasize that inflation coefficients cannot be interpreted as causal relationships in this model because our annual measures of inflation are aggregate variables not specific to each insurer.

We analyze the causality between different insurance variables and their links with inflation by applying a robust GMM procedure to estimate our parameters. For example, we are going to estimate equations (1), where $y_{i,t}$ is for *Reinsurance demand*, $x_{i,t}$ is for the *Liquidity creation ratio*, and $r_{i,t}$ for *ROA*:

$$y_{i,t} = \beta_y + \beta_1 x_{i,t-1} + \beta_2 y_{i,t-1} + \beta_3 r_{i,t-1} + \delta_1 w_{i,t} + \gamma_1 IR_{t-1} + \alpha_i + \varepsilon_{i,t}$$

$$x_{i,t} = \beta_x + \beta_4 x_{i,t-1} + \beta_5 y_{i,t-1} + \beta_6 r_{i,t-1} + \delta_2 s_{i,t} + \gamma_2 IR_{t-1} + \eta_i + \nu_{i,t}. \quad (1)$$

and

$$r_{i,t} = \beta_r + \beta_7 x_{i,t-1} + \beta_8 y_{i,t-1} + \beta_8 r_{i,t-1} + \delta_3 k_{i,t} + \gamma_3 IR_{t-1} + \mu_i + \tau_{i,t}.$$

In equations (1), the dependent variables at time *t* are regressed on the control variables at time *t* and on lagged variables. Each equation of the model is in fact a dynamic panel data relationship with a lagged dependent variable, two lagged endogenous variables, individual fixed effects $(\alpha_i, \eta_i, \mu_i)$, vectors of covariates$(w_{i,t}, s_{i,t}, k_{i,t})$, and lagged *Inflation rate* (IR_{t-1}). The terms $\varepsilon_{i,t}$, $\nu_{i,t}$, and $\tau_{i,t}$ are error terms with zero mean and positive variance for $i = 1 \ldots N$ and $t = 1 \ldots T$, where *N* is the number of firms, and *T* the number of periods.

Each equation in (1) will be estimated separately from the other equations. We must encounter significant endogeneity issues that have been addressed in the estimation process. The first source of endogeneity arises from the presence of individual fixed effects, which create a correlation between the error term and the lagged value of the dependent variable. As a result, the lagged dependent variable must be treated as an endogenous variable in the estimation process.

Consequently, applying the standard OLS method with fixed effects could likely produce biased estimates.

Lagged levels of the explanatory variables serve as instruments. An important advantage of this method is that if a variable at a given period can be used as an instrument, then all its past realizations can also be used in this way. As a result, the number of moment conditions may become quite large, even when the panel's time dimension (T) is finite. This is why we cannot analyze all dependent variables simultaneously. We limit their number to three in each estimation. The presence of a large set of moment conditions can introduce variance bias, commonly referred to as the many instruments problem. Additionally, when the autoregressive parameter is close to unity, the lagged levels of the dependent variable may become weak instruments (Blundell and Bond, 1998).

5.2 Model validity and overidentifying restrictions

When the number of moment conditions exceeds the number of unknown parameters estimated by GMM, it is essential to test the model's validity before making inferences. This is typically done by evaluating the overidentifying restrictions. A widely used test for this purpose is the J-test, proposed by Sargan (1958) and Hansen (1982). To ensure that our model is well specified, we apply the modified version of the J-test in the context of dynamic panel data models (Arellano and Bond, 1991).

As Roodman (2006) explains, the choice between Hansen's J-test and Sargan's test for overidentifying restrictions depends on the error structure. Sargan's test assumes homoscedasticity, whereas Hansen's J-test remains valid under heteroscedasticity. If heteroscedasticity is present, the Sargan test may incorrectly reject the null hypothesis, making it inconsistent for robust GMM estimation. The Sargan test for one-step GMM also imposes stricter assumptions about the error term than necessary.

5.3 Instrument count problem

GMM estimators can generate a large number of moment conditions, with the instrument count increasing quadratically with the panel's time dimension (T). This poses challenges in finite samples. First, because the number of elements in the estimated variance matrix of the moments is quadratic in the instrument count, the matrix itself grows quadratically in T. In small samples, this can lead to poor estimation of the variance matrix, potentially rendering it singular and necessitating the use of a generalized inverse. While this does not affect consistency, it can weaken the Hansen test, sometimes yielding implausibly high *p*-values, such as 1.0.

To select the number of instruments, we ensure that the number of observations exceeds the number of instruments. While adding more instruments may improve efficiency, beyond a certain point it reduces the excess of observations over instruments, leading to increased bias. Thus, the number of instruments in our model is determined based on the *p*-value of the Hansen test, ensuring it remains above 0.1 and below 0.9.

5.4 Forward orthogonal deviation (FOD) transformation

We apply the forward orthogonal deviation (FOD) transformation, introduced by Arellano and Bover (1995). This transformation removes fixed effects problems while minimizing data loss, making it a preferred alternative to first differencing. One key advantage of FOD is that it preserves the structure of the error term, reducing serial correlation issues that often arise with first differencing. By maintaining the integrity of the error structure, FOD helps improve the efficiency of estimations in dynamic panel models.

Additionally, FOD reduces serial correlation in the error term. First differencing often introduces a moving average structure in errors, which can weaken the effectiveness of instrumental variables. In contrast, FOD mitigates this issue by transforming the data in a way that better maintains the integrity of the error term, improving the reliability of estimation results.

5.5 Checking overidentification with the Sargan-Hansen test

The Hansen J-test (also called the Sargan-Hansen test) assesses whether the instruments used in GMM estimation are valid, meaning they are not correlated with the error term. Potential issues with the Hansen test include the risk of using too many instruments, which can lead to weak identification and excessively high *p*-values (e.g., > 0.9), reducing the test's reliability. Conversely, a low *p*-value (e.g., < 0.10) may suggest that some instruments are endogenous, indicating potential overfitting and weak test performance.

6 Econometric results with the GMM-FOD model

In this section, we estimate dynamic models for the three dependent variables: *Reinsurance demand*, *Liquidity creation ratio*, and *ROA*. Other dependent variables are analyzed in Appendix F.

We examine the relationship between *Reinsurance demand*, *Liquidity creation ratio* and *ROA*, controlling for different insurers' financial statement variables, the financial crisis in 2007-2008, the 2001 recession, the 2020 COVID-19 pandemic and inflation measures by applying the two-step Generalized Method of Moment (GMM) procedure to estimate our parameters with forward orthogonal deviation (FOD) transformation. The analyses are performed using Stata xtdpdgmm for two-step GMM-FOD. The two-step estimator is efficient and robust, regardless of the pattern of heteroscedasticity and cross-correlation of the sandwich covariance estimator models (Windmeijer, 2005). Results on control variables are presented in Table A4. Those for large insurers and small insurers are in tables A5 and A6. In Appendix E, we present the OLS estimation results with fixed effects as reference regressions.

6.1 Basic estimation results

Table 7 presents the estimation results of the two-step GMM-FOD model using 1,395 instruments in each equation, with Windmeijer-corrected standard errors. For brevity, control variables are not displayed in the table. The dataset consists of an unbalanced panel, with a maximum of 31 periods per insurer. The number of instruments is computed as 31×30 divided by 2, equal to 465 per variable, resulting in a total of 1,395 instruments for the model.

Table 7: Two-Step GMM-FOD Estimates of *Reinsurance demand*, *Liquidity creation ratio*, and *ROA* for all insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7838	0.0435	-0.0221
	(0.000)	(0.000)	(0.032)
$Liquid_{t-1}$	0.0873	0.6877	0.1101
	(0.000)	(0.000)	(0.000)
ROA_{t-1}	-0.0666	-0.0341	0.2411
	(0.000)	(0.068)	(0.000)
Number of observations	46,816	46,816	46,816
Number of firms	3,163	3,163	3,163
Number of instruments	1,395	1,395	1,395
p-value Hansen test	0.1455	0.0000	0.0000

Note: Two-step GMM-FOD regression model with same numbers of instruments between equations and Windmeijer-corrected standard errors. The corresponding *p*-values are reported in parentheses. Results on control variables are not presented.

The *p*-values of the Hansen test for instrument validity are 0.1455, 0.0000, and 0.0000, respectively. The low *p*-values (0.0000) indicate a rejection of the null hypothesis of instrument validity, suggesting that some instruments may be endogenous. This raises concerns about potential overfitting and weak test performance.

Table 8 presents the estimation results of all insurers of the two-step GMM-FOD model with Windmeijer-corrected standard errors and different numbers of instruments. The *p*-value of the Hansen test is greater than 0.10 in each column, indicating that the null hypothesis of instrument validity cannot be rejected. This suggests that the instruments used in the model are valid, meaning they are uncorrelated with the error term and not overidentified. Therefore, the instruments appear to be appropriate for the estimation process.

Table 8: Two-Step GMM-FOD estimates of *Reinsurance Demand*, *Liquidity creation ratio*, and *ROA* using different instrument sets for all insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7837	0.0365	-0.0197
	(0.000)	(0.001)	(0.052)
$Liquid_{t-1}$	0.0894	0.7185	0.0733
	(0.000)	(0.000)	(0.000)
ROA_{t-1}	-0.0570	-0.2010	0.3566
	(0.000)	(0.000)	(0.000)
Number of observations	46,816	46,816	46,816
Number of firms	3,163	3,163	3,163
Number of instruments	1,860	2,436	2,436
p-value Hansen test	0.3225	0.3620	0.2757

Note: Two-step GMM-FOD regression model with different numbers of instruments between the equation and Windmeijer-corrected standard errors. The corresponding *p*-values are reported in parentheses. Results on control variables are not presented.

The two-step GMM-FOD estimates for the lagged *Reinsurance demand*, lagged *Liquidity creation ratio*, and lagged *ROA* are 0.7837, 0.7185, and 0.3566, respectively. These values are higher than

OLS estimates of Table E1 for both *Reinsurance demand* and *ROA*, suggesting that the instrumentation is not biased due to weak instruments. However, the estimate for the lagged *Liquidity creation ratio* is slightly lower, which may indicate potential bias, but the *p-value* of the Hansen test is greater than 0.10. Table A11 and Table A12 present the estimation results for large and small insurers respectively.

6.2 Bi-causality

Table 8 presents findings for all insurers, indicating a highly significant positive relationship between *Reinsurance demand* and *Liquidity creation ratio*. Specifically, an increase in the *Liquidity creation ratio* is associated with a higher *Reinsurance demand*, and vice versa. This pattern is also observed among small insurers, as shown in Table A12. However, for large insurers, Table A11 shows no statistically significant relationship between *Reinsurance demand* and *Liquidity creation ratio*.

The positive association in Table 8 suggests that as insurers engage in more liquidity creation, they may seek additional reinsurance to mitigate the increased liquidity risk. This strategy allows them to maintain financial stability while continuing to provide the economy with liquidity. Conversely, obtaining more reinsurance can enable insurers to create more liquidity by freeing up capital that would otherwise be reserved for potential claims (see Desjardins et al., 2022, for more details).

Additionally, Table 8 reveals a significant inverse relationship between *Reinsurance demand* and *ROA* across all insurers. Specifically, an increase in *ROA* is associated with a decrease in *Reinsurance demand*. This inverse relationship suggests that more profitable insurers tend to rely less on reinsurance, possibly due to their sufficient capital reserves; they can thus absorb risks internally.

For large insurers, Table A11 indicates that the lag of *ROA* is positively related to *Reinsurance demand*, while the lag of *Reinsurance demand* is negatively correlated with *ROA*. This suggests that as large insurers become more profitable, they may increase their reinsurance purchases to protect their earnings. However, increased reinsurance demand may subsequently lead to a decrease in *ROA*, possibly due to the costs associated with reinsurance premiums.

The results in Table 8 indicate a significant relationship between *Liquidity creation ratio* and *ROA* for all insurers. An increase in liquidity creation is associated with a higher *ROA*, suggesting that greater liquidity creation allows insurers to take advantage of investment opportunities and improve overall returns. However, the relationship appears to be asymmetric: while higher liquidity creation enhances profitability, an increase in *ROA* tends to reduce liquidity creation. This may be because firms with higher profitability rely less on illiquid assets and instead allocate more resources to lower-yield, more liquid investments. Maintaining adequate liquidity is crucial for financial flexibility, and holding excessive amounts in high-yield assets can limit overall liquidity.

Table A4 presents the results of the two-step GMM-FOD model with control variables and three binary variables representing the financial crises: the 2007-2008 financial crisis, the 2001 recession, and the COVID-19 pandemic and other control variables. *Reinsurance demand* is not affected by the three variables, while liquidity creation is positively related to the 2001 recession and the financial crisis period and negatively affected by the 2020 COVID-19 crisis. *ROA* is negatively affected by the 2001 recession, an anticipated result.

7 *Inflation rate* measures results

7.1 Inflation measures

In this section, we examine the relationship between inflation and key indicators of insurance company performance. Inflation is measured with five distinct measures—one observed and four forecasted. The measure observed is based on actual data from the *Inflation rate*, reflecting the real inflation experienced in the economy. The forecasted measures are derived using two different statistical models across two forecast horizons: a Bayesian Vector Autoregression (BVAR) model that incorporates either a multivariate skewed Student-*t* distribution (MST) or a multivariate GAUSS distribution.

To assess the impact of inflation on key financial metrics within insurance companies specifically, we rely on lagged values of both observed and forecasted inflation. For example, if *t* is 1992, the observed *Inflation rate* (IR_{t-1}) in 1991 is used as the lagged observed *Inflation rate*. The one-year-ahead forecasts (F1) corresponds to the expected change in inflation estimated in 1991 for the 1992 period. These are denoted as $F1\text{-}MST_{t-1}$ and $F1\text{-}GAUSS_{t-1}$, depending on the statistical model used. Similarly, the three-year-ahead forecast (F3) refers to the expected change in *Inflation rate* from forecasts made in 1990 for the period between 1992 and 1993, labeled as $F3\text{-}MST_{t-3}$ and $F3\text{-}GAUSS_{t-3}$. Once the lagged forecast of F3 is used in the analysis, it reflects how insurers responded in the past to their medium to long-term inflation expectations.

7.2 Predicted relationships

- Predicted relationship between *Reinsurance demand* and inflation

The predicted relationship between *Reinsurance demand* and inflation is positive. Inflation increases the cost of claims in a competitive world, particularly in long-tail lines such as liability, health, and property insurance, where payouts may occur several years after the policy is written. This creates greater uncertainty around future liabilities and exposes insurers to inflation risk. To manage this uncertainty and preserve capital stability, insurers are likely to cede more risk to reinsurers during the next year, using reinsurance as a strategic tool to reduce exposure. In a longer period, they have more time to adjust their underwriting activities, and may not require as much reinsurance if it is costly.

- Predicted relationship between *Liquidity creation ratio* and inflation

The expected relationship between liquidity creation and inflation is positive in the short run (ratio less negative). Inflation is often accompanied by higher interest rates, which reduce, in the short run, the market value of fixed-income securities that dominate insurance investment portfolios. So insurers should reduce the short-run investments in bonds. Higher interest rates will generate more investments in bonds in the long run, however, and less liquidity creation in the economy is anticipated.

- Predicted relationship between *ROA* and inflation

The expected relationship between *ROA* and inflation should be negative in the short run. Inflation erodes the real value of investment income, especially when insurers hold fixed-income instruments with long maturities and fixed payouts. Additionally, if inflation causes claims to rise faster than insurers can adjust their premiums, underwriting profitability shrinks, reducing underwriting operating returns. In the long run, insurers may have more time to adjust their portfolio by raising premiums and investing in bonds. Table 9 presents the predicted relationships between inflation with *Reinsurance demand*, *Liquidity creation ratio*, and *ROA*.

Table 9: Predicted relationships in the short run and long run
between inflation and *Reinsurance demand*, *Liquidity creation* ratio, and *ROA*

Variable	Predicted relationship	Rationale
Panel A: Predicted relationships in short run (one year)		
Reinsurance demand	Positive	Rising claim uncertainty encourages risk transfer.
Liquidity creation ratio	Positive	Falling bond values reduce investments in bonds in the short run.
ROA	Negative	Inflation reduces real returns when claims outpace pricing adjustments and investments lose value.
Panel B: Predicted relationships in long run (three years)		
Reinsurance demand	Negative	Potential adjustments in premiums may reduce demand for reinsurance if costly.
Liquidity creation ratio	Negative	Higher expected interest rates may have a positive effect on bonds in the long run.
ROA	Neutral	Fixed-income instruments can hedge underwriting potential losses.

Note: This table presents the short-run and long-run predicted relationships between inflation and different dependent variables.

7.3 Results

Table 10 summarizes the two-step GMM-FOD estimation results, examining the impact of various inflation measures across different groups of insurers: all insurers, large insurers, and small insurers. The scores of the different inflation measures are higher with F3 and $IR_{t\text{-}1}$ at 10%. F3 − $MST_{t\text{-}3}$ and F3 $GAUSS_{t\text{-}3}$ are about equivalent with a small advantage for MST.

We assess the impact of inflation while controlling additional explanatory variables. Detailed results are presented in Appendix A. Specifically, Table A7 presents findings based on observed inflation, while Tables A8, A9, and A10 provide results based on forecasted inflation for all insurers, large insurers, and small insurers, respectively. We now discuss the obtained results with emphasis on all insurers.

Table 10: Two-step GMM-FOD summary results of the effect of inflation on *Reinsurance demand*, *Liquidity creation ratio*, and *ROA*, control variables included but not reported

Dependent variable	IR_{t-1}	F1-MST_{t-1}	F1-$GAUSS_{t-1}$	F3-MST_{t-3}	F3-$GAUSS_{t-3}$
All insurers					
Reinsurance demand	+	NS	NS	−	−
Liquidity creation ratio	+	+	+	−	−
ROA	NS	+*	+	NS	+
Large insurers					
Reinsurance demand	NS	NS	+*	NS	NS
Liquidity creation ratio	NS	+	+	NS	−
ROA	−	−	NS	NS	NS
Small insurers					
Reinsurance demand	+	−	NS	−	−
Liquidity creation ratio	+	+	+	−	−
ROA	−*	NS	NS	NS	+
Score at 10%	6	4	4	7	6

Note: *Significant at 10%. All other coefficients are significant at 5% (+,-) or not significant (NS).

- *Reinsurance demand*

As expected, a positive relationship is observed with the lagged value of actual inflation (IR_{t-1}), indicating that higher past inflation tends to be associated with increases in reinsurance demand. This suggests that insurers react in short time to realized inflation after inflation has materialized.

This response is consistent with the industry's need to maintain profitability and solvency in the face of rising costs.

In contrast, a negative relationship is found with the lagged three-years-ahead inflation forecasts (F3-MST_{t-3} and F3-$GAUSS_{t-3}$). These variables reflect expectations, formed three years prior, about how inflation would evolve between the second and third years following the forecast. The observed negative association implies that when insurers previously anticipated long-term inflation increases, they may have adopted more strategic financial or underwriting strategies at that time, limiting the need for reinsurance in the long run. These adjustments—such as strengthening capital positions or reducing exposure to inflation-sensitive lines—could be reflected in improved or more stable current financial outcomes.

Further, no statistically significant relationship is detected with the lagged one-year-ahead inflation forecasts (F1-MST_{t-1} and F1-$GAUSS_{t-1}$), which represent short-term expectations formed just one year prior. This suggests that recent short-term forecasts have had limited impact on current insurer performance. One possible explanation is that short-term expectations are either too volatile to guide meaningful short-term decisions or have already been incorporated into earlier operational responses, rendering their marginal effect at time t negligible.

Taken together, these findings suggest that insurers are more responsive to observed inflation and to long-term expectations formed well in advance, rather than to recent short-term forecasts. This likely reflects the structural lag in many insurance-related decisions, where strategic responses to anticipated long-term inflation are implemented early, while short-term inflation pressures are managed through ongoing operational adjustments.

When examining small insurers, overall patterns remain similar, with one notable exception: a surprising significant negative relationship is found with the lagged one-year-ahead forecast (F1-MST$_{t\text{-}1}$). This indicates that even recent short-term inflation expectations prompted a more cautious response among smaller insurers. Such responses may include reducing risk exposure or adjusting investment allocations because reinsurance may be too costly in periods of inflation. Given their more limited pricing power with narrower margins, small insurers are likely more sensitive to short-term inflation signals and may adopt defensive strategies accordingly.

For large insurers, most inflation variables do not show statistically significant associations with performance. The sole exception is a positive relationship with the lagged one-year-ahead GAUSS forecast (F1-GAUSS$_{t\text{-}1}$), which is significant at the 10% level. This finding suggests that large insurers may have responded to inflation expectations with proactive strategies—such as repricing policies, repositioning portfolios, or enhancing cost controls—that ultimately maintain their performance.

- *Liquidity creation ratio*

The relationship between inflation and insurers' liquidity creation reveals a nuanced, time-sensitive dynamic. A positive association is observed when inflation is measured using lagged values of actual inflation (IR$_{t\text{-}1}$) and the one-year-ahead forecasts formed in the previous year (F1-MST$_{t\text{-}1}$ and F1-GAUSS$_{t\text{-}1}$). In contrast, when inflation is proxied by lagged three-years-ahead forecasts made three years earlier (F3-MST$_{t\text{-}3}$ and F3-GAUSS$_{t\text{-}3}$), the relationship turns negative.

This pattern confirms the short run theoretical expectations, which generally anticipate a positive relationship between inflation and liquidity creation. In theory, higher inflation—often accompanied by rising interest rates—erodes the value of insurers' fixed-income portfolios and exerts upward pressure on liquidity creation (fewer bond investments). However, interest rates for new investments may increase over a longer period and reduce liquidity creation (increase more liquid investments).

When examining smaller insurers, the results align with the broader sample: a positive response to recent inflation and a negative response to past long-term expectations. Due to their limited pricing power and smaller capital capacity, these firms may be more exposed to inflationary pressures and thus more likely to make visible liquidity adjustments in response.

In contrast, for larger insurers, the relationships are less pronounced. No significant association is found with either observed inflation or lagged long-term forecasts (F3-MST_{t-3}), suggesting that large insurers may rely on more sophisticated strategies—such as diversified portfolios, advanced asset-liability matching, or greater market influence—to navigate inflation without substantial shifts in liquidity creation.

Overall, these findings suggest that insurers' liquidity management is horizon dependent. Realized inflation and short-term expectations tend to reduce short-term investments, whereas long-term expectations formed in the past continue to increase liquidity over time.

- *ROA*

A positive relationship is observed between *ROA* and lagged one-year-ahead inflation forecasts, both for F1-MST_{t-1} (significant at the 10% level) and F1-$GAUSS_{t-1}$ (significant at the 5% level). A similar positive association is found with the lagged three-year-ahead forecast (F3-$GAUSS_{t-3}$). These surprising findings suggest that insurers who previously anticipated inflation were able to enhance profitability in the short run, possibly by adjusting pricing, reallocating investment portfolios or using more reinsurance. By incorporating inflation expectations into strategic planning, firms appear to have improved their returns relative to *Total assets*.

In contrast, no statistically significant effect is found between lagged observed inflation (IR_{t-1}) and *ROA* across the full sample. This indicates that profitability is more closely tied to anticipated inflation than to realized inflation, which may be harder to react to effectively given operational and regulatory constraints.

Among small insurers, a different pattern emerges. A negative relationship is observed between *ROA* and lagged observed inflation (IR_{t-1}), significant at the 10% level. This result aligns with theoretical expectations: realized inflation can erode real investment returns, increase claims costs, and compress underwriting margins, especially for smaller firms with limited pricing flexibility. At the same time, small insurers exhibit a positive relationship with lagged three-year-ahead inflation forecasts ($F3\text{-}GAUSS_{t-3}$), indicating that forward-looking strategies such as implementing inflation-aware pricing may have improved profitability when inflation was anticipated. The contrast between the negative effect of realized inflation and the positive effect of prior expectations highlights the importance of timing, particularly for resource-constrained firms.

For large insurers, the results are more nuanced. A negative association is found between *ROA* and both lagged observed inflation (IR_{t-1}) and the lagged one-year-ahead forecast ($F1\text{-}MST_{t-1}$). This suggests that large, well-capitalized firms, may face profitability challenges during inflationary periods, particularly when inflation is either recently realized or had been anticipated over a short horizon. These pressures may stem from rising operational costs, adverse claim developments, or the underperformance of interest-sensitive investments. However, no significant relationship is observed between *ROA* and the lagged three-year-ahead forecast, possibly reflecting large insurers' greater ability to hedge, diversify, or adjust strategically over longer timeframes.

Table 10 highlights the critical role of realized inflation IR_{t-1}. Insurers that used past observed inflation are, surprisingly, making appropriate decisions according to the score results at 10%. F3 models are also performing well without important differences between the two statistical distributions. These results underscore the importance of adaptive, anticipatory strategies in safeguarding insurer profitability amid inflationary environments in the long run. One-year forecast models are less accurate; this may be explained by the surprise COVID-19 pandemic crisis.

8 Summary concerning inflation rate results on six core financial indicators

This section examines the direct effects of inflation on six key financial indicators: premiums, losses incurred, net operational gains, capital gains or losses, investment income, and the capital ratio. The analysis incorporates both observed inflation and lagged inflation expectations—specifically, one-year-ahead and three-year-ahead forecasts generated by the MST and GAUSS models. Detailed results are presented in Appendix F.

Findings indicate that large insurers adapt more quickly and systematically to inflation. They tend to raise premiums in response to current inflation and short-term expectations, likely to protect underwriting margins against rising claims and operational costs. In contrast, small insurers exhibit weaker and less consistent premium adjustments, possibly due to regulatory constraints, limited pricing power, or slower internal decision-making processes.

Losses incurred rise with inflation for large insurers, reflecting inflation's upward pressure on claims-related expenses such as medical care, auto repairs, and construction. Large insurers' losses are more strongly tied to recent observed inflation.

Net operational gains are generally neutral with inflation (NS). This trend suggests that rising costs does not seem to outpace premium adjustments. The effect is more pronounced among large insurers, likely due to their broader operational footprint and fixed cost structures.

Capital gains and losses tend to decline with observed and near-term forecasted inflation, consistent with rising interest rates eroding bond and equity values. Interestingly, a positive relationship sometimes emerges with lagged three-year-ahead forecasts—especially for small insurers—suggesting that long-term inflation expectations may inform strategic investment decisions in bonds.

Investment income increases with short-term inflation, as insurers reinvest maturing assets into higher-yielding instruments in a rising rate environment. This effect is visible across firm sizes when using one-year-ahead lagged forecasts. However, the relationship weakens over longer horizons.

Capital ratios generally decline in response to short-term inflation, as the real value of assets erodes while liabilities rise with inflation-driven claims and expenses. However, this trend reverses over longer horizons: lagged three-year-ahead inflation expectations are positively associated with capital ratios, particularly for small insurers.

In summary, both observed inflation and lagged inflation expectations significantly influence insurer financial performance, but effects vary by firm size and inflation horizon. Large insurers respond more immediately to recent inflation pressures, while small insurers are more affected by past expectations, reflecting differing operational agility and strategic planning horizons. These findings highlight the importance of robust inflation risk management—incorporating forward-looking pricing, disciplined underwriting, proactive capital planning, and dynamic investment strategies tailored to evolving macroeconomic conditions.

9 Conclusion

This study evaluates the impact of inflation—both observed and expected—on *Reinsurance demand*, *Liquidity creation ratio*, and *ROA* for US insurers from 1993 to 2023, with particular attention to differences across firm size. The analysis distinguishes between lagged observed inflation (IR_{t-1}) and inflation forecasts made one and three years prior (F1 and F3), capturing how insurers react to realized inflation and how prior expectations affect inflation management.

For *Reinsurance demand*, the findings reveal a clear positive relationship with lagged observed inflation, suggesting that insurers react to actual inflation through reinsurance protection. In contrast, long-term inflation expectations formed three years earlier are negatively associated with current *Reinsurance demand*. This implies that when insurers anticipated prolonged inflation in the past, they likely adopted more conservative strategies which manifest in more stable financial positions. Short-term forecasts ($F1_{t-1}$), however, show no significant impact on reinsurance demand across the full sample, indicating that recent expectations may have had a limited influence on current decisions. Short-term forecasts may be too volatile, particularly those following the COVID-19 pandemic.

Liquidity creation ratio demonstrates a time-sensitive dynamic. Insurers increase liquidity creation in response to realized inflation and short-term forecasts, likely as a response to manage near-term uncertainty in bond values. Conversely, long-term inflation forecasts are associated with decreasing liquidity creation in the economy and investing more in liquid assets. These patterns are more pronounced among small insurers, who are more exposed to inflationary risks and show clearer adjustments. Large insurers, by contrast, do exhibit less significant changes *in Liquidity creation ratio*, likely due to their greater diversification, stronger asset-liability matching, and broader access to financial instruments.

Regarding profitability, *ROA* improves with prior inflation expectations, a surprising result obtained, particularly with lagged one- and three-year-ahead forecasts, suggesting that insurers who planned for inflation were better positioned to adjust pricing, reallocate investments, or take advantage of higher interest rates. In contrast, realized inflation does not significantly affect *ROA* at the aggregate level. Firm-level differences are notable.

Overall, the findings indicate that insurers are responsive to long-term inflation expectations as well to realized inflation. Proactive strategies—particularly those based on long-term forecasts—appear to enhance profitability and stabilize operations, while reactions to realized inflation are more defensive.

This document also examines the direct effects of inflation on six key financial indicators: *Premiums to Total assets*, *Losses incurred to Total assets*, *Net gain from operations to Total assets*, *Net investment income to Total assets*, *Net realized capital gains to Total assets*, and *Capital ratio*. Findings indicate that large insurers adapt more quickly and systematically to inflation. They tend to raise premiums in response to current inflation and short-term expectations, likely to protect underwriting margins against rising claims and operational costs. In contrast, small insurers exhibit weaker and less consistent premium adjustments, possibly due to regulatory constraints, limited pricing power, or slower internal decision-making processes.

In summary, both observed inflation and lagged inflation expectations significantly influence insurer financial performance, but effects vary by firm size and inflation horizon. Large insurers respond more immediately to recent inflation pressures, while small insurers are more affected by past expectations, reflecting differing operational agility and strategic planning horizons. These findings highlight the importance of robust inflation risk management—incorporating forward-looking pricing, disciplined underwriting, proactive capital planning, and dynamic investment strategies tailored to evolving macroeconomic conditions.

According to the Geneva Association (2023), there is a wide range of management actions insurers can take to respond to the new macroeconomic environment. In terms of product design, insurers could offer more low-cost products with an increased focus on risk and loss prevention. With tight labor markets and increasing wage pressure, insurers can also improve operational cost efficiency and overall productivity.

One underwriting response to inflation is to reset the insurance price of risks that exhibit high claims costs. This activity depends on the competitive environment in insurance markets, insurers' anticipation about central banks' ability to reduce inflation and the degree of public policy and regulatory constraints.

In investment management, inflation protection on asset allocation can be achieved by moving the investment portfolio away from bonds toward commodities, equities and real estate. For many insurers, however, such potential activity is constrained by their very high solvency capital requirements.

In general, effective insurer responses to inflation would have to occur ex-ante, rather than ex-post. This is why inflation anticipation remains a key issue. Once inflation occurs, the value of inflation-linked securities and the level of interest rates reflect capital markets' inflation expectations, which drive up the cost of any hedging strategy. More research is still needed to match aggregate information on inflation and insurer behavior.

References

Alhassan AL, Biekpe N, 2019. Why do property-liability insurers destroy liquidity? Evidence from South Africa. *South African Journal of Economics* 87, 1, 22-45.

Andersen TG, Sørenson BE, 1996. GMM estimation of a stochastic volatility model: A Monte Carlo study. *Journal of Business and Economic Studies* 14, 3, 328-352.

Arellano M, Bond S, 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *The Review of Economic Studies* 58, 2, 277-297.

Arellano M, Bover O, 1995. Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics* 68, 29-51.

Badiel ML, Dionne G, 2025. An overview of social inflation in the US property and casualty insurance industry in 2025. Working paper 25-05, Canada Research Chair in Risk Management, HEC Montréal.

Bernanke B, Blanchard O, 2025. What caused the US pandemic-era inflation? *American Economic Journal: Macroeconomics* 17, 3, 1-35.

Blundell R, Bond S, 1998. Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics* 87, 115-143.

Bowsher C, 2002. On testing overidentifying restrictions in dynamic panel data models. *Economics Letters* 77, 2, 211-220.

Choi BP, Park J, Ho CL, 2013. Liquidity creation or de-creation evidence from US property and liability insurance industry. *Managerial Finance* 39, 10, 938-962.

Cole CR, McCullough KA, 2006. A reexamination of the corporate demand for reinsurance. *The Journal of Risk and Insurance* 73, 1, 169-192.

D'Arcy SP, 1981. A strategy for property-liability insurers in inflationary times. CAS discussion paper, 110-147.

D'Arcy SP, 1982. A strategy for property-liability insurers in inflationary times. *Proceedings of the Casualty Actuarial Society* 69, 163-186.

D'Arcy SP, Au A, Zhang L, 2009. Property-liability insurance loss reserve ranges based on economic value. *Variance* 3, 1, 42-61.

Desjardins D, Dionne G, Koné N, 2022. Reinsurance demand and liquidity creation: A search for bicausality. *Journal of Empirical Finance* 66, 137-154.

Dionne G, Fenou AT, Mnasri M, 2025. The effect of inflation on US insurance markets: A Markov-switching model analysis. Working paper 25-02, Canada Research Chair in Risk Management, HEC Montréal.

Doran HE, Schmidt P, 2006. GMM estimators with improved finite sample properties using principal components of the weighting matrix, with an application to the dynamic panel data model. *Journal of Econometrics* 133, 387-409.

EIOPA, 2023. Report on the impact of inflation on the insurance sector. https://www.eiopa.europa.eu/publications/report-impact-inflation-insurance-sector_en.

Garven JR, Lamm-Tennant J, 2003. The demand for reinsurance: Theory and empirical tests. *Insurance and Risk Management* 7, 3, 217-237.

Geneva Association, 2023. The return of inflation: What it means for insurance. Mimeo, 54 pages.

Hansen LP, 1982. Large sample properties of generalized method of moments estimators. *Econometrica* 50, 4, 1029-1054.

Krivo R, 2009. An update to D'Arcy's 'A Strategy for Property-Liability Insurers in Inflationary Times'. Casualty Actuarial Society E-Forum, Spring. http://www.casact.org/pubs/forum/09spforum/04Krivo.pdf.

Lowe S, Warren R, 2010. Post-recession inflation: An emerging risk for P&C insurers. *Emphasis* 3, 24-29.

Lynch J, Moore D, 2023. Social inflation and loss development – an update. Research paper, Casualty Actuarial Society.

Masterson NE, 1968. Economic factors in liability and property insurance claim costs, 1935-1967. *Proceedings of the Casualty Actuarial Society* 55, 61-89.

Mayers D, Smith CW Jr, 1990. On the corporate demand for insurance: Evidence from the reinsurance market. *The Journal of Business* 63, 1, 19-40.

Mnasri M, Dionne G, Jabir M, Fenou AT, 2025. COVID-19, US macroeconomic tail risk, and inflation forecasts. Working paper 25-04, Canada Research Chair in Risk Management, HEC Montréal.

Okui R, 2009. The optimal choice of moments in dynamic panel data models. *Journal of Econometrics* 151, 1-16.

Pain D, 2020. Social inflation: Navigating the evolving claims environment. The Geneva Association. https://www.genevaassociation.org/sites/default/files/social_inflation_web_171220.pdf.

Powell LS, Sommer DW, 2007. Internal versus external capital markets in the insurance industry: The role of reinsurance. *Journal of Financial Services Research* 31, 3, 173-188.

Roodman D, 2006. How to do Xtabond2: An introduction to difference and system GMM in Stata. Working paper no. 103, Center for Global Development, 48 pages.

Sargan JD, 1958. The estimation of economic relationships using instrumental variables. *Econometrica* 26, 393-415.

Sommer DW, 1996. The impact of firm risk on property-liability insurance prices. *Journal Risk of Insurance* 63, 3, 501-514.

Stock JH, Watson MW, 2007. Has inflation become harder to forecast? *Journal of Money, Credit and Banking* 39, 3-34.

The Institutes, 2020. Social inflation: Evidence and impact on property-casualty insurance. Risk and Insurance Knowledge Group, 4 p.

Weiss MA, Chung JH, 2004. U.S. reinsurance prices, financial quality, and global capacity. *The Journal of Risk and Insurance* 71, 3, 437-467.

Wellington E, 2023. A trend model for social inflation in medical professional liability. CAS E-Forum Spring. https://eforum.casact.org/article/74847-a-trend-model-for-social-inflation-in-medical-professional-liability.

Windmeijer F, 2005. A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics* 126, 1, 25-51.

Winter RA, 1994. The Dynamics of competitive insurance markets. *Journal of Financial Intermediation* 3, 379-415.

Appendix A: Additional data and variables

Table A1: Liquidity creation measure for an insurer

Step 1: We classify all items in *Total assets*, liabilities, and surplus as liquid and illiquid
Step 2: Assign weights to the activities
Step 3: Combine insurance activities as classified in step 1 and as weighted in step 2 to construct the liquidity creation (LC) measure

LC = + ½ × illiquid *Total assets* − ½ × liquid *Total assets*
+ ½ × liquid liabilities − ½ × illiquid liabilities
− ½ × surplus

Total assets	
Illiquid *Total assets* (weight = ½)	Liquid *Total assets* (weight = -½)
Mortgage loan	Cash, cash equivalents, and short-term investments
Real estate	Investments in stock and bonds
Other invested *Total assets*	
Uncollected premiums and agents' balances	
Electronic data processing equipment and software	
Furniture and equipment	

Liabilities and surplus	Liabilities and surplus
Liquid liabilities (weight = ½)	Illiquid liabilities plus surplus (weight = -½)
Loss reserves within one year (Net losses and unpaid expenses)	Loss reserves with more than one year
Reinsurance payable on paid losses and loss adjustment expenses	Funds held by company under reinsurance treaties
Other expenses	Provision for reinsurance
Taxes, licenses, and fees	Amounts withheld or retained by company on others' behalf
Current federal and foreign income taxes	Draft outstanding
Net deferred tax liability	Liability for amounts held under uninsured accident and health plans
Unearned premiums	Surplus
Dividends declared unpaid	

Source: Desjardins et al. (2022).

Table A2: Summary statistics for large insurers, 1992-2023

Variable at time *t*	Obs	Mean	Median	Std	Min	Max
Reinsurance demand	2294	0.3057	0.2434	0.2548	0.0000	0.9486
Liquidity creation ratio	2294	-0.4989	-0.4979	0.1543	-0.9949	0.2610
ROA (return on assets)	2294	0.0376	0.0368	0.0462	-0.4568	0.3989
Premiums on Total assets	2294	0.2996	0.2795	0.1639	0.0002	0.9528
Losses incurred on Total assets	2294	0.1868	0.1690	0.1117	0.0001	0.6503
Net gain from operations on Total assets	2294	0.0376	0.0368	0.0462	-0.4568	0.3989
Net investment income on Total assets	2294	0.0340	0.0318	0.0178	-0.0184	0.2954
Net realized capital gains on Total assets	2294	0.0057	0.0021	0.0238	-0.4082	0.3824
Capital ratio	2294	0.3819	0.3456	0.1519	0.0172	0.9893
Insurance leverage	2294	0.7366	0.5559	0.7884	0.0000	9.4944
Geographical concentration	2294	0.1978	0.0758	0.2794	0.0327	1.0000
Regulatory pressure	2294	0.0201	0.0000	0.1402	0.0000	1.0000
Liabilities	2294	0.3017	0.0000	0.4591	0.0000	1.0000
Line concentration	2294	0.4151	0.3213	0.2574	0.1038	1.0000
Reinsurance price	2294	3.6136	3.4514	1.5064	0.0000	12.0000
Tax exemption	2294	0.3431	0.3309	0.2086	0.0000	0.9782
Information asymmetry	2294	0.0846	0.0587	0.0965	0.0028	1.1110
Loss development ratio	2294	-0.2714	-1.4032	14.7483	-73.7500	80.6200
New York license	2294	0.7977	1.0000	0.4018	0.0000	1.0000
Cost of capital	2294	0.1069	0.0990	0.0999	-0.4648	0.5280
Firm size	2294	22.8284	22.5941	0.8438	21.8226	26.6716
Group affiliation	2294	0.9621	1.0000	0.1911	0.0000	1.0000
Mix concentration	2294	0.5797	0.5141	0.2109	0.2567	1.0000

Note: This table provides summary statistics for the period 1992-2023. Variables are defined in tables 1 and 4.

Table A3: Summary statistics for small insurers, 1992-2023

Variable at time *t*	Obs	Mean	Median	Std	Min	Max
Reinsurance demand	45909	0.3782	0.3235	0.2892	0.0000	1.0000
Liquidity creation ratio	45909	-0.5179	-0.5196	0.2192	-3.2730	0.6358
ROA (return on assets)	45909	0.0281	0.0318	0.0799	-2.7319	2.6411
Premiums on Total assets	45909	0.3722	0.3382	0.2608	0.000	13.8625
Losses incurred on Total assets	45909	0.2075	0.1770	0.1875	0.000	12.0445
Net gain from operations on Total assets	45909	0.0281	0.0318	0.0799	-2.7319	2.6411
Net investment income on Total assets	45909	0.0310	0.0289	0.0238	-0.1567	2.1969
Net realized capital gains on Total assets	45909	0.0045	0.0007	0.0269	-1.1001	2.4636
Capital ratio	45909	0.4506	0.4108	0.1958	0.0000	1.0000
Insurance leverage	45909	2.0055	1.2271	2.9847	0.0000	33.0000
Geographical concentration	45909	0.6206	0.6847	0.3750	0.0303	1.0000
Regulatory pressure	45909	0.0315	0.0000	0.1748	0.0000	1.0000
Liabilities	45909	0.0970	0.0000	0.2960	0.0000	1.0000
Line concentration	45909	0.5974	0.5332	0.2899	0.1139	1.0000
Reinsurance price	45909	3.7793	3.3418	2.3293	0.0000	12.0000
Tax exemption	45909	0.2381	0.1698	0.2391	0.0000	1.0000
Information asymmetry	45909	0.1180	0.0764	0.1433	0.0020	1.1110
Loss development ratio	45909	-2.3773	-1.9042	19.2975	-73.7500	80.6200
New York license	45909	0.2706	0.0000	0.4443	0.0000	1.0000
Cost of capital	45909	0.0692	0.0698	0.1334	-0.4648	0.5280
Firm size	45909	17.7733	17.8647	1.6262	11.1758	20.7227
Group affiliation	45909	0.6233	1.0000	0.4846	0.0000	1.0000
Mix concentration	45909	0.7021	0.6619	0.2489	0.2505	1.0000

Note: This table provides summary statistics for the period 1992-2023. Variables are defined in tables 1 and 4.

Table A4: Two-Step GMM-FOD estimates of *Reinsurance demand*, *Liquidity creation ratio*, and *ROA* for all insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7835	0.0338	-0.0210
	(0.000)	(0.001)	(0.038)
$Liquid_{t-1}$	0.0906	0.7374	0.0645
	(0.000)	(0.000)	(0.000)
ROA_{t-1}	-0.0578	-0.2121	0.3517
	(0.000)	(0.000)	(0.000)
2007-2008	0.0019	0.0077	-0.0013
	(0.276)	(0.000)	(0.325)
2001 recession	0.0031	0.0533	-0.0168
	(0.260)	(0.000)	(0.000)
2020 COVID-19	0.0033	-0.0137	0.0023
	(0.122)	(0.000)	(0.145)
Insurance leverage	0.0105		-0.0045
	(0.000)		(0.004)
Geographical concentration			0.0630
			(0.000)
Liabilities	0.0062		-0.0395
	(0.404)		(0.000)
Line concentration	0.0240		-0.1081
	(0.034)		(0.000)
Reinsurance price	-0.0061	0.0062	0.0116
	(0.000)	(0.000)	(0.000)
Tax exemption	-0.0067	-0.0304	
	(0.531)	(0.000)	
Loss development	-0.0003	0.0002	0.0001
	(0.011)	(0.028)	(0.133)
Firm size			-0.0121
			(0.000)
Group affiliation			-0.0082
			(0.436)
Mix concentration			0.0394
			(0.089)
Capital	0.1899		
	(0.000)		
Number of observations	46,816	46,816	46,816
Number of firms	3,163	3,163	3,163
Number of instruments	1,860	2,436	2,436
p-value Hansen test	0.3152	0.2525	0.2676

Note: This table provides the results of two-step GMM-FOD, with Windmeijer-corrected standard errors. The corresponding *p*-values are reported in parentheses. *p*-values lower the 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively.

Table A5: Two-step GMM-FOD estimates of *Reinsurance demand*, *Liquidity creation ratio*, and *ROA* for large insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7730	-0.0233	-0.0608
	(0.000)	(0.642)	(0.205)
$Liquid_{t-1}$	0.0363	0.8057	-0.0252
	(0.585)	(0.000)	(0.735)
ROA_{t-1}	0.2046	-0.0168	0.3002
	(0.119)	(0.870)	(0.003)
2007-2008	0.0045	0.0177	-0.0180
	(0.461)	(0.004)	(0.074)
2001	0.0219	0.0642	-0.0324
	(0.031)	(0.000)	(0.001)
2020 COVID-19	0.0007	-0.0058	-0.0007
	(0.890)	(0.241)	(0.877)
Insurance leverage	0.0238		0.0084
	(0.103)		(0.709)
Liabilities	0.0233		-0.0407
	(0.251)		(0.025)
Line concentration	0.0224		-0.1369
	(0.307)		(0.006)
Reinsurance price	-0.0028	-0.0012	0.0222
	(0.543)	(0.849)	(0.000)
Tax exemption	0.0164	-0.1122	
	(0.537)	(0.000)	
Loss development ratio	0.0002	-0.0002	0.0001
	(0.683)	(0.526)	(0.725)
Firm size			-0.0175
			(0.170)
Mix concentration			0.1194
			(0.160)
Capital	0.2122		
	(0.021)		
Number of observations	2,078	2,078	2,078
Number of firms	152	152	152
Number of instruments	110	110	98
p-value Hansen test	0.4286	0.2067	0.3896

Note: This table provides the results of two-step GMM-FOD, with Windmeijer-corrected standard errors. Corresponding *p*-values are reported in parentheses. *p*-values lower the 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively.

Table A6: Two-step GMM-FOD estimates of *Reinsurance demand*, *Liquidity creation ratio*, and *ROA* for small insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7918	0.0376	-0.0272
	(0.000)	(0.001)	(0.064)
$Liquid_{t-1}$	0.0881	0.7269	0.1082
	(0.000)	(0.000)	(0.000)
ROA_{t-1}	-0.0560	-0.2038	0.3796
	(0.001)	(0.000)	(0.000)
2007-2008	0.0012	0.0065	0.0007
	(0.584)	(0.000)	(0.632)
2001	0.0041	0.0503	-0.0127
	(0.190)	(0.000)	(0.000)
2020 COVID-19	0.0039	-0.0144	0.0040
	(0.144)	(0.000)	(0.038)
Insurance leverage	0.0092		-0.0049
	(0.000)		(0.016)
Geographical concentration			0.0599
			(0.001)
Liabilities	0.0059		-0.0503
	(0.468)		(0.000)
Line concentration	0.0286		-0.1027
	(0.039)		(0.000)
Reinsurance price	-0.0059	0.0064	0.0112
	(0.000)	(0.000)	(0.000)
Tax exemption	0.0028	-0.0297	
	(0.806)	(0.000)	
Loss development ratio	-0.0001	0.0003	0.0002
	(0.452)	(0.051)	(0.042)
Firm size			-0.0131
			(0.000)
Group affiliation			-0.0058
			(0.636)
Mix concentration			0.0472
			(0.121)
Capital	0.1807		
	(0.000)		
Number of observations	41,005	41,005	41,005
Number of firms	3,030	3,030	3,030
Number of instruments	1860	2030	1950
p-value Hansen test	0.2511	0.2356	0.3256

Note: This table provides the results of two-step GMM-FOD, with Windmeijer-corrected standard errors and the corresponding *p*-values in parentheses. *p*-values lower the 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively.

As indicated in Table A4, the coefficients of *Capital*, *Insurance leverage*, and *Line concentration* are positively and significantly associated with the *Reinsurance demand* at the 5% level of significance. This suggests that insurers with higher capital ratios, greater leverage and concentrated business lines tend to demand more reinsurance. Such relationships imply the following interpretation: Insurers with higher capital ratios, reflecting a stronger financial foundation relative to their total admitted assets, are more likely to demand more reinsurance to further protect their surplus and ensure financial stability in the face of large losses or catastrophic events.

Firms with higher *Insurance leverage*, meaning they write more direct business relative to their capital and surplus, tend to have a greater need for reinsurance to manage the elevated risk exposure tied to their underwriting capacity. A higher value of *Line concentration*, indicating a less diversified portfolio with higher exposure to specific lines of business, increases the possibility of correlated risks. Such firms are likely to demand more reinsurance to mitigate these risks and stabilize their financial performance.

The coefficients of *Reinsurance price* and *Loss development ratio*—defined as the estimated losses and loss expenses incurred two years before the current year and the prior year, scaled by policyholders’ surplus—are negatively and significantly associated with the *Reinsurance demand* at the 5% level of significance. This suggests that insurers reduce their reinsurance purchases when prices rise or when past loss developments indicate higher retained losses, possibly to manage costs.

Also from Table A4, the coefficients of *Reinsurance price* and *Loss development ratio* are positively and significantly associated with *the Liquidity creation ratio* at the 5% level of significance, highlighting the role of external pressures and market dynamics in shaping firms' liquidity strategies.

In contrary, *Tax-exempt* is negatively associated with liquidity creation. Tax-exempt firms often operate with distinct cost structures and financial strategies compared to taxable firms, reducing their motivation to engage in liquidity-creating activities. Their unique financial frameworks provide them with more flexibility, limiting their reliance on liquidity-driven measures.

Firm size is another important determinant. Larger firms typically may benefit from economies of scale and possess significant internal resources, which reduce their dependence on external liquidity. Their robust financial position and operational efficiencies enable them to manage liabilities and growth internally, minimizing the need for liquidity creation. Reinsurance price also drives liquidity creation. Rising reinsurance prices compel firms to generate additional liquidity to alleviate financial strain that necessitates proactive liquidity management.

Loss development is another significant factor. Firms with substantial loss development—unexpected claim obligations or reserve adjustments—require enhanced liquidity creation to address these financial challenges. Liquidity creation in such cases is essential to maintain solvency and fulfill policyholder obligations during periods of heightened claims activity.

Finally, Table A4 indicates that the relationship between various financial and operational metrics and a firm's *ROA* provides significant insights. *Insurance leverage*, *Liabilities*, *Line concentration*, and *Firm size* are negatively associated with *ROA*. Conversely, *Reinsurance price* and *Geographical concentration* are positively associated with *ROA*, both at a 5% significance level. These findings illustrate how specific financial strategies and structural characteristics influence profitability.

A higher *Liquidity creation ratio* suggests that a firm allocates substantial resources to liquidity-enhancing activities, such as maintaining excess reserves or investing in high-yield illiquid assets. While these actions may improve financial stability, they can divert resources from other investments, ultimately reducing returns and impacting *ROA*.

Firms whose liabilities exceed their liquid assets are more susceptible to liquidity pressures and heightened financial risks. This financial strain can reduce operational flexibility and profitability, leading to a negative effect on *ROA*. Similarly, a high *Line concentration*, which reflects a less diversified portfolio, increases a firm's exposure to risks concentrated in specific lines of business. This lack of diversification often results in unstable revenue streams and lower profitability.

Larger firms may face diminishing returns to scale, as operational complexities and inefficiencies increase with size. These firms may also adopt less aggressive profit-maximizing strategies, further reducing *ROA*. Firms affiliated with larger groups may prioritize stability and resource sharing across the group over individual profitability. Although this approach enhances overall group resilience, it can suppress the standalone profitability of individual firms, negatively affecting their *ROA* (but not significant).

Higher reinsurance prices can incentivize firms to optimize their risk management strategies. By carefully evaluating reinsurance arrangements, firms allocate resources more efficiently, ensuring that risk transfer mechanisms align with their financial goals. This strategic optimization of risk and capital contributes to improved profitability and positively influences *ROA*.

Loss development, defined as estimated losses and loss expenses incurred two years before the current year and prior year, scaled by the policyholder's surplus, provides critical insight into a firm's underwriting performance. Firms that effectively manage loss development demonstrate strong risk assessment and operational control capabilities. By minimizing unexpected adjustments and stabilizing claims outcomes, these firms mitigate financial volatility and support consistent profitability, positively influencing *ROA* (but not significant).

Table A7: *Inflation rate* and its effect on *Reinsurance demand*, *Liquidity creation ratio*, and *ROA*, 1993-2023

	All insurers			Large insurers			Small insurers		
Variable	$Reins_t$	$Liquid_t$	ROA_t	$Reins_t$	$Liquid_t$	ROA_t	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7838	0.0376	-0.0198	0.7823	-0.0100	-0.0880	0.7927	0.0386	-0.0241
	(0.000)	(0.000)	(0.052)	(0.000)	(0.846)	(0.088)	(0.000)	(0.001)	(0.100)
$Liquid_{t-1}$	0.0909	0.7162	0.0734	0.0113	0.8008	-0.0103	0.0877	0.7056	0.1174
	(0.000)	(0.000)	(0.000)	(0.869)	(0.000)	(0.898)	(0.000)	(0.000)	(0.000)
ROA_{t-1}	-0.0548	-0.1873	0.3561	0.2681	0.0818	0.1852	-0.0529	-0.1849	0.3928
	(0.000)	(0.000)	(0.000)	(0.046)	(0.451)	(0.065)	(0.002)	(0.000)	(0.001)
IR_{t-1}	0.0009	0.0018	-0.0002	0.0011	-0.0003	-0.0020	0.0011	0.0019	-0.0006
	(0.017)	(0.000)	(0.502)	(0.329)	(0.739)	(0.034)	(0.013)	(0.000)	(0.084)
Number of observations	46,816	46,816	46,816	2,078	2,078	2,078	41,005	41,005	41,005
Number of firms	3,163	3,163	3,163	152	152	152	3,030	3,030	3,030
Number of instruments	1,860	2,436	2,436	110	110	98	1,860	2,030	1,950
p-value Hansen test	0.3383	0.3862	0.2620	0.4617	0.2214	0.4295	0.2049	0.2134	0.3178

Note: This table provides the results of the two-step GMM-FOD. The dependent variables are *Reinsurance demand*, *Liquidity creation ratio* and *ROA*. Control variables results are not presented. Heteroscedasticity-consistent standard errors clustered at the firm level are computed and the corresponding *p*-values are reported in parentheses. *p*-values lower the 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively.

Table A8: Forecasted *Inflation rate* and its effect on *Reinsurance demand*, *Liquidity creation ratio*, and *ROA*, for all insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t	$Reins_t$	$Liquid_t$	ROA_t	$Reins_t$	$Liquid_t$	ROA_t	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t\text{-}1}$	0.7836	0.0373	-0.0198	0.7839	0.0379	-0.0194	0.7807	0.0345	-0.0187	0.7779	0.0313	-0.156
	(0.000)	(0.000)	(0.052)	(0.000)	(0.000)	(0.058)	(0.000)	(0.001)	(0.068)	(0.000)	(0.004)	(0.123)
$Liquid_{t\text{-}1}$	0.0860	0.7207	0.0741	0.0884	0.7171	0.0735	0.0792	0.7130	0.0749	0.0736	0.7092	0.0771
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$ROA_{t\text{-}1}$	-0.0562	-0.2188	0.3514	-0.0574	-0.1970	0.3563	-0.0585	-0.2044	0.3593	-0.0565	-0.2029	0.3667
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$F1\text{-}MST_{t\text{-}1}$	-0.0008	0.0032	0.0006									
	(0.106)	(0.000)	(0.089)									
$F1\text{-}GAUSI_{t\text{-}1}$				-0.0002	0.0025	0.0006						
				(0.594)	(0.000)	(0.032)						
$F3\text{-}MST_{t\text{-}3}$							-0.0011	-0.0012	0.0005			
							(0.001)	(0.002)	(0.130)			
$F3\text{-}GAUSS_{t\text{-}3}$										-0.0003	-0.0007	0.0005
										(0.000)	(0.000)	(0.000)
Number of observations	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816
Number of firms	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163
Number of instruments	1,860	2,436	2,436	1,860	2,436	2,436	1,860	2,436	2,436	1,860	2,436	2,436
p-value Hansen test	0.3046	0.3243	0.2882	0.3241	0.3360	0.2952	0.3064	0.3539	0.2743	0.3079	0.3626	0.3176

Note: This table provides the results of the two-step GMM-FOD. The dependent variables are *Reinsurance demand*, *Liquidity creation ratio* and *ROA*. Control variables results are not presented. Heteroscedasticity-consistent standard errors clustered at the firm level are computed and the corresponding *p*-values are reported in parentheses. *p*-values lower the 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively.

Table A9: Forecasted *Inflation rate* and its effect on *Reinsurance demand*, *Liquidity creation ratio*, and *ROA*, for large insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t	$Reins_t$	$Liquid_t$	ROA_t	$Reins_t$	$Liquid_t$	ROA_t	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7836	0.0101	-0.0958	0.7896	0.0166	-0.0979	0.7843	-0.0182	-0.0904	0.7828	-0.0217	-0.1034
	(0.000)	(0.852)	(0.048)	(0.000)	(0.737)	(0.041)	(0.000)	(0.729)	(0.056)	(0.000)	(0.668)	(0.027)
$Liquid_{t-1}$	0.0232	0.8410	-0.0362	0.0316	0.8271	-0.0233	0.0113	0.7936	0.0005	0.0059	0.7911	-0.0218
	(0.713)	(0.000)	(0.636)	(0.605)	(0.000)	(0.757)	(0.870)	(0.000)	(0.995)	(0.924)	(0.000)	(0.763)
ROA_{t-1}	0.2312	0.0065	0.2819	0.2550	0.1017	0.2039	0.2606	0.0785	0.2180	0.2524	0.0690	0.2073
	(0.059)	(0.948)	(0.011)	(0.040)	(0.358)	(0.045)	(0.060)	(0.440)	(0.027)	(0.043)	(0.501)	(0.060)
$F1\text{-}MST_{t-1}$	0.0014	0.0070	-0.0055									
	(0.401)	(0.000)	(0.003)									
$F1\text{-}GAUSI_{t-1}$				0.0022	0.0051	-0.0016						
				(0.086)	(0.000)	(0.152)						
$F3\text{-}MST_{t-3}$							-0.0003	-0.0010	0.0028			
							(0.859)	(0.403)	(0.106)			
$F3\text{-}GAUSS_{t-3}$										-0.0004	-0.0008	0.0003
										(0.212)	(0.014)	(0.250)
Number of observations	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078
Number of firms	152	152	152	152	152	152	152	152	152	152	152	152
Number of instruments	110	110	98	110	110	98	110	110	98	110	110	98
p-value Hansen test	0.4161	0.2903	0.4638	0.4102	0.2914	0.3592	0.4065	0.2010	0.3794	0.4590	0.2034	0.3122

Note: This table provides the results of the two-step GMM-FOD. The dependent variables are *Reinsurance demand*, *Liquidity creation ratio* and *ROA*. Control variables results are not presented. Heteroscedasticity-consistent standard errors clustered at the firm level are computed and the corresponding *p*-values are reported in parentheses. *p*-values lower the 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively.

Table A10: Forecasted *Inflation rate* and its effect on *Reinsurance demand*, *Liquidity creation ratio*, and *ROA*, for small insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t	$Reins_t$	$Liquid_t$	ROA_t	$Reins_t$	$Liquid_t$	ROA_t	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7923	0.0386	-0.0243	0.7924	0.0393	-0.0243	0.7883	0.0369	-0.0255	0.7858	0.0340	-0.0229
	(0.000)	(0.001)	(0.097)	(0.000)	(0.001)	(0.097)	(0.000)	(0.002)	(0.085)	(0.000)	(0.005)	(0.117)
$Liquid_{t-1}$	0.0825	0.7103	0.1168	0.0855	0.7072	0.1174	0.0767	0.7044	0.1139	0.0697	0.7015	0.1216
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA_{t-1}	-0.0552	-0.2133	0.3969	-0.0568	-0.1967	0.3965	-0.0586	-0.2035	0.3928	-0.0553	-0.2026	0.3974
	(0.002)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
$F1\text{-}MST_{t-1}$	-0.0013	0.0026	-0.0002									
	(0.034)	(0.000)	(0.652)									
$F1\text{-}GAUSI_{t-1}$				-0.0003	0.0021	-0.0005						
				(0.490)	(0.000)	(0.168)						
$F3\text{-}MST_{t-3}$							-0.0011	-0.0011	-0.0007			
							(0.002)	(0.012)	(0.137)			
$F3\text{-}GAUSS_{t-3}$										-0.0004	-0.0006	0.0005
										(0.000)	(0.000)	(0.000)
Number of observations	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005
Number of firms	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030
Number of instruments	1,860	2,030	1,950	1,860	2,030	1,950	1,860	2,030	1,950	1,860	2,030	1,950
p-value Hansen test	0.2377	0.2114	0.3213	0.2444	0.1565	0.3303	0.2367	0.2140	0.3096	0.2801	0.1798	0.3332

Note: This table provides the results of the two-step GMM-FOD. The dependent variables are *Reinsurance demand*, *Liquidity creation ratio* and *ROA*. Control variables results are not presented. Heteroscedasticity-consistent standard errors clustered at the firm level are computed and the corresponding *p*-values are reported in parentheses. *p*-values lower the 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively.

Table A11: Two-Step GMM-FOD Estimates of *Reinsurance demand*, *Liquidity creation ratio*, and *ROA* using different instrument sets for large insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7852	-0.0107	-0.0982
	(0.000)	(0.832)	(0.042)
$Liquid_{t-1}$	0.0143	0.7989	-0.0185
	(0.811)	(0.000)	(0.803)
ROA_{t-1}	0.2655	0.0857	0.2115
	(0.048)	(0.406)	(0.045)
Number of observations	2,078	2,078	2,078
Number of firms	152	152	152
Number of instruments	110	110	98
p-value Hansen test	0.4186	0.2291	0.3475

Note: Two-step GMM-FOD regression model, with Windmeijer-corrected standard errors. The corresponding *p*-values are reported in parentheses. Results on control variables are not presented.

Table A12: Two-Step GMM-FOD Estimates of *Reinsurance demand*, *Liquidity creation ratio*, and *ROA* using different instrument sets for small insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7928	0.0386	-0.0245
	(0.000)	(0.001)	(0.095)
$Liquid_{t-1}$	0.0862	0.7088	0.1170
	(0.000)	(0.000)	(0.000)
ROA_{t-1}	-0.0561	-0.1996	0.3950
	(0.001)	(0.000)	(0.000)
Number of observations	41,005	41,005	41,005
Number of firms	3,030	3,030	3,030
Number of instruments	1,860	2,030	1,950
p-value Hansen test	0.2272	0.2249	0.3257

Note: Two-step GMM-FOD regression model, with Windmeijer-corrected standard errors. The corresponding *p*-values are reported in parentheses. Results on control variables are not presented.

Appendix B: Results of two-step GMM-FOD models with control variables

- *Premiums on Total assets*

The relationship between *Reinsurance demand* and *Premiums on Total assets*, as indicated in Table B1, is negative, meaning that insurers that cede more risk to reinsurers tend to report lower levels of net *Premiums* relative to their *Total assets*. This reflects the fact that purchasing reinsurance reduces the amount of premium retained by the ceding company, as a portion is transferred to the reinsurer in exchange for risk relief.

This result holds consistently across insurer size categories. For large insurers (Table B2) and small insurers (Table B3), the negative relationship is also observed, suggesting that regardless of firm size, greater reliance on reinsurance is associated with lower reported premium income on an asset-adjusted basis. This may reflect a broader strategic choice by insurers to manage underwriting risk through reinsurance, even at the cost of reduced top-line revenue, particularly in competitive markets.

These findings underscore the trade-off between risk transfer and premium retention in reinsurance decisions and highlight how this trade-off shapes reported financial performance across the industry.

For large insurers, firm size (measured as the logarithm of total assets) exhibits a negative relationship with the premium ratio, while the *Liquidity creation ratio* shows a positive relationship. This suggests that as insurers become larger, they tend to generate proportionally less premium income, possibly because they diversify into a broader range of financial activities or allocate more resources to investment and asset management rather than core underwriting.

Conversely, the positive association between *Liquidity creation* and the *Premiums ratio* indicates that insurers with greater liquidity creation capacity are more focused on underwriting activities, supporting a higher proportion of premium revenue relative to their total assets. This may reflect a strategic trade-off between pursuing underwriting growth and utilizing the balance sheet to enhance liquidity through financial channels. Overall, these findings highlight the differing business models that large insurers can adopt — either leveraging size for greater financial flexibility or emphasizing traditional insurance operations to drive premium income.

Insurance leverage shows a positive relationship with the *Premiums* ratio across all insurer, large insurers, and small insurers. However, for both large and small insurers, this relationship is statistically significant only at the 10% level, indicating a weaker but still meaningful association. This suggests that insurers with higher leverage—meaning they write more premiums relative to their surplus—tend to generate more premium income relative to their *Total assets*. This pattern reflects a more aggressive underwriting strategy, where insurers take on more risk to drive growth. The weaker significance for large and small insurers may point to heterogeneity in risk appetite, regulatory constraints, or strategic focus within those groups compared to the broader industry.

- *Losses incurred on Total assets*

The relationships between *Reinsurance demand*, *ROA*, *Reinsurance price*, *Tax exemption*, *Two-year loss development* losses (defined as estimated losses and loss adjustment expenses incurred two years before the current year and the prior year, scaled by policyholders' surplus), and *Mix concentration* offer valuable insights into the dynamics of risk-taking behavior and financial performance in the insurance industry.

As shown in Table B1 for all insurers, and Table B3 for small insurers, all six variables are negatively and significantly associated with *Losses incurred on Total assets*. These findings suggest that when insurers increase their use of reinsurance, achieve higher profitability (*ROA*), face higher reinsurance prices, benefit from tax exemptions, or report greater adverse loss development, they tend to exhibit lower current losses relative to their asset base.

This pattern could imply greater reinsurance utilization and may reflect effective risk transfer strategies, reducing retained losses. Higher *ROA* indicates stronger underwriting discipline or operational efficiency. Higher reinsurance prices may force insurers to be more selective about the risks they underwrite, thus improving underwriting quality.

Tax exemption could ease capital constraints, reducing the incentive to pursue aggressive, high-risk underwriting strategies. Greater *Loss development* may prompt more conservative reserving and underwriting practices, lowering future incurred losses. Lower *Mix concentration* implies a more diversified underwriting portfolio, mitigating risks specific to individual insurance lines.

Collectively, these relationships highlight the complex interplay between financial strength, risk management, and external market pressures, offering a nuanced view of how insurers adjust their behavior to safeguard profitability and reduce loss exposure.

Additionally, *Insurance leverage*, *Geographical concentration*, *Regulatory pressure* (measured as a dummy equal to 1 if net premiums written to surplus are $\geq$ 300%, 0 otherwise), and *Line concentration* are all positively associated with *Losses incurred on Total assets* for both all insurers and small insurers—with the exception that geographical concentration is not significant for small insurers.

These positive relationships suggest that higher insurance leverage exposes insurers to greater underwriting risk, increasing loss volatility relative to total assets. Greater *Geographical concentration* increases vulnerability to region-specific shocks such as natural disasters or economic downturns. *Regulatory pressure*, as indicated by high premium-to-surplus ratios, may reflect aggressive growth strategies or undercapitalization, resulting in reduced resilience to losses. Higher *Line concentration* implies less diversification across product lines, heightening the impact of adverse developments in specific lines of business.

Overall, these findings demonstrate that activity risk—whether geographic, regulatory, or underwriting-based—alongside aggressive leverage strategies, materially heightens insurers' operational loss burden.

While the results are broadly consistent across all insurers and small insurers, the lack of significance for geographical concentration among small insurers suggests that smaller firms may be better adapted to local market conditions or possess more targeted risk management practices, insulating them from regional volatility.

For large insurers (Table B2), the results reveal that *Reinsurance demand*, ROA, and *Reinsurance price* remain negatively related to the losses incurred ratio, similar to the findings for all insurers and small insurers. Regulatory pressure remains positively related to losses incurred.

However, divergences are also observed such as *Tax exemption* and *Mix concentration* are not statistically significant for large insurers, even though they are negatively associated with losses incurred for all insurers and small insurers. Insurance leverage is not significant for large insurers, whereas it is positively related to losses incurred for both all insurers and small insurers.

These differences suggest that large insurers may have more diversified risk profiles, making their losses less sensitive to factors like tax exemptions or underwriting concentration. Insurance leverage may exert less influence on large firms, potentially because of their superior access to capital markets, diversified business models, or stronger internal risk controls.

- *Net gains from operations on Total assets*

Table B1 presents the regression results for *Net gain from operations on Total assets* for the full sample of insurers. The analysis reveals positive and statistically significant relationships with *Geographical concentration*, *Reinsurance price*, *Tax exemption*, and *Two-year loss development* losses.

These findings suggest that insurers with greater geographical concentration may benefit from operational efficiencies or market specialization in specific regions, potentially enhancing underwriting profitability. Higher reinsurance prices could reflect a harder market environment, in which reinsurers and insurers are able to charge higher premiums, thus improving their operational margins. *Tax exemption* can ease financial pressure and improve net operating outcomes by reducing the tax burden on core insurance activities. A positive link with two-year loss development losses may indicate that firms with higher historical adverse development are responding with corrective actions—such as improved pricing, stricter underwriting, or reserve strengthening—which ultimately lead to better operational performance going forward.

Overall, these results highlight how a combination of market conditions, regulatory factors, and firm-specific strategic responses contribute to stronger operational returns relative to total assets.

In addition, we find negative relationships between *Net gain from operations on Total assets* and the variables *Regulatory pressure*, *Line concentration*, and *Group affiliation*.

These findings suggest that insurers facing regulatory pressure—i.e., those flagged by a high net premiums written to surplus ratio (≥ 300%)—may be operating under tighter capital constraints or closer regulatory scrutiny, which can limit their flexibility and reduce their operational profitability. High line concentration, reflecting a lack of diversification across lines of business, increases vulnerability to volatility in specific underwriting segments, making earnings from core operations less stable. Meanwhile, group affiliation may lead to strategic practices—such as group reinsurance, centralized expense sharing, or tax strategies—that reduce reported profits at the individual entity level, even if they benefit the group as a whole.

Together, these results highlight the importance of capital adequacy, diversification in underwriting, and corporate structure in supporting sustainable profitability from core insurance operations.

For small insurers, as shown in Table B3, the results are largely consistent with those for the overall sample, with a few notable differences. Specifically, for small insurers, there is no statistically significant relationship between *Net gain from operations on Total assets* and the variables *Regulatory pressure*, *Tax exemption*, and *Two-year loss development*.

This suggests that these factors—while impactful at the industry level—may exert a more limited influence on the operational performance of smaller firms. The absence of significance could reflect structural or strategic differences. For example, small insurers may adopt more conservative growth strategies that avoid regulatory pressure, be less affected by tax exemptions due to lower taxable income or narrower eligibility and have less exposure to long-tail or complex lines, reducing the role of loss development trends in their financial outcomes.

For large insurers, as shown in Table B2, *Liquidity creation ratio* is negatively related to the *Net gain from operations on Total assets*, while *Line concentration* is positively related. This suggests that a higher *Liquidity creation ratio*—indicating that insurers hold a greater proportion of illiquid assets relative to total assets—can discourage active trading, as these insurers must maintain more stable, long-term portfolios to meet liquidity obligations. This reduces their capacity to frequently rebalance investments and recognize capital gains.

In contrast, the positive relationship with *Line concentration* implies that large insurers that specialize in a narrower set of insurance lines may achieve more stable underwriting results. Greater underwriting predictability enables them to manage their investments more strategically and opportunistically, allowing for better timing of capital gains realization or the mitigation of losses.

Overall, these findings highlight how both external market factors (such as tax policy) and internal strategic choices (such as liquidity management and underwriting focus) jointly shape the investment performance of large insurers, particularly in terms of their ability to realize gains or minimize losses on their asset portfolios.

- *Net realized capital gains on Total assets*

As shown in Table B4, for all insurers, several variables exhibit statistically significant relationships with *Net realized capital gains on Total assets*. Specifically, *ROA*, *Two-year loss development*, *Group affiliation*, and *Capital ratio* are positively related, while *Reinsurance price*, *Tax exemption*, and *New York license* are negatively related to this metric. In contrast, there is no statistically significant relationship between *Net realized capital gains on Total assets* and *Reinsurance demand*, *Line concentration*, or *Business mix concentration*.

These results suggest that higher *ROA* is associated with greater realized investment gains, reflecting a strong overall financial performance that may include strategic asset sales. A positive relationship with two-year loss development may indicate that insurers experiencing adverse reserve developments are more likely to liquidate investments to meet claim obligations, thereby realizing gains or losses. Group affiliation may facilitate internal capital optimization strategies, leading to more frequent realization of gains. Higher capital levels may provide greater financial flexibility, enabling firms to engage in proactive investment management, including profit-taking on appreciated securities.

Conversely, a negative relationship with *Reinsurance price* may reflect a market environment where higher reinsurance costs (indicative of heightened risk) coincide with more conservative investment strategies or fewer opportunities to realize gains. *Tax exemption* may increase the incentive to realize capital gains, as exempt entities may prefer to defer recognition of such income. *New York license*, which often comes with more stringent regulatory oversight, could be associated with more conservative investment practices, resulting in fewer realized gains.

Overall, these findings highlight how profitability, capital strength, reserve dynamics, and regulatory environments influence insurers' decisions to realize gains or losses on their investment portfolios, shaping this important component of overall financial performance.

For small insurers, as shown in Table B6, the relationships with *Net realized capital gains on Total assets* differ in several keyways from those observed for all insurers. Specifically, for small insurers, there is a positive relationship with *ROA*, *Line concentration*, *Group affiliation*, and *Capital ratio*, while a negative relationship is found with *Reinsurance price* and *New York license*. In contrast, there is no statistically significant relationship with *Reinsurance demand*, *Tax exemption*, or *Two-year loss development*.

These findings suggest that for small insurers, higher *ROA* continues to be linked to stronger investment performance, possibly reflecting better overall financial health and more active portfolio management. A positive relationship with line concentration may indicate that small insurers focused on specific lines might manage more targeted investment portfolios, potentially enabling them to realize capital gains more effectively. Being part of a group may offer small insurers access to shared investment strategies or liquidity support, increasing their ability to realize gains. Greater capital reserves may provide small firms with the flexibility needed to realize investment gains strategically, particularly during periods of market opportunity.

Meanwhile, a negative relationship with *Reinsurance price* could reflect cost pressures that limit small insurers' ability to buy reinsurance. The negative impact of *New York license* may suggest costs on small firms in that jurisdiction.

The absence of a significant relationship with *Tax exemption*, *Two-year loss development*, and *Reinsurance demand* may reflect differences in scale and complexity — small insurers might face less exposure to tax-based investment planning or reserve volatility.

Comparison with all insurers, *Two-year loss development* and *Tax exemption* showed significant relationships with realized gains, whereas these were not significant for small insurers — possibly due to differences in portfolio size, claim volatility, or tax exposure. Line concentration, which was not significant for the full sample, is significant for small insurers — suggesting that concentration risk plays a more pronounced role in shaping investment strategies in smaller firms. The consistent positive relationships with *ROA*, *Group affiliation*, and *Capital* across both groups highlight shared underlying dynamics, though their magnitude or strategic implications may vary by size.

For large insurers, as shown in Table B5, reinsurance price and *Liquidity creation ratio* are negatively related to the *Net realized capital gains on Total assets*, while *Line concentration* is positively related.

This suggests that when reinsurance prices rise, large insurers may be less willing or able to realize capital gains, possibly because higher reinsurance costs tighten overall profitability and reduce investment flexibility. Similarly, a higher *Liquidity creation ratio*—indicating that insurers are taking on more illiquid liabilities relative to total assets—could lead them to hold investments longer, as they prioritize liquidity management overactive portfolio rebalancing.

In contrast, the positive relationship with line concentration implies that large insurers that focus more heavily on a narrower set of insurance lines may experience more stable underwriting results, allowing them to manage their investments more opportunistically. Specialization could lead to greater predictability in cash flows and reserve requirements, enabling insurers to time the realization of capital gains or limit realized losses more effectively.

Overall, these findings highlight how external market factors (like reinsurance pricing) and internal strategic choices (like liquidity management and underwriting focus) jointly influence large insurers' investment performance, particularly in terms of realizing gains or minimizing losses on their asset portfolios.

- *Net investment income on Total assets*

From Table B4 (all insurers) and Table B6 (small insurers), we observe that the coefficients for *Liabilities*, *Line concentration*, *Reinsurance price*, *Two-year loss development*, and *Group affiliation* are all negatively and significantly related to *Net investment income on Total assets*. This suggests that insurers with high liabilities relative to liquid *Total assets* may face liquidity constraints or be forced to adopt more conservative investment strategies, which reduce their ability to generate returns on their assets portfolios. Similarly, high line concentration reflects limited diversification across lines of business, which may be correlated with less diversified or risk-averse investment approaches, leading to lower investment income.

Reinsurance price and two-year loss development—as indicators of recent risk exposure or market stress—may also prompt insurers to rebalance portfolios toward safer, lower-yielding assets, again suppressing investment returns. Group affiliation may reflect centralized investment management at the group level, where individual entities report lower income despite broader group-level performance, due to intercompany transactions or capital pooling arrangements.

While *Geographical concentration* shows a positive relationship with *Net investment income* for all insurers, this may suggest that regionally focused firms are able to capitalize on localized investment opportunities or better align investment decisions with regional economic conditions.

The New York license is negatively related to net investment income for all insurers but is not statistically significant for small insurers. This could reflect stricter investment rules or higher costs in New York that affect larger or more complex insurers while smaller firms may be less present.

The *Two-year loss development* is negatively related to *Net investment income* for both all insurers and small insurers, but the relationship is not statistically significant for large insurers. This could reflect the fact that higher loss development weakens financial stability, prompting insurers—particularly smaller ones—to adopt more conservative investment strategies that yield lower returns. For small insurers, adverse loss development may also signal weaker reserve practices or greater exposure to long-tail lines, increasing uncertainty and risk aversion in portfolio management. In contrast, large insurers may be better equipped to absorb reserve adjustments without significantly altering their investment strategy, which could explain the lack of significance in that group.

Lastly, *Tax exemption* is not statistically significant for all insurers, positively related for large insurers (Table B5), and negatively related for small insurers (Table B6). This suggests that larger tax-exempt insurers may benefit from more efficient investment management or favorable regulatory treatment that supports higher investment returns. In contrast, smaller tax-exempt insurers might adopt more conservative investment strategies to maintain compliance or reduce risk exposure, which could lead to lower investment income relative to total assets.

- *Capital ratio*

Table B4 presents the results for all insurers, showing that the *Capital ratio* is positively associated with *Reinsurance demand*, *Reinsurance price*, and *Tax exemption*. In contrast, the liability variable (a dummy equal to 1 if a firm's adjusted liabilities to liquid *Total assets* ratio is ≥100%) shows a negative and significant relationship with the *Capital ratio*. Other variables — including *Geographical concentration*, *Two-year loss development*, and *New York license* — do not exhibit statistically significant relationships.

For large insurers (Table B5), *Capital ratio* is positively associated with *Reinsurance demand*, *Geographical concentration*, and *Reinsurance price*, while *Liabilities* again shows a negative relationship. However, there is no significant relationship with *Tax exemption*, *Two-year loss development*, or *New York license*, marking a distinction from the full sample.

In contrast, for small insurers (Table B6), the pattern differs more substantially. The *Capital ratio* is positively associated with *Tax exemption* and *New York license*, while it is negatively related to *Liabilities*, *Reinsurance price*, and *Two-year loss development*. Notably, there is no significant relationship with *Reinsurance demand* or *Geographical concentration* — both of which were significant for all or large insurers.

These findings suggest that *Liabilities* is consistently negatively related to the *Capital ratio* across all insurer groups, indicating that firms with higher liability exposure relative to liquid *Total assets* tend to hold lower levels of capital. This pattern highlights the adverse impact of tight liquidity positions on capital strength.

Reinsurance demand is positively associated with capital for all and large insurers, but not for small insurers. This could reflect that larger firms use reinsurance more strategically to manage capital efficiently, while smaller firms may face high price constraints or different regulatory incentives.

Reinsurance price is positively related to capital for all and large insurers, but negatively for small insurers. This divergence may suggest that rising reinsurance costs constrain smaller firms' capital positions, while larger firms can absorb the cost or price into their underwriting.

Tax exemption shows a positive relationship with *Capital ratio* for all and small insurers, but not for large insurers. This could mean that tax incentives play a more meaningful role in bolstering capital levels for smaller, potentially more tax-sensitive firms.

Geographical concentration positively relates to capital only for large insurers, suggesting that regionally focused large insurers may face lower diversification risk or benefit from more predictable regional markets, leading to stronger capital positions.

Two-year loss development is negatively related to capital only for small insurers, indicating that reserve volatility or claims uncertainty may more heavily affect their capital adequacy compared to larger peers.

New York license has no significant effect for all and large insurers but is positively associated with capital for small insurers. This may reflect either regulatory discipline or strategic positioning among smaller firms operating in New York.

Large insurers show more strategic and diversified drivers of capital, with factors like reinsurance use and geographical focus playing a stronger role. Small insurers appear more sensitive to regulatory and financial pressures, such as tax benefits, loss development, and reinsurance pricing, which influence their capital positioning more acutely. All insurers reflect a blended view, but the distinctive patterns between large and small firms underscore the importance of firm size and operational complexity in shaping capital strategies within the property-casualty insurance sector.

Table B1: *Inflation rate* and its effect on *Premiums on Total assets*, *Losses incurred on Total assets,* and *Net gain from operations on Total assets* for all insurers, 1993-2023

Variable	*Premiums on Total assets*	*Losses incurred on Total assets*	*Net gain from operations on Total assets*
Premiums on Total assets$_{t-1}$	0.6422		
	(0.000)		
Losses incurred on Total assets$_{t-1}$		0.4703	
		(0.000)	
Net gain from operations on Total assets$_{t-1}$			0.3560
			(0.000)
Inflation rate$_{t-1}$	0.0004	0.0005	-0.0001
	(0.509)	(0.274)	(0.790)
Reins$_t$	-0.2297	-0.1826	
	(0.000)	(0.000)	
ROA$_t$	0.1191	-0.3928	
	(0.398)	(0.000)	
Insurance leverage$_t$	0.0164	0.0157	-0.0040
	(0.008)	(0.000)	(0.078)
Geographical concentration$_t$	-0.0155	0.0567	0.1104
	(0.608)	(0.015)	(0.000)
Regulatory pressure$_t$	0.0998	0.0750	-0.0265
	(0.011)	(0.001)	(0.010)
Line concentration$_t$	0.0772	0.0932	-0.0858
	(0.020)	(0.000)	(0.000)
Reinsurance price$_t$	-0.0051	-0.0093	0.0136
	(0.052)	(0.000)	(0.000)
Tax exemption$_t$	-0.0103	-0.0152	0.0164
	(0.237)	(0.050)	(0.046)
Loss development ratio$_t$	0.0001	-0.0005	0.0003
	(0.633)	(0.000)	(0.001)
New York license$_t$	0.0111	-0.0185	-0.0173
	(0.687)	(0.421)	(0.264)
Group affiliation$_t$	-0.0131	-0.0079	-0.0240
	(0.132)	(0.283)	(0.005)
Mix concentration$_t$	-0.0780	-0.0997	
	(0.049)	(0.002)	
Capital$_t$	-0.0904	0.0560	0.0308
	(0.030)	(0.077)	(0.281)
Number of observations	46,816	46,816	46,816
Number of firms	3,163	3,163	3,163
Number of instruments	2,268	2,268	2,100
p-value Hansen test	0.3230	0.2574	0.6554

Note: This table provides the results of two-step GMM with orthogonal deviations and different number of instruments. Windmeijer-corrected standard errors are computed, and the corresponding *p*-values are reported in parentheses.

Table B2: *Inflation rate* and its effect on *Premiums on Total assets*, *Losses incurred on Total assets,* and *Net gain from operations on Total assets* for large insurers, 1993-2023

Variable	*Premiums on Total assets*	*Losses incurred on Total assets*	*Net gain from operations on Total assets*
Premiums on Total assets$_{t-1}$	0.4911		
	(0.000)		
Losses incurred on Total assets$_{t-1}$		0.1622	
		(0.025)	
Net gain from operations on Total assets$_{t-1}$			0.2161
			(0.019)
Inflation rate$_{t-1}$	0.0012	0.0021	-0.0016
	(0.004)	(0.005)	(0.214)
Reins$_t$	-0.1913	-0.2662	-0.0532
	(0.001)	(0.000)	(0.255)
Liquid$_t$	0.2681		-0.1866
	(0.000)		(0.007)
ROA$_t$		-0.6229	
		(0.000)	
Insurance leverage$_t$	0.0304	0.0396	0.0292
	(0.090)	(0.113)	(0.058)
Line concentration$_t$			-0.0346
			(0.333)
Regulatory pressure$_t$		0.0855	-0.0628
		(0.014)	(0.175)
Geographical concentration$_t$	-0.1083	-0.0558	0.0997
	(0.048)	(0.258)	(0.429)
Reinsurance price$_t$	-0.0022	-0.0130	0.0209
	(0.418)	(0.015)	(0.000)
Tax exemption$_t$		-0.0295	0.0241
		(0.344)	(0.467)
Mix concentration$_t$		-0.0361	
		(0.361)	
Capital$_t$		-0.1777	
		(0.247)	
Size$_t$	-0.0319		
	(0.001)		
Number of observations	2,078	2,078	2,078
Number of firms	152	152	152
Number of instruments	102	102	98
p-value Hansen test	0.3792	0.5071	0.5235

Note: This table provides the results of two-step GMM-FOD and different number of instruments. Windmeijer-corrected standard errors are computed, and the corresponding p-values are reported in parentheses.

Table B3: *Inflation rate* and its effect on *Premiums on Total assets*, *Losses incurred on Total assets,* and *Net gain from operations on Total assets* for small insurers, 1993-2023

Variable	*Premiums on Total assets*	*Losses incurred on Total assets*	*Net gain from operations on Total assets*
Premiums on Total assets$_{t-1}$	0.5766		
	(0.000)		
Losses incurred on Total assets$_{t-1}$		0.4563	
		(0.000)	
Net gain from operations on Total assets$_{t-1}$			0.3741
			(0.000)
Inflation rate$_{t-1}$	0.0004	0.0004	-0.0002
	(0.560)	(0.353)	(0.638)
Reins$_t$	-0.2545	-0.1743	
	(0.000)	(0.000)	
ROA$_t$	0.1394	-0.3867	
	(0.443)	(0.000)	
Insurance leverage$_t$	0.0145	0.0130	-0.0043
	(0.054)	(0.003)	(0.115)
Geographical concentration$_t$	-0.0154	0.0355	0.1092
	(0.696)	(0.205)	(0.000)
Regulatory pressures$_t$	0.1191	0.0954	-0.0171
	(0.018)	(0.001)	(0.172)
Line concentration$_t$	0.0548	0.0776	-0.0929
	(0.062)	(0.002)	(0.000)
Reinsurance price$_t$	-0.0052	-0.0088	0.0124
	(0.162)	(0.000)	(0.000)
Tax exemption$_t$	-0.0106	-0.0217	0.0047
	(0.347)	(0.012)	(0.629)
Loss development ratio$_t$	0.0000	-0.0005	0.0002
	(0.877)	(0.000)	(0.127)
New York license$_t$	0.0116	-0.0199	-0.0105
	(0.749)	(0.481)	(0.599)
Group affiliation$_t$	-0.0118	-0.0106	-0.0331
	(0.268)	(0.171)	(0.008)
Mix concentration$_t$	-0.0510	-0.0867	
	(0.180)	(0.011)	
Capital ratio$_t$	-0.1212	-0.0601	0.0180
	(0.009)	(0.095)	(0.561)
Number of observations	41,005	41,005	41,005
Number of firms	3,030	3,030	3,030
Number of instruments	1,950	1,950	1,771
p-value Hansen test	0.4095	0.3677	0.6255

Note: This table provides the results of two-step GMM-FOD and different number of instruments. Windmeijer-corrected standard errors are computed, and the corresponding *p*-values are reported in parentheses.

Table B4: *Inflation rate* and its effect on *Net realized capital gains on Total assets*, *Net investment income on Total assets*, and *Capital ratio* for all insurers, 1993-2023

Variable	*Net realized capital gains on Total assets*	*Net investment income on Total assets*	*Capital ratio*
Net realized capital gains on Total assets$_{t-1}$	0.0644		
	(0.082)		
Net investment income on Total assets$_{t-1}$		0.6498	
		(0.000)	
Capital ratio$_{t-1}$			0.7992
			(0.000)
Inflation rate$_{t-1}$	-0.0007	0.0009	-0.0011
	(0.000)	(0.000)	(0.000)
Reins$_t$	-0.0068		0.0345
	(0.107)		(0.010)
ROA$_t$	0.0900		
	(0.002)		
Insurance leverage$_t$		0.0001	
		(0.777)	
Geographical concentration$_t$		0.0116	0.0098
		(0.001)	(0.527)
Liabilities$_t$		-0.0064	-0.0786
		(0.000)	(0.000)
Line concentration$_t$	0.0158	-0.0053	
	(0.196)	(0.021)	
Reinsurance price$_t$	-0.0020	-0.0005	0.0013
	(0.000)	(0.003)	(0.057)
Tax exemption$_t$	-0.0066	-0.0012	0.0306
	(0.006)	(0.423)	(0.000)
Loss development ratio$_t$	0.0001	-0.0001	-0.0001
	(0.044)	(0.000)	(0.469)
Size$_t$			0.0029
			(0.160)
New York$_t$	-0.0133	-0.0168	-0.0105
	(0.075)	(0.002)	(0.480)
Group affiliation$_t$	0.0066	-0.0044	
	(0.002)	(0.002)	
Mix concentration$_t$	-0.0020		
	(0.904)		
Capital$_t$	0.0271	-0.0017	
	(0.000)	(0.763)	
Number of observations	46,816	46,816	46,816
Number of firms	3,163	3,163	3,163
Number of instruments	2,268	2,100	2,268
p-value Hansen test	0.3427	0.3539	0.3767

Note: This table provides the results of two-step GMM with orthogonal deviations and different number of instruments. Windmeijer-corrected standard errors are computed and the corresponding *p*-values are reported in parentheses.

Table B5: *Inflation rate* and its effect on *Net realized capital gains on Total assets*, *Net investment income on Total assets*, and *Capital ratio* for large insurers, 1993-2023

Variable	*Net realized capital gains on Total assets*	*Net investment income on Total assets*	*Capital ratio*
Net realized capital gains on Total assets$_{t-1}$	0.2553		
	(0.007)		
Net investment income on Total assets$_{t-1}$		0.3280	
		(0.001)	
Capital ratio$_{t-1}$			0.6649
			(0.000)
Inflation rate$_{t-1}$	-0.0033	0.0008	-0.0021
	(0.001)	(0.001)	(0.048)
Reins$_t$	-0.0208		0.2155
	(0.385)		(0.031)
Liquid$_t$	-0.1300		
	(0.000)		
ROA$_t$		0.1498	
		(0.025)	
Regulatory pressures$_t$	-0.0973		
	(0.253)		
Liabilities$_t$			-0.1238
			(0.000)
Geographical concentration$_t$			0.2036
			(0.095)
Line concentration$_t$	0.0657		
	(0.015)		
Reinsurance price$_t$		-0.0021	0.0116
		(0.225)	(0.001)
Tax exemption$_t$	-0.0568	0.0327	0.0644
	(0.006)	(0.014)	(0.222)
Loss development ratio$_t$		-0.0000	0.0002
		(0.715)	(0.602)
Size$_t$			0.0084
			(0.568)
New York$_t$	-0.0835		0.0834
	(0.349)		(0.418)
Capital ratio$_t$		-0.0630	
		(0.033)	
Number of observations	2,078	2,078	2,078
Number of firms	152	152	152
Number of instruments	98	102	98
p-value Hansen test	0.3354	0.3852	0.4715

Note: This table provides the results of two-step GMM-FOD and different number of instruments. Windmeijer-corrected standard errors are computed, and the corresponding *p*-values are reported in parentheses.

Table B6: *Inflation rate* and its effect on *Net realized capital gains on Total assets*, *Net investment income on Total assets*, and *Capital ratio* for small insurers, 1993-2023

Variable	*Net realized capital gains on Total assets*	*Net investment income on Total assets*	*Capital ratio*
Net realized capital gains on Total assets$_{t-1}$	0.0439		
	(0.150)		
Net investment income on Total assets$_{t-1}$		0.5640	
		(0.000)	
Capital ratio$_{t-1}$			0.7591
			(0.000)
Inflation rate$_{t-1}$	-0.0009	0.0011	-0.0013
	(0.000)	(0.000)	(0.000)
Reins$_{t-1}$	-0.0019		-0.0093
	(0.686)		(0.287)
ROA$_{t-1}$	0.0630		
	(0.057)		
Insurance leverage$_t$		0.0002	
		(0.791)	
Geographical concentration$_t$		0.0119	0.0054
		(0.001)	(0.685)
Liabilities$_t$		-0.0043	-0.0352
		(0.017)	(0.000)
Line concentration$_t$	0.0146	-0.0104	
	(0.010)	(0.000)	
Reinsurance price$_t$	-0.0014	-0.0003	-0.0021
	(0.013)	(0.063)	(0.001)
Tax exemption$_t$	-0.0017	-0.0039	0.0513
	(0.557)	(0.009)	(0.000)
Loss development ratio$_t$	0.0001	-0.0001	-0.0001
	(0.178)	(0.011)	(0.097)
New York$_t$	-0.0182	0.0014	0.0277
	(0.031)	(0.797)	(0.041)
Group affiliation$_t$	0.0076	-0.0051	
	(0.008)	(0.001)	
Capital ratio$_t$	0.0153	-0.0016	
	(0.047)	(0.818)	
Number of observations	41,005	41,005	41,005
Number of firms	3,030	3,030	3,030
Number of instruments	1,950	1,617	2,325
p-value Hansen test	0.4410	0.3817	0.2132

Note: This table provides the results of two-step GMM-FOD and different number of instruments. Windmeijer-corrected standard errors are computed and the corresponding *p*-values are reported in parentheses.

Appendix C: Results of two-step GMM-FOD models on financial crises variables

The research also examines the relationship between *Reinsurance demand*, *Liquidity creation ratio*, and *ROA* during major economic crises: the 2001 recession, the 2007-2008 financial crisis, and the COVID-19 pandemic.

From Table C1, the three economic crises do not significantly influence *Reinsurance demand*. The 2001 recession and the 2007-2008 financial crisis both enhances liquidity creation, while COVID-19 reduces it. The 2001 recession lowers *ROA*, while COVID-19 and 2007-2008 financial crisis have no significant effect on *ROA*.

Table C1: Financial crises and their effects on *Reinsurance demand*, *Liquidity creation ratio*, and *ROA*, for all insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7835	0.0338	-0.0210
	(0.000)	(0.001)	(0.038)
$Liquid_{t-1}$	0.0906	0.7374	0.0645
	(0.000)	(0.000)	(0.000)
ROA_{t-1}	-0.0578	-0.2121	0.3517
	(0.003)	(0.000)	(0.000)
2007-2008	0.0019	0.0077	-0.0013
	(0.276)	(0.000)	(0.325)
2001 recession	0.0031	0.0533	-0.0168
	(0.260)	(0.000)	(0.000)
2020 COVID-19	0.0033	-0.0137	0.0023
	(0.122)	(0.000)	(0.145)
Number of observations	46,816	46,816	46,816
Number of firms	3,163	3,163	3,163
Number of instruments	1,860	2,436	2,436
p-value Hansen test	0.3152	0.2525	0.2676

Note: Two-step GMM-FOD regression model, with Windmeijer-corrected standard errors, the corresponding *p*-values are reported in parentheses. Results on control variables are not presented. Dummy variables were added for the 2007-2008 financial crisis, the 2001 recession, and 2020 COVID-19 pandemic.

Table C2 presents the impact of major economic crises on large insurers' financial metrics. The 2001 recession significantly increased *Reinsurance demand* among large insurers, suggesting a heightened need for risk mitigation during that period. In contrast, other major economic crises, including the COVID-19 pandemic, did not have a statistically significant effect on *Reinsurance demand* for these insurers.

Table C2: Financial crises and their effects on *Reinsurance demand*, *Liquidity creation ratio*, and *ROA* for large insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7730	-0.0233	-0.0608
	(0.000)	(0.642)	(0.205)
$Liquid_{t-1}$	0.0363	0.8057	-0.0252
	(0.585)	(0.000)	(0.735)
ROA_{t-1}	0.2046	-0.0168	0.3002
	(0.119)	(0.870)	(0.003)
2007-2008	0.0045	0.0177	-0.0180
	(0.461)	(0.004)	(0.074)
2001 recession	0.0219	0.0642	-0.0324
	(0.031)	(0.000)	(0.001)
2020 COVID-19	0.0007	-0.0058	-0.0007
	(0.890)	(0.241)	(0.877)
Number of observations	2,078	2,078	2,078
Number of firms	152	152	152
Number of instruments	110	110	98
p-value Hansen test	0.4286	0.2067	0.3896

Note: Two-step GMM-FOD regression model, with Windmeijer-corrected standard errors, the corresponding *p*-values are reported in parentheses. Results on control variables are not presented. Dummy variables were added for the 2007-2008 financial crisis, the 2001 recession, and the 2020 COVID-19 pandemic.

During the 2001 recession and 2007-2008 financial crises, large insurers enhanced their liquidity creation efforts, possibly as a strategic response to the economic downturn. However, the COVID-19 pandemic did not have a significant impact on the *Liquidity creation ratio* for these insurers.

The 2001 recession was associated with a decrease in *ROA* for large insurers, reflecting reduced profitability during that time. In contrast, the COVID-19 pandemic did not have a statistically significant effect on *ROA* for these insurers.

Table C3 reveals that, for small insurers, major economic crises have varying impacts on financial metrics. *Reinsurance demand* remains largely unaffected across these periods. Both the 2001 recession and the 2007-2008 financial crisis led to increased liquidity creation, suggesting a strategic move to bolster financial stability during economic downturns. Conversely, the COVID-19 pandemic results in a reduction in liquidity creation, potentially due to unique challenges posed by the pandemic.

Table C3: Financial crises and their effects on *Reinsurance demand*, *Liquidity creation ratio*, and *ROA* for small insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7918	0.0376	-0.0272
	(0.000)	(0.001)	(0.064)
$Liquid_{t-1}$	0.0881	0.7269	0.1082
	(0.000)	(0.000)	(0.000)
ROA_{t-1}	-0.0560	-0.2038	0.3796
	(0.001)	(0.000)	(0.000)
2007-2008	0.0012	0.0065	0.0007
	(0.584)	(0.000)	(0.632)
2001 recession	0.0041	0.0503	-0.0127
	(0.190)	(0.000)	(0.000)
2020 COVID-19	0.0039	-0.0144	0.0040
	(0.144)	(0.000)	(0.038)
Number of observations	41,005	41,005	41,005
Number of firms	3,030	3,030	3,030
Number of instruments	1,860	2,030	1,950
p-value Hansen test	0.2511	0.2356	0.3256

Note: Two-step GMM-FOD regression model, with Windmeijer-corrected standard errors, the corresponding *p*-values are reported in parentheses. Results on control variables are not presented. Dummy variables were added for the 2007-2008 financial crisis, the 2001 recession and the 2020 COVID-19 pandemic.

Regarding profitability, the 2001 recession is associated with a decrease in *ROA*, while the COVID-19 pandemic corresponds with an increase in *ROA*. The 2007-2008 financial crisis does not have a significant effect on *ROA* for small insurers. These findings highlight that small insurers adjust their liquidity strategies differently in response to various economic crises, reflecting the distinct nature and impact of each event.

Appendix D: Correlations matrix of the key financial variables

Table D1 presents the correlation matrix of the nine key financial variables. The strength and direction of these relationships reveal several important patterns. The *Liquidity creation ratio* is negatively and strongly correlated with *Capital ratio* (-0.6333), while showing strong positive correlations with *Premiums on Total assets* (0.4529) and *Losses incurred on Total assets* (0.4295). These correlations suggest that when premiums and losses incurred rise, insurers tend to increase their liquidity creation activities, possibly to ensure sufficient resources for claim payments and operational needs. Conversely, as capital levels increase, liquidity creation tends to decrease, implying that well-capitalized insurers may face less pressure to generate additional liquidity.

The correlation coefficient between *ROA* and *Net gain from operations on Total assets* is 1, indicating a perfect positive relationship, as expected, since *ROA* incorporates the net gain from operations as a key component. Additionally, *ROA* is negatively correlated with *Losses incurred on Total assets* (-0.2281) and positively correlated with *Net realized capital gains on Total assets* (0.2264). This suggests that higher incurred losses tend to reduce profitability, while realized capital gains improve it.

Premiums on Total assets is positively correlated with *Losses incurred on Total assets* (0.8743), reflecting the direct relationship between business volume and associated claim costs — as insurers write and earn more premiums, the volume of claims naturally increases. Meanwhile, *Premiums on Total assets* is negatively correlated with *Capital ratio* (-0.2354), indicating that insurers operating with relatively higher premium volumes tend to have proportionally lower capital positions, potentially reflecting higher leverage or more aggressive underwriting strategies.

Reinsurance demand is negatively correlated with *Premiums on Total assets* (-0.2349) and *Losses incurred on Total assets* (-0.1584). This suggests that insurers with higher business volumes and claims costs tend to rely less on reinsurance, possibly retaining more risk in-house or indicating that highly reinsured insurers manage smaller, less volatile books of business.

Lastly, *Losses incurred on Total assets* is negatively correlated with *Net gain from operations on Total assets* (-0.2281) and with *Capital ratio* (-0.2678). These relationships imply that higher claims costs erode operational profitability and tend to be associated with weaker capital positions, reinforcing the critical role of underwriting performance in preserving both profitability and capital strength in the property-casualty insurance sector.

Table D1: Correlations between nine financial variables, 1992-2023

	Reins	*Liquid*	*ROA*	Pe	Li	Nibdt	Ii	Rcg	Capital
Reins	1.0000	0.0680	-0.0859	-0.2349	-0.1584	-0.0859	-0.0474	-0.0259	-0.0495
		(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
Liquid		1.0000	-0.1725	0.4529	0.4295	-0.1725	-0.2062	-0.0389	-0.6333
			(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
ROA			1.0000	0.0114	-0.2281	1.0000	0.1807	0.2264	0.1687
				(0.0095)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
Pe				1.0000	0.8743	0.0114	0.1282	-0.0011	-0.2354
					(<0.0001)	(0.0095)	(<0.0001)	(0.7993)	(<0.0001)
Li					1.0000	-0.2281	0.1574	0.0297	-0.2678
						(<0.0001)	(<0.0001)	(<0.0001)	(<0.0001)
Nibdt						1.0000	0.1807	0.2264	0.1687
							(<0.0001)	(<0.0001)	(<0.0001)
Ii							1.0000	0.0998	0.0279
								(<0.0001)	(<0.0001)
Rcg								1.0000	0.0360
									(<0.0001)
Capital ratio									1.0000

Note: *Reins*: *Reinsurance demand*; *Liquid: Liquidity creation ratio*; *ROA*: Return on Total assets; Pe: *Premiums on Total assets*; Li*: Losses incurred on Total assets*; Nibdt: *Net gain from operations on Total assets*; Ii: *Net investment income on Total assets*; Rcg : *Net realized capital gains on Total assets*; *Capital ratio*: *Capital and surplus on Total assets*.
The values in parentheses represent the *p*-values testing the null hypothesis that each correlation coefficient is equal to zero.
Almost all correlations are statistically significant at the 1% level, with one exception.

Appendix E: OLS estimation results

Estimations are made using Stata xtreg for OLS fixed effect. The OLS fixed effects parameters for lagged *Reinsurance demand*, lagged *Liquidity creation ratio* and lagged *ROA* are respectively 0.7493, 0.7391, 0.2360, which should be considered as a lower-bound estimate. If the two-step GMM-FOD estimates obtained are close to or below the fixed-effects estimates, this suggests that the GMM-FOD estimates are downward biased due to weak instrumentation.

Table E1: OLS Estimation Results for *Reinsurance demand*, *Liquidity creation ratio*, and *ROA* for all insurers, 1993-2023

Variable	$Reins_t$	$Liquid_t$	ROA_t
$Reins_{t-1}$	0.7493	0.0299	-0.0052
	(0.000)	(0.000)	(0.160)
$Liquid_{t-1}$	0.0748	0.7391	0.0437
	(0.000)	(0.000)	(0.000)
ROA_{t-1}	-0.0566	-0.0473	0.2360
	(0.000)	(0.001)	(0.000)
Number of observations	46,816	46,816	46,816
Number of firms	3,163	3,163	3,163
R-Square (within)	0.6282	0.5562	0.2188

Note: OLS fixed effects regression model, results on control variables are not presented. Heteroscedasticity-consistent standard errors clustered at the firm level are computed and the corresponding *p*-values are reported in parentheses. *p*-values lower than 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively.

Appendix F: Analysis based on two-step GMM-FOD for additional financial variables

F.1 Variables and predictions

In Section 7, we examined the reciprocal relationships between reinsurers' *Liquidity creation ratio*, their profitability (measured by *ROA*), and their *Reinsurance demand*. These analyses aim to capture how these core operational and financial metrics influence one another within the property-casualty insurance industry.

In addition to these reciprocal relationships, we also included inflation as a control variable in the analysis. While we did not explore the reciprocal effect of inflation itself, its role was important in accounting for broader macroeconomic conditions that could impact the relationships among these decision variables.

In this section, we shift our focus to examine the relationship between inflation and a broader set of six financial variables within the P&C insurance industry. Table F1 describes the variables and presents their short-term predicted relationships with inflation.

Table F1: Predicted relationships between inflation and six financial variables

Variable	Predicted relationship	Explanation
Premiums to Total assets	Positive	As inflation rises, insurers typically adjust premium rates upward to cover higher expected claims costs and expenses. However, premium increases often lag behind inflation due to pricing regulations, competition, or multiyear policy terms. Demand for insurance can also decrease, driving a negative effect on premiums.
Losses incurred to Total assets	Positive	Inflation increases the cost of claims — especially for property repairs, medical expenses, and liability settlements. This leads to higher loss ratios and incurred losses relative to *Total assets*. Insurance coverage may also decrease.

Variable	Predicted relationship	Explanation
Net gain from operations to Total assets	Negative	Claims costs usually increase faster than premiums (due to inflation lag), which reduces underwriting profits. Unless offset by investment income growth, operational profitability should weaken under inflationary pressure.
Net realized capital gains to Total assets	Mixed	In inflationary environments, bond prices usually fall (leading to potential capital losses if sold), while equities and real assets might perform better. Realized gains depend on asset mix, timing of sales, and portfolio strategy in response to inflation expectations.
Net investment income earned to Total assets	Mixed	Inflation typically leads to rising interest rates in the long run, which increase yields on new fixed-income investments. However, existing portfolios may have locked-in at lower rates, so the benefit of net investment income appears gradually as portfolios turn over.
Capital ratio	Negative	Rising inflation erodes asset values (especially fixed income) and raises liabilities (higher claim costs), putting downward pressure on capital to Total assets. Unless offset by strong investment returns or premium adjustments, surplus tends to shrink in inflationary periods.

Note: This table presents the predicted relationships between inflation and additional financial variables.

In summary, inflation directly affects both sides of the insurance balance sheet: liabilities increase through higher claim costs, and *Total assets*, especially fixed-income securities, can lose value in the short run. Premium adjustments often lag behind inflation, so profitability and surplus are pressured to decrease in the short run. Investment performance becomes crucial in inflationary environments, as insurers may rely more on realized gains and recurring investment income to offset underwriting strain. Company size and risk appetite also influence the degree of exposure. Large insurers might manage inflation risk better through diversification, hedging, or faster pricing adjustments.

F.2 Results of two-step GMM-FOD on inflation measures

Table F2 presents the summary results of two-step GMM-FOD models among the six financial indicators and lagged values of both observed and forecasted inflation, for all insurers. Tables F3 and F4 present respectively the results on large insurers and small insurers. Additional results are presented in tables F5 to F10.

Table F2: Two-Step GMM-FOD summary results of the effect of inflation on six core financial indicators, all insurers, control variables included but not reported

Dependent variable	IR_{t-1}	$F1\text{-}MST_{t-1}$	$F1\_GAUSI_{t-1}$	$F3\text{-}MST_{t-3}$	$F3\text{-}GAUSS_{t-3}$
Premiums to Total assets	NS	NS	+*	+*	NS
Losses incurred to Total assets	NS	+	NS	+	NS
Net gain from operations to Total assets	NS	NS	NS	-	+
Net realized capital gains to Total assets	-	-	-	+	+
Net investment income to Total assets	+	+	+	+	NS
Capital ratio	-	-	-	NS	+

*Significant at 10%. All other coefficients are significant at 5% (+,-) or not significant (NS).

Table F3: Two-Step GMM-FOD summary results of the effect of inflation on six core financial indicators, large insurers, control variables included but not reported

Dependent variable	IR_{t-1}	$F1\text{-}MST_{t-1}$	$F1\_GAUSI_{t-1}$	$F3\text{-}MST_{t-3}$	$F3\text{-}GAUSS_{t-3}$
Premiums to Total assets	+	+	+	NS	NS
Losses incurred to Total assets	+	+	+	NS	NS
Net gain from operations to Total assets	NS	-*	NS	NS	NS
Net realized capital gains to Total assets	-	NS	NS	+*	NS
Net investment income to Total assets	+	+	+	NS	NS
Capital ratio	-	-	-	NS	+*

*Significant at 10%. All other coefficients are significant at 5% (+,-) or not significant (NS).

Table F4: Two-Step GMM-FOD summary results of the effect of inflation on six core financial indicators, small insurers, control variables included but not reported

Dependent variable	IR_{t-1}	$F1\text{-}MST_{t-1}$	$F1\_GAUSI_{t-1}$	$F3\text{-}MST_{t-3}$	$F3\text{-}GAUSS_{t-3}$
Premiums to Total assets	NS	NS	+*	NS	NS
Losses incurred to Total assets	NS	+	NS	+	NS
Net gain from operations to Total assets	NS	NS	+	-	NS
Net realized capital gains to Total assets	-	-	-	+	+
Net investment income to Total assets	+	+	+	NS	NS
Capital ratio	-	-	-	+*	+*

*Significant at 10%. All other coefficients are significant at 5% (+,-) or not significant (NS).

Table F5: Forecasted *Inflation rate* and its effect on *Premiums on Total assets*, *Losses incurred on Total assets*, and *Net gain from operations on Total assets* for all insurers, 1993-2023

Variable	Pe_t	Li_t	$Nibdt_t$	Pe_t	Li_t	$Nibdt_t$	Pe_t	Li_t	$Nibdt_t$	Pe_t	Li_t	$Nibdt_t$
Pe_{t-1}	0.6428			0.6427			0.6403			0.6432		
	(0.000)			(0.000)			(0.000)			(0.000)		
Li_{t-1}		0.4763			0.4715			0.4606			0.4718	
		(0.000)			(0.000)			(0.000)			(0.000)	
$Nibdt_{t-1}$			0.3584			0.3538			0.3386			0.3625
			(0.000)			(0.000)			(0.000)			(0.000)
$F1\text{-}MST_{t-1}$	0.0008	0.0017	-0.0002									
	(0.186)	(0.000)	(0.724)									
$F1\text{-}GAUSI_{t-1}$				0.0009	0.0005	0.0003						
				(0.051)	(0.219)	(0.315)						
$F3\text{-}MST_{t-3}$							0.0016	0.0026	-0.0028			
							(0.079)	(0.000)	(0.000)			
$F3\text{-}GAUSS_{t-3}$										-0.0001	-0.0000	0.0003
										(0.213)	(0.868)	(0.008)
Number of observations	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816
Number of firms	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163
Number of instruments	2,268	2,268	2,100	2,268	2,268	2,100	2,268	2,268	2,100	2,268	2,268	2,100
p-value Hansen test	0.3363	0.2648	0.6700	0.3504	0.2544	0.6584	0.3388	0.2294	0.7031	0.3305	0.2441	0.6566

Note: This table provides the results of the GMM-FOD. Heteroscedasticity-consistent standard errors clustered at the firm level are computed and the corresponding *p*-values are reported in parentheses. *p*-values lower the 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively. Pe: *Premiums on Total assets*; Li: *Losses incurred on Total assets*; Nibdt: *Net gain from operations on Total assets.*

Table F6: Forecasted *Inflation rate* and its effect on *Premiums on Total assets*, *Losses incurred on Total assets*, and *Net gain from operations on Total assets* for large insurers, 1993-2023

Variable	Pe_t	Li_t	$Nibdt_t$	Pe_t	Li_t	$Nibdt_t$	Pe_t	Li_t	$Nibdt_t$	Pe_t	Li_t	$Nibdt_t$
Pe_{t-1}	0.5089 (0.000)			0.4964 (0.000)			0.4934 (0.000)			0.4867 (0.000)		
Li_{t-1}		0.2476 (0.001)			0.1879 (0.004)			0.2104 (0.003)			0.2117 (0.005)	
$Nibdt_{t-1}$			0.2990 (0.000)			0.2354 (0.008)			0.2367 (0.006)			0.2334 (0.005)
$F1\text{-}MST_{t-1}$	0.0025 (0.001)	0.0033 (0.046)	-0.0036 (0.068)									
$F1\text{-}GAUSI_{t-1}$				0.0016 (0.006)	0.0027 (0.013)	-0.002 (0.880)						
$F3\text{-}MST_{t-3}$							0.0003 (0.837)	0.0020 (0.158)	0.0005 (0.794)			
$F3\text{-}GAUSS_{t-3}$										0.0001 (0.815)	0.0000 (0.882)	0.0000 (0.988)
Number of observations	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078
Number of firms	152	152	152	152	152	152	152	152	152	152	152	152
Number of instruments	102	102	98	102	102	98	102	102	98	102	102	98
p-value Hansen test	0.4042	0.4463	0.5302	0.4315	0.4984	0.4533	0.3916	0.4694	0.4511	0.4462	0.5375	0.4474

Note: This table provides the results of the GMM-FOD. Heteroscedasticity-consistent standard errors clustered at the firm level are computed and the corresponding *p*-values are reported in parentheses. *p*-values lower the 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively. Pe: *Premiums on Total assets*; Li: *Losses incurred on Total assets*; Nibdt: *Net gain from operations on Total assets.*

Table F7: Forecasted *Inflation rate* and its effect on *Premiums on Total assets*, *Losses incurred on Total assets*, and *Net gain from operations on Total assets* for small insurers, 1993-2023

Variable	Pe_t	Li_t	$Nibdt_t$	Pe_t	Li_t	$Nibdt_t$	Pe_t	Li_t	$Nibdt_t$	Pe_t	Li_t	$Nibdt_t$
Pe_{t-1}	0.5770 (0.000)			0.5775 (0.000)			0.5738 (0.000)			0.5784 (0.000)		
Li_{t-1}		0.4617 (0.000)			0.4578 (0.000)			0.4440 (0.000)			0.4571 (0.000)	
$Nibdt_{t-1}$			0.3739 (0.000)			0.3670 (0.000)			0.3538 (0.000)			0.3771 (0.000)
$F1\text{-}MST_{t-1}$	0.0003 (0.681)	0.0013 (0.017)	0.0000 (0.917)									
$F1\text{-}GAUSI_{t-1}$				0.0010 (0.058)	0.0005 (0.274)	0.0011 (0.004)						
$F3\text{-}MST_{t-3}$							0.0014 (0.208)	0.0026 (0.002)	-0.0031 (0.000)			
$F3\text{-}GAUSS_{t-3}$										-0.0002 (0.114)	-0.0000 (0.984)	0.0001 (0.359)
Number of observations	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005
Number of firms	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030
Number of instruments	1,950	1,950	1,771	1,950	1,950	1,771	1,950	1,950	1,771	1,950	1,950	1,771
p-value Hansen test	0.4260	0.3615	0.6213	0.4184	0.3695	0.5721	0.4195	0.4522	0.5818	0.4408	0.3612	0.6278

Note: This table provides the results of the GMM-FOD. Heteroscedasticity-consistent standard errors clustered at the firm level are computed and the corresponding *p*-values are reported in parentheses. *p*-values lower the 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively. Pe: *Premiums on Total assets*; Li: *Losses incurred on Total assets*; Nibdt: *Net gain from operations on Total assets*.

Table F8: Forecasted *Inflation rate* and its effect on *Net realized capital gains on Total assets*, *Net investment income on Total assets* and *Capital and surplus on Total assets* for all insurers, 1993-2023

Variable	Rcg_t	Ii_t	$Capital_t$	Rcg_t	Ii_t	$Capital_t$	Rcg_t	Ii_t	$Capital_t$	Rcg_t	Ii_t	$Capital_t$
Rcg_{t-1}	0.1205 (0.005)			0.1003 (0.014)			0.0549 (0.157)			0.0782 (0.041)		
Ii_{t-1}		0.6728 (0.000)			0.6703 (0.000)			0.6788 (0.000)			0.6804 (0.000)	
$Capital_{t-1}$			0.8019 (0.000)			0.7983 (0.000)			0.8008 (0.000)			0.7969 (0.000)
$F1\text{-}MST_{t-1}$	-0.0013 (0.000)	0.0014 (0.000)	-0.0023 (0.000)									
$F1\_GAUSI_{t-1}$				-0.0007 (0.000)	0.0013 (0.000)	-0.0024 (0.000)						
$F3\text{-}MST_{t-3}$							0.0013 (0.000)	0.0005 (0.000)	0.0005 (0.171)			
$F3\text{-}GAUSS_{t-3}$										0.0002 (0.000)	-0.0000 (0.931)	0.0007 (0.000)
Number of observations	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816	46,816
Number of firms	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163	3,163
Number of instruments	2,278	2,100	2,268	2,268	2,100	2,268	2,268	2,100	2,268	2,268	2,100	2,268
p-value Hansen test	0.3788	0.3723	0.3605	0.3925	0.4529	0.3480	0.4235	0.3780	0.3572	0.4329	0.3961	0.4077

Note: This table provides the results of the GMM-FOD. Heteroscedasticity-consistent standard errors clustered at the firm level are computed and the corresponding *p*-values are reported in parentheses. *p*-values lower the 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively. Rcg: *Net realized capital gains on Total assets*; Ii: *Net investment income on Total assets*; Capital: *Capital and surplus on Total assets*.

Table F9: Forecasted *Inflation rate* and its effect on *Net realized capital gains on Total assets*, *Net investment income on Total assets* and *Capital and surplus on Total assets* for large insurers, 1993-2023

Variable	Rcg_t	Ii_t	$Capital_t$	Rcg_t	Ii_t	$Capital_t$	Rcg_t	Ii_t	$Capital_t$	Rcg_t	Ii_t	$Capital_t$
Rcg_{t-1}	0.2463 (0.031)			0.2052 (0.053)			0.1805 (0.050)			0.2168 (0.027)		
Ii_{t-1}		0.3487 (0.001)			0.3648 (0.001)			0.3497 (0.000)			0.3577 (0.000)	
$Capital_{t-1}$			0.6841 (0.000)			0.6781 (0.000)			0.6773 (0.000)			0.6803 (0.000)
$F1\text{-}MST_{t-1}$	-0.0012 (0.543)	0.0014 (0.010)	-0.0053 (0.000)									
$F1\text{-}GAUSI_{t-1}$				0.0004 (0.756)	0.0012 (0.000)	-0.0048 (0.000)						
$F3\text{-}MST_{t-3}$							0.0027 (0.057)	0.0007 (0.147)	0.0000 (0.994)			
$F3\text{-}GAUSS_{t-3}$										-0.0000 (0.962)	0.0000 (0.581)	0.0006 (0.096)
Number of observations	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078	2,078
Number of firms	152	152	152	152	152	152	152	152	152	152	152	152
Number of instruments	98	102	98	98	102	98	98	102	98	98	102	98
p-value Hansen test	0.4702	0.2721	0.5825	0.3207	0.2430	0.5745	0.5044	0.3112	0.5582	0.3576	0.3085	0.4372

Note: This table provides the results of the GMM-FOD. Heteroscedasticity-consistent standard errors clustered at the firm level are computed and the corresponding *p*-values are reported in parentheses. *p*-values lower the 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively.

Table F10: Forecasted *Inflation rate* and its effect on *Net realized capital gains on Total assets*, *Net investment income on Total assets* and *Capital and surplus on Total assets* for small insurers, 1993-2023

Variable	Rcg_t	Ii_t	$Capital_t$	Rcg_t	Ii_t	$Capital_t$	Rcg_t	Ii_t	$Capital_t$	Rcg_t	Ii_t	$Capital_t$
Rcg_{t-1}	0.1145 (0.002)			0.0965 (0.006)			0.0456 (0.164)			0.0679 (0.035)		
Ii_{t-1}		0.6300 (0.000)			0.6260 (0.000)			0.6109 (0.000)			0.6093 (0.000)	
$Capital_{t-1}$			0.7602 (0.000)			0.7590 (0.000)			0.7602 (0.000)			0.7608 (0.000)
$F1\text{-}MST_{t-1}$	-0.0015 (0.000)	0.0012 (0.000)	-0.0014 (0.000)									
$F1\text{-}GAUSI_{t-1}$				-0.0010 (0.000)	0.0012 (0.000)	-0.0016 (0.000)						
$F3\text{-}MST_{t-3}$							0.0011 (0.000)	-0.0000 (0.904)	0.0005 (0.073)			
$F3\text{-}GAUSS_{t-3}$										0.0002 (0.002)	-0.0000 (0.274)	0.0001 (0.100)
Number of observations	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005	41,005
Number of firms	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030	3,030
Number of instruments	1,950	1,617	2,325	1,950	1,617	2,325	1,950	1,617	2,325	1,950	1,617	2,325
p-value Hansen test	0.3451	0.2585	0.2031	0.5016	0.3418	0.2113	0.4097	0.2477	0.2319	0.4730	0.2587	0.2125

Note: This table provides the results of the GMM-FOD. Heteroscedasticity-consistent standard errors clustered at the firm level are computed and the corresponding *p*-values are reported in parentheses. *p*-values lower the 0.01 and 0.05 mean the coefficient is significant at 1% and 5% respectively. Rcg : *Net realized capital gains on Total assets*; Ii: *Net investment income on Total assets*; Capital: *Capital and surplus on Total assets*.

- *Premiums to Total assets*

Table F3 indicates a clear and statistically significant positive relationship between *Premiums to Total assets* and inflation for large insurers, whether inflation is measured by the lagged observed rate (IR_{t-1}) or by the lagged one-year-ahead forecast (FI). These findings suggest that large insurers systematically adjust premiums upward in response to inflationary pressures. Such adjustments likely aim to compensate for rising claims costs and inflation-driven increases in administrative and operational expenses, thereby helping to sustain underwriting profitability in real terms. However, when inflation is measured using the lagged three-year-ahead forecast (F3), the relationship becomes statistically insignificant. This implies that pricing decisions are primarily influenced by recent or near-term inflation expectations rather than by forecasts formed several years earlier.

In contrast, the results from Table F2 (all insurers) and Table F4 (small insurers) point to a weaker and less consistent link between premiums earned and inflation. Across the full sample, significance is limited, emerging only at the 10% level for F1-$GAUSS_{t-1}$ and F3-MST_{t-3}. Among small insurers, only the lagged one-year-ahead GAUSS forecast (F1-$GAUSS_{t-1}$) shows a weaker significant relationship at the 10% level. These findings suggest that, while inflation does influence premium-setting across the industry, the degree of responsiveness is considerably stronger among large insurers.

This divergence may reflect structural differences in insurers' operational capabilities and market positioning. Large insurers appear more proactive and efficient in incorporating short-term inflation signals into pricing strategies, likely benefiting from greater pricing power, advanced actuarial modeling, and more adaptable policy frameworks. Their scale and resources may also allow for quicker updates to pricing assumptions in response to changing macroeconomic conditions.

Conversely, small insurers may face a range of constraints that hinder their ability to reprice policies effectively. These may include regulatory oversight, competitive market pressures, slower decision-making processes, or limited research capacity. Additionally, the weaker and more variable inflation-premium relationships for the broader sample and for small insurers may reflect heterogeneity in product offerings, geographic focus, and underwriting strategies. Such factors can influence how inflation is perceived and transmitted into pricing across different segments of the insurance market.

In sum, the results highlight that large insurers are better positioned to respond to inflation through premium adjustments, while smaller insurers demonstrate a more conservative pricing response. This asymmetry underscores the importance of scale, operational agility, and forecasting capacity in adapting to inflationary environments.

- *Losses incurred to Total assets*

For large insurers, *Losses incurred to Total assets* exhibits a positive association with inflation when measured using the lagged value of observed inflation ($IR_{t\text{-}1}$) as well as the lagged one-year-ahead forecasted inflation from both the MST and GAUSS models ($F1\text{-}MST_{t\text{-}1}$ and $F1\text{-}GAUSS_{t\text{-}1}$). This suggests that claims costs tend to increase in line with recent inflation trends and near-term expectations. However, when inflation is measured using lagged three-year-ahead forecasts ($F3\text{-}MST_{t\text{-}3}$ and $F3\text{-}GAUSS_{t\text{-}3}$), the relationship is no longer statistically significant at conventional levels, indicating that long-term inflation expectations formed three years earlier have little bearing on current loss experience. In short, large insurers' incurred losses appear to respond more directly to realized inflation and near-term expectations than to long-range forecasts.

For the full sample and for small insurers, a similar positive relationship is observed between inflation and incurred losses. Notably, this includes significant associations with both the lagged one-year-ahead (F1-MST$_{t\text{-}1}$) and three-year-ahead (F3-MST$_{t\text{-}3}$) inflation forecasts. These findings point to a broader industry sensitivity to inflationary conditions across multiple horizons. Rising claim-related costs—such as medical care, construction materials, and vehicle parts—are all likely contributors to inflation-driven increases in incurred losses. It is interesting to observe that the MST forecasts are more significant.

- *Net gains from operations to Total assets*

The expected relationship between lagged inflation and *Net gains from operations to Total assets* is negative, as inflation tends to elevate operating and claims costs, thereby compressing insurers' profitability. Consistent with this expectation, the results for the full sample reveal a negative association between net operating gains and the lagged three-year-ahead forecasted inflation based on the F3-MST$_{t\text{-}3}$ model. However, surprisingly, a positive relationship is observed when using the same lag from the F3-GAUSS$_{t\text{-}3}$ model. This divergence underscores the influence of the inflation forecasting methodology: different models may capture varying inflationary expectations and macroeconomic contexts, which in turn affect insurers' operational outcomes in distinct ways.

For large insurers, a negative association is found between net operating gains and the lagged one-year-ahead forecasted inflation (F1-MST$_{t\text{-}1}$), significant at the 10% level. This finding suggests that even relatively recent inflation expectations—when not promptly incorporated into pricing or operational adjustments—can erode profitability. Larger insurers, with more complex structures and longer operational lead times, may face challenges in swiftly adapting to changing inflationary conditions, particularly when cost structures are more rigid or fixed.

Small insurers exhibit a pattern similar to the overall sample: a negative relationship with the F3-MST_{t-3} forecast and a positive one with F3-$GAUSS_{t-3}$. However, unlike the overall sample, small insurers display a positive relationship with F1-$GAUSS_{t-1}$, rather than with F3-$GAUSS_{t-3}$. This unexpected, mixed result highlights that small insurers may be more sensitive to the nuances of different inflation signals. Their performance could benefit from inflation dynamics that align with niche markets, more agile decision-making, or localized competitive conditions.

These insights underscore the strategic importance of monitoring and interpreting inflation forecasts—across models and time horizons—as a central component of insurer risk management. Effective pricing and underwriting strategies must account not only for realized inflation but also for the diverse ways in which inflation expectations influence firm behavior and financial outcomes over time.

- *Net realized capital gains to Total assets*

The relationship between lagged inflation and *Net realized capital gains to Total assets* is inherently complex, reflecting the multifaceted interplay between inflation dynamics and asset price movements. Across both the full sample and the subset of small insurers, a consistent pattern emerges: net realized capital gains are negatively associated with both lagged observed inflation and lagged one-year-ahead forecasted inflation, while a positive association is found with the lagged three-year-ahead forecasted inflation.

This pattern suggests that in the short term, inflation—whether realized or expected—tends to exert downward pressure on asset valuations, primarily through rising interest rates that depress bond prices and dampen equity market performance. Consequently, insurers may realize fewer capital gains or even incur losses. Over a longer historical horizon, however, capital markets appear to adjust to inflation expectations, potentially driving price appreciation of nominal assets and, thus enhancing capital gains when the assets are eventually sold.

For large insurers, a negative relationship is observed between net realized capital gains and lagged observed inflation, aligning with the notion that near-term inflationary shocks undermine asset values. However, a positive relationship—significant at the 10% level—is identified with the lagged three-year-ahead forecasted inflation ($\text{F3-MST}_{t\text{-}3}$). This result suggests that large insurers, with their longer investment horizons, broader asset diversification, and more sophisticated risk management capabilities, may be better positioned to benefit from inflation-driven nominal gains over the long run.

Despite these directional trends, many of the observed relationships lack statistical significance, especially among large insurers. This points to the dominant role of firm-specific factors—such as investment strategy, asset allocation, risk tolerance, and timing of asset disposals—in determining realized capital gains. Inflation may shape the macroeconomic context in which these gains occur, but it is not the sole determinant.

These findings highlight the importance of incorporating inflation expectations—particularly long-term ones—into investment strategy and asset-liability management. While inflation alone does not dictate capital gains outcomes, its role reinforces the value of forward-looking portfolio design, especially in volatile or inflationary macroeconomic environments.

- *Net investment income to Total assets*

The expected relationship between inflation and *Net investment income to Total assets* is positive, as inflationary environments are typically associated with rising interest rates. Higher rates boost yields on newly acquired fixed-income securities, progressively enhancing insurers' investment income as maturing assets are reinvested at more favorable terms.

Empirical findings align with this theoretical prediction. A positive and statistically significant association is observed between net investment income and both the lagged value of observed inflation (IR_{t-1}) and the lagged one-year-ahead forecasted inflation ($F1\text{-}MST_{t-1}$ and $F1\text{-}GAUSS_{t-1}$). These results suggest that insurers' investment returns respond relatively quickly to near-term inflationary pressures, leading insurers to invest rapidly in new assets like bonds. The lagged one-year-ahead forecast captures how insurers, at a prior point in time, expected short-term inflation evolve to relative to recent conditions—indicating that firms effectively incorporated these expectations into reinvestment decisions and asset allocation strategies.

By contrast, the relationship between net investment income and the lagged three-year-ahead forecasted inflation ($F3\text{-}MST_{t-3}$ and $F3\text{-}GAUSS_{t-3}$) is not statistically significant for large or small insurers. This forecast reflects how, three years earlier, insurers anticipated the medium- to long-term trajectory of inflation. Notably, for the full sample of insurers, a positive and statistically significant relationship emerges between net investment income and the lagged three-year-ahead forecast from the MST model ($F3\text{-}MST_{t-3}$). This result suggests that, at the industry level, firms may have gradually aligned their investment strategies with earlier long-term inflation expectations.

- *Capital ratio*

The expected relationship between inflation and the *Capital ratio* is negative, reflecting the dual impact of inflationary pressures on insurers' balance sheets. Rising inflation erodes the real value of *Total assets* while simultaneously increasing liabilities through elevated claims costs and operating expenses. This combination compresses surplus and capital relative to *Total assets*, thereby weakening the *Capital ratio*.

Empirical findings support this theoretical expectation. A consistently negative and statistically significant relationship is observed between the *Capital ratio* and both lagged observed inflation (IR_{t-1}) and lagged one-year-ahead forecasted inflation ($F1\text{-}MST_{t-1}$ and $F1\text{-}GAUSS_{t-1}$). These lagged forecasts reflect how, at a point in the past, insurers anticipated short-term inflation trends relative to recent experience. The results indicate that in response to anticipated near-term inflation, insurers—regardless of size—experience capital erosion or adopt more conservative capital policies, likely to preserve solvency under tightening financial conditions.

However, this relationship changes when considering long-term inflation expectations. A positive association emerges between the *Capital ratio* and the lagged three-year-ahead forecasted inflation ($F3\text{-}GAUSS_{t-3}$), particularly among small insurers. Additionally, the $F3\text{-}MST_{t-3}$ forecast is positively associated with capital ratios at the 10% significance level for small firms. These forecasts reflect how, three years ago, insurers anticipated inflation would evolve over the medium to long term—suggesting a more strategic and forward-looking capital response.

In summary, the capital ratio's responsiveness to inflation is time-horizon dependent. While short-term inflation expectations are associated with capital strain across all firms, long-term forecasts appear to prompt capital strengthening—especially among small insurers. These findings underscore the importance of incorporating forward-looking inflation expectations into capital planning frameworks to support long-term solvency and operational stability.