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# (Re)insurance and Diversification Inside P&C Insurers

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## Abstract

We show that the combination of reinsurance and diversification strategies can improve the financial conditions of group-affiliated insurers. Analyzing P&C insurance companies in the United States, we find that firms purchasing huge reinsurance from affiliates while having a largely diversified business, do exhibit low expense ratios, are more profitable and financially solid. Moreover, we show that increasing external reinsurance (i.e. reinsurance from non- affiliates) together with wide geographical diversification decreases expense ratios too. These findings are in line with the hypothesis that "real service efficiencies" from reinsurance Mayers and Smith Jr (1990) would be more substantial if insurers are able to concentrate less of their risk within only a few lines of business or geographical areas. These insights are important to develop managerial strategies to face economic phases characterized by increasing reinsurance costs like we are currently experiencing.

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# 1. Introduction

The current increasing demand for reinsurance and the prospects of higher reinsurance prices pose crucial challenges to insurance risk managers. Reinsurance demand in the United States amounts approximately to 200 billion dollars in 2023. In the coastal areas of the United States, the price of property and casualty (P&C) reinsurance is predicted to increase substantially, by approximately 40%-50% due to natural catastrophes in 2022 (mainly Hurricane Ian in Florida). Along with the hiking cost of construction and increasing demand for insurance in catastrophe-prone regions, the price of P&C insurance exhibits a continuously upward trend for coastal communities.[3] With the risk drivers of climate change, while demographic change and inflation remaining unchanged, the reinsurance demand is expected to see an increase of 10% -15% in the following years.[4]

A surge of 20% - 30% in property insurance prices is observed in North America in 2023, and this trend largely is ascribed to the dynamics within the reinsurance market. In fact, as reinsurance has become more expensive, insurers were forced to increase the premiums paid by policyholders.[5] Reinsurance and diversification are the traditional risk management tools for primary insurers in reducing underwriting risks. As the ongoing dynamics inside reinsurance markets challenge primary insurers, risk managers are urged to identify possible ways to tackle this trend and prevent impairment in growth and profitability.

In this article, we aim to explore the interaction between reinsurance and diversification strategies on primary insurers' performance. The previous literature has proved that both these aspects have important implications on insurers' performance but, to the best of our knowledge, no article has explicitly examined the interconnection between reinsurance and diversification, and its impact on profitability in the P&C insurance industry. Specifically, we aim to explore the financial im- plications of using internal versus external reinsurance along with primary insurers' diversification strategy.

We use data from U.S. P&C group-affiliated insurers during 1996-2022. This sample allows us to distinguish reinsurance transactions into internal and external transactions. Internal reinsurance is

purchased from affiliated companies, while external reinsurance is purchased from non-affiliated insurers. Our results show that multi-line insurers exhibit lower expense ratios and higher profitability by purchasing reinsurance from affiliated insurers. However, buying reinsurance from non-affiliated insurers could lower primary insurers' underwriting expenses and slightly lower return on equity as well.

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[3] https://www.reinsurancene.ws/higher-reinsurance-costs-driving-es-property-premiums-crc/ (accessed on 10 Au-gust 2023).

[4] https://www.swissre.com/risk-knowledge/mitigating-climate-risk/state-of-reinsurance-property-cat-market.html (accessed on 1 September 2023).

[5] https://jencapgroup.com/insights/property/how-to-talk-to-clients-about-reinsurance-and-rising-property-rates/(accessed on 31 July 2023).

Moreover, we find that geographically diversified insurers could lower their expense ratios and combined ratios through external reinsurance, rather than internal reinsurance.

Our study extends the reinsurance and diversification literature by examining the financial implications of the interplay. Moreover, our findings reveal that primary insurers could exploit the interplay between reinsurance and diversification strategies to economize on their performance. This study provides crucial insight for both practitioners and policymakers dealing with increasing reinsurance costs. Practitioners could draw references on how to maximize the benefit from reinsurance transactions given their level of diversification. In addition, this study offers policyholders a better understanding and monitoring of primary insurers' risk reduction activities. In fact, high reinsurance costs could endanger insurers' profitability, while at the same time could also result in higher premiums passed on to policyholders, especially in areas that are prone to catastrophe risks.

The article is organized as follows. Section 2 connects the topic to the most recent literature. Section 3 presents the data and the variables. Section 5 outlines the results. Section 5 conducts robustness tests. Section 6 concludes.

## 2. Review of the Literature

Insurance contracts provide valuable risk management solutions to both individuals and corporations. Diversification strategy and reinsurance agreements are the common means for primary insurers to manage their risk exposures. A large literature demonstrates the determinants and benefits of employing a diversification strategy and purchasing reinsurance. For example, Duijm and Van Beveren (2022) find that product diversification in the Dutch property-liability (P&L) insurance industry during the period 2007-2018 has reduced insurers' risk, although also diminishing their stock returns. Berry-Stölzle et al. (2012) show that insurers do not diversify their lines of business mainly for risk management purposes, whereas they employ diversification strategies in order to overcome barriers to business growth like market size and concentration. Finally, Regele and Regulation (2022) finds that business diversification in insurance has also stabilized systemic risk. However, the financial impacts of the diversification strategy are mixed in the literature. Elango et al. (2008) discover a non-linear effect of product diversification on financial performance, and its inter-dependency with geographic diversification. Liebenberg and Sommer (2008) contend that insurance companies should strategically focus their business, as evidence shows that the value of diversified insurers measured by Tobin's Q is lower than the value of single-line insurers. This argument is challenged by the recent evidence of Kartasheva (2021), who documents that inside global insurance groups the increasing degree of business complexity yields a diversification premium.

The use of reinsurance can not only expand primary insurers' underwriting capacity to acquire more business, but also effectively stabilize the loss pattern and mitigate underwriting risks Cole and McCullough (2006); Cole et al. (2011). However,

reinsurance contracts are expensive, and the performance implications of reinsurance usage are still unclear. Choi (2010) argues that firms ceding more business to reinsurers tend to be less profitable and grow slowly. The main reason is due to reinsurance prices, which often include a profit loading to cover the cost of risk-bearing and expenses from issuing reinsurance contracts. Moreover, the authors point out that reinsurance costs may surge when the ceding firm's moral hazard and monitoring costs increase (Doherty and Smetters, 2005). Using data from the Taiwan insurance market, Lee and Lee (2012) document that insurers with higher reinsurance dependency exhibit poorer performance, despite that reinsurance mitigates insolvency risk.

There is limited literature that explicitly examines the interaction effect between diversification and reinsurance usage on insurers' performance. We can identify two papers that are closely related to the current study. Shiu (2016) examines the possible substitution pattern between derivative usage and reinsurance purchase by using a sample of U.K. non-life insurance companies. Reinsurance and derivatives are tools to hedge insurers' underwriting and investment risks, respectively, and Shiu (2016) discovers strong evidence to support the substitution hypothesis. Another paper by Hsiao and Shiu (2019) explore the impact of business mix on internal and external reinsurance usage. They find that insurers involved in riskier product mixes tend to buy more reinsurance to hedge the underwriting risks. Moreover, they reveal that insurers in high-profit lines use more internal reinsurance, implying internal reinsurance is more cost-effective. In this study, we explicitly explore the inter-relatedness between diversification strategy and reinsurance usage on insurers' performance.

In addition, we aim to examine whether the relationship would be altered by using internal and external reinsurance. Powell et al. (2008) demonstrate that structural differences exist in the use of internal and external reinsurance, and such that they are not perfect substitutes for affiliated insurance companies. External reinsurance appears to serve the role of catastrophe risk mitigation, while internal reinsurance is a common way for group-affiliated insurers to transfer capital in a cost-effective manner. Park et al. (2021) examine the financial implications of internal and external reinsurance, and find that external reinsurance has a negative impact on ceding insurers, while internal reinsurance is beneficial to affiliated insurers.

## 3. Data and Variables

Our sample consists of all operating individual P&C insurance companies from 1996 to 2022 S&P Capital IQ. After standard screening, the final sample consists of 18,273 firm-year observations.[6] We include two measures of diversification: product diversification and geographic diversification. Following prior literature (Berry-Stölzle et al., 2012; Hsieh et al., 2015; Park et al., 2021), we measure product (or line of business) diversification as the complement to one of the Herfindahl-Hirschmann Index (HHI) computed according to the following equation:

$$PDIV_{i,l,t} = 1 - \sum_{i=1}^{I} \frac{DPW_{i,l,t}}{DPW_{i,t}} \quad (1)$$

where $DPW_{i,l,t}$ is the direct premium written of insurer i in business line l in year t. Following the insurance literature, we aggregate the business lines into 23 lines.[7] $DPW_{i,t}$ is the total direct premium written of insurer *i* in year *t*. With the same token, we construct the geographic diversification measure as follows:

$$GDIV_{i,l,t} = 1 - \sum_{i=1}^{I} \frac{DPW_{i,s,t}}{DPW_{i,t}} \quad (2)$$

where $DPW_{i,s,t}$ is the direct premium written of insurer *i* in state *s* in year *t*.

We exploit granularity in accounting data on reinsurance activities to disentangle the reinsurance purchased from affiliated companies and non-affiliated companies (Powell and Sommer, 2007; Park et al., 2021). Therefore, *INTREINS* is the ratio of total reinsurance ceded to affiliates divided by gross premiums written, while *EXTREINS* is the ratio of total reinsurance ceded to non-affiliates divided by gross premiums written.

We include two sets of performance measures as the dependent variable in the regression analy- sis. One set measures the cost of insurers - *EXP* and *OP* are the expense ratio and the operating ratio, respectively. The other set is the measure of profitability - Combined ratio (*COMB*), return on asset (*ROA*), and return on equity (*ROE*). See variable definitions and summary statistics in Table 1. We note that, on average, firms utilize more internal reinsurance than external reinsurance. In addition, insurers engage in more geographic diversification than product diversification.

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[6] We exclude firms that were the target of mergers or acquisitions (M&As) and out of business during the sample period. We also excluded firms with negative net income, negative direct premium written, and negative expenses.

[7] Line 1: fire and allied lines, Line 2: farmowners, Line 3: homeowners, Line 4: commercial multi-perils, Line 5: mortgage guaranty, Line 6: ocean marine, Line 7: inland marine, Line 8: financial guaranty, Line 9: medical professional liability, Line 10: earthquake, Line 11: accident and health, Line 12: workers' compensation, Line 13: other liability, Line 14: product liability, Line 15: private passenger and commercial auto, Line 16: aircraft, Line 17: fidelity, Line 18: surety, Line 19: burglary and theft, Line 20: boiler and machinery, Line 21: credit, Line 22: international, Line 23: warranty.

**Table 1: Variable Definitions and Summary Statistics**

| Variables | Definition | Mean | Min | Max | Std |
|---|---|---|---|---|---|
| *EXP* | Expense ratio, calculated as underwriting expenses/net premium earned | 0.2733 | 0.0360 | 9.9030 | 0.4641 |
| *OP* | Operating ratio, calculated as operating expenses/net premium earned | 0.7296 | 0.0980 | 81.0007 | 1.7400 |
| *COMB* | Combined ratio, calculated as expense ratio plus loss ratio | 0.8555 | 0.0140 | 19.4004 | 0.7883 |
| *ROE* | Return on average equity | 0.0543 | 0.0520 | 0.3882 | 0.0909 |
| *ROA* | Return on average asset | 0.0225 | 0.0322 | 0.3129 | 0.0358 |
| *INT REINS* | Reinsurance ceded to affiliated insurers | 0.4674 | 0.0000 | 1.0000 | 0.3343 |
| *EXT REINS* | Reinsurance ceded to nonaffiliated insurers | 0.1212 | 0.0000 | 0.9999 | 0.1744 |
| *PDIV* | 1 - Herfindahl Index of direct premium written across all product lines | 0.5404 | 0.0000 | 1.0000 | 0.2586 |
| *GDIV* | 1 - Herfindahl Index of direct premium written across 51 geographic regions | 0.7911 | 0.0000 | 1.0000 | 0.2565 |
| *SIZE* | Natural log of total asset | 12.2100 | 6.9231 | 19.7688 | 1.9113 |
| *CAPASS* | Capital/total assets | 0.4615 | 0.0000 | 0.1000 | 21.2388 |
| *RETEN* | Retention ratio, calculated as net premium written/gross premium written | 0.40831 | 0.0631 | 0.9999 | 31.6099 |

## 4. Results

The goal of the regression analysis is to test how the interaction between diversification (product and geographic) and reinsurance (internal and external) affects firm performance. The models are summarized with the following equation (3), where the subscripts *i* and *t* denote respectively the firm and the year:

$$\boldsymbol{Performance_{f,i,t} = \alpha_0 + \alpha_1\left(reisurance_{r,j,t} * diversification_{d,i,t}\right) + \Gamma * controls_{c,i,t} + \tau_t + \psi_j + \omega_{j,t}.}$$

The subscript *f* indicates the specific performance measures, i.e. *EXP*, *OP*, *COMB*, *ROA*, and *ROE*. The subscript *r* denotes the two measures of reinsurance, i.e. *INTREINS* or *EXTREINS*, while the subscript *d* is diversification assessed by *PDIV* or *GDIV*. The controls include *SIZE* and *CAPASS*. $\tau_t$ and $\psi_j$ are time and firm fixed effects, while $\omega_{j,t}$ is the error term. Standard errors are robust and clustered at the firm level.

Table 2 reports the results of the interactive effect of internal reinsurance and product diversification on various performance measures. Using internal insurance is associated with a higher expense ratio and lower operating ratio. However, the

coefficients are not statistically significant. The results in columns (4) and (5) show that using internal reinsurance is associated with lower profitability (*ROE* and *ROA*). These coefficients, after controlling the interaction effect, could be the results of the risk-sensitivity of demand, in which primary insurers use more internal reinsurance or lowering prices to manage increasing underwriting risk. Even though there is a comparative advantage for group-affiliated insurers in acquiring internal reinsurance, it would still lower primary insurers' profitability Sommer (1996); Phillips et al. (1998). The key coefficient of interest is the interaction term between internal reinsurance and product diversification. We observe that increasing internal reinsurance along with a product diversification strategy significantly lowers insurers' expense ratio and increases profitability.

The findings suggest that well-diversified group insurers have an advantage in utilizing internal reinsurance to boost performance, lowering expense costs, and enhance profitability.[8] Furthermore, the significantly negative coefficients on *COMB* indicate that insurers operate more efficiently and are financially solid if they can buy reinsurance from affiliates while being diversified across product lines.

**Table 2: Effects of Internal Reinsurance and Product Diversification on Performance**

| Regressors | (1) ***EXP*** | (2) ***OP*** | (3) ***COMB*** | (4) ***ROE*** | (5) ***ROA*** |
|---|---|---|---|---|---|
| *INTREINS*×*PDIV* | -0.3044*** | -0.2869 | -0.5322*** | 0.0516*** | 0.0160*** |
| | (0.064) | (0.248) | (0.106) | (0.012) | (0.005) |
| *INTREINS* | 0.0308 | -0.2340 | -0.0647 | -0.0379*** | -0.0123*** |
| | (0.041) | (0.157) | (0.067) | (0.008) | (0.003) |
| *PDIV* | 0.0467 | -0.2469 | 0.3084*** | -0.0602*** | -0.0194*** |
| | (0.048) | (0.184) | (0.078) | (0.009) | (0.004) |
| *SIZE* | -0.0062 | 0.0678*** | 0.0650*** | 0.0199*** | 0.0075*** |
| | (0.007) | (0.026) | (0.011) | (0.001) | (0.001) |
| *CAPASS* | 0.0006** | -0.0082*** | -0.0015*** | 0.0004*** | 0.0005*** |
| | (0.000) | (0.001) | (0.000) | (0.000) | (0.000) |
| N of observations | 18,273 | 18,273 | 18,273 | 18,273 | 18,273 |
| R-squared | 0.010 | 0.013 | 0.039 | 0.105 | 0.110 |
| N of firms | 1,330 | 1,330 | 1,330 | 1,330 | 1,330 |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | yes | yes | yes | yes | yes |

*Notes:* See variable definitions in Table 1. Standard errors in parentheses are clustered at the firm level. *** p<0.01, ** p<0.05, * p<0.1

[8] We tested all our models also using one-period lags of the independent variables. These outcomes are available upon request, as they have similar quality to the results reported in the paper.

In Table 3, we test the interactive impact of external reinsurance and product diversification on insurers' performance. Consistent with findings in the prior literature, external reinsurance is more expensive as indicated by the significantly positive coefficients on expense ratio and operating ratio. Meanwhile, we also observe that insurers that use more external reinsurance experience a significantly higher return in profitability. The joint effect of external reinsurance with product di- versification is negatively associated with operating expense and is marginally significantly negative on *ROE*. The opposite patterns between internal and external reinsurance are quite intriguing. It suggests that the marginal benefit for individual multi-line insurers to purchase external reinsurance is to lower underwriting expenses. However, we do not observe a significant enhancement in profitability.

**Table 3: Effects of External Reinsurance and Product Diversification on Performance**

| **Regressors** | **(1) *EXP*** | **(2) *OP*** | **(3) *COMB*** | **(4) *ROE*** | **(5) *ROA*** |
|---|---|---|---|---|---|
| *EXT REINS*× *PDIV* | -0.1678 | -0.9051** | -0.1385 | -0.0354* | -0.0103 |
| | (0.102) | (0.395) | (0.169) | (0.020) | (0.008) |
| | 0.2457*** | 1.0563*** | 0.1703* | 0.0337*** | 0.0133*** |
| *EXT REINS* | (0.062) | (0.239) | (0.102) | (0.012) | (0.005) |
| *PDIV* | -0.0589 | -0.2492 | 0.0859 | -0.0351*** | -0.0118*** |
| | (0.044) | (0.170) | (0.073) | (0.008) | (0.003) |
| *SIZE* | 0.0064 | 0.1034*** | 0.0943*** | 0.0206*** | 0.0078*** |
| | (0.007) | (0.025) | (0.011) | (0.001) | (0.000) |
| *CAPASS* | 0.0004 | -0.0089*** | -0.0022*** | 0.0004*** | 0.0004*** |
| | (0.000) | (0.001) | (0.000) | (0.000) | (0.000) |
| N of observations | 18,273 | 18,273 | 18,273 | 18,273 | 18,273 |
| R-squared | 0.007 | 0.013 | 0.031 | 0.105 | 0.110 |
| N of firms | 1,330 | 1,330 | 1,330 | 1,330 | 1,330 |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | yes | yes | yes | yes | yes |

*Notes:* See variable definitions in Table 1. Standard errors in parentheses are clustered at the firm level. *** p<0.01, ** p<0.05, * p<0.1

In Table 4, we turn our focus to the impact of internal reinsurance and geographic diversification on performance. After controlling for geographic diversification, group-affiliated insurers can effectively lower their expense ratios and operating ratios by purchasing internal reinsurance. Across all regression models, we do not observe any significant impact on the interaction term between internal reinsurance and geographic diversification. Our results suggest that there is limited benefit in utilizing internal reinsurance as a profitability boost for group-affiliated insurers that operate in multiple states. In Table 5, we discover that insurers with businesses in multiple states can significantly lower their expense ratios by buying external reinsurance, although underwriting expenses increase as well. Overall, these companies seem to achieve more resilience as the combined ratios decrease significantly with using both external reinsurance and geographic diversification. However, there is no significant impact on the returns on equity and assets.

**Table 4: Effects of Internal Reinsurance and Geographical Diversification on Performance**

| **Regressors** | **(1) *EXP*** | **(2) *OP*** | **(3) *COMB*** | **(4) *ROE*** | **(5) *ROA*** |
|---|---|---|---|---|---|
| *INT REINS*× *GDIV* | 0.0929 | 0.0586 | -0.1179 | 0.0027 | 0.0051 |
| | (0.073) | (0.284) | (0.121) | (0.014) | (0.006) |
| *INT REINS* | -0.2180*** | -0.4513* | -0.2641** | -0.0121 | -0.0078 |
| | (0.063) | (0.245) | (0.104) | (0.012) | (0.005) |
| *GDIV* | -0.0190 | -0.0505 | 0.2162*** | -0.0237** | -0.0087** |
| | (0.050) | (0.195) | (0.083) | (0.010) | (0.004) |
| *SIZE* | -0.0048 | 0.0692*** | 0.0656*** | 0.0199*** | 0.0075*** |
| | (0.007) | (0.026) | (0.011) | (0.001) | (0.001) |
| | 0.0007*** | -0.0081*** | -0.0014*** | 0.0004*** | 0.0004*** |
| *CAPASS* | (0.000) | (0.001) | (0.000) | (0.000) | (0.000) |
| N of observations | 18,273 | 18,273 | 18,273 | 18,273 | 18,273 |
| R-squared | 0.008 | 0.013 | 0.038 | 0.103 | 0.109 |
| Number of firms | 1,330 | 1,330 | 1,330 | 1,330 | 1,330 |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | yes | yes | yes | yes | Yes |

*Notes:* See variable definitions in Table 1. Standard errors in parentheses are clustered at the firm level. *** p<0.01, ** p<0.05, * p<0.1

**Table 5: Effects of External Reinsurance and Geographical Diversification on Performance**

| Regressors | (1) *EXP* | (2) *OP* | (3) *COMB* | (4) *ROE* | (5) *ROA* |
|---|---|---|---|---|---|
| *EXT REINS× GDIV* | -0.4863*** | 0.7633* | -0.3127* | -0.0101 | -0.0140 |
| | (0.113) | (0.436) | (0.187) | (0.022) | (0.008) |
| *EXT REINS* | 0.5499*** | -0.0402 | 0.3461** | 0.0235 | 0.0193*** |
| | (0.096) | (0.371) | (0.159) | (0.019) | (0.007) |
| *GDIV* | 0.0882* | -0.1932 | 0.2243*** | -0.0218** | -0.0050 |
| | (0.048) | (0.187) | (0.080) | (0.009) | (0.004) |
| *SIZE* | 0.0062 | 0.1011*** | 0.0930*** | 0.0207*** | 0.0078*** |
| | (0.007) | (0.025) | (0.011) | (0.001) | (0.000) |
| *CAPASS* | 0.0004 | -0.0089*** | -0.0021*** | 0.0004*** | 0.0004*** |
| | (0.000) | (0.001) | (0.000) | (0.000) | (0.000) |
| N of observations | 18,273 | 18,273 | 18,273 | 18,273 | 18,273 |
| R-squared | 0.007 | 0.013 | 0.031 | 0.103 | 0.109 |
| N of firms | 1,330 | 1,330 | 1,330 | 1,330 | 1,330 |
| Firm fixed effects | Yes | Yes | Yes | Yes | Yes |
| Time fixed effects | yes | yes | yes | yes | yes |

*Notes:* See variable definitions in Table 1. Standard errors in parentheses are clustered at the firm level. *** p<0.01, ** p<0.05, * p<0.1

In Table 2 and Table 5, we found that *EXP* varies more substantially with the interaction between reinsurance and diversification, as the signs on the regressors are always stronger in magnitude and in statistical significance compared to the other dependent variables. For this reason, to give a better representation of these effects, we plot predictive margins. Thus, we compute the amount of change in EXP with a one unit change in reinsurance while holding diversification constant at different values. That is, we represent the values of simple regression slopes. As reading the figures, we recall that our diversification measures range from zero to one, meaning that "*PDIV=1*" or "*GDIV=1*" indicate that the firm is fully diversified.

Figure 1 (Panel A/B) displays marginal effects from regressions of the response variable *EXP* on the predictor *INTREIN*. In panel A *PDIV* is our moderator variable, i.e. we plot the slope coefficients for different levels of product diversification. We note that the line corresponding to "*PDIV=1*" lies almost always below the linear prediction computed for other fixed values of *PDIV*. This means that expense ratios decrease linearly in internal reinsurance more evidently for fully diversified insurers compared to other less diversified insurers. In Panel B instead, we use *GDIV* as moderator variable. In this case expense ratios do not seem to be relieved by geographical diversification, as the linear prediction for "*GDIV=1*" lies above all other lines. That is, insurers that are fully geographically diversified and obtain reinsurance from affiliates do not exhibit the lowest costs.

In Figure 2 (Panel A/B) we use *EXTREIN* as predictor variable for *EXP*. The panels illustrate that expense ratios tend to increase in external reinsurance. However, comparing the two panels, in Panel B we find the least steep line corresponding to "*GDIV =1*". This means that operating costs increase less sharply when insurers fully diversify across regions while ceding risk to non-affiliates.

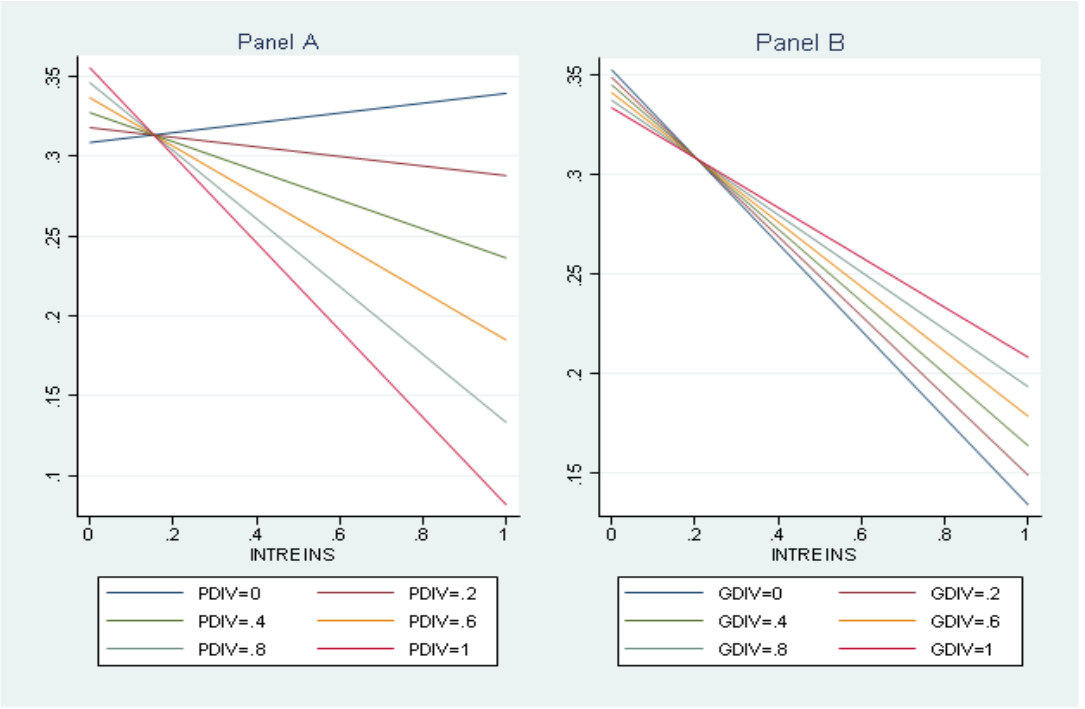


**Figure 1: Predictive Margins from Regressions of Expense Ratios (EXP) on Internal Reinsurance (INTREINS)**

*Notes:* Panel A (B) plots predictive margins from regressions of the response variable *EXP* on the predictor variable *INT REINS* and moderator variable *PDIV* (*GDIV*), controlling also for *SIZE* and *CAPASS*. See variable definitions in Table 1.

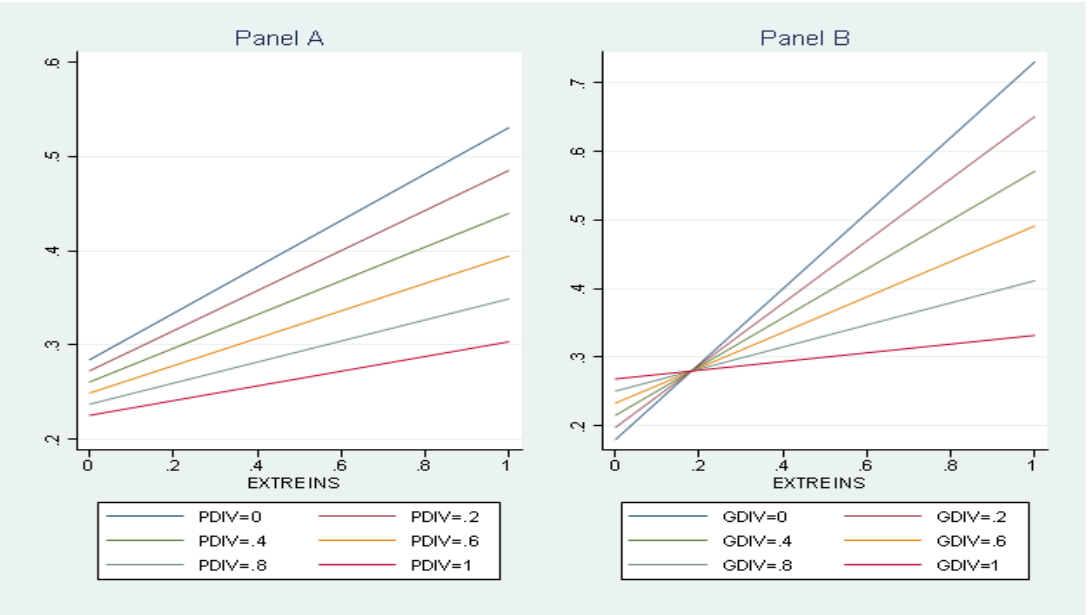


**Figure 2: Predictive Margins from Regressions of Expense Ratios (EXP) on Internal Reinsurance (EXTREINS)**

*Notes:* Panel A (B) plots predictive margins from regressions of the response variable *EXP* on the predictor variable *EXT REINS* and moderator variable *PDIV* (*GDIV*), controlling also for *SIZE* and *CAPASS*. See variable definitions in Table 1.

Overall, we draw the following insights from our findings. The interaction of corporate di- versification with reinsurance is complex, and its effect on financial performance develops across multiple levels. Our outcomes suggest that the two main types of reinsurance available to primary insurers (i.e. internal and external reinsurance) interact differently with diversification strategies. Therefore, potential synergies require careful identification.

Internal reinsurance seems to be more tightly associated with product diversification. We show that insurers diversifying their business are also more profitable as they purchase reinsurance from affiliates. Our intuition is that affiliates may have better information about firms of the same group compared to other firms, and thus are able to better assess the portfolio risk and composition of the cedant. This means that a well-diversified insurer would obtain reinsurance from affiliates at relatively cheaper prices. In addition to the risk reduction from product diversification, the advantageous internal insurance purchase could collectively improve primary insurers' performance.

Our findings are consistent with insights from the previous literature. For example, Doherty and Smetters (2005) find that monitoring costs are lower when the insurer and reinsurer are affiliates. Consistent with this evidence, Powell et al. (2008) argue that, despite demands for internal and external reinsurance having some factors in

common, internal reinsurance costs less than external reinsurance. Park et al. (2021) find that the use of reinsurance, in general, has a negative impact on the return on assets and the return on equity of insurers, but disentangling reinsurance purchases reveals that only reinsurance bought from non-affiliates decreases profitability, while reinsurance obtained from affiliated firms enhances performances, as the result of efficient internal capital markets in the insurance industry.

Instead, geographical diversification appears to relieve costs related to external reinsurance. Our interpretation is that external reinsurance would be less costly when firms locate their business across different areas, to the extent that (foreign) external reinsurers would find it less difficult to assess the risk of ceding firms.

We see our outcomes to be in line with the "real service efficiencies" hypothesis of Mayers and Smith Jr (1990). The authors contend that one important factor explaining the demand for reinsurance is the production of real services. Moreover, these "real service benefits" would be much more substantial as the ceded risks are less concentrated in terms of geographical locations and lines of business. The authors explain that well-diversified insurers obtain a stronger advantage from reinsurers' expertise or infrastructure within a given area or line of business. Empirically, this translates into a negative relationship between measures of concentration and demand for reinsurance. The authors find evidence of this argument by analyzing a sample of United States P&C insurers and show that other competing arguments based on taxes, expected bankruptcy costs, and investment incentives, have no explanatory power.[9]

The argument of Mayers and Smith Jr (1990) provides a plausible interpretation of our out-comes, especially those related to *INTREINS*, which always presented stronger statistical significance.

In fact, we show that insurers ceding risk to affiliates while diversifying across business appear to be more efficient, as they exhibit higher profitability ratios while low combined ratios.[10]

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[9] Powell et al. (2008) show that internal reinsurance decreases considerably in geographical and business concentration, while external reinsurance is not significantly associated with reinsurance.

[10] Several common reasons for reinsurance include: 1) expanding the insurance company's capacity; 2) stabilizing underwriting results; 3) financing; 4) providing catastrophe protection; 5) withdrawing from a line or class of business;
6) spreading risk; and 7) acquiring expertise. See https://content.naic.org/cipr-topics/reinsurance (accessed 29 July 2023). A competing argument to our working hypothesis would rather emphasize the fact that reinsurance and diversification could be considered two alternative tools for risk management. Shiu (2016) document evidence of substitution between the usage of reinsurance and derivatives for the hedging of underwriting risk. Insurance companies that have a well diversified portfolio of risks would tend to retain a higher percentage of risks on their balance sheets. On the other hand, insurance companies whose portfolio is not as well diversified would tend to cede more risks to different reinsurers. This argument would translate into finding a negative correlation between diversification and reinsurance. In our data though, we don't find evidence for such an argument, as we have run preliminary tests addressed to verify that external and internal reinsurance increase in diversification. That is, the substitution hypothesis is not supported in our data. These results are available upon request.

## 5. Robustness

To give further insights into the economic size of the impact on expense ratios, we now conduct a bivariate analysis of the two dimensions of diversification and reinsurance. In Tables 6 we separate our firms into subgroups, intersecting firm quartiles of *INTREINS* with quartiles of *PDIV*. Then, for each group, we calculate the average *EXP*. Firms in the bottom right cell are the firms belonging to the fourth *INTREINS* quartile and contemporaneously to the fourth *PDIV* quartile. Such firms are the most widely diversified and purchase the highest amounts of reinsurance.
The firm average expense ratio is 8.8%, which is approximately 81% lower than the expense ratio inside firms that have a comparable amount of purchased reinsurance but are the least diversified (i.e. firms inside the bottom left cell).
In Table 7 average expense ratios are computed for quartiles of *GDIV* and *EXTDIV*. Again, in the bottom right cell, we find firms making extensive use of external reinsurance while being the most geographically diversified. Expense ratios of these firms are on average 25.8%, i.e. approximately 53% lower than the expense ratio of firms in the same reinsurance category but being much less diversified (i.e. firms inside the bottom left cell).
Overall, these numbers give support to the insight that the interrelation between reinsurance and diversification has a considerable economic impact on insurers. Expense ratios are much lower for firms that combine increasing internal (external) reinsurance with raising levels of product (geographical) diversification.

**Table 6: Average *EXP* inside Insurance Companies ranked by Quartiles of *PDIV* (across Columns) and Quartiles of *INTREINS* (across Rows)**

| Quartile of *INTREINS* | Quartile of *PDIV* | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 1 | 0.3409 | 0.3013 | 0.3466 | 0.3500 |
| 2 | 0.3039 | 0.3334 | 0.3430 | 0.3142 |
| 3 | 0.3191 | 0.3015 | 0.3202 | 0.2842 |
| 4 | 0.1589 | 0.0994 | 0.0941 | 0.0882 |

*Notes:* See variable definitions in Table 1.

**Table 7: Average *EXP* inside Insurance Companies ranked by Quartiles of *GDIV* (across Columns) and Quartiles of *EXTREINS* (across Rows)**

| Quartile of *EXTREINS* | Quartile of *GDIV* | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| 1 | 0.2189 | 0.2538 | 0.1870 | 0.1750 |
| 2 | 0.2764 | 0.2959 | 0.2706 | 0.2100 |
| 3 | 0.3035 | 0.2897 | 0.2953 | 0.2433 |
| 4 | 0.3956 | 0.3171 | 0.3267 | 0.2576 |

*Notes:* See variable definitions in Table 1.

Finally, in Table 8 we test an alternative variable for reinsurance. More precisely, we call *RETEN* the so-called "retention ratio", namely the ratio of net premiums written to gross premiums written. The interaction of *RETEN* with the diversification variables reveals that well diversified insurers that retain substantial risk have also high expense ratios and combined ratios. This effect is more relevant for product diversification compared to geographical diversification, in line with the findings from the previous section. Therefore, we have an additional piece of evidence that affiliated insurers could save on costs if they would transfer risk to affiliates while implementing diversification strategies.

**Table 8: Effects of Overall Reinsurance Usage on Performance**

| Regressors | (1) *EXP* | (2) *EXP* | (3) *COMB* | (4) *COMB* |
|---|---|---|---|---|
| *RETEN × PDIV* | 0.0040*** | | 0.0062*** | |
| | (0.001) | | (0.001) | |
| *RETEN* | -0.0014*** | -0.0002 | 0.0002 | 0.0012 |
| | (0.000) | (0.001) | (0.001) | (0.001) |
| *PDIV* | -0.2544*** | | -0.1734** | |
| | (0.049) | | (0.082) | |
| *SIZE* | -0.0018 | -0.0023 | 0.0646*** | 0.0625*** |
| | (0.007) | (0.007) | (0.011) | (0.011) |
| *CAPASS* | 0.0005** | 0.0006** | -0.0015*** | -0.0014*** |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| *RETEN × GDIV* | | 0.0014* | | 0.0030** |
| | | (0.001) | | (0.001) |
| *GDIV* | | -0.0499 | | 0.0460 |
| | | (0.056) | | (0.093) |
| N of observations | 18,273 | 18,273 | 18,273 | 18,273 |
| R-squared | 0.008 | 0.006 | 0.039 | 0.038 |
| Number of firms | 1,330 | 1,330 | 1,330 | 1,330 |
| Firm fixed effects | Yes | Yes | Yes | Yes |
| Time fixed effects | yes | yes | yes | yes |

*Notes:* See variable definitions in Table 1. Standard errors in parentheses are clustered at the firm level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

## 6. Conclusion

We show that the combination of reinsurance and diversification strategies could improve the efficiency of insurers. Using data from United States P&C insurers, we find that increasing purchases of reinsurance from affiliates together with wide product diversification would reduce expense ratios, making insurers more profitable and financially solid. Moreover, we observe that firms buying reinsurance from non-affiliates have lower expense ratios if they are also widely diversified across geographical regions.

We argue that our findings are in line with the "real services efficiency" hypothesis of Mayers and Smith Jr (1990). Increasing levels of diversification would allow insurers to enjoy real service benefits from reinsurance, with positive consequences on operating costs, and ultimately on financial strength.

These insights are interesting for insurance managers, as they highlight the importance of using joint reinsurance and diversification policies to enhance firm efficiency. Therefore, this evidence is crucial to developing growth strategies in periods of high reinsurance costs and reinsurance demand, as during the recent economic trend.

This work can be extended in several ways. One potential avenue of research involves testing whether insurers could exploit internal reinsurance together with diversification to face episodes of turmoil. In fact, recently Hsiao and Shiu (2023) show that intragroup reinsurance allowed insurance groups to share risk during the financial crisis of 2007-2008, lowering the overall insolvency risk, while also enhancing premiums growth in the aftermath of the crisis. Our findings suggest that this setting could be extended including diversification factors that could contribute to interpreting the income smoothing effect from internal capital markets. Interesting would be to use an exogenous shock the recent COVID-19 pandemic, to test if insurers were able to implement diversification policies to complete their reinsurance purchases in such a way to remain profitable and remain stable throughout the turmoil. Evidently, observations for the post-COVID-19 crisis would be only a few, as insurers report accounting data annually. Therefore, we leave the task to our future research agenda.

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