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Effects of business diversification on asset risk-taking: Evidence from the U.S. property-liability insurance industry

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ABSTRACT

We investigate the effect of line-of-business diversification on asset risk-taking in the U.S. property-liability industry. The coordinated risk management hypothesis (Schrand and Unal, 1998) implies a negative relation between underwriting risk and investment risk. Consistent with this hypothesis we find that diversified insurers take more asset risk than non-diversified insurers, and that the degree of asset risk-taking is positively related to diversification extent. Our results are robust to corrections for potential endogeneity bias, selectivity bias, and alternative diversification and asset risk measures. We also provide event study evidence that further supports the coordinated risk management hypothesis. Specifically, we find that when a focused firm diversifies, it increases its asset risk relative to firms that remain focused, and when a diversified firm refocuses, it reduces its asset risk relative to firms that remain diversified.

1. Introduction

Risk management is of increasing importance to corporations. Prior theoretical research has posited that risk management can increase value by reducing expected tax liabilities, financial distress costs, the cost of external capital, and agency costs (e.g., Mayers and Smith, 1982). Traditional risk management theory (e.g., Mayers and Smith, 1982; Smith and Stulz, 1985; Froot, Scharfstein, and Stein, 1993) focuses on the use of hedging to reduce total firm risk. By contrast, Schrand and Unal (1998) propose the coordinated risk management theory which argues that risk management can be used to allocate risk among multiple risk sources, rather than to reduce total risk.

Business line diversification is one of the most direct ways for corporations to reduce risk by smoothing expected cash flows. For diversified companies, imperfectly correlated cash flows create a natural hedge that reduces cash flow volatility (Lewellen, 1971). In the insurance industry, diversification reduces the volatility of underwriting cash flows by assuaging large unexpected losses (e.g., natural disasters and terrorism) and cross-subsidizing unpredictable lines. Applying the coordinated risk management theory, we expect that business diversification reallocates risk between underwriting and investing. Our study empirically examines whether line-of-business diversification affects asset risk-taking in the U.S. property-liability (P/L) insurance industry. We develop and estimate models of the effects of diversification on asset risk using two different diversification measures and several model specifications that account for various econometric concerns.

The extant literature on the relation between diversification and corporate performance has focused on diversified companies' overall performance by employing a variety of measures including accounting returns (e.g., Berger and Ofek, 1995), firm value (e.g., Lang and Stulz, 1994; Servaes, 1996), and market performance (e.g., Hoyt and Trieschmann, 1991). However, prior empirical research has not investigated the effects of business diversification on corporate asset risk-taking.

Through our empirical analysis, we find that, *ceteris paribus*, multi-line insurers invest more in risky assets than do single-line insurers. Moreover, the extent of diversification is positively related to the proportion of risky asset holdings. To examine changes in asset risk-taking around the diversification decision, we also conduct an event study. The event study suggests that when a focused firm diversifies, it increases its asset risk relative to firms that remain focused, and when a diversified firm refocuses, it reduces its asset risk relative to firms that remain diversified.

We choose to study the insurance industry because insurance firms, like other firms in the financial sector, have substantial capital to invest. Insurers invest in diversified financial assets (e.g., gov-

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ernment and corporate bonds, common stocks, preferred stocks, mortgage loans, and real estate) to produce sufficient cash flows to make claim payments, cover underwriting expenses, and accumulate capital. As is suggested by modern finance theory, the investment portfolio mix is a key determinant of a portfolio's expected return and its associated volatility. Insufficient risk-taking undermines an insurer's profitability. Excessive risk-taking subjects an insurer to high uncertainty that could cause solvency problems. Therefore, understanding asset risk-taking in the investment portfolio is important for risk management in insurance industry.

Moreover, the regulatory reporting requirements for insurance firms provide us with several natural advantages over investigating firms in unregulated industries. First, we benefit from the richness of the insurance statutory data because all licensed insurers (both private and public) are required to file their statutory statements on an annual basis. By contrast, only public firms in unregulated industries are required to file annual statements. Thus, most previous diversification literature in the general finance field studies exclusively public firms. Second, insurers are required to report their highly disaggregated premium data across all distinct business lines, while firms in unregulated industries are not required to provide data in such a detail. We leverage the benefits of this disaggregated reporting by focusing on P/L insurers whose extent of business line classification is substantially greater than life/health (L/H) insurers.[1] Hence, by using insurance industry data, we can directly observe business-line diversification. Third, unlike managers of unregulated firms who exercise considerable discretion in segment-level revenue allocation, managers of insurers do not need to exercise any discretion in premium allocation as contractual premiums are directly linked to specific lines of business. Therefore, our study avoids the well-known reporting bias (e.g., minimum unit size, ad-hoc categorization by management, and self-reporting errors) that affects diversification disclosure by unregulated firms.

Our study contributes to both diversification literature and coordinated risk management literature by providing some initial evidence of the relation between line-of-business diversification and asset risk-taking.

The remainder of this paper is organized as follows. The "Literature Review" section reviews the prior literature on business line diversification. The "Hypothesis Development and Testing" section develops our hypotheses and is followed by the "Data and Sample" section that introduces the data source and the sample we employ in the empirical analysis. The "Empirical Method" section describes our research approaches. Then the "Univariate Analysis" section presents the results from our univariate tests. In the "Multivariate Analysis" section, we discuss our main empirical results from three regression models on two different diversification measures. The subsequent "Robustness Test" section describes the multivariate regression results by using an alternative estimation method and a set of alternative measures. Then "Event Study" section presents empirical results on the effect of diversification during the event year. Finally, the "Conclusion" section concludes our study.

[1] Specifically, the statutory filing completed by all licensed P/L insurers lists 35 lines of business, which researchers have aggregated into 24 distinct lines (e.g. Berry-Stölzle et al., 2012). By contrast, the statutory filing for L/H insurers lists 11 business lines which researchers have aggregated into 5 distinct lines (e.g. Baranoff and Sager, 2003). Thus, P/L insurers have almost 5 times as many distinct business lines.

2. Literature review

2.1. Diversification literature

Over the last few decades, there is abundant research that has been done to study the relation between diversification and firm performance in general finance and insurance. In the general finance literature, Martin and Sayrak (2003) review and summarize three rounds of research on the diversification effect. The first round of research finds that diversified companies tend to have lower Tobin's Qs, implying that diversification destroys firm value (e.g., Servaes, 1996). The second round of research casts doubt on the endogeneity of diversification decisions, arguing that diversification discount is the result that diversifying firms have already been traded at a discount prior to diversification events (e.g., Lang and Stulz, 1994). The last round of research argues that diversified firms are traded at a premium rather than at a discount, and the diversification discount found by prior studies is due to measurement errors (e.g., Villalonga, 2004).

One strand of more recent diversification research focuses on sources of the discount, or premium. Dimitrov and Tice (2006) examine whether the access to credit can explain the differences in performance between diversified firms and focused firms. Consistent with the credit constraint explanation, they find that during recessions sales and inventory growth rates drop more for bank-dependent focused firms than for bank-dependent diversified firms. Hund et al. (2010) also explore the sources of diversification discount. They suggest that rational learning about mean profitability provides an alternative explanation (independent of agency costs) for the diversification discount. Mitton and Vorkink (2010) propose and test their hypothesis that diversified firms trade at a discount in order to compensate investors for offering less upside potential than focused firms. Consistent with their expectation, they find that diversified firms offer less skewness exposure than focused firms, and the diversification discount becomes larger when the diversified firms offer less skewness. Hann et al. (2013) study the relation between diversification and a firm's cost of capital. They argue that the coinsurance effects of diversification reduce systematic risk through the avoidance of countercyclical deadweight costs, and that the coinsurance effect is decreasing in the correlation of cross-segment cash flows.

Recent literature also investigates the effect of market conditions on the value of diversification. Yan (2006) investigates variations in the value of diversification over time under various capital market conditions. He finds that the value of diversified firms relative to focused firms increases when external capital is more expensive at the aggregate level. Yan et al. (2010) study investment of diversified and focused firms and show that more expensive external capital leads to investment declines for focused firms but not for diversified firms. They also show that the internal capital markets become more efficient in a more depressed capital market, and during such a market, the value of diversified firms decreases less than that of focused firms. Kuppuswamy and Villalonga (2016) examine the value of diversification during the 2007–2009 financial crisis. They show that the value of diversified firms relative to focused firms increases significantly during the crisis. They find evidence of two channels through which the crisis increases the value of diversification. First, diversified firms have better access to credit markets than the focused firms. Second, diversified firms have both better access to, and more efficient use of, internal capital markets.

In the insurance literature, Hoyt and Trieschmann (1991) use mean-variance and CAPM approaches to make a comparison of the risk-return relation for specialized and diversified insurers. They find that the investment in specialized insurers performs better than that in diversified insurers. Their results suggest that diversifiers are less efficient than specialists. Meador et al. (2000) focus on diversification in the L/H insurance industry, and report a positive relation between diversification and X-efficiency, implying that diversified companies are more cost-efficient than focused companies. Liebenberg and Sommer (2008) analyze the performance of P/L insurance companies from 1995 to 2004, and find a diversification penalty of 1% of ROA or 2% of ROE, suggesting that non-diversified P/L insurers perform better than the diversified P/L insurers. Elango et al. (2008) report a complex and nonlinear relation between line-of-business diversification and financial performance in P/L insurance industry, and they find that the effect of business line diversification is also contingent upon an insurer's geographic diversification. Cummins et al. (2010) study scope economies in the U.S. insurance industry and test the conglomeration hypothesis versus the strategic focus hypothesis using data envelopment analysis (DEA). They report that revenue scope diseconomies offset cost scope economies for P/L insurers, while for L/H insurers revenue scope diseconomies and cost scope diseconomies coexist.

2.2. Coordinated risk management literature

Schrand and Unal (1998) argue that firms earn rents for bearing risk related to the activities where they have a comparative information advantage (termed core-business risk) but not for bearing risk in activities where they have no comparative information advantage (termed homogenous risk). They define coordinated risk management as the substitution of core-business risk for homogenous risk. To find empirical evidence, they examine the credit (core-business) risk and interest-rate (homogenous) risk decisions of 134 demutualizing thrifts in the savings and loan (S&L) industry. Consistent with their prediction, they observe that thrifts significantly increase credit risk and decrease interest-risk simultaneously following conversion. They suggest that hedging allows the thrifts to unbundle the risks of the investment portfolios and adjust the risk allocation to achieve the most favorable risk-return trade-off. McShane et al. (2012) test the coordinated risk management theory by using reinsurance and derivatives as hedging proxies for underwriting risk and investment risk in the P/L insurance industry. They argue that underwriting risk represent core-business risk for insurers because this is the area in which they have a comparative information advantage while investment risk represents homogeneous risk because insurers are not expected to have an information advantage over other financial institutions. They find evidence of coordinated risk management as insurers hedge investment risk using derivatives while simultaneously increasing underwriting risk.

2.3. Asset risk-taking literature

Cummins and Sommer (1996) examine the relation between capitalization and portfolio risk in the P/L insurance industry by using a pooled cross-section, time series sample. They find a positive relation between the capital-to-asset ratio and asset risk-taking. Lee et al. (1997) investigate changes in risk-taking around the enactments of state guaranty fund laws. They show that insurers' asset risk-taking significantly increases following the enactments. Yu et al. (2008) study the role of intangible assets in asset risk-taking decisions of P/L insurance firms. They find that insurers' asset risk is negatively related to their intangible assets, supporting the protection of intangible assets hypothesis. They also suggest that firm size and capitalization enlarge insurers' appetites for asset risk-taking.

There is a paucity of literature studying the relation between asset risk-taking and diversification. Demsetz and Strahan (1997) use a return-generating model R^2 to measure the relation between diversification and bank holding company (BHC) size. They find a positive relation between BHC size and diversification, but they do not find evidence that BHC size is negatively related to stock return variance. They suggest that large BHCs take advantage of diversification to pursue riskier lending and higher leverage. Duchin (2010) focuses on cash holdings (an inverse asset risk measure) of diversified firms. He finds that diversified firms hold about half as much cash as focused firms because diversified companies enjoy risk reduction from coinsurance which allows them to hold less cash than their counterparts. Tong (2011) studies the relation between diversification and the value of cash in diversified firms. He finds that the marginal value of cash in diversified firms is \$0.92, compared to \$1.08 in focused firms. His study suggests that diversification undermines the value of cash reserves.

3. Hypothesis development and testing

Product diversification leads to diversification of cash flows. As is suggested by Lewellen (1971), imperfectly correlated cash flows create a natural hedge that decreases volatility through the coinsurance effect. According to coordinated risk management theory (Schrand and Unal, 1998) hedging is not only a tool for risk reduction, but also a technique for risk reallocation. According to the theory, the total variability of the portfolio's cash flow reflects both core-business risk and homogeneous risk. Firms have a comparative information advantage in bearing core-business risk and earn positive economic rents, while they do not have such an advantage in bearing homogenous risk and earn zero economic rents. For a firm that faces bundled risks, reducing homogeneous risk allows the firm to obtain additional exposure to core-business risk and still maintain its target level of risk. The substitution of core-business risk for homogeneous risk to achieve equilibrium (the most favorable risk-return trade-off) is called coordinated risk management. Schrand and Unal (1998) suggest that coordinated risk management is optimal regardless of whether the firm attempts to increase, maintain, or decrease the total risk.

If insurers coordinate risk management whether they are increasing, maintaining, or decreasing total risk, we would expect higher (lower) levels of diversification to be associated with more (less) asset risk-taking. While Schrand and Unal's theory suggests this reallocation, traditional risk management theory (e.g., Mayers and Smith, 1982; Smith and Stulz, 1985; Froot et al., 1993) focuses on the use of hedging to reduce total firm risk. In terms of this theory, insurers that diversify underwriting risk might aim to reduce total risk without reallocating towards asset risk. Thus, it is an empirical question whether insurers use diversification to only decrease total risk or reallocate risk between underwriting and investing in the manner of coordination.[2] If coordinated risk management is widely used in the P/L insurance industry, we expect that because product diversification strategically reduces underwriting risk, diversified insurers will reallocate risk to investment by increasing asset portfolio risk.[3] We raise our main hypothesis as follows:

H1 (*Coordinated Risk Management Hypothesis): Line-of-business diversification increases asset risk-taking.*

[2] We empirically test the diversification-total risk relation. Following Ho et al. (2013), we measure the overall risk by the standard deviation of return on assets (ROA) with 5-year rolling period data. We do not find evidence of a reduction in total risk resulting from diversification.

[3] Duchin (2010) finds that the diversified firms hold less precautionary cash than do while stand-alone firms. We use the proportion of cash in an insurer's portfolio to represent the other side of asset risk in our robustness check. See Section 8.2.

Table 1
Variables and their descriptions. This table presents the variables, their descriptions, and predicted signs in the multivariate regressions.

Variable name	Variable description	Predicted sign in regression
Asset risk-taking measure:		
ASSET_RISK	Asset risk, measured by the percentage of total invested assets in common stocks and junk bonds.	
Diversification Measure:		
MULTILINE	Diversification decision, as measured by the dummy variable that is equal to 1 for diversified insurers and 0 for non-diversified insurers.	+/−
LINES_DIV	Diversification extent, as measured by the complement of the Herfindahl Index of net premiums written across business lines.	+/−
Control variables:		
SIZE	Firm size, as measured by the natural logarithm of total net admitted assets.	+/−
GEO_DIV	Geographic diversification, measured by the complement of Herfindahl index of direct premiums written across 58 states and territories.	+
LEVERAGE	Leverage, as measured by the complement of the capital-to-asset ratio. The capital-to-asset ratio is calculated as the ratio of policyholder surplus to total assets.	–
REINSURANCE	Reinsurance use, as measured by the ratio of premiums ceded to the sum of direct premiums written and reinsurance assumed.	+
GROUP	Affiliation status, as measured by the dummy variable that is equal to 1 for affiliated insurers and 0 for unaffiliated insurers.	+
MUTUAL	Ownership structure, as measured by the dummy variable that is equal to 1 for mutual insurers and 0 for stock insurers.	+/–
LONG_TAIL	Weight of long-tail line insurance, as measured by the percentage of net premiums written on long-tail lines.	–
COMBINED_RATIO	Underwriting combined ratio, calculated as the sum of the loss ratio and the expense ratio. The loss ratio is equal to incurred losses as a proportion of premiums earned. The expense ratio is equal to underwriting expenses as a percentage of premiums earned.	+
ROA	Return on assets, calculated as the ratio of net income over total net admitted assets.	–
INSOLVENCY_RISK	Insolvency risk, as measured by the dummy variable that is equal to 1 if an insurer fails four or more IRIS ratios and 0 otherwise.	+
PUBLIC	Public status, as measured by the dummy variable that is equal to 1 for public insurers and 0 for private insurers.	+/–

To test our hypothesis, we estimate a model that tests the following relation:

$$Asset\ Risk - Taking = f\left(Diversification, Controls\right) \quad (1)$$

Asset Risk-Taking Measure: Various measures of insurer asset risk-taking have been used in the literature. Two recent examples include Gaver and Pottier (2005), who use the ratio of common stocks to cash and total invested assets and Yu et al. (2008), who use the ratio of common stocks and risky bonds to total invested assets. We follow the more comprehensive approach of Yu et al. (2008) and define asset risk-taking (*ASSET_RISK*) as the ratio of common stock and speculative bonds (NAIC class 3 and above) to total invested assets.[4]

Diversification Measures: In our empirical analysis, we employ two diversification measures. First, following Liebenberg and Sommer (2008) and Berry-Stölzle et al. (2012), we use a binary variable (*MULTILINE*) to measure diversification status. *MULTILINE* is equal to 1 for insurers that operate in more than one line and 0 for single-line insurers. This measure is used to capture differences in asset risk-taking between diversified and non-diversified insurers. Second, we use a continuous variable (*LINES_DIV*) to measure diversification extent. *LINES_DIV* is calculated as the complement of the Herfindahl Index of net premiums written (NPW) across all lines of business. Consistent with Elango et al. (2008) and Berry-Stölzle et al. (2012) we calculate *LINES_DIV* as follows,

$$LINES\_DIV_{i,t} = 1 - \sum_{j=1}^{24} \left(\frac{NPW_{i,j,t}}{NPW_t} \right)^2,$$

where $NPW_{i,\,j,\,t}$ denotes the net premiums written by insurer i in line $j = 1, \ldots, 24$[5] in year t, and $NPW_{i,\,t}$ denotes the total net premiums written in a given year t. Insurers with larger values for *LINES_DIV* are relatively more diversified.

Control variables

Firm Size: As is suggested by Pottier (2007), large insurance companies retain in-house expertise of investment analysts and credit specialists. Investing in risky assets requires that insurers assess and monitor risks. The internal expertise of large insurance companies provides an advantage to implement risk-taking strategies. However, the recent trend of investment management outsourcing provides small insurers access to riskier investment opportunities that were previously out of their reach due to insufficient scale and/or in-house expertise (NAIC, 2015). While, we are unable to observe internal or external investment management, we do recognize the potential influence of investment outsourcing on asset risk taking for small and medium firms – particularly in a low interest rate environment. Following Pottier (2007), we use the size of an insurance company to proxy for investment expertise. We measure firm size (*SIZE*) as the natural logarithm of total net

[4] In our robustness section we use three alternative asset risk measures. First, we calculate an industry-adjusted measure of asset risk. Second, we use the ratio of cash to total invested assets (Duchin, 2010) as an inverse asset-risk measure. Third, we measure asset risk by the standard deviation of return on investment with 5-year rolling period data (Ho et al., 2013).

[5] We follow Berry-Stölzle et al. (2012) in grouping similar business lines to arrive at 24 distinct lines that are written by P/L insurers: Accident and Health, Aircraft, Auto, Boiler and Machinery, Burglary and Theft, Commercial Multiple Peril, Credit, Earthquake, Farmowners' Multiple Peril, Financial Guaranty, Fidelity, Fire and Allied lines, Homeowners' Multiple Peril, Inland Marine, International, Medical Professional Liability, Mortgage Guaranty, Ocean Marine, Other, Other Liability, Products Liability, Reinsurance, Surety, and Workers' Compensation.

Table 2
Summary Statistics. This table presents the summary statistics of the variables in the asset risk-taking regression. The sample is obtained from NAIC (National Association of Insurance Commissioners) database for the years 1997–2013 and consists of 12,509 firm-year observations. All affiliated firms are aggregated at group level.

Variable name	N	Mean	Median	Min	Max	Std. Dev.	1st Quartile	3rd Quartile
Dependent variables:								
ASSET_RISK	12,509	0.1544	0.1131	0.0000	0.7136	0.1608	0.0155	0.2356
Diversification measures:								
MULTILINE	12,509	0.7183	1.0000	0.0000	1.0000	0.4499	0.0000	1.0000
LINES_DIV	12,509	0.3423	0.3599	0.0000	0.8413	0.3045	0.0000	0.6425
Control variables:								
SIZE	12,509	17.9088	17.5843	13.3265	24.4908	2.4000	16.1222	19.4963
GEO_DIV	12,509	0.3116	0.0252	0.0000	0.9578	0.3710	0.0000	0.6949
LEVERAGE	12,509	0.5186	0.5581	0.0093	0.9274	0.2032	0.4027	0.6659
REINSURANCE	12,509	0.2867	0.2400	0.0000	0.9022	0.2301	0.0982	0.4416
GROUP	12,509	0.2999	0.0000	0.0000	1.0000	0.4582	0.0000	1.0000
MUTUAL	12,509	0.4589	0.0000	0.0000	1.0000	0.4983	0.0000	1.0000
LONG_TAIL	12,509	0.6722	0.7673	0.0000	1.0000	0.3343	0.5780	0.9425
COMBINED_RATIO	12,509	1.0973	1.0078	0.2880	6.3496	0.6387	0.9171	1.1144
ROA	12,509	0.0200	0.0250	-0.2211	0.1861	0.0581	0.0014	0.0482
INSOLVENCY_RISK	12,509	0.1210	0.0000	0.0000	1.0000	0.3261	0.0000	0.0000
PUBLIC	12,509	0.0716	0.0000	0.0000	1.0000	0.2579	0.0000	0.0000

Table 3
Profile of insurers' diversification over time from 1997 to 2013. This table presents the absolute number of diversified firms and the percentage of diversified firms in the industry over time. A firm is categorized as a diversified firm if it operates in more than one business line, as reported in its statutory annual statements. In addition, the table includes the mean and median of diversification extent, measured by the complement of the Herfindahl Index of Net Premiums Written (NPW).

Year	Number of all firms	Number of diversified firms	% diversified firms	Complement of Herfindahl index of NPW	
				Mean	Median
1997	798	600	75.19%	0.3420	0.3565
1998	803	608	75.72%	0.3474	0.3648
1999	781	591	75.67%	0.3470	0.3613
2000	765	569	74.38%	0.3498	0.3890
2001	771	563	73.02%	0.3501	0.3942
2002	748	548	73.26%	0.3495	0.3919
2003	751	544	72.44%	0.3449	0.3792
2004	745	530	71.14%	0.3406	0.3560
2005	742	529	71.29%	0.3414	0.3423
2006	748	523	69.92%	0.3376	0.3379
2007	746	522	69.97%	0.3324	0.3101
2008	741	519	70.04%	0.3360	0.3230
2009	724	510	70.44%	0.3395	0.3501
2010	686	479	69.83%	0.3431	0.3690
2011	672	467	69.49%	0.3395	0.3627
2012	648	449	69.29%	0.3417	0.3713
2013	640	434	67.81%	0.3349	0.3528

admitted assets. In light of the recent trend towards investment outsourcing, the expected relation between investment risk-taking and firm size is indeterminate.

Geographic diversification: Similar to product diversification, geographic diversification can also reduce underwriting risk by cross-subsidization. Thus a more geographically diversified insurance company can have greater capacity to take risk in its investment portfolio. We expect geographic diversification to be positively related to asset risk-taking. We use the complement of the Herfindahl Index of direct premiums written (DPW) across 58 states and territories (*GEO_DIV*) as the geographic diversification measure. The formula to calculate the geographic diversification is as follows,

$$GEO\_DIV_{i,t} = 1 - \sum_{k=1}^{58} \left(\frac{DPW_{i,k,t}}{DPW_{i,t}} \right)^2,$$

where $DPW_{i,\,k,\,t}$ denotes the direct premiums written by an insurer i in state $k = 1, \ldots, 58$ in year t, and $DPW_{i,\,t}$ denotes the total direct premiums written in a given year t.

Leverage: Colquitt and Cox (1999) argue that agency costs and underinvestment problems will increase as an insurer becomes more levered. As a consequence, an insurance company is more likely to reduce the risk associated with investment for the purpose of assuaging agency problems and underinvestment. Thus we expect a negative relation between leverage and risk-taking. Following Yu et al. (2008), we use the complement of the capital-to-asset ratio to measure an insurer's leverage (*LEVERAGE*). Consistent with Liebenberg and Sommer (2008), the capital-to-asset ratio is calculated as the ratio of policyholder surplus to total assets.

Reinsurance: As is suggested by Mayers and Smith (1990), insurance companies use reinsurance to hedge risk. Lee et al. (1997) report a negative relationship between insolvency risk and risky assets holdings for P/L insurance companies. Therefore, we expect reinsurance use to be positively related to the asset risk-taking. We use the reinsurance ratio (*REINSURANCE*) to measure the extent of reinsurance. The reinsurance ratio is defined as premiums ceded divided by the sum of direct premiums written and reinsurance assumed.

Table 4
Comparison between diversifiers and non-diversifiers. This table compares the asset risk-taking between diversifiers and non-diversifiers. The significance of differences in means is tested by a *t*-test with its t-statistic and p-value reported. The significance of differences in medians is tested by a Mann–Whitney–Wilcoxon test with its *p*-value reported.

Variables		Non-diversifier (1)	Diversifier (2)	Difference (3) = (1)–(2)	*p*-value (4)	*t*-statistic (5)
ASSET_RISK	Mean	0.1026	0.1748	−0.0722	0.00	−23.06
	Std. Dev.	0.1576	0.1574			
	Std. Err.	0.0027	0.0017			
	Median	0.0345	0.1451	−0.1106	0.00	
	N	3524	8985			
ADJ_ASSET_RISK	Mean	−0.0011	0.0705	−0.0716	0.00	−22.30
	Std. Dev.	0.1644	0.1604			
	Std. Err.	0.0028	0.0017			
	Median	−0.0670	0.0413	−0.1083	0.00	
	N	3524	8985			

Table 5
Diversification effect on asset risk-taking. This table presents multivariate regressions of asset risk-taking on diversification for all firms. The dependent variable is asset risk (*ASSET_RISK*). OLS is an ordinary least squares regression. Heckman is a two-step treatment effect regression to correct for selection bias. 2SLS is a two-stage least squares regression. Instruments include firm age (*FIRM_AGE*) and exposure to competition with single-line insurers (*SINGLE_INDEX*). Standard errors (in parentheses) in models OLS and 2SLS are corrected for clustering at the insurer level.

Dependent variable: ASSET_RISK					
Variables	OLS	Heckman	2SLS	OLS	2SLS
INTERCEPT	0.0013	0.0075	0.0132	-0.0011	-0.0011
	(0.0552)	(0.0172)	(0.0569)	(0.0554)	(0.0572)
MULTILINE	0.0387***	0.1042***	0.1646***		
	(0.0089)	(0.0068)	(0.0261)		
LINES_DIV				0.0791***	0.2193***
				(0.0146)	(0.0345)
SIZE	0.0119***	0.0092***	0.0067*	0.0129***	0.0116***
	(0.0037)	(0.0011)	(0.0040)	(0.0037)	(0.0039)
GEO_DIV	0.0132	0.0021	-0.0081	0.0121	-0.0013
	(0.0191)	(0.0074)	(0.0198)	(0.0191)	(0.0198)
LEVERAGE	−0.2015***	−0.1916***	−0.1826***	−0.2050***	−0.2011***
	(0.0302)	(0.0086)	(0.0317)	(0.0303)	(0.0311)
REINSURANCE	−0.0573***	−0.0810***	−0.1028***	−0.0604***	−0.0906***
	(0.0178)	(0.0067)	(0.0227)	(0.0182)	(0.0214)
GROUP	0.0592***	0.0553***	0.0518***	0.0543***	0.0416***
	(0.0127)	(0.0045)	(0.0134)	(0.0129)	(0.0138)
MUTUAL	0.0233**	0.0153***	0.0080	0.0171*	−0.0021
	(0.0093)	(0.0032)	(0.0098)	(0.0094)	(0.0100)
LONG_TAIL	0.0134	0.0041	−0.0044	0.0089	−0.0088
	(0.0151)	(0.0048)	(0.0165)	(0.0150)	(0.0159)
COMBINED_RATIO	−0.0066	−0.0016	0.0031	−0.0065	−0.0010
	(0.0119)	(0.0024)	(0.0132)	(0.0119)	(0.0126)
ROA	−0.1351*	−0.0866***	−0.0420	−0.1390**	−0.0953
	(0.0699)	(0.0282)	(0.0816)	(0.0700)	(0.0748)
INSOLVENCY_RISK	0.0144**	0.0177***	0.0207***	0.0171**	0.0254***
	(0.0070)	(0.0047)	(0.0079)	(0.0069)	(0.0077)
PUBLIC	0.0100	0.0100	0.0101	0.0055	−0.0024
	(0.0159)	(0.0061)	(0.0169)	(0.0152)	(0.0155)
Wald test statistic			973.6770***		1528.1070***
Hansen's J statistic			1.3420		0.0060
Self-selection parameter		−0.0491***			
		(0.0044)			
Year fixed effects	Yes	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes	Yes
N. of obs.	12,509	12,509	12,509	12,509	12,509
Adjusted R-square	0.1974	0.1982	0.1044	0.2032	0.1574

* denote significance at 10% levels.
** denote significance at 5% levels.
*** denote significance at 1% levels.

Group status: Companies within insurer groups are more liquid (Colquitt et al., 1999). Thus they are more likely to have greater capacity to invest in riskier assets. Therefore, we expect group status to be positively related to the asset risk-taking. We indicate group status using a dummy variable (*GROUP*), which is equal to 1 if an observation is an aggregated group and 0 if it is a single-unaffiliated insurer.

Ownership structure: Yu et al. (2008) find that stock insurance companies take less investment risk than do mutual insurers. They suggest that, unlike mutuals, stock insurers are subject to the monitoring of shareholders. However, since stock companies have relatively easier access to capital markets they are capable of assuming more risk. Therefore, the relationship between ownership structure and asset risk-taking is not clear. We measure ownership structure

Table 6

Diversification effect on industry-adjusted asset risk-taking. This table presents a robustness test of the diversification effect on asset risk-taking for all firms. The dependent variable is industry-adjusted asset risk (*ADJ_ASSET_RISK*). OLS is an ordinary lease squares regression. Heckman is a two-step treatment effect regression to correct for selection bias. 2SLS is a two-stage least squares regression to tackle the endogeneity problem of diversification measures. Instrument variables (IV) include firm age (*FIRM_AGE*) and exposure to competition with single-line insurers (*SINGLE_INDEX*). Standard errors (in parentheses) in models OLS and 2SLS are corrected for clustering at the insurer level.

Dependent variable: ADJ_ASSET_RISK					
Variables	OLS	Heckman	2SLS	OLS	2SLS
INTERCEPT	−0.1063*	−0.0998***	−0.0948	−0.1087*	−0.1066*
	(0.0567)	(0.0178)	(0.0581)	(0.0570)	(0.0586)
MULTILINE	0.0390***	0.1072***	0.1604***		
	(0.0091)	(0.0071)	(0.0269)		
LINES_DIV				0.0767***	0.2147***
				(0.0150)	(0.0357)
SIZE	0.0119***	0.0090***	0.0068*	0.0128***	0.0116***
	(0.0038)	(0.0011)	(0.0041)	(0.0038)	(0.0040)
GEO_DIV	0.0118	0.0003	−0.0087	0.0111	−0.0022
	(0.0196)	(0.0077)	(0.0201)	(0.0196)	(0.0202)
LEVERAGE	−0.1994***	−0.1892***	−0.1812***	−0.2031***	−0.1992***
	(0.0308)	(0.0089)	(0.0322)	(0.0310)	(0.0317)
REINSURANCE	−0.0611***	−0.0857***	−0.1049***	−0.0635***	−0.0933***
	(0.0184)	(0.0069)	(0.0235)	(0.0189)	(0.0221)
GROUP	0.0612***	0.0572***	0.0541***	0.0565***	0.0440***
	(0.0130)	(0.0046)	(0.0137)	(0.0132)	(0.0142)
MUTUAL	0.0209**	0.0126***	0.0061	0.0151	−0.0038
	(0.0098)	(0.0033)	(0.0101)	(0.0098)	(0.0104)
LONG_TAIL	0.0154	0.0057	−0.0018	0.0112	−0.0062
	(0.0159)	(0.0049)	(0.0172)	(0.0158)	(0.0167)
COMBINED_RATIO	−0.0040	0.0013	0.0054	−0.0040	0.0015
	(0.0130)	(0.0025)	(0.0143)	(0.0130)	(0.0136)
ROA	−0.1215	−0.0710**	−0.0317	−0.1263*	−0.0833
	(0.0765)	(0.0292)	(0.0877)	(0.0765)	(0.0811)
INSOLVENCY_RISK	0.0153**	0.0187***	0.0214***	0.0179**	0.0261***
	(0.0071)	(0.0048)	(0.0080)	(0.0071)	(0.0079)
PUBLIC	0.0077	0.0078	0.0079	0.0033	−0.0044
	(0.0159)	(0.0063)	(0.0168)	(0.0153)	(0.0156)
Wald test statistic			973.6770***		1528.1070***
Hansen's J statistic			1.7220		0.0150
Self-selection parameter		−0.0511***			
		(0.0046)			
Year fixed effects	Yes	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes	Yes
N. of obs.	12,509	12,509	12,509	12,509	12,509
Adjusted R-square	0.1819	0.1844	0.0995	0.1865	0.1443

* denote significance at 10% levels.
** denote significance at 5% levels.
*** denote significance at 1% levels.

using a dummy variable (*MUTUAL*), which is equal to 1 for a mutual insurer and 0 for a stock insurer.

Long-tail lines: As is suggested by Yu et al. (2008), insurance companies writing more business in long-tail lines take less asset risk to achieve a balanced portfolio. We use the proportion of net premiums written in long-tail business lines[6] (*LONG_TAIL*) to measure the weight of long-tail business in an insurer's underwriting portfolio. We expect *LONG_TAIL* to be negatively related to asset risk-taking.

Underwriting and overall firm performance: Insurance companies generate profits from both underwriting and investment operations. When one does not work well, risk can be shifted to the other. Therefore, it is important to control underwriting and overall firm performance in asset risk-taking decisions. We measure underwriting performance by the combined ratio (*COMBINED_RATIO*), calculated as the sum of the loss ratio and the expense ratio. The loss ratio is equal to losses incurred as a proportion of premiums earned. The expense ratio is equal to underwriting expenses as a percentage of premiums earned. We expect *COMBINED_RATIO* to be positively related to asset risk-taking. We measure overall firm performance by return on assets (*ROA*), calculated as the ratio of net income over total net admitted assets. We expect *ROA* to be negatively related to asset risk-taking.

Insolvency risk: The overinvestment problem is more severe for firms with higher insolvency risk. Consistent with Gaver and Paterson (2004), we use the number of unacceptable IRIS ratios to proxy for insolvency risk. Specifically, firms that fail four or more ratios are considered as weak. We measure insolvency risk by a dummy variable (*INSOLVENCY_RISK*) that is equal to 1 if an insurer fails four or more IRIS ratios and 0 otherwise. We expect *INSOLVENCY_RISK* to be positively related to asset risk-taking.

Public status: Public and private insurance companies face different pressure from owners about firm performance. Public firms need to report to their shareholders quarterly, and thus their asset allocation strategy, risk-taking behavior and risk appetite may differ from private insurers. We include public status (*PUBLIC*) as another control in our analysis. *PUBLIC* is a dummy variable that is equal to 1 for public insurers and 0 for private insurers. The

[6] Consistent with Phillips et al. (1998), long-tail lines include the following: Ocean Marine, Medical Professional Liability, International, Reinsurance, Workers' Compensation, Other Liability, Product Liability, Aircraft, Boiler and Machinery, Farmowners Multiple Peril, Homeowners Multiple Peril, Commercial Multiple Peril, and Automobile Liability. Short-tail lines include the following: Inland Marine, Financial Guaranty, Earthquake, Fidelity, Surety, Burglary and Theft, Credit, Fire and Allied Lines, Mortgage Guaranty, and Automobile Physical Damage.

Table 7
Diversification effect on cash ratio.
This table presents a robustness test of the diversification effect on asset risk-taking for all firms. The dependent variable is the cash ratio (*CASH_RATIO*). OLS is an ordinary least squares regression. Heckman is a two-step treatment effects regression to correct for selection bias. 2SLS is a two-stage least squares regression to tackle the endogeneity problem of diversification measures. The instrument variable (IV) is firm age (*FIRM_AGE*). Standard errors (in parentheses) in models OLS and 2SLS are corrected for clustering at the insurer level.

Dependent variable: CASH_RATIO					
Variables	OLS	Heckman	2SLS	OLS	2SLS
INTERCEPT	1.1544***	1.1418***	1.1420***	1.1598***	1.1576***
	(0.0707)	(0.0252)	(0.0711)	(0.0720)	(0.0728)
MULTILINE	−0.0740***	−0.2066***	−0.2050***		
	(0.0146)	(0.0118)	(0.0376)		
LINES_DIV				−0.0965***	−0.2419***
				(0.0189)	(0.0438)
SIZE	−0.0498***	−0.0442***	−0.0443***	−0.0520***	−0.0508***
	(0.0040)	(0.0016)	(0.0044)	(0.0041)	(0.0042)
GEO_DIV	−0.0810***	−0.0587***	−0.0589***	−0.0843***	−0.0704***
	(0.0197)	(0.0109)	(0.0220)	(0.0200)	(0.0218)
LEVERAGE	−0.0036	−0.0235*	−0.0232	0.0048	−0.0007
	(0.0378)	(0.0127)	(0.0381)	(0.0379)	(0.0384)
REINSURANCE	0.1255***	0.1734***	0.1728***	0.1196***	0.1509***
	(0.0272)	(0.0100)	(0.0306)	(0.0280)	(0.0294)
GROUP	0.0161	0.0239***	0.0238*	0.0205	0.0337**
	(0.0125)	(0.0066)	(0.0137)	(0.0126)	(0.0143)
MUTUAL	−0.0527***	−0.0366***	−0.0368***	−0.0485***	−0.0285**
	(0.0119)	(0.0047)	(0.0126)	(0.0124)	(0.0128)
LONG_TAIL	−0.0597**	−0.0409***	−0.0411*	−0.0579**	−0.0396
	(0.0236)	(0.0070)	(0.0244)	(0.0237)	(0.0247)
COMBINED_RATIO	−0.0059	−0.0161***	−0.0160	−0.0040	−0.0097
	(0.0134)	(0.0035)	(0.0150)	(0.0133)	(0.0140)
ROA	−−0.0498	−0.1479***	−0.1467	−0.0252	−0.0706
	(0.0928)	(0.0415)	(0.1026)	(0.0925)	(0.0959)
INSOLVENCY_RISK	0.0748***	0.0681***	0.0681***	0.0728***	0.0642***
	(0.0114)	(0.0068)	(0.0118)	(0.0115)	(0.0118)
PUBLIC	0.0309**	0.0307***	0.0308**	0.0364**	0.0446***
	(0.0140)	(0.0089)	(0.0143)	(0.0145)	(0.0155)
Wald test statistic			1178.6140***		2311.5110***
Self-selection parameter		0.0919***			
		(0.0073)			
Year fixed effects	Yes	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes	Yes
N. of obs.	12,509	12,509	12,509	12,509	12,509
Adjusted R-square	0.3389	0.3470	0.2989	0.3348	0.3153

* denote significance at 10% levels.
** denote significance at 5% levels.
*** denote significance at 1% levels.

expected relation between investment risk-taking and *PUBLIC* is indeterminate.

Year and state fixed effects: The sample in our study covers the period from 1997 to 2013. In this time window, there are substantial fluctuations in financial markets, particularly the 2008-2009 financial crisis, which caused ripples throughout the world's economy. Our sample period also includes the 2001 terrorist attacks and the 2005 losses from hurricanes Katrina, Rita, and Wilma. We therefore use year fixed effects to control for variation in asset risk-taking due to economic and insurance market conditions. We also include state fixed effects to account for the effect of state-specific regulation on insurer asset risk-taking.

4. Data and sample

We obtain an initial sample of P/L insurance companies from the National Association of Insurance Commissioners (NAIC) InfoPro database for the years 1997 through 2013. Consistent with Berger et al. (2000), we aggregate affiliated insurance companies because diversification decisions are likely made at the group level rather than at the individual firm level. We exclude observations with negative total net admitted assets, negative net premiums written, and those with a substantial proportion (more than 25 percent) of net premiums written in life and health insurance. We also exclude insurers that are neither mutuals nor stocks. A group is assigned an ownership structure (e.g., mutual and stock) based upon data collected from the A. M. Best's Insurance Reports. Our last screen is to winsorize the top 1 percent and the bottom 1 percent of variables to diminish the effects of outliers.[7] Our final sample consists of 1154 insurers with 12,509 firm-year observations.

Table 1 reports variable descriptions and predicted signs (for independent variables), and Table 2 presents summary statistics. Overall, the variables in our paper have means that are very similar to those reported by other researchers. For example, the mean of *ASSET_RISK* (0.1544) is close to that in Berry-Stölzle et al. (2012), where the sum of common stock weight (0.1390) and junk bond weight (0.010) is 0.1490. Similarly, Yu et al. (2008) report mean asset risk of 0.1140. For our three key independent variables, the mean of *MULTILINE* (0.7183) is very close to the 0.7120 reported by Elango et al. (2008); and the mean of *LINES_DIV* (0.3423) is almost identical to the 0.34 reported by Berry-Stölzle et al. (2012). Summary statistics for control variables are also in line with prior literature.

[7] We also perform a robustness check by trimming, rather than winsorizing the outliers, and our empirical results are qualitatively the same.

5. Empirical method

To test the relation between line-of-business diversification and asset risk-taking we estimate the following model using several ordinary least squares regressions:

$$\begin{aligned}ASSET\_RISK_{i,t} = {} & a_t + \beta_1 DIV_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 GEO_{DIV\,i,t} \\ & + \beta_4 LEVERAGE_{i,t} + \beta_5 REINSURANCE\_RATIO_{i,t} \\ & + \beta_6 GROUP_{i,t} + \beta_7 MUTUAL_{i,t} + \beta_8 LONG\_TAIL_{i,t} \\ & + \beta_9 COMBINED\_RATIO_{i,t} + \beta_{10} ROA_{i,t} \\ & + \beta_{11} INSOLVENCY\_RISK_{i,t} + \beta_{12} PUBLIC_{i,t} \\ & + \beta_{13-28} YEAR_t + \beta_{29-86} STATE_{i,t} \qquad (2)\end{aligned}$$

where $DIV_{i,t} = \{MULTILINE_{i,t},\ LINES\_DIV_{i,t}\}$.

Prior literature suggests that diversification is endogenous (e.g., Laeven and Levine, 2007). We examine the exogeneity of our diversification measures by conducting a Hausman test. The t-statistics from the result of the Hausman test are significant at 1% significance level and thus reject the null hypothesis of exogeneity on asset risk-taking. We implement a Heckman treatment effects approach and a two-stage least squares (2SLS) approach when regressing asset risk on diversification status and a 2SLS approach when regressing asset risk on diversification extent. Specifically, the Heckman treatment-effects model corrects for self-selection bias by including a self-selection parameter obtained from a first-stage logit regression. Successful instrumental variables for Heckman and 2SLS need to fulfill two conditions. The first condition is that the instrumental variable is correlated with the endogenous explanatory variable. The second condition is that the instrumental variable is uncorrelated with the error term in the explanatory equation. Liebenberg and Sommer (2008) suggest three instruments for *MULTILINE*: firm age, the reinsurance ratio, and the exposure to competition with focused companies.[8] Because we include the reinsurance ratio as a control variable in our asset risk model we consider only firm age (*FIRM_AGE*) and the extent of exposure to single-line insurers (*SINGLE_INDEX*) as instruments. We test instrument relevance using a Wald test and instrument validity using Hansen's *J*-test of overidentifying restrictions. We find that *FIRM_AGE* and *SINGLE_INDEX* are successful instruments for *MULTILINE* and *LINES_DIV*. Following Campa and Kedia (2002) we also attempt to address endogeneity bias using fixed-effects regression estimation. However, our diversification measures do not have sufficient within-firm variation, hindering the applicability of the fixed-effects model. Therefore, we address the panel nature of our data by adjusting the standard errors for firm-level clustering.

6. Univariate analysis

6.1. Diversification profile

Table 3 presents the diversification behavior in the P/L industry for the years 1997 to 2013. In the third and fourth column, we list the number of diversified insurers and the percentage of diversified insurers for each year. We also show the mean and median of the complement of the Herfindahl Index of net premiums written (NPW). While the percentage of diversified firms reduces over time, the level of diversification remains fairly constant.

[8] The exposure to competition with single-line firms ($SINGLE\_INDEX_{i,t}$) is measured based on the method suggested by Liebenberg and Sommer (2008). In each business line, we first calculate the market share of focused firms ($\%SINGLE_{j,\,t}$ = NPW by single-line insurers in line j /Total NPW of line j). Then the exposure to competition with focused insurers is calculated as the average market share of single-line firms weighted by the participation of the multiline insurer in each line (w_{it}). That is, $SINGLE\_INDEX_{it} = \sum_{j=1}^{24}(w_{it} \times \%SINGLE_{jt})$.

6.2. Comparison of diversifiers and non-diversifiers

Table 4 compares asset risk-taking between diversified insurers and focused insurers. The significance of differences in means is tested by t-statistics, and the significance of differences in medians is tested by a Mann–Whitney–Wilcoxon test. Panel A reports that, on average, diversified insurers have substantially higher *ASSET_RISK* than do non-diversified insurers. Similarly, the Panel A reports that median *ASSET_RISK* of diversified firms is almost 4 times greater than that of undiversified firms. Panel A and Panel B of Fig. 1 complement our descriptive statistics by showing that asset risk increases with the extent of diversification.

However, it is possible that the differences are driven by industry (line-of-business) influences and are not related to the diversification decision (e.g., Allayannis and Weston, 2001; Liebenberg and Sommer, 2008). Thus, we compute industry-adjusted asset risk-taking (*ADJ_ASSET_RISK*) by a "chop-shop" approach suggested by Lang and Stulz (1994) whereby industry-adjusted values are constructed by computing the difference between the multi-segment firm's value and the weight-adjusted industry value ("pure-play" firm value). Because there are several lines of property-liability insurance in which very few single-line insurers operate we follow Liebenberg and Sommer (2008) and use cluster analysis to aggregate the business lines into homogeneous clusters.[9] We then aggregate the net premiums written in those four clusters, and regard insurers that have business within only one cluster as focused insurers. The industry-adjusted values of asset risk-taking are calculated as follows:

$$Industry\ Adjusted\ Value_{i,t}$$

$$= Actual\ Value_{i,t} - \sum_{c=1}^{4}(w_{i,c,t} \times Pure\ Play\ Value_{i,c,t})$$

$$w_{i,c} = \frac{NPW_{i,c,t}}{NPW_{i,t}}$$

where $NPW_{i,\,t}$ is the net premiums written by an insurer i in year t, and $NPW_{i,\,c,\,t}$ is the net premiums written on cluster c by an insurer i in year t.

In Panel B of Table 4, we report the results from the comparison between diversifiers and non-diversifiers for industry-adjusted asset risk-taking and find that our univariate comparison between diversifiers and non-diversifiers is robust to industry adjustment. Panel C and Panel D of Fig. 1 further illustrate the positive relation between diversification and industry-adjusted asset risk.

7. Multivariate analysis

In Table 5 we test the coordinated risk management hypothesis using multivariate regressions of asset risk-taking on diversification status and extent. We find that the coefficient estimates on our diversification measures are consistently positive and significant across all our regression models. In the *MULTILINE* (diversification status) regressions, the positive sign implies that diversified insurers take more asset risk in their portfolios than

[9] We follow Liebenberg and Sommer (2008) and use the VARCLUS procedure in SAS to perform cluster analysis based upon the net premiums written in each line of business. The VARCLUS procedure attempts to maximize the variance that can be explained by the components clusters and drive variables into hierarchical groups. The four clusters generated by the SAS VARCLUS procedure are as follows: Cluster 1: Commercial Multiple Peril, Ocean Marine, Inland Marine, Workers' Compensation, Fidelity, Surety, Burglary and Theft, and Products Liability; Cluster 2: Farmowners' Multiple Peril, Homeowners' Multiple Peril, Earthquake, International, and Auto; Cluster 3: Mortgage Guaranty, Aircraft, Boiler and Machinery, Credit, Fire and Allied Lines, Accident and Health, and Other Liability; Cluster 4: Financial Guaranty, Other, Medical Professional Liability, and Reinsurance.

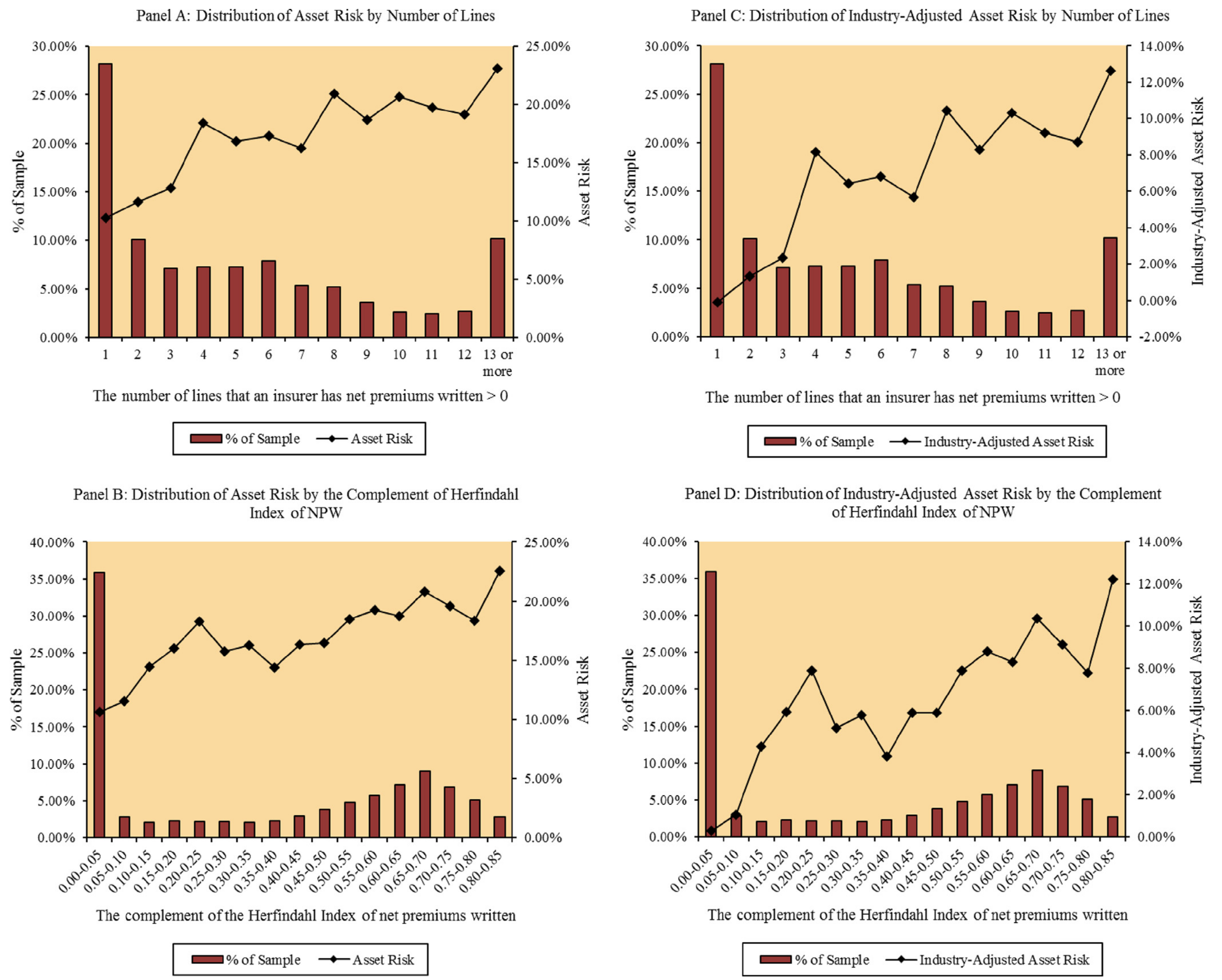

Fig. 1. Distribution of asset risk of insurers by diversification. This figure presents the distribution of insurers and asset risk by diversification. Panel A and Panel B (Panel C and Panel D) depict the distribution of asset risk (industry-adjusted asset risk) across the number of lines that an insurer has positive net premiums written (NPW) and the complement of Herfindahl Index of NPW, respectively.

non-diversified insurers. Similarly, in the *LINES_DIV* (diversification extent) regressions we find that as an insurer becomes more diversified, it correspondingly takes more asset risk. Therefore, we find evidence in support of the coordinated risk management hypothesis as insurers with reduced underwriting risk choose to increase investment risk.

Several results for our control variables are noteworthy. The sign of the coefficient on *SIZE* is positive and significant in all regressions of our study, providing some evidence that large insurers are able to take more risk. The negative coefficients on *LEVERAGE* support our hypotheses that highly levered insurers take less risk in their portfolios to assuage agency problems.[10] Interestingly, contrary to our expectation we find that *REINSURANCE* is negatively related to asset risk-taking in all regression models, suggesting that reinsurance is not a substitute for business line diversification. In addition, we find that *MUTUAL* is positively related to asset risk-taking in three out of five regression models. This finding provides mixed evidence for the hypothesis that stock insurers take less asset risk because they are subject to the monitoring of shareholders.

8. Robustness tests

8.1. Sensitivity to alternative estimation method

To check the robustness of our multivariate regressions, we first employ an alternative estimation method by applying an industry adjustment to our dependent variables. As mentioned in our univariate analysis, the observed differences in asset risk across diversification status may be due to industry (line of business) effects. We eliminate the industry influence by using industry-adjusted values of asset risk-taking in our regressions. Table 6 provides the results for the robustness of the diversification effect on asset risk-taking by using an industry-adjusted approach. The positive sign on both diversification measures in our regression models implies that the diversification effect on asset risk-taking is robust to industry adjustment.

[10] Generally speaking, firms with higher leverage should take less asset risk because of surplus constraint. But the overinvestment problem may exist for insurers with extremely high insolvency risk. We have performed a test to capture the non-linearity by utilizing a squared term of leverage in our multivariate regression. The coefficient estimate on the squared term is negative and significant, implying that the highly levered insurers tend to take less asset risk. Therefore, we find evidence that is inconsistent with the conjecture.

Table 8
Diversification effect on asset risk-taking with asset risk measured by the standard deviation of return on investment. This table presents multivariate regressions of asset risk-taking on diversification for all firms. The dependent variable is an alternative measure of asset risk, calculated as the standard deviation of return on investment (*INV_RET_STD*) by using 5-year rolling periods data. OLS is an ordinary least squares regression. 2SLS is a two-stage least squares regression where the instrument is the exposure to competition with single-line insurers (*SINGLE_INDEX*). Standard errors (in parentheses) in models OLS and 2SLS are corrected for clustering at the insurer level.

Dependent variable: INV_RET_STD			
Variables	OLS	OLS	2SLS
INTERCEPT	0.0203***	0.0200***	0.0195***
	(0.0052)	(0.0053)	(0.0055)
MULTILINE	0.0019**		
	(0.0009)		
LINES_DIV		0.0035***	0.0130**
		(0.0013)	(0.0055)
SIZE	−0.0002	−0.0001	−0.0002
	(0.0004)	(0.0004)	(0.0004)
GEO_DIV	−0.0015	−0.0015	−0.0024
	(0.0018)	(0.0017)	(0.0019)
LEVERAGE	−0.0023	−0.0026	−0.0024
	(0.0025)	(0.0025)	(0.0025)
REINSURANCE	−0.0042***	−0.0043***	−0.0063***
	(0.0015)	(0.0015)	(0.0019)
GROUP	−0.0010	−0.0012	−0.0020
	(0.0012)	(0.0012)	(0.0013)
MUTUAL	−0.0024***	−0.0027***	−0.0041***
	(0.0008)	(0.0008)	(0.0012)
LONG_TAIL	0.0000	−0.0002	−0.0015
	(0.0013)	(0.0013)	(0.0016)
COMBINED_RATIO	0.0000	0.0000	0.0005
	(0.0005)	(0.0005)	(0.0006)
ROA	−0.0123*	−0.0126*	−0.0096
	(0.0067)	(0.0067)	(0.0069)
INSOLVENCY_RISK	0.0070***	0.0071***	0.0076***
	(0.0011)	(0.0011)	(0.0011)
PUBLIC	0.0003	0.0002	−0.0005
	(0.0014)	(0.0014)	(0.0015)
Wald test statistic			579.5590***
Year fixed effects	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes
N. of obs.	8241	8241	8241
Adjusted R-square	0.0642	0.0650	0.0421

* denote significance at 10% levels.
** denote significance at 5% levels.
*** denote significance at 1% levels.

8.2. Sensitivity to alternative asset-risk measures

We also test the robustness of our results to two alternative measures of asset risk-taking. First, we use the ratio of cash to total invested assets (*CASH_RATIO*) as an inverse measure of asset risk-taking. We perform a Wald test to detect endogeneity in the *CASH_RATIO* regression, and find that the *SINGLE_INDEX* does not fulfill the condition of relevance. Therefore, we only use *FIRM_AGE* as our instrument in the regressions with *MULTILINE* measure and *LINES_DIV* measure.[11] Table 7 provides the results for the robustness of the diversification effect on the asset risk-taking by using *CASH_RATIO* as the dependent variable. Consistent with our expectation, we find that *MULTILINE* and *LINES_DIV* are negatively related to cash reserves. Second, following Ho et al. (2013), we measure asset risk as the standard deviation of return on investment (*INV_RET_STD*) by using 5-year rolling periods data. Table 8 reports the results.[12] We find that the coefficient estimates on our diversification measures, *MULTILINE* and *LINES_DIV*, are positive and significant.

8.3. Robustness to non-linearity of diversification

Business diversification helps reduce insurers' underwriting risk, however, the marginal benefit of diversification is diminishing, as suggested by Myers and Read (2001). At some point, "super diversified" firms may not be able to reduce underwriting risk anymore, and with a fixed risk appetite, firms may not be able to take more asset risk. Following Morck et al. (1988) and Wruck (1989), we test for a non-linear relation by estimating piecewise linear regressions allowing for changes in the slope coefficient on business diversification. Based on the distribution of our data and the trend shown in Fig. 1, we choose the value of diversification extent (*LINES_DIV*) 0.2 and 0.7 as the first set of turning points. In addition, we regard the firms with *LINES_DIV* above the 75th or 90th percentile as "super diversified". Therefore, we use three different specifications of turning points of *LINES_DIV*, (0.2, 0.7), the 75th percentile, and the 90th percentile in our analysis. Table 9 reports the results. The results indicate that the positive relation between diversification and asset risk-taking is significant and positive only when the diversification level is low. Therefore, we find evidence that is consistent with Myers and Read (2001). Specifically, the relation between asset risk-taking and diversification is non-linear.

8.4. Robustness to an interactive effect between firm size and diversification

Because large firms are usually more diversified than small firms, and are generally able to take higher investment risk, the relation between diversification and asset risk-taking may vary with firm size. We therefore investigate the non-linear relation between diversification and asset risk-taking on firm size by including in our regression models the interaction between firm size and diversification (*MULTILINE* × *SIZE* and *LINES_DIV* × *SIZE*). In Table 10 we find that the positive diversification-asset risk relation is independent of firm size when using the binary diversification measure (*MULTILINE*). However, for the continuous diversification measure (*LINES_DIV*), we find that the effect is diminished for larger firms. Given that larger firms tend to be more diversified, this result is consistent with the non-linearity of the diversification-asset risk taking relation reported above.

9. Event study

In this section, we conduct an event study to investigate the changes in asset risk-taking around diversification and refocusing events. Diversification events are defined as adding one or more new business lines in a year. We distinguish between two categories of diversification events: (1) from focused to diversified, and (2) from diversified to more diversified. Refocusing events are defined as deducting one or more old lines from the underlying business in a year. Corresponding to the classification of diversification events, we distinguish between two categories of refocusing events: (1) from diversified to focused, and (2) from diversified to less diversified. We use univariate pairwise comparison and multivariate regressions to investigate whether insurers significantly increase (reduce) asset risk-taking following diversification (refocusing) events.

[11] Given that we have only one relevant instrument we are unable to perform an overidentification test and therefore we do not report Hansen's J statistic in Tables 7 and 8.

[12] The Hausman test for exogeneity of *MULTILINE* in Table 8 indicates that it is not endogenous. Accordingly we do not report 2SLS and Heckman results for *MULTILINE* in this table.

Table 9
Piecewise regression of diversification effect on asset risk-taking. This table represents the results from the piecewise regressions of asset risk-taking on diversification for all firms. $LINES\_DIV\_0to0.2 = LINES\_DIV$ if $LINES\_DIV < 0.2$; $= 0.2$ if $LINES\_DIV >= 0.2$. $LINES\_DIV\_0.2to0.7 = 0$ if $LINES\_DIV < 0.2$; $= (LINES\_DIV - 0.2)$ if $0.2 \le LINES\_DIV \le 0.7$; $= 0.7$ if $LINES\_DIV \ge 0.7$. $LINES\_DIV\_over0.7 = 0$ if $LINES\_DIV < 0.7$; $= (LINES\_DIV - 0.7)$ if $LINES\_DIV \ge 0.7$. $LINES\_DIV\_0toP75 = LINES\_DIV$ if $LINES\_DIV < P75$; $= (LINES\_DIV - P75)$ if $LINES\_DIV \ge P75$, where P75 presents 75th percentile. $LINES\_DIV\_0toP90 = LINES\_DIV$ if $LINES\_DIV < P90$; $= (LINES\_DIV - P90)$ if $LINES\_DIV \ge P90$, where P90 represents 90th percentile. The piecewise regressions are estimated using OLS. Standard errors (in parentheses) are corrected for clustering at the insurer level.

Dependent variable: ASSET_RISK			
Turning point	0.2, 0.7	P75	P90
INTERCEPT	−0.0072	−0.0063	−0.0057
	(0.0552)	(0.0555)	(0.0554)
LINES_DIV_0to0.2	0.1490**		
	(0.0674)		
LINES_DIV_0.2to0.7	0.0651*		
	(0.0355)		
LINES_DIV_over0.7	−0.1975		
	(0.1549)		
LINES_DIV_0toP75		0.0951***	
		(0.0173)	
LINES_DIV_overP75		−0.1047	
		(0.0977)	
LINES_DIV_0toP90			0.0856***
			(0.0152)
LINES_DIV_overP90			−0.2757
			(0.2100)
SIZE	0.0128***	0.0129***	0.0130***
	(0.0037)	(0.0037)	(0.0037)
GEO_DIV	0.0131	0.0131	0.0127
	(0.0191)	(0.0191)	(0.0191)
LEVERAGE	−0.2020***	−0.2030***	−0.2046***
	(0.0298)	(0.0302)	(0.0303)
REINSURANCE	−0.0612***	−0.0602***	−0.0600***
	(0.0180)	(0.0182)	(0.0182)
GROUP	0.0535***	0.0539***	0.0536***
	(0.0129)	(0.0129)	(0.0129)
MUTUAL	0.0167*	0.0164*	0.0166*
	(0.0094)	(0.0094)	(0.0094)
LONG_TAIL	0.0092	0.0093	0.0091
	(0.0150)	(0.0150)	(0.0150)
COMBINED_RATIO	−0.0057	−0.0060	−0.0062
	(0.0119)	(0.0119)	(0.0119)
ROA	−0.1305*	−0.1336*	−0.1373*
	(0.0695)	(0.0699)	(0.0700)
INSOLVENCY_RISK	0.0168**	0.0169**	0.0171**
	(0.0069)	(0.0069)	(0.0069)
PUBLIC	0.0119	0.0107	0.0111
	(0.0152)	(0.0152)	(0.0151)
Year fixed effects	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes
N. of obs.	12,509	12,509	12,509
Adjusted R-square	0.2052	0.2047	0.2042

* denote significance at 10% levels.
** denote significance at 5% levels.
*** denote significance at 1% levels.

Table 10
Diversification effect on asset risk-taking accounting for interactive effect of firm size. This table presents multivariate regressions of asset risk-taking on diversification for all firms. The dependent variable is asset risk (*ASSET_RISK*). OLS is an ordinary least squares regression. Standard errors (in parentheses) are corrected for clustering at the insurer level.

Dependent variable: ASSET_RISK		
Variables	OLS	OLS
INTERCEPT	−0.0729	−0.1008
	(0.0704)	(0.0628)
MULTILINE	0.1490*	
	(0.0784)	
LINES_DIV		0.4028***
		(0.1158)
MULTILINE × SIZE	−0.0065	
	(0.0044)	
LINES_DIV × SIZE		−0.0181***
		(0.0063)
SIZE	0.0166***	0.0189***
	(0.0045)	(0.0042)
GEO_DIV	0.0139	0.0135
	(0.0192)	(0.0190)
LEVERAGE	−0.2060***	−0.2128***
	(0.0302)	(0.0303)
REINSURANCE	−0.0575***	−0.0618***
	(0.0178)	(0.0181)
GROUP	0.0622***	0.0581***
	(0.0130)	(0.0129)
MUTUAL	0.0216**	0.0136
	(0.0093)	(0.0094)
LONG_TAIL	0.0119	0.0056
	(0.0152)	(0.0151)
COMBINED_RATIO	−0.0062	−0.0056
	(0.0119)	(0.0119)
ROA	−0.1370*	−0.1446**
	(0.0699)	(0.0699)
INSOLVENCY_RISK	0.0142**	0.0170**
	(0.0070)	(0.0069)
PUBLIC	0.0126	0.0138
	(0.0160)	(0.0155)
Year fixed effects	Yes	Yes
State fixed effects	Yes	Yes
N. of obs.	12,509	12,509
Adjusted R-square	0.1984	0.2083

* denote significance at 10% levels.
** denote significance at 5% levels.
*** denote significance at 1% levels.

9.1. Pairwise comparison

In the pairwise comparison, we examine the effects of diversification and refocusing by calculating the pairwise difference between insurers' asset risk-taking at the end of the event year and the previous year. The significance of differences in means is tested by t-statistics, and the significance of differences in medians is tested by a Mann–Whitney–Wilcoxon test. Panel A of Table 11 presents the results for the diversification events in which a focused firm becomes diversified. We find that asset risk-taking increases following the diversification events and that this increase is statistically significant. Panel B reports the results for the diversification events in which a diversified firm becomes more diversified. We find that the changes are not statistically significant. Panel C presents the results for the refocusing events in which a diversified firm becomes focused, and Panel D presents the results for the refocusing events in which a diversified firm becomes less diversified. We do no find evidence that an insurer changes its asset risk when it refocuses. Overall, in the univariate test, we find evidence that insurers increase asset risk only when they change from focused to diversified.

9.2. Multivariate regressions

We follow the event study framework suggested by Allayannis and Weston (2001) to further test the effects of diversification changes on asset risk-taking by using multivariate regressions. We conduct the analysis on changes in both diversification status and diversification extent. The diversification status change refers to that a diversified (focused) insurer refocuses (diversifies) in a year. The diversification extent change refers to that a diversified insurer becomes more (less) diversified by increasing (decreasing) the number of business lines.

We classify insurers into six categories: (1) Diversified insurer keeps the number of lines constant ($D_{i,t-1}D^{c}_{i,t}$); (2) Diversified in-

Table 11

Pairwise comparison of asset risk-taking around diversification and refocusing events. This table presents the pairwise comparison of asset risk-taking around the diversification and refocusing events. Year t represents the diversification year. The significance of differences in means is tested by a *t*-test with its t-statistic and p-value reported. The significance of differences in medians is tested by a Mann–Whitney–Wilcoxon test with its *p*-value reported. Panel A presents the results for the diversification events in which a focused firm becomes diversified. Panel B presents the results for the diversification events in which a diversified firm becomes more diversified. Panel C presents the results for the refocusing events in which a diversified firm becomes focused. Panel D presents the results for the refocusing events in which a diversified firm becomes less diversified.

Variables		Year t-1 (1)	Year t (2)	Pairwise Difference (3)=(2)-(1)	*p*-value(4)	*t*-statistic (5)
Panel A: Diversification events from focused to diversified						
ASSET_RISK	Mean	0.0917	0.1080	0.0163	0.08	1.78
	Median	0.0327	0.0528	0.0000	0.09	
	N	122	122			
ADJ_ASSET_RISK	Mean	−0.0105	0.0063	0.0168	0.06	1.93
	Median	−0.0619	−0.0538	0.0041	0.07	
	N	122	122			
Panel B: Diversification events from diversified to more diversified						
ASSET_RISK	Mean	0.1768	0.1764	−0.0003	0.90	−0.13
	Median	0.1570	0.1481	0.0000	0.10	
	N	822	822			
ADJ_ASSET_RISK	Mean	0.0718	0.0718	−0.0001	0.98	−0.03
	Median	0.0482	0.0446	0.0020	0.31	
	N	822	822			
Panel C: Refocusing events from diversified to focused						
ASSET_RISK	Mean	0.1083	0.0942	−0.0140	0.15	−1.43
	Median	0.0510	0.0425	0.0000	0.18	
	N	104	104			
ADJ_ASSET_RISK	Mean	0.0075	−0.0060	−0.0135	0.19	−1.33
	Median	−0.0559	−0.0553	−0.0023	0.24	
	N	104	104			
Panel D: Refocusing events from diversified to less diversified						
ASSET_RISK	Mean	0.1827	0.1816	−0.0011	0.65	−0.46
	Median	0.1618	0.1641	0.0000	0.58	
	N	891	891			
ADJ_ASSET_RISK	Mean	0.0777	0.0768	−0.0010	0.68	−0.42
	Median	0.0571	0.0596	−0.0004	0.96	
	N	891	891			

surer refocuses in the current period ($D_{i,t-1}N_{i,t}$); (3) Focused insurer begins diversification in the current period ($N_{i,t-1}D_{i,t}$); (4) Focused insurer does not diversify in either period ($N_{i,t-1}N_{i,t}$); (5) Diversified insurer increases the number of lines ($D_{i,t-1}D^{+}_{i,t}$); (6) Diversified insurer reduces the number of lines ($D_{i,t-1}D^{-}_{i,t}$). The estimation of regression models is as follows,

$$\begin{aligned}\Delta ASSET\_RISK_{i,t} = {} & \beta_1\left(D_{i,t-1}D^{c}_{i,t}\right) + \beta_2(D_{i,t-1}N_{i,t}) + \beta_3(N_{i,t-1}D_{i,t}) \\ & +\beta_4(N_{i,t-1}N_{i,t}) + \beta_5\left(D_{i,t-1}D^{+}_{i,t}\right) + \beta_6\left(D_{i,t-1}D^{-}_{i,t}\right) \\ & +\gamma\,\Delta X_{i,t} + \varepsilon_{i,t} \qquad (3)\end{aligned}$$

where $\Delta ASSET\_RISK_{i,t}$ represents the change in industry-adjusted asset risk-taking. $D_{i,t-1}D^{c}_{i,t}$ is an indicator variable set to 1 if the diversified insurer keeps the number of lines. $D_{i,t-1}N_{i,t}$ is an indicator variable set equal to 1 if the diversified refocuses in the current period. $N_{i,t-1}D_{i,t}$ is an indicator variable set equal to 1 if the focused insurer begins diversification in the current period. $N_{i,t-1}N_{i,t}$ is an indicator variable set equal to 1 if the focused insurer does not diversify in either period. $D_{i,t-1}D^{+}_{i,t}$ is an indicator variable set equal to 1 if the diversified insurer increases the number of lines. $D_{i,t-1}D^{-}_{i,t}$ is an indicator variable set equal to 1 if the diversified insurer reduces the number of lines. $\Delta X_{i,\,t}$ is the vector of changes of control variables (i.e., *SIZE*, *GEO_DIV*, *LEVERAGE, REINSURANCE, GROUP, MUTUAL*, *LONG_TAIL*, *COMBINED_RATIO*, *ROA*, *INSOLVENCY_RISK*, and *PUBLIC*) in the asset risk-taking regression, and $\varepsilon_{i,\,t}$ represents the error term. The regression also includes year and state fixed effects. As an alternative dependent variable, $\Delta ADJ\_ASSET\_RISK_{i,t}$ represents the change in industry-adjusted asset risk-taking.

In terms of the changes in diversification status, if diversification (refocusing) strategy is positively (negatively) related to asset risk-taking, then we would expect that focused insurers that begin to diversify have higher asset risk, compared to focused insurers that do no diversify in either period (i.e., $\beta_3 > \beta_4$), and diversified insurers that refocus have lower asset risk in the next year, compared to insurers that keep the number of lines constant (i.e., $\beta_1 > \beta_2$,). Panel A of Table 12 provides results of the event study on changes in diversification status. We find that, for both raw asset risk and industry-adjusted asset risk, focused insurers that diversify ($N_{i,t-1}D_{i,t}$) experience a larger increase in asset risk than insurers that remain undiversified ($N_{i,t-1}N_{i,t}$). The difference is 1.36% (2.80% versus 1.44%) using raw asset risk and 1.26% (2.48% versus 1.22%) using industry-adjusted asset risk. Both are statistically significant. Also, we find that, for both raw asset risk and industry-adjusted asset risk, diversified insurers that refocus ($D_{i,t-1}N_{i,t}$) experience a smaller increase in asset risk than diversified insurers that keep the number of lines constant ($D_{i,t-1}D^{c}_{i,t}$). The difference is −1.48% (−0.15% versus 1.33%) using raw asset risk and −1.35% (−0.23% versus 1.12%) using industry-adjusted asset risk. Both are statistically significant. We further test the joint hypothesis that $\beta_1 > \beta_2$ and $\beta_3 > \beta_4$ by a Wald test. For both raw asset risk and industry-adjusted asset risk, we reject the hypothesis that there is no relation between a change in diversification status and asset risk-taking.

With regards to the changes in diversification extent, if diversification (refocusing) strategy is positively (negatively) related to asset risk-taking, then we would expect that diversified insurers that increase number of lines have higher asset risk in the next year, compared to insurers that keep the number of lines constant (i.e., $\beta_5 > \beta_1$), and diversified insurers that reduce the number of lines have lower asset risk, compared to insurers that keep the number of lines constant (i.e., $\beta_1 > \beta_6$). Panel B of Table 12 presents the results of the event study on changes in diversification extent. We

Table 12
Event study of changes in diversification status and extent. This table presents an event study of how the changes in diversification affect asset risk-taking. The diversification status change refers to that a diversified (focused) insurer refocuses (diversifies) in a year. The diversification extent change refers to that a diversified insurer becomes more (less) diversified by increasing (decreasing) the number of business lines. We classify insurers into six categories: (1) Diversified insurer keeps the number of lines constant ($D_{i,t-1}D^c_{i,t}$); (2) Diversified insurer refocuses in the current period ($D_{i,t-1}N_{i,t}$); (3) Focused insurer begins diversification in the current period ($N_{i,t-1}D_{i,t}$); (4) Focused insurer does not diversify in either period ($N_{i,t-1}N_{i,t}$); (5) Diversified insurer increases the number of lines ($D_{i,t-1}D^+_{i,t}$); (6) Diversified insurer reduces the number of lines ($D_{i,t-1}D^-_{i,t}$). The estimation of regression models is as follows,

$$\Delta ASSET\_RISK_{i,t} = \beta_1(D_{i,t-1}D^c_{i,t}) + \beta_2(D_{i,t-1}N_{i,t}) + \beta_3(N_{i,t-1}D_{i,t}) + \beta_4(N_{i,t-1}N_{i,t}) + \beta_5(D_{i,t-1}D^+_{i,t}) + \beta_6(D_{i,t-1}D^-_{i,t}) + \gamma\Delta X_{i,t} + \varepsilon_{i,t}$$

where $\Delta ASSET\_RISK_{i,t}$ represents the change in industry-adjusted asset risk-taking. $D_{i,t-1}D^c_{i,t}$ is an indicator variable set to 1 if the diversified insurer keeps the number of lines. $D_{i,t-1}N_{i,t}$ is an indicator variable set equal to 1 if the diversified refocuses in the current period. $N_{i,t-1}D_{i,t}$ is an indicator variable set equal to 1 if the focused insurer begins diversification in the current period. $N_{i,t-1}N_{i,t}$ is an indicator variable set equal to 1 if the focused insurer does not diversify in either period. $D_{i,t-1}D^+_{i,t}$ is an indicator variable set equal to 1 if the diversified insurer increases the number of lines. $D_{i,t-1}D^-_{i,t}$ is an indicator variable set equal to 1 if the diversified insurer reduces the number of lines. $\Delta X_{i,\,t}$ is the vector of changes of control variables (i.e., *SIZE*, *GEO_DIV*, *LEVERAGE*, *REINSURANCE*, *GROUP*, *MUTUAL*, *LONG_TAIL*, *COMBINED_RATIO*, *ROA*, *INSOLVENCY_RISK*, and *PUBLIC*) in the asset risk-taking regression, and $\varepsilon_{i,\,t}$ represents the error term. The regression also includes year and state fixed effects. As an alternative dependent variable, $\Delta ADJ\_ASSET\_RISK_{i,t}$ represents the change in industry-adjusted asset risk-taking. Panel A reports the results from changes in diversification status. Panel B reports the results from changes in diversification extent.

Variables	Obs.	ΔASSET_RISK	ΔADJ_ASSET_RISK
Panel A: Changes in diversification status			
Focused insurer begins diversification in the current period ($N_{i,t-1}D_{i,t}$)	122	0.0280	0.0248
Focused insurer does not diversify in either period ($N_{i,t-1}N_{i,t}$)	3024	0.0144	0.0122
Difference ($N_{i,t-1}D_{i,t}$- $N_{i,t-1}N_{i,t}$)		0.0136	0.0126
Wald Test: $N_{i,t-1}D_{i,t} = N_{i,t-1}N_{i,t}$ (*p-value*)		0.04	0.07
Diversified insurer refocuses in the current period ($D_{i,t-1}N_{i,t}$)	104	−0.0015	−0.0023
Diversified insurer keeps the number of lines constant ($D_{i,t-1}D_{i,t}{}^c$)	6392	0.0133	0.0112
Difference ($D_{i,t-1}N_{i,t}$- $D_{i,t-1}D_{i,t}{}^c$)		−0.0148	−0.0135
Wald Test: $D_{i,t-1}N_{i,t} = D_{i,t-1}D_{i,t}{}^c$ (*p-value*)		0.04	0.07
Panel B: Changes in Diversification Extent			
Diversified insurer increases the number of lines ($D_{i,t-1}D_{i,t}{}^+$)	822	0.0136	0.0112
Diversified insurer keeps the number of lines constant ($D_{i,t-1}D_{i,t}{}^c$)	6392	0.0133	0.0112
Difference ($D_{i,t-1}D_{i,t}{}^+$- $D_{i,t-1}D_{i,t}{}^c$)		0.0003	0.0000
Wald Test: $D_{i,t-1}D_{i,t}{}^+ = D_{i,t-1}D_{i,t}{}^c$ (*p-value*)		0.90	0.99
Diversified insurer reduces the number of lines ($D_{i,t-1}D_{i,t}{}^-$)	891	0.0108	0.0091
Diversified insurer keeps the number of lines constant ($D_{i,t-1}D_{i,t}{}^c$)	6392	0.0133	0.0112
Difference ($D_{i,t-1}D_{i,t}{}^-$- $D_{i,t-1}D_{i,t}{}^c$)		−0.0025	−0.0021
Wald test: $D_{i,t-1}D_{i,t}{}^- = D_{i,t-1}D_{i,t}{}^c$ (*p-value*)		0.34	0.43

find that the difference in changes of asset risk between insurers that increase the number of lines and insurers that keep the number of lines constant is not statistically significant. In terms of the events in which diversified insurers reduce the number of lines, we find that the difference in changes of asset risk between insurers that reduce the number of lines and insurers that keep the number of lines constant is also not statistically significant.

Overall, we perform an event study to test the changes in asset risk around the diversification events. We find that when a focused firm diversifies, it increases its asset risk relative to firms that remain focused, and when a diversified firm refocuses, it reduces its asset risk relative to firms that remain diversified. We do not find similar results in the events in which diversified firms become more or less diversified. In other words, the changes in asset risk are only pronounced around the events of diversification status changes.

10. Conclusion

This paper investigates the effect of line-of-business diversification on asset risk-taking for a sample of 1154 U.S. property-liability insurers between 1997 and 2013. The coordinated risk management hypothesis (Schrand and Unal, 1998) predicts that insurers will strategically allocate risk between core-business activities where they have a comparative information advantage (i.e. underwriting) and activities where they do not have a comparative advantage (i.e. investment). We empirically test this coordinated risk management hypothesis by modelling asset risk as a function of various diversification measures and controls. We find that diversified insurers invest more in risky assets than do non-diversified insurers and that the extent of diversification is positively related to the proportion of risky asset holdings. These results are robust to an alternative estimation method (i.e., industry adjustment), alternative asset-risk measures (i.e., cash reserves and rolling standard deviation of investment returns), and corrections for endogeneity and selectivity bias.

For the purpose of examining the changes around diversification decisions, we also perform an event study. Our analysis suggests that when a focused firm diversifies, it increases its asset risk relative to firms that remain focused, and when a diversified firm refocuses, it reduces its asset risk relative to firms that remain diversified. Taken together, our analyses provide strong evidence in support of the coordinated risk management hypothesis.

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