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Original Publication Citation

McShane, M. K., Zhang, T., & Cox, L. A. (2012). Risk allocation across the enterprise: Evidence from the insurance industry. *Journal of Insurance Issues, 35*(1), 73-99.

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Risk Allocation across the Enterprise: Evidence from the Insurance Industry

Michael K. McShane[1], Tao Zhang[2], and Larry A. Cox[3]

Abstract: Financial researchers initially regarded hedging activities as a means to reduce total firm risk, which often is defined in terms of cash flow volatility. More recently, researchers have focused on the strategic allocation of risk. Direct tests of risk allocation have been problematic, however, because hedging data are rarely available and, when available, are specific only to a single operation of the firm, such as bank lending. In this study, we exploit unique data from the insurance industry that allows us to observe hedging proxies for both investment and insurance underwriting risks and test the risk allocation hypothesis developed in the finance literature. We also conduct separate examinations of life-health and property-casualty insurers, which reveal differences in the risks and hedging activities of these two types of insurers. [Key words: risk allocation, hedging, enterprise risk management.]

INTRODUCTION

During the past two decades, financial researchers have begun to explore the economic rationale for and methods of managing risk across the enterprise. Froot, Scharfstein, and Stein (1993) develop a model showing that in imperfect capital markets, risk management can enhance the firm's value and decrease firm-wide risk by reducing cash flow volatility. Froot and Stein (1998) subsequently build an integrated framework to incorporate risk management, capital structure, and investment policy decisions to reduce firm-wide risk in the banking industry. Stulz (1996) introduces an alternative view, contending that managers should bear,

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Journal of Insurance Issues, 2012, **35** (1): 73–99.
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rather than hedge, those financial risks in which they have comparative advantages.

In line with Stulz's contention, Schrand and Unal (1998) suggest that firm managers should follow a risk allocation strategy in which they hedge homogeneous risks, i.e., those in which they have no informational advantages, so that they can devote more capital to core-business activities in which they have special expertise. Since Schrand and Unal, research on managing multiple risks simultaneously has been scant, with Mun and Morgan (2003) and Lookman (2009) providing notable exceptions.

Schrand and Unal (1998) examine thrift institutions converting from mutual to stock organizational forms, reasoning that such firms will have greater opportunities to expand capital and exploit core-business growth opportunities. They expect that managers of recently demutualized thrifts generally will increase total risk as they simultaneously hedge homogeneous risk and expand core-business risk. Because Schrand and Unal (1998) cannot directly observe the hedging activities of thrifts, they develop indirect risk proxies for homogeneous (interest rate) and core-business (credit) risk. Applying regression to test for differences before and after stock conversions, they conclude that their results are consistent with the use of risk allocation strategies.

We expand upon the work of Schrand and Unal (1998) in two ways. First, we are able to directly test for risk allocation via hedging proxies for the two primary operations of insurers—underwriting and investment. In contrast, Schrand and Unal (1998) test for allocation of financial risks only within a single operation, i.e., lending activities.

Second, in contrast to Schrand and Unal, we do not have to make strong assumptions about hedging activity, but can directly observe well-established proxies for hedging activities by insurers that are fully reported to regulators in annual reports. For instance, insurers primarily use derivatives to hedge investment risk.[4] Reinsurance is the primary means for hedging underwriting risk (Doherty, 2000). The available data for insurers

[4] One potential concern is that derivatives usage measures also can impound speculative holdings (Geczy, Minton, and Schrand, 1997). Survey research (Hoyt, 1989; Santomero and Babbel, 1997) suggests that insurance managers generally use derivatives for hedging purposes, however. Based upon their analysis of insurer financial data, Cummins, Phillips, and Smith (2001) also conclude that the preponderance of derivatives transactions by insurers is for hedging, rather than speculative, purposes. Raturi (2005) discusses hedging and speculative uses of derivatives by insurers and states that insurers mainly use derivatives for hedging market, credit, and liquidity risks, but property-liability insurers sometimes use covered calls of their equity portfolio for income generation. He argues that non-hedging, speculative use of derivatives is rare due to strict regulation by state insurance regulators.

also allow us to incorporate multiple factors found by previous researchers to be important in hedging decisions.

Applying Schrand and Unal's taxonomy, we classify underwriting risk as the core-business risk of insurers while investment risk inherent in insurers' investment portfolios represents homogeneous risk. Because of many years of data and experience in insurance underwriting, insurers should have a comparative information advantage in this core-business operation, which allows them to take risks that are more likely to produce positive economic rent.

In contrast, managers of insurers should have no information advantages in their investment operations compared to managers of other financial institutions, assuming that investment markets are reasonably efficient. Managers of all financial institutions can directly hedge investment risk via derivatives. Only insurers must file detailed annual reports on such activities with regulators, however.

Our evidence indicates that managers of property-casualty (P-C) insurers that retain higher levels of underwriting risk because of relatively low usage of reinsurance simultaneously carry lower investment risk levels because of greater use of derivatives. Also for P-C insurers, we do not find a significant relation between cash flow volatility (total risk) and hedging activity via derivatives or reinsurance. Our findings therefore provide evidence that P-C insurers hedge to strategically allocate risk across the enterprise to take advantage of core-business strengths rather than reducing total risk.

For life-health (L-H) insurers, our results are not as clear cut. We find evidence of risk allocation in only one of our specifications. We suggest that this is not totally unexpected because many L-H contracts, such as universal life insurance, annuities, and guaranteed investment contracts, have a substantial investment component. In such instances, underwriting risk is at least partially akin to investment risk. Consequently, the incentives to hedge investment risk in asset portfolios as a means of accepting additional underwriting risk are not as great for L-H insurers as for P-C insurers.

In the next section, we review the research literature relevant to the rationale for and implementation of risk management. We then discuss the hedging of risk in the insurance industry and the factors affecting hedging activity. The remaining sections contain our empirical research design, results, and conclusions, respectively.

RATIONALES FOR HEDGING

A tenet of modern portfolio theory is that firms in perfect markets should not hedge because investors can eliminate unsystematic risk through diversification. Market imperfections do exist, however, and researchers have offered a variety of reasons to hedge, which we discuss subsequently.

Financial Distress Costs

Hedging can decrease total risk by reducing the direct costs related to financial distress and also indirect costs, such as reputational loss, that can adversely affect relations with customers, employees, and suppliers (Smith and Stulz, 1985). Cummins, Phillips, and Smith (2001) provide empirical evidence that managers of insurers use derivatives to reduce financial distress costs.

Tax Liabilities

Hedging can reduce the variability of pre-tax firm values and, consequently, expected tax liabilities under typically convex tax schedules (Mayers and Smith, 1982; Smith and Stulz, 1985). Empirical evidence from both nonfinancial and insurance firms supports the presence of such tax incentives (Nance, Smith and Smithson, 1993; Cummins, Phillips, and Smith, 1997, 2001). Alternatively, Graham and Rogers (2002) suggest that firm managers can hedge to increase debt capacity, which allows them to borrow more and decrease taxable income via larger interest deductions.

Capital Shocks and Underinvestment Costs

In the Froot, Scharfstein, and Stein (1993) model, if external funds cost more than internal funds, perhaps because of the information asymmetries suggested by Myers and Majluf (1984), firm managers may underinvest if sufficient internal funds are not available.[5] Hedging therefore can reduce income volatility and preserve adequate internal funds to finance profitable investments. Their model predicts that firms with relatively lower liquidity positions, more volatile cash flows, and higher growth opportunities are more likely to hedge. Geczy, Minton, and Schrand (1997) analyze currency derivatives hedging by firms and find evidence of reduction in financial shocks.

Froot and Stein (1998) develop a model of hedging, capital structure, and capital budgeting for financial institutions. They imply that any

[5]Myers and Majluf (1984) specifically show that managers with informational advantages over essentially passive shareholders and limited operating cash flows can rationally refuse to issue stock to finance projects with positive net present values. Under such circumstances, issuing stock can be interpreted as a "bad news" signal by investors, resulting in a devaluation of the stock that exceeds the positive benefits of the new projects.

efficiently tradable risk should be fully hedged to avoid financial shock. Guay (1999) examines new derivatives users and provides evidence suggesting that hedging reduces firm risk, measured in several ways, including stock return volatility.

Building upon Stulz's contention that managers should selectively bear financial risks in which they comparative advantage, Schrand and Unal (1998) analyze 134 demutualizing thrifts. They assume that demutualization provides thrift managers with greater opportunities to take risks because of new access to capital markets and/or more incentives to accept risk because of new stock-based compensation schemes. Their tests provide evidence that managers of demutualizing thrifts allocate risk by hedging their homogeneous (interest-rate) risk while simultaneously accepting more core-business (credit) risk. In doing so, total risk may not be reduced. In fact, it can be increased.

Because of data limitations, Schrand and Unal (1998) can apply only indirect proxies for homogeneous and core-business risk and implement a simple regression method to imply relations that are consistent with the risk allocation hypothesis.[6] The measurement problems they face are challenging because even the most elemental hedging expenditures of businesses generally are shielded from public view.

Since the Schrand and Unal (1998) study, research related to comparative advantage and risk allocation by firms has been limited. Naik and Yadav (2003) find that UK bond dealers with higher order flow assume more interest-rate risk and hedge less, which is consistent with selective hedging. Mun and Morgan (2003) find that banks can improve performance by hedging foreign exchange and interest rate risks simultaneously rather than separately. Lookman (2009) provides evidence that banks with an active derivatives trading operation have a comparative advantage in bearing lending risk.

SPECIFIC FACTORS AFFECTING HEDGING ACTIVITIES

Researchers have separately explored various determinants of hedging via derivatives and reinsurance. We next discuss the rationale and empirical evidence pertaining to these factors.

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[6] Schrand and Unal (1998) specifically create risk proxies for homogeneous and core-business risk and assume that changes in these proxies over time indicate hedging activity. They alternately regress these risk proxies on quarterly event time variables without controlling for any other factors.

Size

Hedging operations can benefit from economies of scale, especially if initial costs are large (Booth, Smith, and Stolz, 1984; Hoyt, 1989). Nance, Smith, and Smithson (1993) and Mian (1996) are among the researchers finding empirical support for a positive relation between firm size and hedging via derivatives. Alternatively, Cummins, Phillips, and Smith (1997) state that the larger, more diversified insurers may have relatively lower needs for derivatives hedging. However, their empirical results support a positive relation between size and derivatives usage for samples of P-C and L-H insurers. Colquitt and Hoyt (1997) also observe a positive relation for a L-H insurer sample.

Mayers and Smith (1990) posit that larger insurers can have relatively lower needs for reinsurance hedging because of real-services efficiencies in underwriting and claims and lower bankruptcy costs, for which size can serve as a proxy. Their empirical results for a sample of P-C insurers show a negative relation between reinsurance activity and size. Cole and McCullough (2006) regard size as an inverse proxy for the costs of bankruptcy and they also observe a significantly negative relation with reinsurance purchases. Based upon the extant research, we expect a positive relation between size and derivatives hedging, but a negative relation with reinsurance hedging.

CAPITAL ADEQUACY

Stulz (1996) argues that hedging is a direct substitute for equity capital, because hedging helps firms reserve more capital for investment opportunities by decreasing the probability of financial distress. Cummins and Sommer (1996) provide both theoretical and empirical support for a positive relation between capitalization and asset portfolio risk in the property–casualty insurance industry. Baranoff and Sager (2002) report similar empirical relations in the L-H segment. However, after finding a positive relation between derivatives usage and both risk-based capital (RBC) ratio and capital-to-asset ratio in some of their derivatives volume models, Cummins, Phillips, and Smith (2001) speculate that firms that maintain a higher RBC ratio are more risk averse and thus more likely to hedge using derivatives. Considering the conflicting results in previous research, we do not make a prediction for the capital adequacy results.

Both underinvestment risks and bankruptcy costs can encourage managers of riskier firms to purchase reinsurance (Mayers and Smith, 1990). Applying A.M. Best ratings as a proxy for capital adequacy, they show the expected negative relation with reinsurance activity for P-C insurers.

Stock Organizational Form

The *managerial discretion hypothesis* suggests that managers of stock firms tend to engage in more complex and risky business activities (Mayers and Smith, 1988) and are more likely to use complex financial instruments such as derivatives (Colquitt and Hoyt, 1997). The *managerial risk aversion hypothesis* (Cummins, Phillips, and Smith, 2001) predicts that managers of mutual firms are more likely to be risk averse because of organizational specific-capital and difficulty in diversifying personal wealth and, therefore, more likely to reduce risk by hedging via derivatives. In light of these conflicting hypotheses, we cannot predict the impact of organizational form on derivatives hedging.

We consider reinsurance a more familiar, less complex hedging tool than derivatives to managers of insurers. Cole and McCullough (2006) note that mutual managers, who have less access to capital markets in the event of catastrophic loss, should be more likely to reinsure. For these reasons, we expect mutual insurers to use reinsurance to a greater extent than stock insurers.

Group Affiliation

Cummins and Sommer (1996) state that managers of an insurance group can hedge risk by spreading it through separate insurance firms that make up the group, which gives them the freedom to allow individual firms to go bankrupt in the event of financial distress. Group affiliation therefore can serve as a form of hedging, an expectation supported by evidence from both the P-C and L-H insurance industries (Cummins and Sommer, 1996; Baranoff and Sager, 2002). By this line of reasoning, group affiliation should decrease managers' use of derivatives and reinsurance. Cummins, Phillips, and Smith (2001) provide evidence of this inverse relation for the derivatives activity of P-C insurers and mixed evidence for L-H insurers. They posit that the greater volatility of P-C insurance markets can make the separation of assets among affiliated firms more important to managers of P-C insurers than to those of L-H insurers.

Alternatively, Mayers and Smith (1990) suggest that group-affiliated insurers should use relatively more reinsurance than nonaffiliated insurers because of the ability to shift profits and reduce taxes between group members via reinsurance transactions. Both Mayers and Smith (1990) and Cole and McCullough (2006) provide supporting empirical evidence from the P-C insurance market.

Considering the conflicting results in previous research, we do not make a prediction of the relation of group affiliation with derivatives or reinsurance activity for our sample.

Tax Shields

Smith and Stulz (1985) show that, because of the convex tax schedule, a firm can decrease expected tax liabilities by hedging to reduce the volatility of income flow. Managers also are likely to hedge risks to exploit tax shields such as tax credits and loss carry-forwards, especially if expected future income streams are highly volatile. Nance, Smith, and Smithson (1993) generate empirical evidence for a positive relation between tax credits and corporate hedging. We consequently expect a positive relation between tax shields available to insurers and the use of hedging devices, including derivatives and reinsurance.

To investigate tax-induced hedging, we use two tax shield proxies that were developed by Cummins, Phillips, and Smith (CPS) (2001) because data on tax credits and tax-loss carry-forwards are not publicly available. The first is a binary variable equal to one if no taxes were paid, which could be indicative of tax-loss carry-forwards. CPS reason that insurers hedge to produce positive taxable income to take advantage of unused tax-loss carry-forwards. The second is a binary variable for which a value of one indicates that the insurer is in the alternative minimum tax range, which reflects maximum income tax convexity. If it falls in this range, the insurer should have a tax incentive to hedge to decrease income volatility.

Growth Opportunities

The theoretical model of Froot, Scharfstein, and Stein (1993) indicates that potential underinvestment problems can induce managers with greater growth opportunities to hedge more. While Nance, Smith, and Smithson (1993), Mian (1996), and Schrand and Unal (1998) report empirical evidence of a relation between growth opportunities and corporate hedging, Tufano's (1996) evidence from the gold mining industry indicates no such relation. Cummins, Phillips, and Smith (2001) use several growth opportunity proxies to test for potential underinvestment effects on derivatives usage by insurers, but find no empirical relation.

Mayers and Smith (1987) argue that leveraged firms can mitigate underinvestment problems by purchasing corporate insurance. Their subsequent study of reinsurance purchases by insurers provides no direct evidence of such effects, however. Given the conflicting empirical evidence concerning potential underinvestment effects on hedging, the expected effect on either derivatives or reinsurance activity is necessarily ambiguous.

To account for growth opportunities, we initially use the one-year growth rate in premiums. While book-to-market ratios often are used as proxies for growth opportunities, these can be applied only for firms with publicly-traded equity. Our measure can be applied to all insurers in our sample, which includes a large number of privately-held companies. For robustness purposes, we subsequently test the one-year asset growth rate for both P-C and L-H insurers. For L-H insurers, we also test the ratio of net premiums from reinvestment of policyholders' dividends and coupons for existing policies, which was suggested by Cummins, Phillips, and Smith (2001).

Cash Flow Volatility

Froot, Scharfstein, and Stein (1993) state that high variation in internal cash flows causes managers to bypass profitable projects when external financing is costly. Hedging can be used to increase the firm's value by mitigating cash flow volatility. Minton and Schrand (1999) examine a broad cross-section of nonfinancial firms and find that cash flow volatility is positively related to a firm's cost of external capital and also reduces investment in potential growth projects by the firm. They therefore suggest that existing cash flow volatility is an important factor in managers' risk management decisions, but state that the impact will vary depending upon the benefits of future reductions in volatility, the costs of hedging, and managers' preferences regarding future levels of volatility.

Minton and Schrand (1999) further note that hedging costs are low for firms in which well-developed derivatives markets exist, such as oil and gas or agriculture. Extending their conjecture to the insurance industry, we argue that derivatives markets are highly developed for hedging financial risk, such as the interest-rate, exchange-rate, and stock market risks accepted by insurers. While hedging these risks is directly relevant to the investment portfolios of both P-C and L-H segments of the industry, differences may occur when it comes to underwriting portfolios. We expect these well-developed derivatives markets to apply particularly to life insurance and annuity contracts underwritten by life insurers. In contrast, derivatives markets for P-C underwriting risks are not nearly as well-established and contracts are quite costly (see, e.g., Froot, 1999).

A strong positive relation between cash flow volatility and hedging activities would suggest that hedging activities are conducted to reduce total firm risk whereas a weak or no relation would be consistent with risk allocation. Our measure of cash flow volatility is the standard deviation of unhedged cash flow during the previous five years, divided by the mean of admitted assets. To estimate unhedged cash flow, we make adjustments to account for income related to both derivatives and reinsurance.

Liquidity

Doherty (1985) suggests that some managers prefer liquid assets rather than post-loss instruments to finance losses because recovery is more rapid and allows immediate reinvestment. Froot, Scharfstein, and Stein (1993) state that if external costs of funds are more expensive than internally generated funds, then liquidity is an alternative for funding investments after financial shocks. To the extent that liquidity problems signal poor management practices and even threaten the firm's solvency, Doherty (2000) demonstrates that managers will use liquidity as a smoothing mechanism to avoid financial distress costs. Because of this possible substitution effect, we expect firm liquidity to be negatively related to hedging with either derivatives or reinsurance. As our proxy for liquidity we use the quick ratio, i.e., cash and short-term investments divided by admitted assets. Geczy, Minton, and Schrand (1997) show that this measure is less prone to asymmetric information problems than are other liquidity estimates.

Loss Development

We include a loss development variable in the reinsurance equation for P-C insurers to control for possible under- or over-reserving. Cole and McCullough (2006) find that insurers that have positive loss development (under-reserve) use more reinsurance, and we expect such a relation for our sample.[7]

Line-of-business Concentration and Geographic Concentration

The *real services hypothesis* of Mayers and Smith (1990) implies that managers of insurers that are more concentrated by line of business or geography have a comparative advantage in writing policies and therefore a larger propensity for risk taking. Their empirical evidence from the P-C insurance industry reveals that both line-of-business and geographic concentration negatively affect the demand for reinsurance. Cole and McCullough (2006) observe similar relations. We consequently expect a negative relation between these two forms of underwriting concentration and reinsurance activity.

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[7]We do not include this variable in our tests of L-H insurers. Manipulation of estimated losses and reserves is less likely because well-established actuarial tables are thought to limit managerial discretion (Petroni, 1992; Gaver and Paterson, 1999).

Asset-Liability Structure

Cummins, Philips, and Smith (CPS) (2001) note that mismatches of asset and liability duration expose insurers to interest-rate risk, but these can be hedged with derivatives. They develop an estimate for the duration gap between insurer assets and liabilities, but do not find any relation with hedging activity. They also include proxies for the relative holdings of several classes of assets and liabilities that are more susceptible to duration mismatching, whether intended or unintended, by managers. We test the asset holding and liability issuance variables that CPS find to be significant.

For P-C insurers, we include both stock and real estate holdings as percentages of admitted assets. On the liability side, we follow CPS in applying binary variables for foreign liabilities and products liabilities. We also include commercial long-tailed liability reserves as a percent of total reserves. For L-H insurers, we use stock, private bond, and collateralized mortgage obligations (CMOs) as percentages of admitted assets. On the liability side, we include variables for both individual life and annuity reserves and guaranteed investment contract (GIC) reserves as a percentage of total reserves. While CPS expect these measures to be positively related to derivatives hedging, their coefficients are consistently positive only for P-C insurers' holdings of stocks and L-H insurers' private CMO holdings and GIC reserves.

Product Differences

We expect hedging activity to be different between L-H insurers and P-C insurers. Some life insurer products directly encompass both investment and underwriting risks, while P-C products generally impound underwriting risk. For example, L-H insurer products, such as permanent life, universal life, annuities, and guaranteed investment contracts, impound substantial investment components. Therefore, L-H insurers should be relatively more active in hedging underwriting-related investment risk via derivatives. In addition, the underwriting risks faced by P-C insurers because of potentially catastrophic losses such as hurricanes, tornados, earthquakes, and wildfire should produce relatively greater reinsurance activity because of contracts designed to hedge these exposures. Because of these product differences, we test samples of P-C and L-H insurers separately.

RESEARCH DESIGN

We test for allocation of risk across the insurance enterprise by developing a simultaneous equations model that assesses both the hedging of investment risk with derivatives and the hedging of underwriting risk with reinsurance.

Data

We obtain our data from the National Association of Insurance Commissioners (NAIC) InfoPro database, which contains annual financial statements for virtually all firms licensed to sell insurance in the U.S. The NAIC began publishing data for insurer activity in derivatives in 2001, and our sample includes data derived from the Schedule DB database for years 2001 through 2008. The initial sample consisted of 12,008 life-health (L-H) firm-year observations and 15,264 property-casualty (P-C) firm-year observations. We omit insurers with zero or negative admitted assets, premiums written, or surplus. The final sample consists of 8,384 firm-year observations for L-H insurers and 12,880 for P-C insurers for the period from 2001 through 2008. This screening eliminated many very small firms, none of which used derivatives, and account for only about 2.1% of industry assets.

The NAIC InfoPro dataset does not provide consolidated financial data for L-H insurance groups, and Cummins, Phillips, and Smith (1997) find that group-level analysis of the derivatives participation decision provides no more information than company-level analysis, so we analyze data for individual firms rather than groups.

Model

In their regression model, Schrand and Unal (1998) regress their measure of homogeneous risk (interest rate risk) on their measure of core-business risk (credit risk) without applying any control variables. Our data allow us to implement a multivariate, simultaneous-equations system in which the dependent variable in the first equation is our measure for hedging homogeneous risk (derivatives) and the dependent variable in the second equation is our measure for hedging core-business risk (reinsurance activity). In contrast to Schrand and Unal, we are able to include control variables that researchers have found to be important in determining derivatives and reinsurance activity. If the use of derivatives and reinsurance is jointly determined, as would be expected in a risk allocation approach, then a simultaneous-equations model should detect a relation between these two hedging activities. In contrast, a single-equation model will be mis-specified.

Our model represents a refined presentation of the simultaneous-equations approach first developed by Zhang (2005) for both P-C and L-H insurers. We note that Cummins and Song (2008) later proposed a similar method for P-C insurers. They present a mean-variance efficiency optimization model, which is dependent upon corporate insurers acting as entities that are risk averse and maximize utility. Our approach contrasts with that of Cummins and Song because it is firmly rooted in the previously developed literature on financial risk allocation and is not dependent upon corporate entity risk aversion and/or utility functions. Our model follows:

Simultaneous equations for P-C insurers:

$$DERIV_{it} = \alpha + \beta_0^{IR} REINS_{i,t} + \beta_1^{IR} SIZE_{i,t} + \beta_2^{IR} CAPADEQ_{i,t} + \beta_3^{IR} STOCK_{i,t} + \beta_4^{IR} GROUP_{i,t} + \beta_5^{IR} TAXA_{i,t} + \beta_6^{IR} TAXB_{i,t} + \beta_7^{IR} GROWTH_{i,t} + \beta_8^{IR} VOLAT_{i,t} + \beta_9^{IR} LIQUID_{i,t} + \beta_{10}^{IR} \%STK_{i,t} + \beta_{11}^{IR} \%RE_{i,t} + \beta_{12}^{IR} FORLIAB_{i,t} + \beta_{13}^{IR} \%COMMLT_{i,t} + \%\beta_{14}^{IR} PRODLIAB + \varepsilon_{i,t}^{IR} \quad (1)$$

$$REINS_{it} = \alpha_0^{UR} + \beta_0^{UR} DERIV_{i,t} + \beta_1^{UR} SIZE_{i,t} + \beta_2^{UR} CAPADEQ_{i,t} + \beta_3^{UR} STOCK_{i,t} + \beta_4^{UR} GROUP_{i,t} + \beta_5^{UR} TAXA_{i,t} + \beta_6^{UR} TAXB_{i,t} + \beta_7^{UR} GROWTH_{i,t} + \beta_8^{UR} VOLAT_{it} + \beta_9^{UR} LIQUID_{i,t} + \beta_{10}^{UR} LOSSDEV + \beta_{11}^{UR} LOD_{it} + \beta_{12}^{UR} GEOG + \varepsilon_{i,t}^{UR} \quad (2)$$

Simultaneous equations for L-H insurers:

$$DERIV_{it} = \alpha + \beta_0^{IR} REINS_{i,t} + \beta_1^{IR} SIZE_{i,t} + \beta_2^{IR} CAPADEQ_{i,t} + \beta_3^{IR} STOCK_{i,t} + \beta_4^{IR} GROUP_{i,t} + \beta_5^{IR} TAXA_{i,t} + \beta_6^{IR} TAXB_{i,t} + \beta_7^{IR} GROWTH_{i,t} + \beta_8^{IR} VOLAT_{i,t} + \beta_9^{IR} LIQUID_{i,t} + \beta_{10}^{IR} \%STK_{i,t} + \beta_{11}^{IR} \%PRIVBOND_{i,t} + \beta_{12}^{IR} PRIVCMO_{i,t} + \beta_{13}^{IR} INDL\&A_{i,t} + \beta_{14}^{IR} \%GIC_{i,t} + \varepsilon_{i,t}^{IR} \quad (3)$$

$$REINS_{it} = \alpha_0^{UR} + \beta_0^{UR} DERIV_{i,t} + \beta_1^{UR} SIZE_{i,t} + \beta_2^{UR} CAPADEQ_{i,t} + \beta_3^{UR} STOCK_{i,t} + \beta_4^{UR} GROUP_{i,t} + \beta_5^{UR} TAXA_{i,t} + \beta_6^{UR} TAXB_{i,t} + \beta_7^{UR} GROWTH_{i,t} + \beta_8^{UR} VOLAT_{i,t} + \beta_9^{UR} LIQUID_{i,t} + \beta_{10}^{UR} LOB_{it} + \beta_{11}^{UR} GEOG + \varepsilon_{i,t}^{UR} \quad (4)$$

where IR and UR superscripts indicate investment risk and underwriting risk, respectively. Definitions of independent variables and their expected signs are provided in Table 1.

Table 1. Variable Definitions and Expected Signs

Variable	Expected signs: DERIV L/H	DERIV P/C	REINS L/H	REINS P/C	Definition
DERIV	n/a		+/–		Ratio of derivatives year-end position held (or alternatively derivatives whole-year transaction vol.) to admitted assets
REINS	+/–		n/a		Ratio of reinsurance ceded to reinsurers by the insurer to direct premiums written plus reinsurance assumed
SIZE	+	+	–	–	Natural logarithm of admitted assets
CAPADEQ	+/–		+/–		Ratio of total adjusted capital to the authorized control level of risk-based capital, as specified by the NAIC
STOCK	+/–		–	–	Organizational form dummy (1 if stock insurer and 0 otherwise)
GROUP	+/–		+/–		Group affiliation dummy (1 if insurer is affiliated with a group of insurers and 0 otherwise)
TAXA	+	+	+	+	Tax shield dummy (1 if no federal income tax paid or 0 otherwise)
TAXB	+	+	+	+	Tax shield dummy (1 if federal taxes incurred are positive while taxable net income is non-positive *and* the ratio of federal income tax incurred to pre-tax income is less than 25%; 0 otherwise)
GROWTH	+/–		+/–		One-year premium growth rate
VOLAT	+	+/–	+	+/–	Ratio of the standard deviation of unhedged cash flow during the previous five years to the mean of admitted assets during the previous five years
LIQUID	–	–	–	–	Ratio of cash and short-term investments to admitted assets
LOSSDEV	n/a	n/a	n/a	+	Ratio of two-year loss development to surplus
LOB	n/a	n/a	–	–	Herfindahl index for line-of-business concentration
GEOG	n/a	n/a	–	–	Herfindahl index for the geographic concentration
Asset-Liability Structure Variables					
STK	+	+	n/a	n/a	Ratio of stock holdings to admitted assets
RE	n/a	+	n/a	n/a	Ratio of real estate holdings to admitted assets
PRIVBOND	+	n/a	n/a	n/a	Ratio of private placement bond holdings to admitted assets

Table continues

Table 1. *continued*

PRIVCMO	+	n/a	n/a	n/a	Ratio of private placement CMO holdings to admitted assets
FORLIAB	n/a	+	n/a	n/a	Foreign liability dummy (1 if the insurer has liabilities denominated in foreign currencies or 0 otherwise)
COMMLT	n/a	+	n/a	n/a	Ratio of commercial long-tailed line (workers comp, commercial auto liability and other liability) reserves to total reserves
PRODLIAB	n/a	+	n/a	n/a	Ratio of product liability reserves to total reserves
INDL&A	+	n/a	n/a	n/a	Ratio of individual life & annuity reserves to total reserves
GIC	+	n/a	n/a	n/a	Ratio of GIC reserves to total reserves

We alternately use two measures for derivatives activity (DERIV). Cummins, Phillips, and Smith (1997, 2001) suggest that derivatives transaction volumes reported for the entire year can better reflect hedging activity compared to year-end positions because some insurers close positions prior to year end for window-dressing purposes. Using only year-end data also may eliminate some insurers that hedge during the year, but have no year-end positions. We consequently use both year-end positions and transactions volume for the entire year to estimate derivatives activity. We follow Mayers and Smith (1990) in applying reinsurance ceded to reinsurers divided by direct premiums written plus reinsurance assumed as our measure for reinsurance hedging activity.

Estimation Method

To estimate our simultaneous equations model, we use a two-step approach following Maddala (1983) and Greene (2003). For the derivatives equation (1) applied to our P-C insurer sample, we first regress our reinsurance activity proxy on all exogenous variables in the reduced form of the reinsurance equation (2), using a random effects model, and get the predicted value of reinsurance usage, ˆ . Next, we insert ˆ into the modified structural form of the derivatives equation (1), and estimate using a Tobit random effects model. For the reinsurance equation (2), we first regress our derivatives activity proxy on all exogenous variables in the reduced form of the derivatives equation (1), and get the predicted value of derivatives usage, ˆ , using a Tobit random effects model.[8] We next insert ˆ into the modified structural form of reinsurance equation (2) and estimate using a random effects model. Because a Tobit model is used to estimate the coefficients for the derivatives equation (1), we also report the marginal effects. For the L-H sample, we follow the same method, simply substituting equations (3) and (4) for equations (1) and (2) in the prior description.

We further analyze the potential impacts of multicollinearity and heteroscedasticity on the estimates. To detect any multicollinearity problems, we generate variance inflation factors (VIFs). We use the Lagrange multiplier test to check for heteroscedasticity in the Tobit model (derivative equations 1 and 3), and use the GLS estimator to mitigate any heteroscedasticity problems in reinsurance equations 2 and 4, which are not limited dependent variable models.

EMPIRICAL RESULTS

Summary statistics for our main test variables are shown in Table 2. L-H insurers are more active in derivatives hedging than P-C insurers. For example, L-H insurers held year-end derivatives positions with nominal values of 27% of admitted assets, compared to only 9% for P-C insurers. A possible explanation is that L-H insurers are exposed to more financial market risk because they hold larger proportions of long-term assets to match their long-term liabilities for mortality and morbidity exposures. Also, as mentioned previously, L-H insurers face investment risks not only in their investment operations, but also in their underwriting operations due to the nature of some interest-sensitive L-H insurance products (Raturi, 2005).

On the other hand, P-C insurers hold reinsurance positions more than double those of L-H insurers relative to direct premiums written. This result is consistent with that of Cummins, Phillips, and Smith (2001) and suggests that P-C insurers are more willing to cede underwriting risk, probably because of the volatility of shorter term, catastrophic losses. In addition, we note that users of derivatives cede less than non-users.

Approximately 80% of P-C insurers and 90% of L-H insurers are stock firms. Insurers that are members of insurance groups tend to use relatively more derivatives whether they are predominantly P-C or L-H insurers.

[8] Greene (2004) discusses problems when using fixed effects estimation for Tobit panel data models. Even if fixed effects estimation is applied in such models, Greene argues, researchers cannot determine whether fixed or random effects estimation is more appropriate. In essence, a Hausman test cannot be devised because of the incidental parameters problem. Also, fixed effects are not suitable for estimating variables with insufficient within-firm variation, which is the case for some of our binary independent variables.

Table 2. Summary Statistics: For Users and Non-Users of Derivatives

	P-C Insurers		L-H Insurers	
	Mean		Mean	
Variable	Users	Non-users	Users	Non-users
Derivative year-end position	0.089	—	0.271	—
Derivative whole-year volume	0.247	—	0.879	—
Reinsurance	0.29	0.38	0.14	0.16
Size	20.94	18.01	21.32	17.35
Stock Form	0.79	0.81	0.88	0.95
Group affiliation	0.83	0.74	0.89	0.79
Total year-firm observations	12,880		8,384	

Notes: The time period is from 2001 through 2008. The variables are described in Table 1.

Regression Results

Although not fully reported here, correlation coefficients for our test variables never exceed 0.38 and variance inflation factors are uniformly low. We conclude that collinearity is highly unlikely to be a problem with our data.

Table 3 reports simultaneous regression results for P-C insurers in our sample, with activity in derivatives and reinsurance serving as the dependent variables in panels A and B, respectively. As shown in panel A, we first apply the derivatives proxy based upon year-end position and then the proxy using whole-year volume. We alternately use these two estimates of derivatives activity in two specifications of the reinsurance model.

The derivatives model results in panel A indicate that the reinsurance coefficient is negative and significant in all four specifications. The reinsurance model results in panel B also indicate a negative relation with derivatives activity for both specifications, but only significant at the 10% level when the whole-year derivatives proxy is used. Overall, our results are consistent with the risk allocation expectations of Schrand and Unal (1998). In other words, insurers that hedge relatively more homogeneous (investment) risk using derivatives simultaneously hedge less of their core-business (underwriting) risk, via reinsurance. The results suggest that U.S.

Table 3. Estimation of Simultaneous Equations Models for Property-Casualty Insurers

Panel A: Derivatives Model
Dependent variable is censored. P-values are in parentheses. Marginal effects are reported in the shaded areas.

	Derivatives model			
	Year-end position		Whole-year volume	
Reinsurance	–4.966	–0.064	–9.386	–0.261
	(0.055)*	(0.021)**	(0.008)***	(0.002)***
Size	0.081	0.001	0.277	0.026
	(0.032)**	(0.189)	(0.074)*	(0.019)**
Capital adequacy	0.029	<0.001	0.075	0.008
	(0.141)	(0.041)**	(0.226)	(0.028)**
Stock form	0.098	0.004	–0.102	–0.001
	(0.186)	(0.072)*	(0.471)	(0.019)**
Group affiliation	0.387	0.009	1.219	0.054
	(0.045)**	(0.002)***	(0.076)*	(0.039)**
TaxA	–0.103	<–0.001	–0.073	<–0.001
	(0.67)	(0.59)	(0.81)	(0.62)
TaxB	0.107	0.004	0.329	0.023
	(0.041)**	(0.025)**	(0.027)**	(0.072)*
Growth opportunities	0.512	0.007	0.801	0.037
	0.387	0.009	1.219	0.054
Volatility	0.610	0.011	1.200	0.011
	(0.649)	(0.537)	(0.182)	(0.478)
Liquidity	–0.589	–0.007	–1.500	–0.077
	(0.032)**	(0.057)*	(0.035)**	(0.002)***
Stock holdings	0.120	0.005	1.07	0.033
	(0.285)	(0.107)	(0.167)	(0.043)**
Real estate holdings	–3.12	–0.073	–1.655	–0.078
	(0.086)*	(<0.001)***	(0.736)	(0.245)
Foreign liabilities	–0.265	–0.011	–0.022	<0.001
	(0.118)	(0.004)***	(0.453)	(0.111)
Commercial long-tail reserves	–0.044	<0.001	0.336	0.025
	(0.639)	(0.889)	(0.567)	(0.033)**
Product liability reserves	–0.133	–0.006	0.456	0.009
	(0.277)	(0.171)	(0348)	(0.088)*
Adjusted R^2	0.472		0.543	

Table continues

Table 3. *continued*

Panel B: Reinsurance Model
P-values are in parentheses.

	Reinsurance mode	
Deriv. year-end position	–0.838	
	(0.145)	
Deriv. whole-year volume		–1.238
		(0.089)*
Size	–0.109	–0.083
	(0.035)**	(0.069)*
Capital adequacy	0.005	<0.001
	(0.012)**	(0.213)
Stock form	<–0.001	–0.002
	(0.67)	(0.53)
Group affiliation	0.035	1.238
	(0.011)**	(0.052)*
TaxA	0.045	0.031
	(0.572)	(0.653)
TaxB	0.025	0.096
	(0.428)	(0.365)
Growth opportunities	0.089	0.040
	(0.053)*	(0.084)*
Volatility	0.070	0.056
	(0.473)	(0.401)
Liquidity	–0.205	–0.107
	(0.091)*	(0.056)*
Loss development	0.098	0.041
	(0.932)	(0.944)
LOB concentration	0.037	0.027
	(0.501)	(0.432)
Geographic concentration	–0.017	–0.047
	(0.398)	(0.426)
Adjusted R^2	0.194	0.251

Notes: The time period is from 2001 through 2008. The variables are described in Table 1. The t-statistics are in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and * respectively.

P-C insurer managers actively allocate risk across the enterprise rather than simply endeavoring to reduce total risk.

Among the control variables, size is consistently positive and generally significant in the derivatives models, which supports the concepts of substantial initial costs and economies of scale in derivatives hedging operations. For the reinsurance models, we find size to be significantly, negatively related to reinsurance activity. This finding is consistent with arguments for real-services efficiencies and nontrivial bankruptcy costs, as well as extant empirical results. In the derivatives and reinsurance models, we observe a significantly positive capital adequacy coefficient in three of six specifications, but the average magnitude of this effect is small. These results do not support the argument that capital is a substitute for hedging. Cummins, Phillips, and Smith (2001) find similar results and contend that a higher risk-based-capital (RBC) ratio may indicate a more risk averse firm that is more likely to hedge risks.

The results for the stock organizational form coefficients are mixed and generally of minor magnitude, which is reflective of the conflicting theories and empirical results in the prior literature. As stated previously, Cummins, Phillips, and Smith (2001) consider whole-year derivatives volume to better reflect an insurer's derivative usage because the year-end figure is likely to reflect "window dressing" actions. In cases where results are significant in the opposite directions for year-end and whole-year, such as the stock organizational form results for P-C insurers, we lean toward the whole-year results, which show a negative relation between stock form and derivatives use. This indicates that mutual insurers are more likely to use derivatives than stock insurers, which supports the managerial risk aversion hypothesis. In the reinsurance regression, the stock form variable is negative, in agreement with the Cole and McCullough (2006) expectation, but not significant. Cole and McCullough (2006) found mixed regression results for the stock form variable, suggesting no clear support for a relation between stock form and reinsurance usage.

The group affiliation variable is uniformly and significantly positive in both the derivatives and reinsurance models, which is not consistent with the argument that group affiliation serves as a form of hedging that is a substitute for derivatives and reinsurance usage. The positive relation between group affiliation and reinsurance is consistent with the Mayers and Smith (1990) contention that affiliation may lead to more reinsurance usage as a way to shift profits among group members to reduce taxes.

While the first tax shield variable, TAXA, is not significant in either the derivatives or reinsurance models, the second variable, TAXB, is significantly positive in the derivatives model, as expected. This result implies that P-C insurers are using derivatives to reduce income volatility and thereby reduce taxes. Our results reveal a uniformly and significantly positive relation between our premium growth proxy for growth opportunities and hedging via derivatives and a marginally significant and positive relation between premium growth and reinsurance hedging. These results are supportive of the preponderance of theory, although prior empirical evidence has been scant. We therefore also test an alternative proxy—i.e., asset growth—and find the resulting coefficients to generally be quite small and insignificant. We conclude that the results specific to growth variables in our sample are sensitive to the choice of proxy.

The cash flow volatility coefficients for P-C insurers, while reflecting the expected positive sign for both the derivatives and reinsurance models, are not significant in either. Coefficients for liquidity ratios are significantly negative, as expected, in both the derivatives and reinsurance models, supporting the argument that liquidity serves as a substitute form of hedging. While the asset and liability structure variables provide some explanatory power for derivatives activity in individual specifications, we do not observe consistently significant relations across all the specifications for the P-C insurer sample.

Our regression results for the L-H insurer sample are provided in Table 4. Although we consistently find the expected negative relation between derivatives and reinsurance, this relation is significant in only one specification. This result does not surprise us because the inclusion of elements of homogeneous investment risk in L-H products means that derivatives can be used to hedge core-business (underwriting) operations, too. We find that size positively affects derivatives hedging on a consistent basis, although this variable is not always significant. As with P-C insurers, size is significantly and negatively related to reinsurance hedging by L-H insurers, which is supportive of real-services efficiencies and/or substantial costs of bankruptcy arguments.

Our capital adequacy measures are negatively related to derivatives hedging, but not significant. Similar to results for the P-C insurer sample, a positive relation between capital adequacy and reinsurance activity is observed, but with marginal significance. We find a negative relation between group affiliation and derivatives activity for all of our specifications, but only one is marginally significant, so we generally do not find support for the argument that group affiliation can serve as an alternative to hedging. The group affiliation coefficients are significantly positive for both forms of the reinsurance models, however. This evidence is consistent with previous work finding that group affiliated insurers use more reinsurance.

Table 4. Estimation of Simultaneous Equations Models for Life-Health Insurers

Panel A: Derivatives Model
Dependent variable is censored. P-values are in parentheses. Marginal effects are reported in the shaded areas.

	Derivatives model			
	Year-end position		Whole-year volume	
Reinsurance	–3.899	–0.059	–6.377	–0.327
	(0.431)	(0.636)	(0.179)	(0.033)**
Size	0.278	0.009	0.669	0.078
	(0.256)	(0.755)	(0.007)***	(<0.001)***
Capital adequacy	–0.023	<–0.001	–0.078	–0.008
	(0.244)	(0.329)	(0.370)	(0.114)
Stock form	–0.216	–0.023	0.317	0.029
	(0.763)	(0.618)	(0.954)	(0.570)
Group affiliation	–0.230	–0.004	–1.101	–0.023
	(0.451)	(0.766)	(0.931)	(0.088)*
TaxA	–1.433	–0.032	–1.029	–0.065
	(0.835)	(0.387)	(0.165)	(0.103)
TaxB	0.349	<0.001	–0.689	–0.021
	(0.978)	(0.806)	(0.051)*	(0.114)
Growth opportunities	–0.012	<–0.001	–0.112	–0.009
	(0.286)	(0.744)	(0.482)	(0.377)
Volitility	0.037	<0.001	–0.335	–0.009
	(0.875)	(0.729)	(0.478)	(0.542)
Liquidity	0.454	0.007	2.301	0.109
	(0.696)	(0.710)	(0.983)	(0.036)**
Stock holdings	–0.488	<–0.001	1.849	0.231
	(0.922)	(0.914)	(0.161)	(0.042)**
Private bond holdings	0.898	0.012	3.387	0.14
	(0.953)	(0.762)	(0.923)	(0.020)**
Private CMO holdings	0.234	0.002	3.281	0.153
	(0.202)	(0.670)	(0.089)*	(0.114)
Individual L-A reserves	0.138	<0.001	0.578	0.011
	(0.354)	(0.218)	(0.143)	(0.055)*
GIC reserves	0.378	<0.001	0.104	<0.001
	(0.520)	(0.187)	(0.183)	(0.157)
Adjusted R^2	0.154		0.326	

Table continues

Table 4. *continued*

Panel B: Reinsurance Model
P-values are in parentheses.

	Reinsurance model	
Derivative year-end position	–0.095	
	(0.129)	
Derivative whole-year volume		–0.021
		(0.150)
Size	–0.033	–0.021
	(0.003)***	(0.029)**
Capital adequacy	<0.001	0.003
	(0.091)*	(0.152)
Stock form	0.035	0.009
	(0.657)	(0.413)
Group affiliation	0.081	0.029
	(0.041)**	(0.024)**
TaxA	0.005	<0.001
	(0.822)	(0.943)
TaxB	0.032	0.004
	(0.195)	(0.310)
Growth opportunities	<–0.001	<–0.001
	(0.294)	(0.309)
Volatility	0.064	0.033
	(0.139)	(0.079)*
Liquidity	–0.011	<–0.001
	(0.473)	(–0.08)
LOB concentration	–0.086	–0.021
	(0.149)	(0.193)
Geographic concentration	–0.108	–0.067
	(0.009)***	(<0.001)***
Adjusted R^2	0.321	0.398

Notes: The time period is from 2001 through 2008. The variables are described in Table 1. The t-statistics are in parentheses. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and * respectively.

While we do not find cash flow volatility to be significantly related to derivatives hedging, it is positive and marginally significant in one of the reinsurance specifications. Our other strong finding is a significantly negative relation between geographic concentration and hedging via reinsurance, which is consistent with prior research.

We find no other independent variables that are consistently significant in the derivatives models. Factors such as group affiliation, tax shields, growth opportunities, and liquidity were consistently significant explanatory factors for derivatives activity among our sample of P-C insurers, but not for our L-H insurers. For robustness purposes, we again test an alternative growth proxy, asset growth, and find no significant relation. We also test a third growth proxy, the ratio of new premiums from the reinvestment of policyholders' dividends and coupons, but generally do not find significant relations.

Our results suggest that the different nature of underwriting operations for L-H insurers substantially mitigates the many strong relations that we observe for P-C insurers with respect to derivatives activity. The comparative results are somewhat more consistent between these two sectors of the insurance industry in terms of explaining reinsurance hedging, however.

SUMMARY AND CONCLUSION

Risk traditionally has been managed in silos with corporate risk managers focusing on insurable operational losses while the treasury department uses derivatives to reduce investment risks, such as interest rate, credit, market, and foreign exchange risk. Recent theory and industry practice have evolved to address coordination and strategic allocation of all firm risks. The convergence of financial risk management and insurance-related risk management provides a broader platform for firms to more effectively allocate and finance their risks. Scant empirical research exists in this area, however, despite the currently prevalent discussion of enterprise risk management in risk management and insurance trade journals. A major problem has been the paucity of publicly available data for assessing corporate hedging practices.

Using data from the insurance industry, we are able to directly investigate hedging proxies to assess the allocation of risk across the firm. We find some evidence that insurers are hedging their homogeneous, investment risks while simultaneously accepting more core-business, underwriting risk. We also find evidence that differences in the underwriting risks facing P-C and L-H insurers lead to different strategies for allocating risk.

Although Stulz (1996), Schrand and Unal (1998), and others provide a starting point for the development of theory and empirical research related to risk allocation, much work remains as researchers explore this topic within the broad framework of enterprise risk management. Research into whether managers can improve firm value by strategically allocating risk should have great promise. Alignment of underwriting risk profiles with risk allocation strategies also begs further examination. In light of the critical failures of risk management during the credit crisis of 2008 and 2009, the deployment of capital based upon risk should also be of great interest to researchers. Extensive and detailed financial data from the insurance industry should prove to be very important in examining these issues in the future.

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