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The Working Paper Series is made possible by a generous grant from the Alfred P. Sloan Foundation

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July 1998

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Derivatives and Corporate Risk Management:
Participation and Volume Decisions in the Insurance Industry

This paper examines factors that influence the use of financial derivatives in the U.S. insurance industry. We investigate rationales that might explain both the decision to use derivatives as well as the volume of these transactions. The principal objective is to empirically investigate the general motivations for corporate risk management as well as several more specific hypotheses relating to the insurance industry. In our empirical analysis, we take advantage of the disclosure requirements imposed on insurers by state regulators that provide detailed information on individual holdings and transactions in derivatives markets.

The use of derivatives in corporate risk management has grown rapidly in recent years, fueled in part by the success of the financial industry in creating a variety of over-the-counter and exchange-traded products. A 1995 survey of major non-financial firms revealed that at least 70 percent are using some form of financial engineering to manage interest rate, foreign exchange, or commodity price risk (Wharton-Chase, 1995). Financial firms, including banks (see, for example, Gunther and Siems, 1995, and Shanker, 1996), savings and loans (Brewer, et al., 1996), and insurers (Colquitt and Hoyt, 1997, Cummins, Phillips, and Smith, 1997), also are active in derivatives markets. Although the types of risks confronting managers vary across industries, there is substantial commonality in the underlying rationale for the use of derivatives and the financial engineering techniques that are employed.

At first glance, modern finance theory provides little motivation for hedging by widely held corporations. According to theory, shares of such corporations are held by diversified investors who, operating in frictionless and complete markets, eliminate non-systematic risk through their portfolio choices. In this context, risk management at the firm level is a dead-weight cost that destroys shareholder value. Although valuable as a starting point, this frictionless theory has given way in recent years to a richer set of hypotheses whereby various market imperfections, incentive conflicts, and information asymmetries

create motivations for even value-maximizing corporate managers to alter the risk/return profile of the firm.[1] Alternatively, managerial risk aversion, incentive conflicts between managers and owners, and related factors may also lead to a demand for risk management activities that conflicts with value maximization.[2]

In the value-maximization category, firms faced with costly frictions are hypothesized to manage risks to the benefit of shareholders. Examples of these frictions include explicit bankruptcy-related costs, such as legal and court costs, and also include increased costs of borrowing and reputational loss that can affect relationships with employees, suppliers, and customers. The convexity of the corporate income tax schedule provides another potentially value-increasing motivation for corporate hedging. Hedging that arises from managerial risk aversion, on the other hand, is likely to reduce firm value. Managers may behave in a risk averse manner, taking less risk than would be optimal for the firm's owners, because their human capital and wealth are poorly diversified. These factors are especially likely to have an adverse effect if managerial compensation arrangements are poorly designed.[3]

Prior research suggests that the factors motivating corporations in general to manage risk are also important in the insurance industry (Cummins and Lamm-Tennant, 1993, Santomero and Babbel, 1997). As financial intermediaries engaged in asset transformation, life insurers are subject to significant interest rate risk. They are also subject to liquidity risk due to their heavy investment in illiquid privately-placed securities and real estate investments (including mortgages) as well as the embedded options in many insurance policies that permit buyers to withdraw funds in response to interest rate changes and other economic fluctuations. While property-liability insurers face some of the same risks as life insurers, they are also subject to extremely volatile cash outflows due to liability lawsuits, property catastrophes such as hurricanes and earthquakes, and other

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[1]For more extensive discussions of the rationale for corporate risk management, see Smith and Stulz (1985), Froot, Scharfstein, and Stein (1993), Stulz (1996), and Tufano (1996).

[2]See Smith and Stulz (1985), Stulz (1996), and Tufano (1996).

[3]Another managerial motivation for hedging involves the use of risk management to signal managerial skill in the presence of asymmetric information (Breedon and Viswanathan, 1996, DeMarzo and Duffie, 1995).

contingent events affecting claim costs. Both types of insurers face exchange rate risk due to the increasing internationalization of insurance and financial markets as well as the risk of regulatory intervention triggered by deteriorating financial condition.

As noted earlier, managerial risk aversion and incentive issues also may be important practical rationales for risk management in the insurance industry. A substantial proportion of the firms in the industry are closely-held stocks and mutual companies, where managers are likely to exhibit risk aversion because of suboptimal diversification of personal wealth, organization-specific capital, and/or the absence of effective mechanisms for owners to use as disciplining devices.

In this paper, we develop a set of hypotheses regarding the hedging behavior of insurers, specify variables to represent the hypotheses, and then perform tests on a sample of life and property-liability insurers. The sample consists of all U.S. life and property-liability insurers reporting to the National Association of Insurance Commissioners (NAIC). The data on derivatives positions are taken from Schedule DB of the 1994 annual regulatory statements filed by insurers with state regulators. We investigate both the decision to conduct derivatives transactions (the participation decision) and the volume of transactions undertaken by firms who enter derivatives markets (the volume decision). Unlike many earlier studies, our data allow us to identify virtually all derivatives transactions across instruments. This, in turn, allows us to observe the entire portfolio of derivative securities, presumably the relevant choice variable for optimization purposes. However, we build on earlier theory and econometric techniques that have provided evidence on the determinants of derivative participation by nonfinancial firms (Nance, Smith, and Smithson, 1993, Fenn, Post and Sharpe, 1996, and Tufano, 1996) and banks (Sinkey and Carter, 1995, Gunther and Siems, 1995).

There have been two prior papers on derivatives activity in the insurance industry. Cummins, Phillips, and Smith (CPS) (1997) present extensive descriptive statistics on the use of derivatives by U.S. life and property-liability insurers and conduct a probit analysis of the participation decision. Colquitt and Hoyt (CH) (1997) analyze the participation and volume decisions for life insurers licensed in Georgia.

In this paper we extend the analysis in CPS (1997) in a number of ways. Our first major extension

of CPS is to empirically analyze the *volume* decision as well as the *participation* decision. We formulate a specific hypothesis regarding the interrelationship between the participation and volume decisions. Moreover, our estimation technique, based on Cragg's (1971) extension of the Tobit methodology, permits the sign of the relationship between the explanatory variables and the decision to use derivatives to differ from that linking these variables to the volume of derivatives transactions. This is particularly important since we argue later that, if participation is driven mainly by fixed costs while, once in the market, volume decisions are mainly determined by marginal cost (in the form of risk premiums) considerations, the signs of the relationships in these two regressions may be different for some variables.

Our second important extension of CPS (1997) is to specify and test economic hypotheses regarding the factors driving the participation and volume decisions by insurers. By going beyond CPS to formulate and test economic hypotheses relating to both participation and volume decisions, as well as their interrelationship, we are able to provide a broad overview of how our work is related to and extends the extant literature on risk management as it relates to both financial and non-financial firms. In doing so, we analyze a number of new explanatory variables that were not used by either CPS or CH.

Our third major extension of CPS is to analyze both within-year derivatives transactions and end-of-year positions.[4] The distinction between end-of-year and within-year decisions is particularly important in the volume regressions, as explained below. Our analysis extends CH (1997) by using data for a more recent year (their data are for 1992), including property-liability insurers as well as life insurers, investigating the universe of insurers rather than those licensed in Georgia, and utilizing a much more extensive set of hypotheses and explanatory variables.

[4] The CPS analysis counted an insurer as participating in derivatives markets if it reported either within-year transactions, or open end of year positions.

The remainder of the paper is organized as follows: Section I formulates hypotheses and specifies variables to be used in the empirical tests. Section II describes the sample and explains our estimation methodology. The results are presented in section III, and section IV concludes.

I. Hypothesis Formulation

As mentioned above, there are two primary, non-mutually exclusive, classes of theories about the motivations for corporate risk management — maximization of shareholder value and maximization of managerial utility. This section provides a more complete discussion of the theories, develops hypotheses concerning rationales for risk management by insurance firms, and specifies variables to test the hypotheses.

The Participation and Volume Decisions

We start by assuming that hedging is not costless, either in terms of fixed or variable costs. In particular, we recognize that, absent any fixed costs of setting up derivatives activities and obtaining expertise in their management, almost all insurers would have some non-zero positions in these additional markets for managing risk. Thus, if the participation decision is driven by these fixed costs, we would argue that only firms with high enough levels of risk exposure, for example, due to a high tolerance for risk per unit of expected return, would find it worthwhile to enter the derivatives market. However, conditional on being active in derivatives, firms/managers with high appetites for risk will generally hedge less at the margin to the extent that each additional unit imposes marginal costs in the form of risk premiums. It follows, according to this hypothesis, that certain measures of risk may have opposite signs in the participation vs. volume regressions. With this general idea in mind, we now turn to specific rationales that have been provided for why corporations may choose to engage in risk management.

Shareholder Value Considerations

Financial Distress. One important theory of corporate risk management is that firms engage in hedging activities to avoid the costs of financial distress. In addition to the direct costs resulting from bankruptcy, e.g., legal fees and court costs, shareholders also face costs arising prior to bankruptcy. These include such factors as reputational loss that may affect the firm's ability to retain its relationships with key

employees, customers, or suppliers. Financial distress costs also can arise if cash flows are adversely affected by contingencies that, left unhedged, may force managers to forego profitable investment projects for lack of affordable capital.[5]

The hypothesis that firms engage in risk management to avoid non-tradable costs associated with financial distress seems particularly applicable to the insurance industry. In addition to the product market and related costs of financial distress, insurers are subject to especially stringent solvency regulation by the states that includes detailed reporting requirements, computerized audit ratio tests, extensive site audits, and the recently adopted risk-based capital standards (Klein, 1995). Insurance commissioners can and do sometimes seize control of financially troubled insurers long before the value of assets falls below the value of liabilities. Even prior to seizure, commissioners can impose restrictions on firm growth and on the composition of asset portfolios. Such actions will reduce the value of the owners' interest in the firm and may ultimately result in the company being seized and liquidated.[6]

We specify several variables to capture the effects of potential distress costs on the participation and volume decisions of insurers. The first is the firm's capital-to-asset ratio. The rationale is that firms with high capital-to-asset ratios are less likely to experience financial distress because they hold adequate capital to cushion the firm against adverse loss or investment shocks (Stulz, 1996). In this sense, equity capital serves as a substitute for hedging as a way to avoid the costs of financial distress. We expect an inverse relationship between the capital-to-asset ratio and the decision to engage in derivatives transactions. However, as noted

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[5]See Andrade and Kaplan (1998) for one attempt to measure the costs of financial distress.

[6]Indeed, the risk-based capital laws now in effect in all states require commissioners to take specified actions when a firms risk-based capital ratio, defined as the ratio of actual capital to risk-based capital, falls below certain thresholds (see Cummins, Harrington, and Niehaus, 1994). However, a caveat with regard to the importance of risk-based capital for our analysis is that 1994 was the first year that life insurers were required to report risk-based capital in their regulatory statements and the system did not go into effect for property-liability insurers until the 1995 statement year. Nevertheless, risk-based capital still may be relevant because the formulas had been circulating in discussion drafts for at least two years prior to implementation so that insurers would have known in 1993 what the charges were going to be for the principal balance sheet and income statement items considered in the formulas.

earlier, conditional on having a high enough risk exposure to make derivatives activities worthwhile, firms with a bigger appetite for leverage may find it less appealing to pay the marginal cost of hedging additional units, resulting in a lower than average level of derivatives activity for these firms. This rationale predicts a direct relationship between the capital-to-asset ratio and the volume of derivatives transactions, whereas an inverse relationship would be consistent with insurers viewing capital and derivatives as substitutes with regard to volume as well as participation.

A second variable we specify to measure the effects of distress costs pertains directly to the risk-based capital system. This variable is a dummy variable equal to 1 if the highest risk-based capital threshold is binding, i.e., if a firm's capital is less than 200 percent of its risk-based capital. A continuous version of this variable equal to the insurer's actual risk-based capital ratio (the ratio of policyholders' surplus to risk-based capital) also is tested. The expected signs of the risk-based capital variables are ambiguous. If insurers use derivatives to hedge against regulatory intervention costs, we predict a positive sign on the risk-based capital dummy variable and a negative sign on the risk-based capital ratio. However, opposite signs are also possible, either because the insurer is experiencing financial difficulties and thus has an incentive due to limited liability to engage in hedging activities, or because it refrains from hedging because of regulatory skepticism about the use of derivatives.

A third type of financial distress variable that we consider consists of the ratios of preferred capital stock and *surplus notes* to total assets.[7] The rationale is that the use of such subordinated claims is a substitute for hedging (Sinkey and Carter, 1994, Dolde, 1996). The predicted signs on these variables are negative based on economic logic similar to that used in the discussion of the capital/asset ratio.

To test the hypothesis that reputation plays a role in risk management, we specify a dummy variable equal to 1 if the insurer primarily distributes its products through insurance brokers rather than through a tied

[7]We refer here to the insurer's own preferred stock rather than to preferred stock held as an asset. A *surplus note* is a financial instrument similar to preferred stock that mutual insurers are permitted to use as capital, subject to advance approval by the regulator. Surplus notes are actually debt instruments, subordinated to policyholder liabilities, but are counted as equity capital for regulatory purposes.

(exclusive) distribution network. The logic here is that brokers have relationships with more than one insurer and thus can direct business to a variety of sources. Such independent distributors tend to be extremely sensitive to the financial condition of insurers in order to serve their customers and to avoid "errors and omissions" lawsuits. In addition, brokers are knowledgeable and sophisticated in interpreting information concerning insurer financial condition. Insurers using the independent distribution channel are thus expected to be more likely to engage in corporate risk management in order to avoid reputational costs than are insurers using the exclusive distribution channel. We test this hypothesis by including a dummy variable equal to 1 if the insurer uses the brokerage distribution channel and equal to zero otherwise. We expect this variable to be positively related to the use of derivatives.

Interest Rate Risk and Investment Portfolio Structure. Like other financial intermediaries, insurers issue a variety of debt claims and invest the proceeds in financial assets. The data suggest that both property-liability and life insurers tend to have positive equity duration gaps, with the duration of assets exceeding the duration of liabilities (Cummins and Weiss, 1991, Staking and Babbel, 1995). There is also evidence that insurers seek to hedge the resulting duration and convexity risk (Santomero and Babbel, 1997). To capture the effects of interest rate risk management, we specify a proxy variable for duration gap equal to the difference between the weighted average maturity of insurer assets and liabilities.[8] We expect a positive relationship

[8]Maturity is used here as a proxy for duration because the regulatory statements do not provide enough information to calculate duration. To calculate duration of the insurer's bond portfolio, it would be necessary to know the cash flow patterns under all of the insurer's bonds. Such information is not reported in the regulatory statements. In a supplementary statement that is not part of our data base, insurers are required to report a limited amount of information on each bond in their portfolio. Although in principle this statement could be used along with a general data base that identifies bonds by CUSIP number to compute the duration of an insurer's bond portfolio, in reality such a calculation would be prohibitively expensive for a study of this type. Instead, we calculate the average maturity of insurer bond portfolios from information reported by insurers in Schedule D of the regulatory annual statements. The information provided is the book value of bonds in five maturity categories – 1 year or less until maturity, 1 through 5 years from maturity, 5 through 10 years, 10 through 20 years, and over 20 years. We assume the bond holdings of the insurer from each category mature uniformly over the time period to calculate the average maturity of the portfolio.

The maturity measure we use for P&C insurer liability portfolios is a weighted average maturity based upon aggregate industry data from Schedule P - Part 1 reported in *Best's Aggregates and Averages, 1995 Edition*. For each line of business, the payout tail proportions were determined using the method prescribed by the Internal Revenue Service (see Cummins, 1990). The industry average maturity measures

between our proxy for the duration gap and the decision to use derivatives.

Although both life and property-liability insurers invest the majority of their funds in high-grade, publicly-traded bonds, they also invest in assets with higher default risk, higher return volatilities, and/or lower liquidity. Clearly, insurers might desire to hedge part of these default/volatility/liquidity risks. For example, investments in real estate may expose insurers to more price and liquidity risk than they would like to retain. Some life insurers also invest heavily in privately placed bonds and mortgages, which are subject to liquidity risk and often contain embedded options. Moreover, both life and property-liability insurers invest in collateralized mortgage obligations (CMOs), which expose them to similar risks.

To capture hedging activities relating to asset risk, we include in our analysis the proportion of insurer assets invested in relatively risky (in terms of price and/or liquidity measures) classes of assets. Specifically, we include separate variables that measure the proportion of assets invested in stocks, real estate, privately placed bonds, and both private and publicly traded CMOs.[9] These variables are expected to be positively related to the decision to use derivatives.

With the increasing internationalization of financial markets, insurers have begun to invest more heavily in foreign securities, either as a hedge against foreign liabilities or simply to enhance portfolio diversification and take advantage of attractive yields. Although insurers are sophisticated portfolio managers, we have no reason to believe that they have a comparative advantage in managing exchange rate risk. Accordingly, they may decide to hedge this component of the risk of investing in foreign securities or holding foreign liabilities.

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were then weighted by the proportion of the insurer's reserves in each line of business to calculate the insurer's average liability maturity. For life/health insurers, we used average liability maturity measures suggested to us through informal discussions with experts in the field because detailed information on the cash flow patterns of major life insurance liability classes are not available in the regulatory statements and there is only anecdotal evidence reported in published reports. The maturity measures we used by major line of business groupings were as follows: two (three) years for individual annuity reserves for stock (mutual) insurers; three (two) years for group annuity reserves for stock (mutual) insurers; seven (five) years for ordinary life insurance reserves for stock (mutual) insurers; and one year for group life and accident and health reserves for both stock and mutual life insurers.

[9]For property-liability insurers, we include only one CMO variable, the proportion of assets in total CMOs, because these insurers have almost no privately placed CMOs.

We use several variables to test the hypothesis that insurers use derivatives to manage exchange rate risk. The variables tested to measure the level of exposure are the proportions of assets in non-U.S. and non-Canadian stocks and bonds.[10] Other proxies for foreign risk exposure include a dummy variable, set equal to 1 if the insurer has foreign liabilities and equal to zero otherwise, and an interaction variable equal to the product of the foreign liabilities dummy variable and the ratio of foreign bonds and stocks to total assets. A dummy variable set equal to 1 if the insurer has any foreign assets and zero otherwise is also tested along with the interaction between this dummy variable and the dummy variable for exposure to foreign liabilities. We expect a positive relationship between the foreign exposure variables and the decision to use derivatives. A negative relationship is expected between the asset/liability interaction variables and the decision to use derivatives since holding both foreign assets and foreign liabilities creates a natural hedge against exchange rate risk that may substitute for hedging through the use of foreign exchange derivatives.

Certain classes of liabilities also potentially expose insurers to abnormal risks. For life insurers, these include group annuities and individual life insurance and annuities. Group annuities are held by sophisticated institutional investors such as corporate pension plans, which are generally believed to be highly sensitive to both yields and insurer financial ratings. Individual life insurance and annuities are relatively long maturity contracts that contain numerous embedded options and are particularly sensitive to changes in interest rates. Property-liability insurers also issue relatively long-maturity liabilities in the commercial casualty lines such as general liability and workers' compensation insurance.

To capture the effects of liability risk on the use of derivatives, we separately include the proportions of reserves in individual life insurance and annuities and in group annuities in the life insurer analysis. These variables are expected to be positively related to the decision to use derivatives. For property-liability insurers, the long-tail commercial lines of business (commercial liability and workers' compensation) have longer

[10]We also tested the proportions of assets in Canadian stocks and bonds, but these variables were not statistically significant.

maturities than other lines of property-liability insurance and are also generally regarded as having higher underwriting risk than most other coverages. To measure the effects of exposure to commercial long-tail risk, we include the proportion of reserves in commercial liability (except products liability) and workers' compensation insurance and separately include the proportion of reserves in products liability insurance. Products liability insurance is included separately to account for any differences in the risk characteristics of this line versus other commercial long-tail coverages.[11] The commercial liability/workers' compensation variable and the products liability variable are expected to be positively related to the use of derivatives if the risk of these lines of business motivates insurers to hedge. On the other hand, because these lines have relatively long payout-tails, they provide a natural hedge against the duration risk of long-term assets held by insurers and thus may reduce somewhat the need to manage interest rate risk through derivatives transactions.

Life insurers issue another type of debt instrument, guaranteed investment contracts (GICs), similar to structured notes, that are purchased primarily by institutional investors. GICs are yield sensitive and contain embedded options that are likely to be exercised in response to changes in interest rates and other economic fluctuations. Insurers are well aware of the risks of issuing GICs, as well as the increasing sensitivity of GIC investors to insurer financial quality (Finn, 1988, Liscio, 1990). Accordingly, we expect an insurer's GIC exposure to be positively related to the use of derivatives; and we test this hypothesis using the ratio of GICs to total reserves.

The Underinvestment Problem. The classic underinvestment problem was first identified by Myers (1977). The basic argument is that the presence of debt in the firm's capital structure can lead firms to forego positive net present value projects if the gains primarily augment the value of the firm's debt. The

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[11]Products liability has historically (e.g., during the mid-1980s) been a source of abnormal underwriting losses for property-liability insurers, and insurers are now required to report this line separately from other liability lines for regulatory purposes. In addition, we obtained quarterly data on commercial lines loss ratios on a confidential basis from two top ten (in terms of market share) commercial lines insurers for the period 1987-1996. Calculating the volatility of these time series either as the standard deviation or coefficient of variation shows that products liability is <u>much</u> more volatile than the other long-tail commercial lines.

underinvestment problem is more likely to occur in firms that are relatively highly leveraged, providing a motivation for firms to hedge to avoid shocks to equity that result in high leverage ratios. A related problem, identified by Froot, Scharfstein, and Stein (1993) arises if external funds are more costly than internal funds, due to, say, information asymmetries between insiders and outsiders. Firms may hedge to reduce the variability of their income stream and thus help to ensure that adequate internal funds are available to take advantage of attractive projects.

Researchers often use growth rates to proxy for the presence of investment opportunities that might motivate a firm to hedge. However, the growth rate variables we tested (growth in premiums and assets) were not statistically significant. For life insurers, we are able to specify a unique variable to serve as a proxy for growth opportunities (or, rather, the lack thereof). This variable is the proportion of an insurer's new premium volume that arises from the reinvestment of policyholder dividends and coupons from existing policies. The argument is that firms that have a relatively high proportion of revenues from existing policies rather than new policy sales are lacking in growth opportunities. We expect this variable to be inversely related to the use of derivatives. No comparable variable is available for property-liability insurers.

Taxes. Smith and Stulz (1985) argue that the presence of a convex income tax schedule provides a motive for corporate hedging. With a convex tax schedule, firms can minimize taxes and enhance firm value by reducing the volatility of earnings, thus providing a motivation for risk management. The tax schedules affecting both life and property-liability insurers have convex segments, and property-liability insurers, in particular, engage in especially active tax management (Cummins and Grace, 1994).

Because the amount of information insurers disclose to regulators on Federal income taxation is very limited, we are not able to test variables commonly used in the existing literature such as the amount of unused tax loss carryforwards (e.g., Nance, Smith, and Smithson, 1993). However, we are able to specify dummy variables to proxy for insurers' tax positions. We specify a dummy variable equal to 1 if the insurer paid no Federal income tax in 1994 and 0 otherwise; and similar variables are specified for 1992 and 1993. The expected signs of these variables are ambiguous. On the one hand, not paying taxes may indicate the presence

of tax loss carryforwards that the insurer risks losing if it does not generate positive taxable income. This rationale would predict positive signs for the "no tax" dummy variables. On the other hand, if the insurer has been paying little or nothing in taxes, it may indicate that it does not expect to pay taxes in the future and hence does not have a tax motivation for engaging in hedging activities.

A second variable designed to capture the effects of tax-induced hedging is a dummy variable equal to 1 if the insurer's ratio of incurred Federal income taxes to pre-tax income is between zero and 25 percent and equal to zero otherwise. This variable is designed as an indicator for insurers that are in the convex segment of the tax schedule, between the alternate minimum tax (AMT) rate (20 percent) and the regular corporate tax rate (34 percent).[12] This "AMT" dummy variable is expected to have a positive relationship with the use of derivatives.[13]

The Maximization of Managerial Utility

We argue that mutual insurance companies are likely to be more affected by incentive conflicts between managers and owners than are stock companies. The mutual ownership form does not provide effective mechanisms that owners can use to control and discipline managers, such as the alienable claims, voting rights in elections for directors, and the proxy and takeover fights available to the owners of stock companies. The opportunities to align owner and shareholder interests through management compensation systems (such as stock option plans) also are more limited in the mutual ownership form. Thus, mutual managers are likely to behave in a risk-averse manner, placing a higher priority on avoiding or hedging risks that may threaten their jobs than on maximizing firm value. This reasoning suggests the hypothesis that managers of mutuals are more

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[12]The 25 percent threshold was chosen somewhat arbitrarily because we do not actually know which insurers are paying the AMT and which are paying taxes at the regular rate. Because insurers do not provide information on tax loss carryforwards, insurers paying the regular tax rate could have ratios of incurred taxes to income that are less than 34 percent. Experimentation with a few other reasonable thresholds, such as 20 percent and 15 percent, indicate that the results are not sensitive to the choice of a threshold in the 15 to 25 percent range.

[13]We also tested a continuous tax variable equal to the ratio of taxes incurred to net income before taxes. This variable was never statistically significant and was eliminated from the models reported in the paper.

likely to engage in derivatives activity than comparable stock insurers.

An alternative view is provided by the managerial discretion hypothesis, which predicts that mutuals will be relatively successful in less complex and less risky activities than stocks (Mayers and Smith, 1988). To the extent that less complex and less risky activities give rise to less need for hedging, the managerial discretion hypothesis would predict that mutuals may be less active in derivatives than stocks. Of course, these two hypotheses are not mutually exclusive, i.e., mutuals on average may be less risky and less complex than stocks, while at the same time mutual managers exhibit greater risk aversion than managers of similar stock insurers.

To test for the potential effect of managerial risk aversion on hedging behavior in the insurance industry, we specify a dummy variable equal to 1 if the company is organized as a mutual insurance company and equal to zero otherwise. The managerial risk aversion hypothesis predicts a positive relationship between this variable and the use of derivatives. The managerial discretion hypothesis predicts an inverse relationship, but only to the extent that our other independent variables do not completely control for firm risk and product line characteristics.

The ratio of surplus notes to total assets also may provide a proxy for managerial risk aversion. Because surplus notes are used as a financing device almost exclusively by mutuals (Webersen and Hope, 1996), the presence of surplus notes in a mutual's capital structure may indicate that its managers are relatively more risk averse than the managers of mutuals that have not taken advantage of this source of financing. This reasoning predicts a positive relationship between surplus notes and the use of derivatives.

Other Variables

We expect firm size to be positively correlated with derivatives activity if there are significant economies of scale in human capital investment and derivatives trading (Booth, Smith and Stolz, 1984, Hoyt, 1989) and if derivatives operations require significant investments in computer hardware and software (Stulz, 1996). However, these scale economies, if they exist, may be offset by the fact that larger insurers may be more diversified and therefore in less need of derivatives contracts as additional risk management tools. Based on the previous literature on corporate hedging by both insurers (Hoyt, 1989, Colquitt and Hoyt, 1997, and

Cummins, Phillips, and Smith, 1997) and other types of firms (Mian, 1996) our overall expectation is that information and transactions cost economies of scale will dominate any built-in diversification benefits, resulting in greater usage of derivatives by larger insurers. The variable used to test for the size effect is the natural logarithm of total assets.

Another scale-related variable included in our analysis is a dummy variable set equal to 1 if the insurer is a member of a group of insurers where at least one other member of the group is active in derivatives trading and to zero otherwise.[14] If one member of the group is involved in derivatives trading, then the cost of other group members taking advantage of these risk/return opportunities is declining to the extent that each member of the group rationally does not duplicate these fixed costs. We expect this dummy variable to be positively related to the decision to use derivatives. However, controlling for other factors, this variable is expected to be inversely related to the volume of derivatives transactions, on the rationale that having affiliated insurers trading derivatives reduces the volume needs for other members of the group.

A dummy variable is also included for unaffiliated single companies.[15] Unaffiliated insurers may be more likely to engage in risk management through derivatives trading than insurers that are members of groups because unaffiliated companies forfeit a source of diversification by not being organized as a group. An insurance group is similar to a portfolio of options, worth more to the owners than an option on a portfolio. Under corporate law, the creditors of an insolvent subsidiary cannot reach the assets of other members of the group unless they are successful in "piercing the corporate veil," which usually requires a finding of fraud or similar wrong-doing by the group's owners. Thus, we expect the unaffiliated company variable to be positively related to the decision to use derivatives.

Although derivatives are a relatively recent risk management tool for most insurers, they have long used

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[14]The reasons for conducting our tests with the company rather than the group as the unit of observation are explained below.

[15]Thus, the excluded category not represented by the group affiliate dummy and unaffiliated single company dummy variable consists of members of groups where at most one group member is active in derivatives.

reinsurance to hedge underwriting risk. More recently, insurers have used financial reinsurance to hedge their exposure to, for example, interest rate and market risk (Tiller and Tiller, 1995**)**. To the extent that underwriting risk and financial risk are correlated, reinsurance designed to reduce underwriting risk could serve as a substitute for derivatives activities. On the other hand, reinsurance and financial derivatives might be complements if insurers that engage in hedging of underwriting risk are also more likely to hedge financial risk. We account for the use of reinsurance by including in our regressions the ratio of ceded reinsurance premiums written to direct premiums written plus reinsurance assumed.

Hedging versus Speculation

Although our hypotheses deal almost exclusively with motivations for hedging, it is difficult to completely rule out the possibility that some insurers are using derivatives purely for speculative purposes due to rogue traders or to a deliberate corporate policy to take more risk. We do not consider the possible existence of speculation to be a serious problem, for several reasons: First, survey research provides considerable evidence that many insurers are focusing on the use of derivatives as a risk-management tool (Hoyt, 1989, Lehman Brothers, 1994, Santomero and Babbel, 1997).

Second, financial theory suggests that the optimal approach to risk management is to hedge risks where the firm does not have a comparative advantage, i.e., risks for which it will not be compensated, and take on more of the types of risk in which the firm does have a comparative advantage and thus can earn economic rents (Stulz, 1996, Schrand and Unal, 1998). Thus, to the extent that insurers do not have a comparative advantage in predicting returns on stocks, commodities, foreign exchange, or other assets, it would not be optimal for the vast majority of insurers to speculate in these markets using derivatives. Thus, we find it unlikely that speculative behavior is driving our results, even if a few insurers are engaging in this type of activity.

Third, with pure speculation, some of the sign patterns that we observe between the participation and volume regressions (see below) would not be anticipated. For example, for life insurers the privately placed bond variable has a positive coefficient in the participation (probit) equation and a negative coefficient

in the volume of transactions equation. We argue that having more private placements motivates insurers to enter the derivatives market for hedging purposes, but, conditional on entering the market, firms with more tolerance for risk are likely to hedge less, explaining the negative sign in the volume regression. This sign would be difficult to explain under the hypothesis that insurers are using derivatives for pure speculation. Likewise, tax hedging is difficult to explain under a speculation hypothesis. Finally, we would not expect to observe consistency of our regression results with a *wide range* of hedging-related hypotheses and variables if insurer derivatives activity were driven mainly by speculation. Insurers could speculate on stocks or foreign exchange through derivatives without holding any stocks or foreign assets.

Thus, we believe that the weight of evidence we present is consistent with insurers primarily using derivatives for hedging purposes. This does not mean that no speculative activity is taking place, only that the preponderance of derivatives transactions appear to involve hedging rather than speculation.[16]

II. Data and Methodology

The Data

Our data come from Schedule DB of the 1994 regulatory annual statements filed by insurers with the National Association of Insurance Commissioners. Parts A through D of Schedule DB list individual transactions across four general categories of derivatives; (A) options, caps and floors owned, (B) options, caps and floors written, (C) collar, swap and forward agreements, and (D) futures. In part E of schedule DB, insurers report their year-end counterparty exposure for all the contracts contained in sections A through D. The explanatory variables used in our analysis also are taken from the 1994 NAIC regulatory statements.

The sample of insurers we analyze initially consisted of all life and property-liability companies that filed regulatory annual statements with the NAIC for calendar-year 1994, a total of 1,760 life insurers and 2,707 property-liability insurers. Initial screening resulted in the elimination of firms with zero or negative

[16]We also observe that insurers can legitimately be using derivatives for purposes of income enhancement without taking additional risk. For example, covered call strategies are no more risky than investing in traditional assets such as stocks and bonds.

assets, premiums, or surplus (equity) and firms that lack adequate group affiliation identifiers. The screening criteria resulted in the elimination of a large number of very small firms (in the aggregate accounting for only 2.2 percent of industry assets). The final sample consists of 1,216 life insurers and 1,668 property-liability insurers.

Many insurers are members of groups that operate under common ownership. Because members of groups are likely to share common financial strategies and, in many cases, common investment departments, we considered analyzing firms at the group level as well as the individual company level. However, Cummins, Phillips, and Smith (1997) found that the group level analysis provided virtually no information concerning the participation decision not provided by the company level analysis and, in fact, some interesting information was lost as a result of aggregating individual companies into groups. Consequently, we report only the company-level analysis in this paper.

Methodology

In this paper, we analyze the factors affecting the decision by insurers to enter the market for derivatives (the participation decision) as well as the factors affecting the volume of transactions undertaken (the volume decision). We use two criteria to determine whether an insurer is active in derivatives markets and to measure the volume of derivatives transactions – derivatives transactions during the year and derivatives positions at year-end. Using the within-year criterion has the advantage of enabling us to analyze all insurers that are active in derivatives markets rather than only those that report year-end positions. Some insurers close out their positions at year-end, either for regulatory window-dressing or for other reasons, and using the year-end criterion eliminates such insurers from our sample.[17] The disadvantage of using the within-year definition of activity is that insurers which adopt short-term rollover strategies, as opposed to hedging with long-term contracts, will appear to be more aggressively managing their exposures when, in reality, the

[17]In our sample, there are 118 life insurers that use derivatives under the within-year criterion but only 107 under the end-of-year. For property-liability insurers, there are 111 users under the within-year criterion and 77 under the end-of-year criterion.

economic benefits of the two strategies are arguably very similar. Conducting the analysis under both criteria thus provides an important check on the robustness of the results.

We use probit analysis to study the participation decision — the same approach used for this purpose by Colquitt and Hoyt (1997) and Cummins, Phillips, and Smith (1997). The dependent variable is set equal to 1 if an insurer had derivatives transactions during 1994 (the within-year definition) or, alternatively, if it reported derivatives holdings at year-end 1994 (the end-of-year definition) and equal to zero otherwise. The explanatory variables are those formulated above to test our hypotheses. A positive sign on an explanatory variable in the probit analysis implies that the variable is associated with a higher than average propensity for insurers to use derivatives and vice versa if the variable carries a negative sign.

To analyze the volume of derivatives transactions, we adopt two approaches. The first is a Tobit analysis. In Tobit analysis the dependent variable is equal to zero if an insurer does not use derivatives and equal to the volume of derivatives transactions divided by the total assets of the insurer if the firm uses derivatives. We use notional amounts to measure the volume of derivative transactions.[18] Tobit analysis is a standard procedure for dealing with censored dependent variables, where the variable is continuous for some observations but equal to zero (or some other constant) for others.

A criticism of Tobit analysis is that it measures the participation decision and the volume decision simultaneously, i.e., it forces variables to have the same signs with respect to the decision to participate and the volume of transactions, given that participation takes place. To the extent that there are reasons, like those noted earlier, why some variables in the participation and volume regressions should have opposite signs, the Tobit model would be mis-specified. Consequently, we also utilize a generalization of the Tobit model, due to Cragg

[18]We are aware that notional volume is, at best, an imprecise measure of the economic value of these activities. However, to the extent the measurement error is uncorrelated with the explanatory variables, our estimates will remain unbiased. Virtually all previous analyses of derivatives transactions volume in both financial and non-financial firms have also used notational amounts. To help control for measurement error due to insurer size, we use the ratio of an insurer's notional transactions to its assets as the dependent variable in our probit models and the natural log of this variable as the dependent variable in the volume analysis (see below).

(1971), that does allow different parameter values for the participation and volume decisions.

Cragg's framework is quite general and allows a variety of assumptions concerning the underlying probability distributions entering into the participation and volume decisions. Here we adopt an approach, used previously by Gunther and Siems (1995), that assumes a normal distribution for the participation decision and a lognormal distribution for the volume decision, conditional on the fact that the firm is participating in this market. The resulting likelihood function is

$$L = \prod_{i=1}^{N} [1 - \Phi(\beta' X_i)]^{(1 - I_i)} [\Phi(\beta' X_i) f(y_i \mid y_i > 0)]^{I_i}$$

$$\textit{where} \quad f(y_i \mid y_i > 0) = (\sigma y_i)^{-1} (2\pi)^{-\frac{1}{2}} e^{-\frac{1}{2}\frac{(\ln y_i - \gamma' X_i)^2}{\sigma^2}}, \quad y_i > 0$$

I_i is an indicator variable equal to 1 if the insurer uses derivatives and zero otherwise, β and γ are parameter vectors, y_i is the volume of derivatives relative to the insurer's assets for insurer i, and X is a vector of independent variables for insurer i. The model is equivalent to estimating a probit model for the participation decision and a lognormal regression model for the volume decision. The two parts of the model (parameter vectors) can be estimated separately. We conduct likelihood ratio tests of the null hypothesis that the participation and volume decisions can be modeled using the same coefficients (as in Tobit) versus the alternative hypothesis that the impact of the independent variables on participation differs significantly from their effect on transactions volume. The results of these tests are reported in the next section.

III. Estimation Results

To facilitate the discussion of results, the hypotheses, variables, and expected signs are summarized in Table 1. The empirical findings are also summarized in the Table 1, with greater than or less than signs indicating the signs of the variables that are statistically significant. In order to keep the table as concise as possible, variables are shown as being significant if they are significant in <u>either</u> the within-year or year-end regressions. However, the findings are obviously stronger for variables that are significant in <u>both</u>

equations; and the results tables present full information on coefficient magnitudes and significance levels.

Descriptive Statistics

About 10.9 percent of life insurers and 6.9 percent of property-liability insurers use derivatives. However, usage is much more widespread in the largest size quartile, where 34.4 percent of life and 21.1 percent of property-liability insurers are active in derivatives markets (see CPS, 1997, for more details).[19]

Summary statistics for the variables appearing in our models are presented in Table 2. The average notional amounts of derivatives transactions during the year and positions still open at the end of year by life insurers are $2.629 billion and $661 million, respectively. The average notional amount of transactions for property-liability insurers both during the year and open at the end of the year is much less, only about $289 million and $90 million, respectively. Clearly, life insurers are, on average, bigger players in derivatives markets than their property-liability counterparts.

Table 2 also contains data on the means of the independent variables for derivatives users and non users, by insurer type, as well as t-tests for the significance of the differences between the means of the variables for users and non-users. Both life and property-liability insurers that use derivatives are significantly larger than their non-user counterparts. Life insurers engaged in derivatives activities have significantly higher proportions of their assets in real estate, publicly traded and privately placed CMOs, privately placed commercial bonds, and non-US/non-Canadian bonds. Life insurance users also have significantly higher proportions of group annuities and GICs on their balance sheets than do non-users, and users have larger maturity gaps than non-users. The direction and significance of these mean differences are consistent with our hypothesis that life insurers are using derivatives to hedge interest rate risk, volatility risk, liquidity risk, and exchange rate risk.

Life insurers who use derivatives have lower capital-to-asset ratios than non-users but are less likely

[19]As an additional robustness check, we also estimated our regression models using only the firms in the largest size quartile. The results are consistent with those reported for the full sample and lead to the same conclusions.

to have risk-based capital ratios less than 200 percent.[20] Life insurance users are significantly less likely than non-users to have incurred a Federal tax liability in 1993 and 1994. Finally, users are more likely to be mutuals, less likely to be unaffiliated companies, and much more likely to have another affiliated company that is active in derivatives. The findings with respect to mutuals and unaffiliated companies probably reflect uncontrolled size effects rather than being contrary to our hypotheses, since mutual life insurers on average are much larger than stock life insurers and affiliated companies are larger than unaffiliated companies.

Property-liability insurers that use derivatives have higher proportions of their assets in stocks, real estate, and non-US/non-Canadian stocks and bonds than non-users. Although not significant, commercial long-tail lines (other than products liability) account for a lower proportion of reserves for users than for non-users, but products liability accounts for a significantly higher proportion of reserves for users. As in the case of life insurers, property-liability users have larger maturity gaps and lower capital-to-asset ratios than non-users, and users are more likely than non-users to have an affiliate active in derivatives markets. Property-liability users of derivatives are more likely to be in the AMT range of the tax schedule than non-users. Overall, the descriptive statistics provide suggestive evidence in support of many of our hypotheses; in particular the hypothesis that firms with above average risk exposure, relative to overall population of insurers, will find it beneficial to pay the fixed cost of becoming active participants in the market for derivative securities.[21]

An analysis of life insurer derivatives transactions reveals that both within-year and year-end

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[20]The capital-to-asset ratio is known to be negatively related to size. We control for this correlation in our probit, Tobit, and Cragg models by including a measure of size as an explanatory variable. Even after controlling for size, we still find that users have lower capital ratios than non-users.

[21]We also analyzed the bivariate correlation coefficients between the variables used in the regression models as a screen for possible multicollinearity. Although a number of the bivariate correlations are statistically significant, most are quite small and only a few are around 0.5 in absolute value, e.g., the capital to asset ratio and the log of assets. The regression results are very stable and are robust to the elimination of correlated variables, i.e., the signs and significances of the remaining variables hold up when various variables are dropped from the regressions.

transactions volume tends to be concentrated in bond and interest rate derivatives,[22] as expected if insurers are using derivatives to hedge the duration and convexity risk inherent in their balance sheets. The largest category of derivatives for life insurers is interest rate swaps, followed by interest rate caps and floors. Life insurers also show significant activity in foreign currency derivatives, consistent with the finding in Table 2 that life insurers using derivatives have significantly higher holdings of foreign bonds than do non-users. However, the volume of foreign currency transactions is much less than for bond and interest rate contracts. The leading category of derivatives for property-liability insurers in terms of year-end positions consists of foreign currency contracts, followed by bond and interest rate derivatives. The largest volume of within-year transactions for property-liability insurers consists of writing equity calls, suggesting that these firms may be engaging in dividend capture transactions. Foreign currency transactions rank second in terms of within-year trading for property-liability insurers.

Tobit Versus Cragg Analysis

We first examine the null hypothesis that the relationship between the independent variables and the volume decision is not statistically different from the relationships explaining the participation decision. The dependent variable in the volume regressions is the natural logarithm of the ratio of the notional value of derivatives transactions to total assets. The ratio to total assets is used to control for the size effects and possible heteroskedasticity. We estimate both Tobit and Cragg models for the volume decision and compute a likelihood ratio statistic to test the null hypothesis that the coefficient vectors in the two models are the same (see Greene, 1997, p. 970). The test results, shown in Table 3, overwhelming reject the null hypothesis. Consequently, we conclude that Tobit analysis is not appropriate for analyzing the volume decision and report only the Cragg lognormal regression results for the volume decision in the tables.[23]

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[22]For more extensive summary statistics on the types of derivatives used by insurers, see Cummins, Phillips, and Smith (1997).

[23]The Tobit results generally have nearly the same significant variables (with the same signs) as the probit equations shown in the tables, indicating that the Tobit estimates are primarily driven by the participation decision rather than the volume decision.

We also conducted tests for heteroskedasticity in both the probit and lognormal regressions. A likelihood ratio test failed to reject the hypothesis of homoskedasticity for the error term of the probit models (see Greene, 1997, pp. 889-890). Accordingly, no adjustment for heteroskedasticity is made in the probit models. However, the Breusch-Pagan test led to rejection of the hypothesis of homoskedasticity for the lognormal volume regressions. Consequently, the lognormal standard errors reported in the regression tables are based on White's heteroskedasticity consistent covariance estimator.

Multi-Variate Results: Life Insurers

Table 4 shows the probit and lognormal regression models estimated as part of the Cragg analysis. Two sets of equations are shown – based on within-year transactions and year-end positions.

The Participation Decision. Most of the significant variables in the probit models for the probability of participation in derivatives markets are the same for the within-year and end-of-year regressions. We discuss these variables first and then discuss differences between the within-year and year-end models.

The coefficients on the log of assets are positive and highly significant, supporting the hypothesis that derivatives activities are subject to scale economies. The positive and significant coefficients on the dummy variable for having an affiliate active in derivatives markets also support the scale economies hypothesis and provide evidence that fixed costs play a role in the decision to use derivatives.

Positive and significant coefficients are obtained on the proportions of assets in stocks, privately placed bonds, privately placed CMOs, and non-US/non-Canadian stocks, providing support for the hypothesis that insurers engage in derivatives transactions to manage volatility, liquidity, and exchange rate risks arising from the asset portfolio. The coefficients on the proportions of liabilities represented by individual life and annuity contracts and GICs are also positive and significant, consistent with the argument that insurers use derivatives to manage interest rate risk arising from the liability portfolio.[24]

[24]As a robustness check, we also conducted the analysis based on insurer participation in markets for specific types of derivatives instruments. We estimated three additional probit equations for life insurers – for bond/interest rate derivatives, equity derivatives, and foreign exchange derivatives. The dependent variables were set equal to 1 if the insurer is a user of a specific type of derivatives and to zero otherwise.

Positive and significant coefficients on the dummy variable for having an incurred tax rate in the AMT range provide support for the hypothesis that derivatives usage is motivated by convexity of the income tax schedule. The dummy variable for no Federal taxes in the second year prior to the regression year is positive and significant in the year-end regression, providing support for the hypotheses that insurers engage in hedging to avoid losing tax loss carryforwards.

A few other variables are significant in only one of the probit regression models shown in Table 3. The capital-to-asset ratio is negative and significant in the within-year regression and negative but insignificant in the end-of-year regression. The results thus provide some support for the hypothesis that well-capitalized insurers are less likely to use derivatives because their probability of incurring distress costs is relatively low and suggests that derivatives and capital may be viewed as substitutes by some insurers. The unaffiliated single firm dummy is positive and significant at the 10 percent level in the within-year regression, consistent with the hypothesis that unaffiliated firms use derivatives because their organizational form deprives them of a source of diversification available to insurance groups. The brokerage distribution system dummy variable is positive and significant in the within-year probit model, supporting the hypothesis that insurers distributing insurance through brokers are more sensitive to the need to manage risk than insurers using tied distribution systems. Contrary to expectations, the foreign denominated liabilities dummy variable is negative and significant (at the 10 percent level) in the year-end regressions.

The Volume Decision. Consistent with the marginal cost hypothesis set forth earlier, the lognormal volume regressions provide evidence that, conditional on being in derivatives, firms with more tolerance for

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These instrument-specific results indicate that the overall regression results can generally be interpreted as implying that insurers use specific instruments to hedge risks related to these instruments. For example, the proportion of assets in stocks is significant in the equity probit equation but not significant in the interest rate or foreign exchange probit models. The privately placed bond variable is significant in the interest rate derivatives probit equation but not in the equity derivatives equation. The CMO variable is significant in the interest rate probit model but not in the equity or foreign exchange models, and the non-US/non-Canadian stock variable is significant in the foreign exchange probit model but not in the equity or interest rate models. The GIC variable is significant in the interest rate risk probit model but not in the equity or foreign exchange models.

risk choose to hedge relatively less than firms with lower risk tolerance. For example, the proportion of assets in privately placed bonds is positive in the participation (probit) regressions, but this variable is negative and significant in the volume regressions. The proportion of assets in stocks follows the same pattern, except that the stock variable is not significant in the within-year volume regression. Weaker support for the hypothesis is provided by the capital-to-asset variable. This variable is negative and significant in the within-year probit regressions, positive but not significant in the within-year volume regressions, and positive and significant in the end-of-year volume regressions.

The unaffiliated company dummy variable is positive and (weakly) significant in the within year probit equation and negative and significant in the within-year volume regression. This finding is consistent with our marginal costs hypothesis if unaffiliated firms have a higher tolerance for risk than affiliates. Cummins and Sommer (1996) provide evidence that unaffiliated firms tend to have relatively high risk tolerance. They find that unaffiliated firms take more risk than insurance groups with similar characteristics, supporting their theoretical argument that there is a product market penalty for being organized as a group because the group structure increases the probability of default.

The proportion of assets in publicly traded CMOs is negative and significant in both the within-year and end-of-year volume regressions. This finding could be interpreted as providing further support for the marginal costs hypothesis, and/or it could reflect the lower liquidity risk of publicly-traded relative to privately-placed CMOs, an interpretation that is reinforced by the positive and significant coefficient on the privately-placed CMO variable in the within-year volume regression.

It is to be emphasized that the result with privately-placed CMOs, i.e., a positive coefficient in both the participation and the volume regressions, is not necessarily inconsistent with our marginal costs hypothesis. The reasoning behind the hypothesis suggests that the aversion to marginal costs may be overcome if there is a particularly compelling reason to hedge the risk of specific assets or liabilities. The fact that CMOs are considered to be especially risky investments may account for the different signs on privately placed bonds and CMOs in the volume regressions.

The GIC variable also is positive and significant in both the participation and the volume regressions. We have two, non-mutually exclusive explanations for finding. The first is that purchasers of GICs tend to be more sophisticated investors, on average, than the purchasers of other life insurer products. Accordingly, they may engage in more active monitoring of firm risk and hedging decisions than other investors, imposing a market penalty on insurers that under-hedge their GIC exposure. The second explanation is that an insurer's liability (product) portfolio is less likely than its asset portfolio to provide an indicator of risk tolerance. A wide range of historical, managerial, and strategic considerations having little to do with risk tolerance play a role in determining the products an insurer emphasizes. Thus, while the proportion of assets in stocks or privately-placed bonds may convey significant information about risk tolerance, the firm's product portfolio is likely to be determined largely by other factors. The positive and significant coefficient on the individual life and annuity reserves variable in the year-end volume regression is also consistent with this interpretation.

The maturity gap variable is negative and significant in both the within-year and end-of-year volume regressions, suggesting that insurers with larger maturity gaps may have more risk tolerance than insurers with smaller maturity gaps. The dummy variable for having an incurred tax rate in the AMT range is positive and significant at the 10 percent level in the year-end volume regression, providing some additional evidence that being in the convex segment of the tax schedule motivates insurers to hedge.

The proportion of premiums ceded to reinsurers is positive and significant in the end-of-year volume regression, providing some evidence that insurers view reinsurance and derivatives as complements, i.e., that insurers with relatively low risk tolerance are likely to use more derivatives and more reinsurance. An alternative interpretation that cannot be ruled out on the basis of our data is that insurers with better reinsurance hedges use derivatives to take more risk for speculative purposes. A variable with similar implications is the preferred-stock to assets ratio, which is positive and significant in the volume regressions.

As expected, the "active affiliate" dummy variable is negative and significant in the within-year lognormal regression, whereas it was positive and significant in the within-year probit model. Thus, conditional on size, the transactions volumes of individual affiliates are likely to be less if other group members are also

active in derivatives.

Finally, the brokerage distribution system dummy variable is negative and significant in the year-end volume regressions. An analysis of life insurers using brokers versus those using other distribution systems reveals that the brokerage firms take less risk, almost across the board, based on a large number of asset and liability risk indicators. Consequently, the lower volume of derivatives usage for these firms seems to reflect the fact that they have less need to use derivatives to hedge than firms using other distribution systems, i.e., the variable is picking up the lower risk of these firms that is not accounted for by other variables.

Overall, the results provide support for the hypotheses that insurers engage in derivative transactions to reduce the expected costs of financial distress, manage interest rate, exchange rate, and liquidity risk, and minimize expected tax liabilities. However, the results provide no support for the hypothesis that the managers of mutual life insurers behave differently from managers of stock insurers.

Multi-Variate Results: Property-Liability Insurers

The probit and lognormal regression results for property-liability insurers are shown in Table 5. As above, we first discuss the participation decision and then turn to a discussion of the volume decision.

The Participation Decision. The discussion in this section applies to variables that are significant in both the within-year and end-of-year probit regressions unless specifically indicated.

The property-liability models provide further support for the hypothesis that there are economies of scale in running derivatives operations. The log of total assets has a highly significant positive coefficient, and the "active affiliate" dummy variable is also positive and significant.

The hypotheses that insurers use derivatives to manage asset volatility and/or engage in dividend capture strategies are supported by the significant positive coefficients on the proportions of the asset portfolio in stocks. The hypothesis that insurers use derivatives to hedge exchange rate risk is supported by the significant positive coefficient on the foreign-asset exposure dummy variable. Further support is provided by the positive coefficient on the foreign liabilities dummy variable in the within-year regression. The coefficient on the interaction of the foreign assets and foreign liabilities dummy variables is statistically significant (at the

10 percent level) and negative in the within-year equation, consistent with the argument that having exposure to both foreign assets and foreign liabilities creates a natural foreign currency hedge, reducing the need to hedge through derivatives transactions. The hypothesis that insurers use derivatives to manage liquidity risk is supported by the real estate variable in the within-year probit regression.[25]

The capital-to-asset ratio is statistically significant and negative in both property-liability insurer probit regressions, consistent with the hypothesis that insurers engage in derivatives transactions to reduce the expected costs of financial distress. The ratio of actual capital to risk-based capital (RBC) is significant at the 10 percent level in the within-year probit model with a positive coefficient, suggesting that insurers are less likely to use derivatives the closer they are to the RBC threshold, perhaps to avoid regulatory costs due to regulator skepticism about the use of derivatives. The weakness of the RBC variable here and the insignificance of the RBC variable in the life insurer regressions may be due to the fact that the risk-based capital system was newly adopted for life insurers in 1994 and did not go into effect for property-liability insurers until 1995. Another explanation is that the other variables in the regression provide better measures of the expected costs of financial distress. The latter explanation would be consistent with the Cummins, Harrington, and Klein (1995) finding that risk-based capital performs poorly as an insolvency predictor.

The results also provide some support for the tax management hypothesis. The dummy variable, set equal to 1 if no taxes are incurred in the current year, is statistically significant (at the 10 percent level) with

[25]As for life insurers, we also conducted the analysis separately for property-liability insurer participation in the markets for interest rate/bond derivatives, equity derivatives, and foreign exchange derivatives. The results are weaker than for life insurers but are generally consistent with the argument that insurers use specific types of contracts to hedge risks reflected in those contracts. For example, the proportion of assets in stocks is significant in the equity derivatives probit model but not in the interest rate or foreign exchange models; and the foreign asset dummy variable is significant in the foreign exchange and equity derivatives model but not in the interest rate derivatives model. The real estate variable is positive and has t-values greater than 1 but is not quite significant in the equity and interest rate derivatives models but is negative and insignificant in the foreign exchange model. This makes sense if real estate investments have some characteristics similar to stocks but are also behave somewhat similarly to mortgages. The mutual dummy variable is statistically significant and positive in the equity derivatives probit model, providing some support for the managerial risk aversion hypothesis, that mutuals hedge more than stocks.

a negative coefficient. This suggests that insurers that are not paying taxes do not have a motive to hedge in order to avoid higher taxes due to the convexity of the income tax schedule. Although one might think that insurers would hedge to avoid income volatility that might drive their taxable income into the convex segment of the tax schedule, property-liability insurers have been very successful over a long period of time in hitting their taxable income targets through the use of tax favored investments and the manipulation of loss reserves (Grace, 1990, Cummins and Grace, 1994). Life insurers have less ability to manage their reserves and are taxed under a different section of the tax code than property-liability insurers. As a result, they have been less successful in managing their taxable income through conventional techniques and, therefore, are more likely than property-liability insurers to use derivatives transactions to accomplish this objective, accounting for the stronger results with respect to the tax variables in the life insurer regressions.

The proportion of reserves accounted for by products liability insurance is positive and statistically significant in the within-year probit regression, whereas the proportion of reserves accounted for by other commercial long-tail lines is negative and significant in both the within-year and year-end probits. The product liability result suggests that insurers who are active writers of products liability insurance have an incentive to hedge the high volatility inherent in this type of coverage. Such hedges can be constructed by transacting in derivatives on the stocks of their insured policyholders.[26] The negative sign on the non-products liability long-tail commercial variable is consistent with the argument that reserves in the lower-risk long-tail lines provide a natural hedge against interest rate risk arising from the asset portfolio.

The ceded reinsurance variable is negative and weakly significant in the property-liability insurer within-year participation regression, whereas it was insignificant for life insurers. The negative sign on this variable is consistent with the hypothesis that firms that hedge their underwriting exposure have lower overall

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[26]For example, an insurer writing a products liability policy on a drug manufacturer could hedge the risk of lawsuits by taking a derivatives position in the manufacturer's stock. This might be especially effective in hedging the risk of products liability losses that affect many of the manufacturer's customers simultaneously, such as those resulting from unforeseen side effects of a particular drug. The positive coefficient on the products liability variable also is consistent with the DeMarzo and Duffie (1995) hypothesis that managers hedge to provide a less noisy signal of managerial quality to shareholders.

risk levels and therefore have less need to pay the fixed costs of entering the market for financial derivatives. The result is also consistent with the finding that insurers appear to hedge products liability risk using derivatives, because reinsurance would be another way to manage the risk of products liability losses. It is possible that the reinsurance variable is significant in the probit regression for property-liability insurers but not for life insurers because the hedging function is more important for property-liability reinsurance than for life reinsurance due to the significantly higher underwriting risk faced by property-liability insurers. Reinsurance plays an important role in reducing expected financial distress costs for property-liability insurers, whereas for life insurers it may be used more often to provide the capacity to write "jumbo" policies and as a financing device to cushion the surplus strain from writing individual insurance policies.

The unaffiliated single company dummy variable has a highly significant positive coefficient, consistent with the hypothesis that such insurers forfeit a source of diversification by not being organized as a group. Because property-liability insurers experience more volatility in their losses and operating income than do life insurers, diversification through the group organizational form is more important in the property-liability insurance industry, leading to the strong significance of the variable here whereas it was weakly significant in the within-year life insurer participation model.[27]

The ratio of surplus notes to total assets is significant (at the 10 percent level) and positive in the within-year probit regression, contrary to the hypothesis that the use of such subordinated claims is a substitute for hedging. However, because surplus notes are used exclusively by mutuals, this variable may be indicative of managerial risk aversion, i.e., relatively risk averse mutual managers may have a tendency to raise additional subordinated capital through surplus notes and also to hedge risk using derivatives.

The Volume Decision. The volume regressions for property-liability insurers provide some additional support for our hypothesis that, conditional on being in the derivatives market, firms with higher tolerance for

[27]For example, several insurers have set up subsidiaries to write property insurance in Florida and California because of the risk of catastrophic loss due to hurricanes and earthquakes. If a major catastrophe were to wipe out the equity of a subsidiary, the parent insurer would not be required to post additional capital, unlike the case where the parent insurer were to write the property insurance policy.

risk will demand lower quantities of derivatives due to the marginal costs of hedging. The foreign liabilities dummy variable is positive and significant in the within-year probit equation but negative and significant in the within-year volume regression. The real estate variable and the foreign asset dummy variable provide additional but weaker support for the hypothesis. Thus, although further research is clearly needed into this marginal costs hypothesis, our results suggest that the hypothesis may help to explain the demand for derivative securities by both life and property-liability insurers.

On the other hand, the proportion of assets in stocks is positive in both the participation and volume regressions and is statistically significant in the end-of-year volume regression. This would be consistent with property-liability insurers primarily writing equity derivatives for dividend capture rather than for volatility management.

As in the case of life insurers, the proportion of premiums ceded to reinsurers is positive and highly significant in the end-of-year volume regression for property-liability insurers. This provides additional evidence that insurers may tend to view reinsurance and derivatives as complements, i.e., that they use the two types of hedging devices to deal with different risks.

The ratio of surplus notes to assets is positive and significant at the 10 percent level in the year-end volume regression. This is consistent with the interpretation that this variable is proxying for managerial risk aversion, i.e., mutual managers that raise relatively large amounts of capital through surplus notes also hedge the risk of financial distress through the use of derivatives. The alternative interpretation – that managers take advantage of the added capitalization to speculate in derivatives – seems unlikely considering the negative sign on the capital-to-asset ratio. Thus, we believe that the surplus notes variable supports the managerial utility maximization hypothesis. The fact that surplus notes are significant for property-liability but not for life insurers may again reflect the higher underwriting risk in the property-liability industry, which provides a strong motivation for risk averse managers to raise additional capital.

The mutual dummy variable is negative and significant in the lognormal regression, providing some support for the managerial discretion hypothesis. Recall that the managerial risk aversion and managerial

discretion hypotheses are not necessarily mutually exclusive. Thus, the surplus notes variable could be picking up risk aversion, while at the same time, the mutual dummy reflects differences in complexity of operations or levels of risk-taking between mutuals and stocks that are not being fully captured by the other independent variables.

Although the broker dummy variable is insignificant in the probit models for property-liability insurers, it is significant and positive in the within-year volume regression. This provides some support for the hypothesis that insurers are motivated to hedge in order to protect their financial reputations with independent distributors. Unlike life insurers, property-liability insurers using brokers do not seem markedly different from insurers using other distribution systems in terms of asset and liability risk indicators. Consequently, the higher volume of derivatives transactions would be consistent with lower risk tolerances for this group of firms. We would not necessarily expect life and property-liability insurers using brokers to behave identically because of the inherently different risks faced in the two industry segments.

IV. Conclusion

In this paper, we formulate and test a number of hypotheses regarding insurer participation and volume decisions in derivatives markets. We base our hypotheses on the financial theories of corporate risk management that have developed over the past several years. The two primary, and non-mutually exclusive, strands of the theoretical literature hold that corporations are motivated to hedge in order to increase the welfare of shareholders and/or managers.

Our results provide a considerable amount of support for the hypothesis that insurers hedge to maximize value. Several specific hypotheses are supported by our analysis. In terms of participation in derivatives markets, we find evidence that insurers are motivated to use financial derivatives to reduce the expected costs of financial distress — the decision to use derivatives is inversely related to the capital-to-asset ratio for both life and property-liability insurers. We also find evidence that insurers use derivatives to hedge asset volatility, liquidity, and exchange rate risks. Life insurers appear to use derivatives to manage interest rate risk and the risk from embedded options present in their individual life insurance and GIC liabilities. There

is also some evidence that tax considerations play a role in motivating derivatives market participation decisions by insurers. Finally, we provide support for the hypothesis that there are significant economies of scale in running derivatives operations. Thus, only large firms and/or those with higher than average risk exposure would find it worthwhile to pay the fixed cost of setting up a derivatives operation.

Interestingly, however, we find that, conditional on being a user of derivatives, the relationship between the volume of derivatives activities and these same risk measures often displays exactly the opposite result to those found in the participation regression. We argue that this result is broadly consistent with the hypothesis that there is also a per unit risk premium associated with hedging and that, conditional on having risk exposures large enough to warrant participation, firms with a larger appetite for risk will be less willing than average to pay this marginal cost. Such firms therefore have larger than average risk exposure (lower than average derivatives positions) vis a vis the sub-group of insurers that use derivatives, who themselves may be, on average, higher-risk firms than non-users.

Our analysis provides only weak support for the utility maximization hypothesis. The only variable that carries significant implications regarding utility maximization is the ratio of surplus notes to assets, which is positively but weakly related to both the participation and volume decisions for property-liability insurers. Because surplus notes are used almost exclusively by mutuals, this finding is consistent with risk averse mutual managers raising capital through surplus notes as well as hedging risk through derivatives transactions. However, we also find that the mutual dummy variable is inversely related to derivatives volume for property-liability insurers, consistent with the managerial discretion hypothesis. To provide a more complete test of the utility maximization hypotheses, information is needed that is not readily available for most insurers such as the proportion of an insurer's stock owned by managers and the incentive features in managerial compensation plans. More definitive tests of managerial utility maximization will be conducted in future work we are undertaking on the derivatives activities of publicly traded insurers.

Our conclusion that insurers with higher than average asset risk exposures use derivative securities has important public policy implications. State regulators are currently considering the imposition of new

restrictions on insurer derivatives transactions. While more work is clearly needed regarding the net effect of derivatives on the risk profile of insurers, it seems premature to deny access to this potentially valuable risk management technique. Restricting derivatives could increase risk for some insurers now participating in derivatives markets and would reduce the ability of other insurers to access this source of risk management. The findings are also relevant in terms of reporting requirements imposed by state insurance regulators, the Financial Accounting Standards Board, and the Securities and Exchange Commission. More detailed and accurate reporting is likely to be beneficial in facilitating market monitoring of insurer derivatives activities. Such monitoring is likely to be much more effective than additional regulation in ensuring that derivatives are used to enhance insurance market efficiency rather than to increase market risk.

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