INTERNAL CAPITAL MARKETS IN THE INSURANCE INDUSTRY

by

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(Under the direction of David W. Sommer)

ABSTRACT

The dissertation investigates the relevance and efficiency of internal capital markets within insurance groups. Two primary questions are addressed. The first question is, are internal and external capital perfect substitutes? A simultaneous equations model is used to compare factors affecting demand for internal and external reinsurance. Results from the model present both structural and cost-based differences in demand for internal and external reinsurance. We conclude that internal reinsurance costs lest than external reinsurance. The second question is, are internal capital markets operating efficiently within insurance groups? Internal capital market activity is defined as that envisioned by Williamson (1975) where, within a multi-segment firm, each segment must compete for the firm's resources instead of automatically allocating cash flows back to their origin. An efficient internal capital market is defined following Shin and Stulz (1998), where a central governing authority reallocates capital within the group to affiliates with the best investment opportunities. Empirical tests explore the relationship between a firm's investment and changes in its capitalization from internal capital market transactions and other sources. Results are consistent with active and efficient internal capital markets operating within insurance groups.

INDEX WORDS: Internal Capital Markets, Reinsurance, Financial Intermediation

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CHAPTER 1

INTRODUCTION

1.1) Introduction

Internal capital markets may affect insurance groups in at least two ways. First, there could be differences in the costs of internal and external capital. If one group member has capital to spare and another needs capital, it may be less costly for the financially constrained insurer to acquire capital from an affiliate than from an external source. For example, Fazarri, Hubbard, and Petersen (1988) show that information asymmetry and agency costs drive a wedge between the costs of internal and external capital. Second, if a central governing authority of the group has increased incentives to monitor affiliates and reallocate capital to the members with the best investment opportunities (Gertner, Scharfstein, and Stein, 1994), then this could improve the overall performance of the group.

The dissertation develops and tests hypotheses regarding both aspects of internal capital markets in the insurance industry described above.

1.2) Major Questions and Outline of the Dissertation

The dissertation addresses two primary questions. The first question is, are internal and external capital perfect substitutes? A simultaneous equations model is used to compare factors affecting demand for internal and external reinsurance. Results from the model present both structural and cost-based differences in demand for internal and external reinsurance.

The second question is, are internal capital markets within insurance groups operating efficiently? Internal capital market activity is defined as that envisioned by Williamson (1975) where, within a multi-segment firm, each segment must compete for the firm's resources instead of automatically allocating cash flows back to their origin. We follow Shin and Stulz (1998) in defining internal capital market efficiency. The authors describe an efficient internal capital market as one where a corporate headquarters redeploys assets to the segments with the best investment opportunities. We conclude that internal capital markets within insurance groups operate efficiently during our sample period because we find a positive relationship between investment and internal capital market transactions.

1.2.1) Literature Review

Chapter two describes the theoretical foundations of the dissertation, and empirical tests that have been performed to test specific hypotheses. The chapter first describes hypotheses of demand for reinsurance, first offered by Mayers and Smith (1982). Then tests of theses hypotheses by Mayers and Smith (1990) and Garven and Lamm-Tennant (2000) are reviewed and results are interpreted. The focus then turns to internal sources of capital and internal capital markets. This section begins with Akerlof's (1970) "lemons" theory where asymmetric information is related to market inefficiency. Subsequent studies of capital structure within a single firm are then summarized. Internal capital markets literature is then highlighted from the earliest conceptualizations of internal capital markets by Alchain (1969) and Williamson (1975) up to more recent theoretical work by Gertner, Scharfstein, and Stein (1994), and Stein (1997). Empirical studies testing for internal capital market activity discussed in Chapter Two include Shin

and Stulz's (1998) effort using segment data from the Compustat universe of firms, Lamont's (1997) study of multi-segment firms participating in the oil industry, and a study of bank holding companies by Houston, James, and Marcus (1997).

1.2.2) Empirical Framework

Chapters Three and Four provide an empirical framework to analyze the implications of internal capital markets in the insurance industry. The analysis is divided into two studies, one presented in each chapter. Chapter Three compares demand for internal and external reinsurance. The fourth chapter tests the efficiency of internal capital markets among affiliated insurers.

Prior research has produced fairly consistent results concerning demand for reinsurance. However, no study has made the distinction between internal and external reinsurance explicit in empirical tests. Previous efforts have examined a sample period that predates the separation of internal and external reinsurance as recorded in the NAIC annual statement. Thus they have, for the most part, excluded affiliated insurers from their samples. Affiliated insurers write approximately ninety-three percent of insurance premiums, and cede ninety-eight percent of reinsurance premiums. Seventy-five percent of reinsurance transactions occur among affiliated insurers, we believe this distinction alone is worthy of investigation.

Separating internal and external reinsurance also affords us opportunities to compare internal and external sources of capital, and to test for internal capital market efficiency. Prior studies of internal capital market activity have borne consistent results as to the existence of internal capital markets, but results differ as to their relative importance and impact on firms. By examining insurance company data, the dissertation exploits a unique opportunity to test for internal capital market efficiency in financial intermediaries.

1.2.2.1) Chapter Three – Internal Capital Markets in the Insurance Industry: The Role of Reinsurance

Chapter Three simultaneously examines demand for external versus internal reinsurance. We choose to examine differences between internal and external reinsurance, as opposed to other internal capital market transactions, because reinsurance is the most uniformly and widely used instrument for transferring capital and risks across all types of insurance companies. On the other hand, availability of instruments such as surplus notes and equity are obviously not equal across the universe of insurers. Mutual insurers cannot issue equity, and stock insurers are less likely to use surplus notes because they can issue equity. The model treats demand for reinsurance from each source as endogenous. As in prior studies, factors hypothesized to affect demand for reinsurance include provisions in the United States tax code, transactions costs of bankruptcy, investment incentives, and reinsurers' advantages in real service production. This study contributes to finance literature by making a direct comparison between demand for capital from internal and external sources. It also extends previous studies on demand for insurance by focusing on a larger, more representative sample of insurance companies, and presenting differences in demand for reinsurance based on affiliation.

1.2.2.2) Chapter Four – Internal Capital Market Efficiency among Financial Intermediaries: Evidence from the Insurance Industry

Chapter Four investigates internal capital market transactions within insurance groups to determine if they are efficiently allocating capital to the affiliates with the best investment opportunities. First, we develop a model of insurance company investment and test the model empirically. Then we adjust the model to identify internal capital

market transactions. If an insurer's investment is positively related internal capital market transactions then the internal capital market is efficient. Otherwise we cannot reject the hypothesis that internal capital markets are subsidizing insurers that have performed poorly.

1.3) Key Findings

There are two sets of key findings in the dissertation. The first set, from Chapter Three, illustrates that internal and external reinsurance are not perfect substitutes. Some of these results also apply to the more general case of internal and external sources of capital. First we identify structural differences in demand for internal and external reinsurance. Several factors appear to affect demand for either internal reinsurance, or external reinsurance, but not both. These include the number of affiliates in the insurer's group (internal), and real service efficiencies (external). Another result in the chapter is consistent with information and agency problems driving a wedge between cost of internal and external capital. It appears that tax-related savings of reinsurance may be greater than the cost of internal reinsurance, but that external reinsurance includes loading costs that are greater than expected decreases in tax liabilities from purchasing reinsurance.

In Chapter Four we present evidence consistent with efficient internal capital markets within insurance groups. First we validate a model of insurance company investment. The model tests the relationships between investment and change in capitalization, and investment and change in exposure to underwriting risk. Results display a positive relationship between investment and change in capitalization, and a negative relationship between investment and change in exposure to underwriting risk. Then we separate

internal capital market transactions from other changes in capitalization. We find a positive relationship between investment and internal capital transactions. This is consistent with the definition of internal capital market efficiency used in the dissertation.

CHAPTER 2

PRIOR LITERATURE

2.1) Introduction:

Foundations of the dissertation lie in two areas of corporate finance literature: corporate demand for insurance and internal capital markets. This chapter describes studies from both areas that make the greatest contributions to the development of theory and empirical tests used in the dissertation. Section 2.2 presents Mayers and Smith's (1982) study on the corporate demand for insurance, as well as subsequent tests of their hypotheses using data on reinsurance purchases. Section 2.3 summarizes the literature pertaining to internal capital markets and internal sources of capital as they apply to the dissertation.

2.2) Demand for Insurance

2.2.1) Introduction

Insurance premiums can be split into two components, the pure premium, which is equal to the expected cost of losses, and a premium loading that includes the insurer's operating cost and a fair profit. The loading component indicates that premiums paid to an insurance company are greater than the expected value of claim payments an insured will receive. The willingness of individuals to pay a risk premium to purchase insurance can be explained by risk aversion. However, widely held corporations pay a significant portion of insurance premiums. The explanation for these insurance purchases is not as simple. A corporation is a nexus of contracts and should not inherently display risk

aversion. Owners of a corporation can hold diversified portfolios to hedge nonsystematic risk.

2.2.2) Corporate Demand for Insurance

Mayers and Smith (1982) analyze a set of incentives for the corporate purchase of insurance that are consistent with the modern theory of finance. Modigliani and Miller (1958) show that given investment policy in the absence of contracting costs and taxes a firm's financing policy is irrelevant. Therefore, if financing policy does impact firm value it does so via its effect on taxes, contracting costs, or the firm's investment decisions. The purchase of insurance is a method of financing future losses. Thus it may be considered part of the firm's financing decision. Mayers and Smith (1982) present seven potential explanations for the corporate purchase of insurance including: (1) optimal allocation of risk, (2) transactions costs of bankruptcy, (3) real service efficiencies, (4) monitoring, (5) bonding, (6) tax considerations, and (7) regulation.

Optimal risk shifting. Stockholders and bondholders have divisible claims to the firm and can diversify in well-organized secondary markets. Other parties such as employees, managers, customers, and suppliers hold claims on human capital and future income that may be more difficult to diversify. These parties are likely to charge a premium for bearing risk. If the risk premium is greater than the loading fee charged by the insurance company then buying insurance increases the value of the firm. The authors hypothesize that the greater the employees', customers', and suppliers' claim to the firm's output, the higher the probability that the firm will purchase insurance.

Transactions costs of bankruptcy. The process of declaring bankruptcy and liquidating a firm's assets involves significant transactions costs. A firm can reduce the

probability of incurring financial distress by purchasing insurance. Lowering the probability of financial distress obviously reduces the expected cost of bankruptcy. If the loading costs included in the insurance premium are less than the difference in expected bankruptcy costs with and without insurance then the purchase of insurance increases firm value. Warner (1977) shows that transactions costs of bankruptcy are less than proportional to firm size. Thus small firms may be more likely to purchase insurance for this reason.

Real service efficiencies. Insurance companies may have a comparative advantage in producing real services such as claims settlement, legal defense, and safety inspection because of economies of scale and gains from specialization. Firms with higher claims frequency may be more likely to purchase insurance to benefit from these real service efficiencies.

Insurance and monitoring. Jensen and Meckling (1976) and Fama (1980) discuss the conflict of interest between owners and managers of a firm. This conflict can provide a basis for the corporate demand for insurance. Owners' and managers' interests in the firm face different time horizons. The manager's working life with the firm is limited where as the owner's is indefinite. If managers are compensated based on accounting measures of performance they may choose to forego costly maintenance of safety measures. For example, they may be able to increase their expected wealth by neglecting maintenance on a fire sprinkler system, reaping immediate rewards in the form of lower costs, but increasing future costs of repairing the sprinkler or experiencing increased damage from an uncontrolled fire. If the insurer has a comparative advantage in monitoring maintenance on the sprinkler system, it may be less costly to both parties to

purchase insurance and allow the insurer to assume these duties. Based on this monitoring argument, firms in which managers are afforded the most discretion in decision-making should display a greater demand for insurance.

Insurance and bonding. Conflicts between equity-holders and debt-holders may also provide an explanation for corporate insurance purchases. Jensen and Meckling (1976), Myers (1977), and Smith and Warner (1979) indicate that actions available to the firm after bonds are sold can reduce the value of the bonds. When debt is issued to a firm creditors set a rate of return based on the risk of projects to be undertaken by the firm. If after receiving these funds the owners of the firm increase the risk of the firm's activities the value of the debt-holder's claim decreases. However, debt-holders are aware of equity-holders' incentive to increase risk after debt is issued, and they will factor this incentive into the cost of the debt. In this case it is to the benefit of both parties to bond owners of the firm to not increase risk after debt is issued. One way to prevent future increases in risk is to include insurance requirements in bond covenants. Requiring insurance reduces the owner's incentive to increase risk because insurance premiums would also increase. Insurance may also limit the financial effects of losses associated with the new risky activity. Based on this bonding argument, firms with the highest leverage should display increased demand for insurance.

Insurance and taxes. Provisions in the tax code provide explanations for the corporate purchase of insurance. Insurance premiums are immediately fully deductible from taxable income. The amount of large losses that may be deducted from taxable income is limited by restrictions on loss carry-forwards. Also, to the extent that

corporations face a convex tax schedule, stability of earnings provided by insurance can decrease expected tax liabilities.

Insurance and regulated industries. Regulated industries often require firms to purchase insurance, or provide an actuarial estimate of expected losses. Insurance companies may have a comparative advantage in actuarial forecasting, which would increase demand for insurance. Also, firms in regulated industries can pass loading costs directly through to the consumer.

2.2.2) Demand for Reinsurance

Mayers and Smith (1990) test some of the hypotheses for demand for insurance discussed above using data from reinsurance purchases. They also reform some of their previous hypotheses to apply to insurance companies' demand for reinsurance.

The authors form hypotheses concerning the effects of the tax code, expected bankruptcy costs, investment incentives, optimal risk sharing, and real service efficiencies on the demand for reinsurance.

One aspect of the tax code is especially relevant to insurance companies. Because insurers may deduct incurred losses from taxable income while investing in tax-exempt bonds they are more likely than firms in other industries to have expected income in the convex region of the tax schedule. Insurers with expected income in the convex region of the tax schedule, or insurers with more volatile pretax earnings are expected to display greater demand for reinsurance.

Expected costs of bankruptcy should be positively related to demand for reinsurance. Therefore, smaller insurers and insurers with more volatile cash flows should display greater demand for reinsurance.

Myers (1977) explains the underinvestment problem as it relates to a firm with risky debt in its capital structure. In some cases owners of a firm will forego positive net present value projects because any benefits of the project would accrue only to the firm's bondholders. Mayers and Smith (1987) demonstrate that insurance can control this underinvestment problem in certain situations. The same argument can be made for insurance companies purchase of reinsurance. Large unexpected losses could reduce the value of the insurer's equity as well as its outstanding promises to indemnify current policyholders. In this case a positive net present value project might be rejected because benefits would only accrue to existing policyholders. By purchasing reinsurance the insurer can transfer some of the risk of absorbing a large unexpected loss.

Evidence supporting the optimal risk-sharing hypothesis may be found in comparing reinsurance purchases across various ownership structures of insurance companies. Closely held insurers may demand reinsurance because the owners are risk averse. Ownership forms allowing more managerial discretion may demand reinsurance to more effectively monitor managers. Mayers and Smith use hand-collected data on the ownership structure and concentration of 1,276 insurance companies to test these hypotheses.

Reinsurance firms routinely provide a set of services to ceding insurers related to ratemaking and claims settlement. These services are likely to represent greater value to small insurers and insurers that are well diversified geographically or across lines of business.

The insurer characteristics measured by Mayers and Smith (1990) include size, business concentration, geographic concentration, ownership structure, default risk, and

business mix. Size is expected to affect demand for insurance through taxes, expected bankruptcy costs, investment incentives, and real-service efficiencies. They measure insurer size by the natural logarithm of total admitted assets. Line of business concentration should be negatively related to demand for a reinsurer's real-service efficiencies. The effect of business concentration on earnings volatility depends on the line in which the insurer is concentrated. Thus the impact of business concentration on demand for reinsurance is ambiguous. The authors measure line of business concentration by the Herfindahl index of concentration across lines of business. Geographic concentration could increase the volatility of pretax earnings, increase the volatility of firm value, or decrease the value of real services provided by the reinsurer. It follows that tax, expected bankruptcy costs, and investment incentives all imply a positive relationship between concentration and demand for reinsurance, where as the real services argument implies a negative relationship. The negative of the number of states in which the insurer is licensed measures geographic concentration. The authors control for ownership structure using dummy variables to identify insurers based on organizational form (stock, mutual, Lloyds, and reciprocal), and another set of dummies to classify stock companies as owned by a single family, closely held (less than 100 shareholders), or widely held (more than 100 shareholders). They also indicate if the insurer is affiliated with an insurance group. They use the company's A.M. Best rating to proxy for default risk. Finally, they control for variation in demand for reinsurance across lines by including each company's percentage of direct premiums written in each of 23 lines of insurance.

Results from cross sectional analysis provide evidence that size, credit standing, geographic concentration, and line of business concentration reduce demand for reinsurance. Their estimated negative effect of concentration suggests that the real-services argument in quantitatively important. They find that diversification of the owners' portfolios is negatively related to demand for reinsurance. The authors list as limitations of their study that, (1) their data do not distinguish between internal and external reinsurance, (2) they cannot directly observe insurers' tax liabilities, and (3) they cannot accurately account for within-line policy heterogeneity.

Garven and Lamm-Tennant (2000) model the insurance company in an explicit options framework and test hypotheses on an insurer's demand for reinsurance. They focus on four hypotheses based on the option-pricing model, but also find results consistent with Mayers and Smith (1990) in their control variables.

Comparative statics of the model suggest that the demand for reinsurance will be greater, (1) the higher the insurer's leverage, (2) the lower the correlation between the insurer's investment returns and claims-costs, (3) for insurers that write "longer-tail" lines of insurance, and (4) the more the firm concentrates its investments in tax-favored assets.

The first hypothesis reflects the fact that increasing reinsurance ceded has the same effect on an insurer's leverage as increasing surplus. Both actions effectively decrease financial leverage. A highly levered insurer faces greater probabilities of insolvency and tax-shield underutilization. Leverage is measured by the ratio of direct premiums written to surplus.

Lower correlation between investment-returns and claim-costs represents a natural hedge for insurers that retain both risks. By reinsuring the natural hedge may be destroyed. Destroying this natural hedge increases the variances of pre-tax income and taxable income, which in turn increases the government's expected claim to the insurer's assets. Correlation between investment returns and claim costs (*RHO*) is estimated using a measure similar to Cummins and Sommer (1996).

The third hypothesis is also related to the insurer's leverage. The authors argue that writing long-tail lines of insurance increases the insurer's premium to surplus ratio, which may increase demand for reinsurance. They use percentage of direct premiums written in liability lines as a proxy for business written in long-tail lines.

The fourth hypothesis is the most relevant to the dissertation. Insurers may deduct incurred losses from pre-tax income. Large unexpected losses may more than offset an insurer's earned premium income. In this case the insurer would not be able to fully recognize the tax shield provided by investing in tax-favored assets. Because after-tax certainty-equivalent returns must be equal across all securities, the chance of not being able to recognize the tax shield reduces the value of tax-favored securities. The purchase of reinsurance reduces the probability of experiencing a large unexpected loss.

Garven and Lamm-Tennant (2000) present evidence consistent with the first three hypotheses, but do not find evidence to support their hypothesis that investment in tax favored assets increases demand for external reinsurance.

The two studies discussed above do not separate internal and external reinsurance. Mayers and Smith (1990) use a dummy variable equal to one if the insurer is a group member to control for affiliation. As a robustness test they also test their hypotheses on a

sub-sample of unaffiliated insurers. Garven and Lamm-Tennant (2000) exclude affiliated insurers from their sample.

2.3) Internal Capital Markets

2.3.1) Introduction

Alchain (1969) and Williamson (1975) were among the first to consider the concept of internal capital markets. In Williamson's description of an internal capital market, cash flows in the M-form firm are not automatically returned to their sources, but instead are allocated to the segments of the firm with the best investment opportunities. This concept of an internal capital market is consistent with that considered in the dissertation. Alchian (1969) and Williamson (1975) argue that internal capital markets mitigate information and agency costs associated with external sources of capital. In these studies corporate headquarters are assumed to have comparative advantages in information production and reallocation of assets. Gertner, Scharfstein, and Stein (1994) present a framework for analyzing the costs and benefits of internal versus external capital allocation where advantages or disadvantages of internal capital markets are a product of increased monitoring incentives created by headquarters' residual claim to the firm's assets. Although the aforementioned studies offer conflicting theories on the genesis or existence of advantages of internal capital markets, they share an underlying hypothesis that if multi-segment firms operate as internal capital markets they could realize gains from such activity.

2.3.2) Internal versus External Sources of Capital

In a perfect capital market internal and external sources of capital are perfect substitutes. In such an environment a firm's investment decisions are independent of its

financial condition. Observed capital markets appear to face several imperfections that may drive a wedge between the costs of internal and external funds. Among the most prominent factors explaining firms' observed preferences for internal finance over new share issues and debt finance are transaction costs, tax advantages, agency problems, cost of financial distress, and asymmetric information (Fazzari, *et al*., 1988). Akerlof (1970) was the first to consider the "lemons" problem where some sellers with inside information about the quality of an asset will be unwilling to accept the terms offered by a less informed buyer. This may force the sale of an asset at a price lower than it would command if all buyers and sellers had full information. The "pecking order" or "financial hierarchy" theories, first introduced by Myers and Majluf (1984), Myers (1984), and Greenwald, Stiglitz, and Weiss (1984), apply the asymmetric information argument to choices among internal finance, debt finance, and issuing new equity. In the Myers and Majluf (1984) model, managers are assumed to have perfect information about the value of the firm's existing assets and investment opportunities, while external investors cannot distinguish the quality of firms. External investors value all firms at the population average. In this model new shareholders will demand a premium to purchase shares of relatively good firms to offset the losses that arise from funding lemons. This premium may raise the cost of issuing new equity for high quality firms above the opportunity cost of internal finance faced by existing shareholders. Fazzari, Hubbard, and Petersen (1988) present empirical evidence that asymmetric information makes it costly for providers of external finance to evaluate the quality of a firm's investment opportunities. As a result, the cost of new debt and equity may differ substantially from

the opportunity cost of internal finance generated through cash flow and retained earnings. In this situation internal and external capital are not perfect substitutes.

2.3.3) Internal Capital Market Activity and Efficiency

Recent studies on internal capital markets have focused on two basic questions: Do diversified firms act as internal capital markets? And, are internal capital markets efficient? Houston, James, and Marcus (1997) address the first question empirically using data from bank holding companies. They find that subsidiary loan growth (a proxy for investment in banks) is more sensitive to the holding company's cash flow and capital position than to the subsidiary's own cash flow and capital. They also find that bank loan growth is negatively correlated with loan growth among other subsidiaries in the holding company. They interpret this evidence as suggesting that bank holding companies establish internal capital markets to allocate capital among subsidiaries. Lamont (1997) comes to similar conclusions based on data from a natural experiment in the oil industry. In 1986 oil prices dropped abruptly and significantly. The author finds evidence consistent with non-oil subsidiaries of oil companies subsidizing the capital-constrained oil segments following this price shock.

Shin and Stulz (1998) address both questions using segment information from Compustat. They hypothesize that if diversified firms are operating as internal capital markets then the investment of a segment will be related to the cash flows of the rest of the firm in addition to the cash flows of the segment. They find that investment at the segment level is positively related to cash flows of both the segment and the rest of the firm, but that a segment's investment is significantly more dependent upon the segment's own cash flows. The authors define an efficient internal capital market as one where

assets are reallocated to segments with the best investment opportunities. Using the Tobin's *q* of the segment's industry as a proxy for quality of investment opportunities they find that the sensitivity of a segment's investment to the cash flows of other segments does not depend on the quality of its investment opportunities. Based on this evidence the authors conclude that internal capital markets play a significant yet limited role in diversified firms, but they do not find compelling evidence that internal capital markets allocate capital efficiently.

Houston, James and Marcus (1997) point out an important distinction between their study of internal capital markets and the others mentioned above. It is based on the industry in which their sample participates, financial intermediation. Stein (1997) speculates that incentives to establish internal capital markets may be strongest among firms that are narrowly focused and whose assets present difficulty in valuation. Financial intermediaries display both of these characteristics. Most would agree that financial intermediaries play an important role in mitigating capital market frictions, including information problems, that make external financing costly. It follows intuitively that a financial intermediary's assets may be difficult for outside investors to value. Diamond (1984) offers that financial intermediation may create an additional layer of agency problems, which creates the need for contracts and institutions to 'monitor the monitor'. For example, when a bank makes a loan it designs the terms of the loan based on its proprietary knowledge of the borrower. Those outside the bank, without the privilege of this information, may find it difficult to make an accurate evaluation of the bank's merits as borrower. Insurance companies face a very similar issue. An insurer's role as a financial intermediary is borne out of its liabilities. This

may be most easily explained via a comparison to banking versus insurance operations. Banks lend money in return for the borrower's promise to repay the loan. Insurers do nearly the opposite. An insurer essentially borrows policyholders' funds in return for its promise to make payments in the event of a covered loss. It follows that insurers assimilate proprietary information involving their liabilities that may affect outsiders' ability to value an insurer, similar to the situation faced by other financial intermediaries.

2.4) Conclusions

The preceding sections describe prior literature related to the main topics of the dissertation. There are several hypotheses on the demand for reinsurance for which empirical support is consistent across existing studies. These include expected transactions costs of bankruptcy, investment incentives, and real service efficiencies. Evidence supporting the existence of internal capital markets is also consistent, although results across studies differ with respect to their relative importance and efficiency. It is obvious that the separation of internal and external sources of reinsurance will expand on and complement prior studies on the demand for reinsurance. This distinction also provides opportunities to test hypotheses regarding internal versus external sources of capital, and internal capital market activity.

Others have speculated that financial intermediaries, such as insurance companies, present several characteristics conducive to the establishment of internal capital markets. Therefore, the insurance company may be an ideal platform for observing and testing theories of capital structure and internal capital market activity. Subsequently, Chapter Three investigates insurers' preference between internal and external sources of capital, and Chapter Four tests for internal capital market efficiency among affiliated insurers.

CHAPTER 3

INTERNAL VERSUS EXTERNAL CAPITAL MARKETS IN THE INSURANCE INDUSTRY: THE ROLE OF REINSURANCE

3.1) Introduction:

Insurance firms are often affiliated as members of an insurance group. In 1997, 1724 out of 2740 U.S. property casualty insurance companies are affiliated with insurance groups. These 1724 group members accounted for ninety-one percent of industry direct written premiums in that year. The use of reinsurance contracts among affiliated insurers may represent an internal capital market. Our data shows reinsurance activity within insurance groups to be a common practice. In 1997, almost $150 billion were exchanged within property casualty insurance groups as reinsurance premiums. Roughly seventy-five percent of reinsurance activity (by premium volume) occurs within groups rather than between group members and unaffiliated external reinsurers, and ninety-eight percent of reinsurance premiums ceded are ceded by affiliated insurers.

Previous studies have tried to determine factors influencing the demand for reinsurance. Mayers and Smith (1982, 1990) propose hypotheses about the demand for insurance and subsequently test these hypotheses using data from the insurance industry. They contend the purchase of reinsurance by an insurance company is comparable to the purchase of insurance by firms in other industries. In their study, internal and external reinsurance are not separated.[1] Mayers and Smith (1990) find results that one would not

[1] As a robustness check, Mayers and Smith (1990) use a subsample of single unaffiliated insurers.

expect to hold for intra-group reinsurance. Garven and Lamm-Tennant (2000) examine the demand for reinsurance from a capital-structure perspective, but only include unaffiliated insurers in their sample, which represent a small, unrepresentative segment of the industry.

This study simultaneously examines demand for internal and external reinsurance. External reinsurance activity is measured as reinsurance ceded to non-affiliates divided by the sum of direct premiums written and reinsurance assumed (Mayers and Smith, 1990). Our measure for internal reinsurance substitutes reinsurance ceded to affiliates net of reinsurance assumed from affiliates in the numerator.[2] The analysis will be performed using internal capital markets theory to develop predictions. First, this will serve as a test of whether the results of previous literature, which treated internal and external reinsurance the same or looked only at single unaffiliated insurers, hold up when the data is refined so that internal and external reinsurance are disaggregated. Second, this paper will be able to determine whether the factors that influence internal reinsurance purchases differ from those factors that influence external reinsurance. In so doing, the paper will shed light on the issue of internal versus external capital markets, an issue that is only beginning to be explored in the insurance industry.

This research is of potential interest to parties both inside and outside of the insurance industry. The importance of reinsurance in the industry is without question. However, despite the fact that the majority of reinsurance transactions occur between group members rather than with external reinsurers, to our knowledge no previous research has ever explored the topic of intra-group reinsurance. More broadly, analyzing internal

[2] This adjustment is necessary to appropriately capture some of the differences between internal and external reinsurance discussed below.

reinsurance along with external reinsurance provides a unique opportunity to explore issues related to the general finance topic of internal capital markets.

3.2) Hypotheses Development and Description of Variables

Reinsurance Activity. The majority of insurance company liabilities consist of expected claim payments to policyholders. These claim payments are contingent on the joint occurrence of the policyholder experiencing a covered loss, and the insurer having adequate resources to meet its contractual obligation. Therefore, insurers must demonstrate the financial capacity to pay claims. This can be accomplished by holding adequate surplus or by purchasing reinsurance, a method of transferring layers or percentages of a risk to another insurer. By purchasing reinsurance an insurer effectively reduces its leverage, implying that the purchase of reinsurance is a capital structure decision.

Previous studies have contributed to a theory of demand for reinsurance and tested several of the hypotheses presented. Demand for reinsurance may be a function of the structure of the tax code, expected costs of financial distress, the insurer's ownership structure, investment incentives, and comparative advantages in real service production, among other factors. In these studies, reinsurance supply is not mentioned.

The demand for reinsurance has received considerably more attention than supply of reinsurance in academic studies because demand for firm specific risk reduction expenditures is a phenomenon not easily explained. Because the owners of corporations can reduce firm specific risk by holding a diversified portfolio, firms should not be risk averse. Thus, the literature has tried to explain the corporation's purchase of insurance by examining the factors listed above. Several of these studies have used data on the

purchase of reinsurance by insurance companies to examine the firm's demand for insurance.

Obviously, the decision to purchase any good in a competitive market involves consideration of both supply and demand. In previous studies, supply of reinsurance is not mentioned. It is important to note that several of the characteristics used below to proxy for factors affecting the insurers' demand for reinsurance would also affect the supply of reinsurance. Phifer (1996) offers leverage, size, default risk, and expertise in underwriting and claims handling as factors that would affect the cost of reinsurance for an insurance company. We assume throughout this paper that the decision to purchase reinsurance is based on the equilibrium price available to the insurer. In our model, we also control for the capacity constraints applying to internal reinsurance transactions and some of the group and insurer level characteristics that are most likely to affect the loading costs in external reinsurance transactions (see section 3.3.1 for further explanation).

Our measure of external reinsurance activity (*External Reinsurance*) is consistent with that used by Mayers and Smith (1990) and Garven and Lamm-Tennant (2000); namely, the ratio of reinsurance ceded externally to premiums written (direct and assumed). Our measure of internal reinsurance activity (*Internal Reinsurance*) is a net reinsurance measure. It uses net internal reinsurance ceded (reinsurance ceded net of reinsurance assumed) in the numerator. The adjustment is necessary because this study is concerned with how capital is shared among members within a group. A net measure of

external reinsurance activity would not be appropriate because unaffiliated companies do not share the common goal of maximizing a group's value.[3]

Taxes. Provisions in the United States Tax Code may play a role in an insurer's decision to purchase reinsurance. Insurance firms are likely to be on the convex portion of the tax schedule. In 1997 nearly 84% of firms reported taxable earnings on the portion of the tax function that is likely to be convex.[4] Mayers and Smith (1982, 1990) point out that the purchase of reinsurance can lower the volatility of an insurer's pretax earnings thereby decreasing its expected tax liability. The authors also note that insurance groups may use internal reinsurance to distribute profits among group members to minimize the group's total expected tax liability.

Garven & Lamm-Tennant (2000) offer the following hypothesis regarding taxes: "Other things equal, the demand for reinsurance will be greater for firms that concentrate their investments in tax favored assets." Insurers may deduct incurred losses from pre-tax income. Large unexpected losses may more than offset an insurer's earned premium income. In this case the insurer would not be able to fully recognize the tax shield provided by the tax-favored asset. Because after-tax certainty-equivalent returns must be equal across all securities, the chance of not being able to recognize the tax shield reduces the value of tax-favored securities. The purchase of reinsurance reduces the probability of experiencing a large unexpected loss. Garven and Lamm-Tennant (2000) do not find evidence to support the hypothesis that investment in tax favored assets increases demand for external reinsurance.

[3] As a robustness test we re-estimate our models presented in the following sections using alternative specifications of the dependent variables. We apply net measures of both internal and external reinsurance, and measures of only reinsurance ceded. Results are qualitatively similar across all models.

We expand on the Garven and Lamm-Tennant tax hypothesis as follows: if internal reinsurance costs less than external reinsurance, this difference may be great enough to make the cost of internal reinsurance less than the expected cost of not realizing the tax shield on these investments even if the cost of external reinsurance is greater than the expected tax savings. This result would support Mayers and Smith's more general hypothesis that provisions in the tax code affect insurers' demand for reinsurance. Furthermore, it would be consistent with the hypothesis that information and agency problems increase the cost of external capital relative to internal capital.

We estimate the ratio of tax-exempt investment income to total investment income (*Tax-Exempt Investment Income*) as follows. Tax-exempt investment income equals bond interest exempt from federal taxes plus seventy percent of dividends on common and preferred stock. This calculation is similar to that used by D'Arcy and Garven (1990) and Garven and Lamm-Tennant (2000), but it is adjusted to reflect changes in the tax code since 1987. The seventy percent multiplier for dividends is a conservative estimate because, according to IRS form 1120pc, property-casualty insurers may deduct eighty percent of dividend income received from a company of which it owns at least twenty percent. We chose the seventy percent measure because we have limited information about insurers' ownership share of non-insurance firms, and the lower percentage biases against our expected result. This method also partially mitigates the unobservable cost of the Alternative Minimum Tax. Similar results were calculated by assuming dividends from affiliates were in the twenty percent ownership classification.

[4] According to IRS form 1120pc the federal income tax schedule for property-casualty insurers becomes a linear function for income in excess of $18,333,333. This number must be considered a rough estimate because it does not fully account for implications of the Alternative Minimum Tax introduced in 1986.

Expected cost of bankruptcy. If the loading costs in a reinsurance agreement are less than the expected transaction costs involved in bankruptcy, an insurer can increase its value by shifting risk to a reinsurer to decrease its probability of insolvency. Warner (1977) provides evidence that bankruptcy costs are less than proportional to firm size.

Mayers and Smith (1990) and Garven and Lamm-Tennent (2000) find evidence of an inverse relationship between firm size and the demand for external reinsurance, consistent with the bankruptcy cost hypothesis. We also expect larger firms to demand less reinsurance. We measure firm size by the natural logarithm of total admitted assets gross of reinsurance transactions.

Default risk. The quality of insurance products is a negative function of the insurer's default risk. Sommer (1996) finds evidence that policyholders will pay higher premiums to be insured by less risky insurers. This provides an additional incentive for insurers to reduce default risk by purchasing reinsurance. Mayers and Smith (1990) use A.M. Best insurer ratings as a proxy for default risk. Because A.M. Best considers reinsurance in their financial strength rating, and thus the rating already reflects reinsurance transactions, we use alternative measures of default risk. All else equal, insurers with more assets and less financial leverage are less likely to become insolvent. Sommer (1996) finds evidence that consumers pay higher prices to be insured by companies with more total assets and less financial leverage. Cummins, Harrington, and Klein (1995) find that smaller insurers are more likely to become insolvent. BarNiv and Hershbarger (1990) and Carson and Hoyt (1995) find that insurers with higher financial leverage have greater risk of insolvency. We use size and leverage measures gross of reinsurance

transactions as measures of default risk prior to reinsurance transactions. We expect a positive relationship between an insurer's default risk and demand for reinsurance.

Investment incentives. Myers (1977) shows that firms may have incentives to forego valuable investment opportunities. In some circumstances, with risky debt in the capital structure, taking a positive net present value (NPV) project makes stockholders worse off because the benefits accrue to the bondholders. Bondholders anticipate the owner's incentive and factor this situation into the rate of return they demand for debt. Both parties can be made better off if the owner can bond itself against such investment activity. Mayers and Smith (1987) show that the purchase of insurance can control this underinvestment problem by softening the impact of large unexpected losses.

Policyholders have a claim to the insurance company's assets similar to debt-holders in other firms. Large unexpected losses may cause equity-holders of an insurance company to reject a positive NPV project because the benefits would accrue primarily to the policyholders. By purchasing reinsurance an insurer can transfer the risk of large unexpected losses, reducing the expected cost of foregoing valuable projects. In an insurance company with higher leverage, policyholders have a proportionally greater claim to the company's assets. This increases the probability of foregoing valuable projects because returns will primarily benefit policyholders rather than owners. Thus we expect insurers with higher leverage to demand more reinsurance because of investment incentives. Our measure of insurer financial leverage (*Leverage*) is the ratio of total liabilities to total assets, gross of reinsurance transactions.

There are two factors we expect to affect demand for either internal or external reinsurance, but not both. They are the number of affiliates in a group, and real service efficiencies.

Number of affiliates. In our sample the number of affiliated property-liability insurers in a given group ranges from two to fifty-two. This may affect the amount of internal reinsurance ceded by a company in at least three ways. First, if each affiliate specializes in a different type or types of insurance (based on line of business, geographic location, or commission schedule) then the companies might reinsure internally to spread the risks evenly across the group based on financial capacity.

Second, a group of insurers represents a portfolio of options, while an unaffiliated insurer represents an option on a portfolio. From the insurer's standpoint an option on a portfolio is worth less than a portfolio of options because in the latter case the insurer has the ability to exercise each option individually (Cummins and Sommer, 1996). In this case individual exercise would be allowing one company to fail while the others remain solvent. Through put-call parity it can be shown that this decreases the value of insurance to the insured and, all else equal, the insured will prefer the same coverage written by an unaffiliated insurer. Therefore, the insurance group has an incentive to bond itself not to exercise its options individually. One way this can be accomplished is by linking the survival of the group's members via a nexus of internal reinsurance contracts.

Finally, it may be the case that an insurer with more affiliates faces a greater supply of internal reinsurance. Thus, we expect insurers with a greater number of affiliates to cede more internal reinsurance. Our proxy for the number of affiliates in an insurer's

group (*Number of Affiliates*) is the natural logarithm of the number of affiliates in its group.

Real service efficiencies. Mayers and Smith (1982, 1990) offer comparative advantages in real service production as a factor influencing the demand for reinsurance. They measure the benefit of real services by the geographic concentration and line of business concentration of risks insured. If risks covered by an insurer are spread across regions and lines of business they may benefit more from a reinsurer's expertise or infrastructure in a given area or line. If a reinsurer has valuable expertise in real services such as claims handling or insurance pricing, an insurer may choose to enter into a reinsurance contract to gain access to those services. This argument obviously applies to external reinsurance, but not to internal reinsurance. If sharing these services can add value to the group, these services should be shared among members of the group without need for a reinsurance contract. It may also be the case that, within a group of insurers, the best way to share these comparative advantages in real service production is for the advantaged insurer to write the business directly then cede some of the exposure back to other members of the group to increase capacity. This scenario cannot be envisioned for external reinsurance transactions due to obvious incentive problems. The authors also note other possible implications of geographic and line of business concentration pertaining to expected bankruptcy costs and taxes. If an insurer's exposures are concentrated geographically they are more likely to be affected by the same catastrophic event, resulting in a large unexpected loss. Thus the two arguments pertaining to concentration lead to conflicting expected signs. Mayers and Smith (1990) find geographic concentration and line of business concentration to be negatively related to

demand for external reinsurance. They conclude that the real-services incentive for purchasing reinsurance is quantitatively more important than the reduction in expected tax payments and bankruptcy costs to be gained through geographic diversification. If this is true then we anticipate the same result for our measure of geographic concentration in the equation for external reinsurance, but not for internal reinsurance. We measure geographic concentration (*Geographic Concentration*) by the Herfindahl index of direct premiums written in each state. We measure line-of-business concentration (*Line-of-Business Concentration*) by the Herfindahl index of premiums written across lines of business.

An alternative explanation of Mayers and Smith's result is that insurers writing business in a concentrated area participate in lines of insurance with less exposure to a common catastrophic loss. For example, geographic concentration will present substantial catastrophe exposure if the insurer is writing property coverage; however, the same is not true for an insurer writing liability coverage. Geographic concentration as a measure of catastrophe risk may also depend on the region in which the coverage is concentrated. Eastern coastal states face a significant risk from hurricanes, not realized by land-locked regions. Also, regions located on a fault line are subject to increased earthquake exposure. Damages from hurricanes and earthquakes represent the largest insured losses in history (Property-Casualty Insurance Fact Book, 1997). We measure exposure to catastrophic losses (*Catastrophe Exposure*) using the ratio of each insurer's direct premiums written for property coverage in eastern coastal states and earthquake coverage in California to total direct premiums (Gron, 1999). We expect demand for internal and external reinsurance both to be positively related to catastrophe exposure, but

only demand for external reinsurance should be related to geographic concentration, especially when controlling for catastrophe exposure.

Corporate finance literature seeks to explain how corporations choose their capital structure. Many of the existing studies focus on capital sources that are external to the firm such as debt and equity. Some focus on the single firm's preferences among various sources of capital used to fund projects (Myers, 1984, Myers and Majluf, 1984, Greenwald, Stiglitz, and Weiss, 1984). Fazzari, Hubbard, and Petersen (1988) show that information asymmetries between recipients and providers of capital increase the cost of external capital relative to the cost of internal capital. Others investigate internal capital markets in which a corporate headquarters allocates capital among members of a conglomerate. Several studies present hypotheses of costs and benefits of internal capital markets. Alchian (1969), Williamson (1975), and Gertner, Scharfstein, and Stein (1994) progress to a theory where consequences of internal and external capital markets differ by relative effects of asymmetric information and agency problems. More specifically, internal capital markets may be associated with decreased information asymmetries, increased monitoring incentives, decreased managers' entrepreneurial incentives, and more efficient redeployment of assets. If these factors do not affect the cost of capital, or do not differ between internal and external sources of capital, then internal and external reinsurance will be perfect substitutes.

Organizational form. Mayers and Smith (1990) find organizational form is an important factor in the demand for reinsurance. Our sample includes 515 mutual insurers, 84 reciprocal insurers, 136 Lloyd's associations, and 4027 stock insurers. The owners of mutual and reciprocal companies are their policyholders. Equity holders retain

the residual rights to a stock company. Lloyd's associations are made up of individuals, called names, who in many cases retain unlimited personal liability for risks insured.[5] We control for organizational form using dummy variables to classify insurers as stock, mutual, reciprocal, or Lloyd's associations.

Lines of business. Some lines of insurance present significantly different risks based on expected size, timing, and volatility of cash flows. It follows that these differences among lines would affect an insurer's demand for reinsurance. Mayers and Smith (1990) note significant improvement in their model's explanatory power when they control for the insurer's business mix. Similar to Mayers and Smith (1990) we control for business mix by including the percentage of direct premiums written in each line for each insurer.[6] Mayers and Smith (1990) comment that one limitation of their data is that direct premiums written by line of business do not account for within-line policy heterogeneity. For example, NAIC data does not differentiate among homeowners policies, even though the risk insured by a homeowners policy (from wind and hail) in Florida is significantly greater than a policy insuring an identical home in Kansas. We attempt to partially account for these differences by adding the proxy for catastrophe exposure discussed above.

Information asymmetry. Information asymmetry between recipients and providers of capital will increase the cost of capital in the presence of incentive conflicts between the two parties.[7] Such asymmetric information is likely to increase transaction costs involved in correctly assessing the recipient's characteristics. One way to mitigate this agency cost

[5] In recent years some Lloyd's associations have included corporate capital.
[6] We omit one line, commercial multiple peril, to avoid singularity in the model. This line is chosen arbitrarily. Results do not change significantly when other lines are omitted.
[7] See Myers and Majluf (1984) and Fazzari *et al*. (1988)

is to remove the incentive conflict by combining the two parties, as is the case with internal sources of capital, or with internal capital markets. Our proxy for asymmetric information, *Publicly Traded*, is a dummy variable equal to one if the insurer is publicly traded, or belongs to a group or holding company that is publicly traded. We assume that information asymmetry between the insurer and an external party is lower for publicly traded firms due to disclosure requirements and the efforts of analysts who follow these firms (Pottier and Sommer, 1999). While each firm does not have its own ticker symbol, it should be examined by regulators and analysts in the process of assessing the publicly traded entity. It is important to note that although we are using *Publicly Traded* to proxy for improved information, Mayers and Smith (1982, 1990) hypothesize that a widely held firm is less averse to nonsystematic risk because its owners can hold diversified portfolios. Publicly traded firms are likely to be widely held. Therefore, the anticipated sign on this coefficient is ambiguous. We expect that *Publicly Traded* will have an impact on external reinsurance due to information asymmetry, but there should be no direct relation between *Publicly Traded* and *Internal Reinsurance* except for the indirect effect it has through its impact on *External Reinsurance*.

Group characteristics. The size of member companies is not consistent across groups. While the size of the company may affect its *demand* for reinsurance, the size of the company relative to the rest of its group may affect the *supply* of reinsurance available to the company. In the case of internal reinsurance supply may be dictated by capacity. If the company is large relative to the rest of its group, its affiliates may not be able to reinsure a large percentage of the company's direct written premiums. In the case of external reinsurance, size is likely to affect the price the company must pay for

reinsurance. Reinsurers consider company level factors in pricing reinsurance. All else equal, insurers with more assets are likely to be charged lesser premiums for reinsurance (Phifer, 1996). In an efficient internal capital market the insurer that can acquire external capital at the lowest cost should do so on behalf of the rest of the group. We control for these differences across groups with the ratio of the company's total assets to the total assets of the rest of the group net of that company (*Company-to-Group Size Ratio*).

Table 3-1: Summary of Hypotheses and Variables:

Hypothesis One: Larger insurers will demand less reinsurance.

Measure: *Size* = Natural logarithm of total assets.

Expected Sign: (-)

Hypothesis Two: Highly levered insurers will demand more reinsurance.

Measure: *Leverage* = Gross Liabilities / Gross Assets.

Expected Sign: (+)

Hypothesis Three: Insurers with greater exposure to catastrophic losses will demand more reinsurance.

Measure: *Catastrophe Exposure* = Proportion of direct premiums written by insurer j in property insurance lines in coastal states and earthquake coverage in California.

Expected Sign: (+)

Hypothesis Four: Insurers demand external reinsurance to utilize a reinsurer's comparative advantage in real service production.

Measures:

Geographic Concentration = Herfindahl index of premiums written across states.

Expected Sign: (-) only for external reinsurance.

Line-of-Business Concentration = Herfindahl index of premiums written across lines of business.

Expected Sign: (-) only for external reinsurance.

Hypothesis Five: Use of internal reinsurance will increase with the number of affiliates in an insurer's group.

Measure: *Number of Affiliates* = The natural logarithm of the number of companies in the insurer's group

Expected Sign: (+) only for internal reinsurance.

3.3) Data and Empirical Tests

3.3.1) Description of Sample and Summary Statistics

Table 3-2 displays descriptive statistics for our sample. Table 3-3 includes a correlation matrix of the key variables used in empirical tests. Company level data for insurers for data years 1996 through 1999 are from the National Association of Insurance Commissioners (NAIC). 9728 observations of active insurance companies were reported to the NAIC during the four-year sample period. 6456 were affiliated with at least one other property-casualty insurer. The ideal sample for this study includes active insurers that write direct business then have the opportunity to cede some portion of direct premiums to another insurer that may be in its group. We exclude insurers that reported non-positive numbers for direct written premiums or total assets. Another step in our sample selection process was to exclude insurers reporting extraordinary or incomplete figures for our dependent variables. Some insurers report a value greater than one for one of the dependent variables, indicating premiums ceded were greater than the sum of premiums written and assumed. Mayers and Smith (1990) attribute this phenomenon to an insurer's decision to exit from a line of business, or a geographic region, because it has stopped issuing new policies, but reinsures policies still in force. We believe it is appropriate to exclude these observations because they represent extraordinary operating characteristics. We then recalculate the number of affiliates in each group. Insurers left without any affiliates are excluded. Finally, obvious outliers are identified and removed based on examination of studentized residuals. Our final sample includes 4762 affiliated insurer observations. These insurers wrote eighty-two percent of the industry's total

premiums written during the sample period, and eighty-six percent of premiums written by affiliated insurers.

Table 3-2: Description of Sample

Company Form	Observations
Mutual	515
Reciprocal	84
Lloyd's	136
Stock	4027
Publicly-Traded*	2275
Total	4762

Descriptive Statistics:

	Mean	Median	Standard Deviation
Internal Reinsurance	0.2262	0.0707	0.5188
External Reinsurance	0.1026	0.0172	0.1813
Company to Group Size Ratio	0.6141	0.0690	1.5044
Company Size	18.7460	18.6077	1.7963
Leverage	0.6880	0.7385	0.2174
Tax-Exempt Investment Income	0.2696	0.1943	0.2668
Line-of-Business Concentration	0.4478	0.3821	0.2606
Geographic Concentration	0.4973	0.3984	0.3737
Catastrophe Exposure	0.0339	0.0000	0.1303
Number of Affiliates	14.3325	8.0000	13.2620

*Publicly-traded is the sub-sample of stock insurers that are traded on public equity exchanges.

Table 3-3: Correlation Matrix

	Internal Reinsurance	*External Reinsurance*	*Company-to-Group Size Ratio*	*Size*	*Number of Affiliates*	*Leverage*	*Tax-Exempt Investment Income*	*Line-of-Business Concentration*	*Geographic Concentration*	*Catastrophe Exposure*	*Publicly Traded*
External Reinsurance	-0.210	1.000									
Company-to-Group Size Ratio	-0.203	0.190	1.000								
Size	-0.247	0.012*	0.206	1.000							
Number of Affiliates	0.133	-0.170	-0.302	0.257	1.000						
Leverage	0.139	-0.013*	-0.052	0.351	0.208	1.000					
Tax-Exempt Investment Income	0.041	0.032	-0.028	-0.233	-0.067	0.035	1.000				
Line-of-Business Concentration	-0.065	0.037	-0.063	-0.335	-0.100	-0.306	0.041	1.000			
Geographic Concentration	0.121	-0.076	-0.085	-0.539	-0.144	-0.145	0.138	0.240	1.000		
Catastrophe Exposure	0.161	0.052	-0.052	-0.127	0.026	0.038	0.070	0.031	0.203	1.000	
Publicly Traded	0.033	-0.108	-0.159	0.183	0.428	0.071	-0.217	-0.045	-0.159	0.003*	1.000
Mutual	-0.061	0.044	0.324	0.026	-0.203	-0.027	0.093	-0.084	0.072	0.024*	-0.229
Lloyds	0.192	-0.027	-0.063	-0.177	0.025	0.065	0.101	0.059	0.230	0.617	0.018*
Stock	-0.038	-0.027	-0.263	0.062	0.172	-0.007*	-0.133	0.048	-0.176	-0.321	0.199

*Pearson Correlation Coefficient is not significant at the ten-percent level.

Table 3-4 displays a summary of the reinsurance activity in our sample. The occurrence of reinsurance transactions among insurers is quite common. Eighty-three percent of the observations in our sample cede some reinsurance to affiliates, and sixty-five percent cede reinsurance outside of their groups. Only two percent of the observations do not cede any reinsurance. Some insurers cede reinsurance only to their affiliates, while others cede premiums only to insurers outside of their groups. Over half of the insurers in our sample cede reinsurance both internally and externally. It is also common for insurers to assume reinsurance from both their affiliates and other insurers.

Table 3-4: Reinsurance Activity
Sample includes 4762 observations.

	Ceded	Assumed
Only Internal[1]	1539	1266
Only External[2]	708	480
Both Internal and External[3]	2393	1500
None[4]	122	1364

1: Number of companies that executed reinsurance transactions with affiliated insurers only.

2: Number of companies that executed reinsurance transactions with non-affiliated insurers only.

3: Number of companies that executed reinsurance transactions with both affiliated and non-affiliated insurers.

4: Number of companies that did not execute reinsurance transactions.

3.3.2) Analysis of Sub-Samples Based on Reinsurance Purchase Decision

Before proceeding to more formal analysis, we first consider the insurers' choice of reinsurer. To better understand the insurers' reinsurance purchase decisions, we perform two sets of exploratory diagnostics on four sub-samples of our sample of insurers. Observations in the sub-samples are chosen based on the reinsurance activity of the

observations. The first sub-sample consists of observations that only cede reinsurance to companies outside of their group. It is identified in Table 3-5 as *EXTONLY*. The second sub-sample, *INTONLY*, includes insurers that only cede reinsurance to insurers with which they are affiliated. The third sub-sample, *BOTH*, consists of observations where reinsurance is ceded to affiliates and other companies. Observations in the final sub-sample, *NONE*, do not cede any reinsurance.

First, we compare means and medians of four sub-samples to means and medians of their complements in our full sample. Results are presented in Table 3-5. We also estimate four probit regression equations, one for each sub-sample. The dependent variable in each equals one if the observation is a member of the sub-sample being tested, and zero otherwise. Results from these regressions are presented in Table 3-6.

We add two variables, *Personal Lines* and *Long-Tailed Lines*, to our analysis to provide more general categorizations of the types of coverage written by insurers in each sub-sample.

Personal Lines is the ratio premiums written in the personal lines, Homeowners and Automobile, to total premiums written. It is often assumed that these lines require less expertise to underwrite and price. *Long-Tailed Lines* is the ratio of premiums written in long tailed lines to total premiums written. Long tailed lines are lines of insurance that typically involve a long time period between the time a loss occurs and the time the loss is paid in full by the insurer. Thus, the distribution of claim payments made over time might be represented by a longer tail than that of other lines of insurance. Often these lines involve complicated civil litigation. Examples of long-tailed lines include medical

Table 3-5: Comparing Means and Medians Between Sub-Samples and their Complements*

		Sub-sample							
	FULL	*EXTONLY*		*INTONLY*		*BOTH*		*NONE*	
Variable	Mean / (Med.)	Mean / (Med.)	*t* / (*Z*) .	Mean / (Med.)	*t* / (*Z*) .	Mean / (Med.)	*t* / (*Z*) .	Mean / (Med.)	*t* / (*Z*) .
Reinsurance	0.54 (0.54)	0.24 (0.15)	-33.52 (-25.10)	0.74 (0.89)	31.34 (28.68)	0.53 (0.53)	-2.20 (-2.55)	0.00 (0.00)	N/A (N/A)
External Reinsurance	0.11 (0.02)	0.24 (0.15)	16.87 (25.97)	0.00 (0.00)	-43.26 (-54.87)	0.14 (0.06)	11.69 (36.45)	0.00 (0.00)	N/A (N/A)
Internal Reinsurance	0.43 (0.40)	0.00 (0)	-90.30 (-42.31)	0.74 (0.89)	47.56 (39.42)	0.39 (0.36)	-7.66 (-1.01)	0.00 (0.00)	N/A (N/A)
Company-to-Group Size Ratio	0.83 (0.06)	2.36 (0.49)	13.85 (20.50)	0.08 (0.02)	-25.13 (-29.53)	0.81 (0.11)	-0.53 (13.16)	1.10 (0.08)	1.09 (-1.54)
Size	18.76 (18.63)	18.47 (18.51)	-5.36 (-3.70)	18.39 (18.27)	-10.17 (-9.76)	19.15 (19.04)	15.38 (14.15)	17.60 (17.27)	-7.23 (-7.37)
Number of Affiliates	14.07 (7.00)	6.60 (3.00)	-24.59 (-21.12)	19.16 (15.00)	20.56 (19.42)	13.25 (6.00)	-2.39 (-2.01)	13.04 (6.00)	-1.98 (-2.40)
Leverage	0.69 (0.74)	0.61 (0.66)	-11.31 (-14.41)	0.72 (0.79)	5.96 (12.03)	0.70 (0.74)	5.99 (2.43)	0.42 (0.46)	-10.08 (-10.07)
Tax-Exempt Investment income	0.27 (0.19)	0.27 (0.20)	-0.41 (1.77)	0.26 (0.16)	0.44 (-3.14)	0.27 (0.21)	-0.60 (2.16)	0.23 (0.05)	1.28 (-3.02)
Line-of-Business Concentration	0.60 (0.54)	0.68 (0.67)	8.07 (7.92)	0.59 (.052)	-1.52 (-0.73)	0.57 (0.49)	-7.92 (-8.86)	0.90 (1.00)	17.24 (11.95)
Geographic Concentration	0.50 (0.40)	0.57 (0.52)	5.28 (4.99)	0.56 (0.51)	7.77 (7.78)	0.43 (0.31)	-13.60 (-13.19)	0.73 (0.96)	7.93 (7.24)
Personal Lines	0.43 (0.34)	0.47 (0.44)	2.60 (1.83)	0.47 (0.43)	4.29 (5.24)	0.40 (0.28)	-5.13 (-4.94)	0.34 (0.0)	-2.30 (-4.10)
Long-Tailed Lines	0.69 (0.74)	0.65 (0.70)	-3.71 (-3.16)	0.72 (0.76)	5.74 (4.47)	0.70 (0.74)	2.40 (1.03)	0.36 (0.01)	-9.60 (-9.19)
Catastrophe Exposure	0.04 (0.0)	0.04 (0.0)	-0.61 (-3.43)	0.08 (0.0)	3.54 (6.59)	0.02 (0.0)	-4.18 (-1.62)	0.01 (0.0)	-3.79 (-6.47)
Mutual	0.11	0.18	5.17	0.06	-10.18	0.13	4.22	0.07	-1.88
Reciprocal	0.02	0.02	-0.20	0.00	-6.19	0.03	4.02	0.04	1.26
Lloyds	0.03	0.02	-1.82	0.07	8.28	0.01	-8.51	0.02	-1.15
Stock	0.84	0.79	-4.05	0.87	4.72	0.83	-1.28	0.87	1.16
Publicly Traded	0.47	0.35	-7.91	0.52	4.25	0.48	1.81	0.44	-0.71
N	4762	708		1539		2393		122	

*Means are compared using a two-sample *t* test with unequal variances. Medians are compared using a *Z* score from the two-sample Wilcoxon (Mann-Whitney) test. The complement of a sub-sample is the remainder of the full sample excluding that sub-sample.

malpractice and products liability, among other lines.[8] The longer payout tail introduces more interest rate risk, as well as more uncertainty at the time of loss regarding the amount that will eventually be paid.

Several insurer characteristics appear to be associated with the choice between internal and external reinsurance. The sub-samples differ significantly in mean and median from their complements in almost every variable. Results from the probit regressions generally reinforce the results from mean and median comparisons.

Results from Tables 3-5 and 3-6 suggest that supply, or capacity, factors influence the choice of internal versus external reinsurance provider. An insurer that is large relative to its group is more likely to only cede reinsurance externally, while relatively small insurers are more likely to only cede reinsurance to group members. We find that insurers with fewer affiliates tend to only cede reinsurance to non-affiliates. Insurers with more affiliates are more likely to only cede reinsurance internally. These results imply that the larger insurers in a group cannot cede a large portion of their premiums to other group members because the other group members do not have enough capacity to assume them.

On average, insurers that only cede reinsurance externally cede less reinsurance than their complements, while the opposite is true for those that only cede reinsurance to their affiliates. This may reflect the practice of fully reinsuring smaller affiliates that would otherwise receive a lower financial strength rating. By fully reinsuring these companies,

[8] Long tail lines include: Farmowners Multiple Peril, Homeowners Multiple Peril, Commercial Multiple Peril, Medical Malpractice, Workers Compensation, Other Liability, Products Liability, Private Passenger Auto Liability, Commercial Auto Liability, and Aircraft.

they receive the same financial strength rating as the reinsurer.[9] This reinsuring behavior may also be consistent with reduced information and agency costs involved in internal reinsurance transactions.

Table 3-6: Results from Probit* Regressions

	LHS = extonly[1]		LHS = intonly[2]		LHS = both[3]		LHS = none[4]	
Variable	Estimate	P-ChiSq	Estimate	P-ChiSq	Estimate	P-ChiSq	Estimate	P-ChiSq
Intercept	1.4453	0.0001	-0.3247	0.3369	-2.4496	<.0001	-2.7493	<.0001
Reinsurance	-1.7009	<.0001	1.2390	<.0001	0.0679	0.2662	N/A	N/A
Company-to-Group Size Ratio	0.0986	<.0001	-0.4300	<.0001	-0.0868	<.0001	0.0473	0.0309
Size	-0.0744	0.0002	-0.0781	<.0001	0.1589	<.0001	0.0297	0.3887
Number of Affiliates	-0.3277	<.0001	0.3117	<.0001	-0.2273	<.0001	0.0943	0.0975
Leverage	-0.0292	0.8307	-0.0961	0.3947	0.1870	0.0668	-1.1950	<.0001
Tax-Exempt Investment Income	0.1010	0.3478	0.2250	0.0068	-0.2406	0.0014	-0.4279	0.0203
Line-of-Business Concentration	0.2656	0.0076	-0.2421	0.0037	-0.0962	0.1790	1.3212	<.0001
Geographic Concentration	-0.0050	0.9527	0.2332	0.0013	-0.2843	<.0001	0.8971	<.0001
Personal Lines	0.1065	0.1076	0.1471	0.0132	-0.1043	0.0414	-0.2528	0.0281
Long Tailed Lines	-0.0632	0.4769	0.2395	0.0057	0.0455	0.5329	-1.1826	<.0001
Catastrophe Exposure	0.0453	0.3733	0.5826	0.0037	-1.0499	<.0001	-1.2476	0.0149
Mutual	-0.1458	0.0792	-0.2956	0.0008	0.3420	<.0001	-0.3029	0.1142
Reciprocal	-0.6727	0.0003	-0.5353	0.0194	0.7442	<.0001	0.3144	0.2343
Lloyds	0.4176	0.0205	0.1443	0.3769	-0.2369	0.1492	0.2094	0.5525
Traded	0.0042	0.9454	-0.2270	<.0001	0.1748	<.0001	-0.0171	0.8817
Year97	-0.0964	0.1965	-0.0487	0.4382	0.0671	0.2213	0.1480	0.3122
Year98	-0.0216	0.7675	-0.0898	0.1530	0.0268	0.6232	0.0958	0.5116
Year99	0.0266	0.7100	-0.1501	0.0140	0.0676	0.2044	0.2019	0.1497
LHS = 1		708		1539		2393		122
N		4762		4762		4762		4762

*Logit regressions provide qualitatively similar results.

1: Dependent variable equal to one if the insurer only cedes reinsurance externally.

2: Dependent variable equal to one if the insurer only cedes reinsurance internally.

3: Dependent variable equal to one if the insurer only cedes reinsurance both externally and internally.

4: Dependent variable equal to one if the insurer does not cede any reinsurance.

[9] If an insurer is fully reinsured by a company rated "A" by A.M. Best, it would receive a rating of A-r indicating that it is reinsured by an "A" rated company.

Some evidence suggests that, on average, insurers that cede both internal and external reinsurance cede more external reinsurance, and less internal reinsurance, than other companies. It may also be the case that this sub-sample participates in more complicated insurance activities. It is characterized by larger companies that are more diversified by line of business, and geographic location, of premiums written. Writing more lines of business requires the insurer to have expertise in more lines of insurance, and, because insurance is regulated at the state level, insurers operating in more states must be familiar with more differences in coverage interpretations and policy forms. These companies also write more premiums in commercial insurance lines than in personal lines. It is widely accepted that commercial lines coverage is more complicated than personal lines coverage.

3.3.3) Regression Analysis:

The following system of simultaneous equations is estimated for the sample:

$$\textit{Internal Reinsurance}_j = \alpha_{0j} + \alpha_{1j}\ \textit{External Reinsurance}_j + \alpha_{2j}\ \textit{Number of Affiliates}_j + \sum_{i=3}^{35} \alpha_{ij} X_{ij} + \varepsilon_j$$

$$\textit{External Reinsurance}_j = \beta_{0j} + \beta_{1j}\ \textit{Internal Reinsurance}_j + \beta_{2j}\ \textit{Publicly Traded}_j + \sum_{i=3}^{35} \beta_{ij} X_{ij} + \delta_j$$

where,

Internal Reinsurance$_j$ = (RCTA – RAFA) / (DPW+RA) for insurer *j*.

RCTA = reinsurance ceded to affiliates

RAFA = reinsurance assumed from affiliates

DPW = direct premiums written

RA = total reinsurance assumed

External Reinsurance$_j$ =	RCTNA / (DPW+RA) for insurer j. RCTNA = reinsurance ceded to non-affiliates
Number of Affiliates$_j$ =	the natural log of number of affiliates in the same group as insurer j.
Publicly Traded$_j$ =	Binary indicator equal to 1 if insurer j is publicly traded and otherwise.
X_{ij}'s:	
Size$_j$ =	natural logarithm of insurer j's size, measured as total admitted assets gross of reinsurance transactions.
Leverage$_j$ =	Liabilities / assets (gross of reinsurance ceded) for insurer j.[10]
Tax-Exempt Investment Income$_j$ =	Estimate of the ratio of tax-exempt investment income to total investment income. Tax-exempt investment income = [bond interest exempt from federal taxes + .70 * (Dividends on common and preferred stock)][11]
Line-of-Business Concentration$_j$ =	Herfindahl index of line of business concentration using direct premiums written in each line by insurer j.
Geographic Concentration$_j$ =	Herfindahl index of geographic concentration using direct premiums written in each state by insurer j.

[10] Assets and liabilities gross of reinsurance ceded are reported in schedule F part 8 of the NAIC Annual Statement for property-casualty insurers.

[11] This calculation is similar to that used by Garven and Lamm-Tennant (2000), but is adjusted to reflect changes in the tax code since 1987. The 70% multiplier for dividends is a conservative estimate because, according to IRS form 1120pc, property-casualty insurers may deduct 80% of dividend income received from a company of which it owns at least 20%. We chose the 70% figure because we have limited information about insurers' ownership share of investment firms, and the lower percentage biases against our expected result. This method also partially mitigates the unobservable cost of the Alternative Minimum Tax. Similar results were calculated by assuming dividends from affiliates were in the 20% ownership classification.

Catastrophe Exposure$_j$ =	Proportion of direct premiums written by insurer j in property insurance lines in coastal states and earthquake coverage in California.
Company-to-Group Size Ratio$_j$ =	Ratio of insurer j's assets to the sum of the group's assets net of insurer j's assets.[12]
Mutual$_j$ =	Binary indicator =1 if insurer j is organized as a mutual.
Lloyds$_j$ =	Binary indicator =1 if insurer j is organized as a Lloyd's association.
Reciprocal$_j$ =	Binary indicator =1 if insurer j is organized as a reciprocal.
Year 1997 =	Binary indicator =1 if the observation is from 1997.
Year 1998 =	Binary indicator =1 if the observation is from 1998.
Year 1999 =	Binary indicator =1 if the observation is from 1999.
$X_{13j} - X_{35j}$ =	Proportion of DPW in 23 lines of insurance by insurer j.

[12] Stocks of affiliates are subtracted from insurers within the group before aggregating to prevent double counting.

3.3.3) Results

Results for the simultaneous equations regression appear in Table 3-7. Some of the results in this study are similar to those of Mayers and Smith (1990) and Garven and Lamm-Tennant (2000) with respect to demand for internal and external reinsurance. This is an important contribution to the literature because it shows that several results from previous studies of demand for reinsurance hold true when tested on a larger, more representative sample of insurers, and when internal and external reinsurance are examined simultaneously. The coefficient on *Size* is significant and negative in both equations. This evidence supports the hypothesis that larger firms cede less reinsurance. Consistent with our hypotheses regarding investment incentives and expected cost of bankruptcy, the coefficient on *Leverage* is significant and positive in both equations. Coefficients on the *Size* and *Leverage* variables are consistent with our hypothesis that insurers with greater default risk will cede more reinsurance.

Table 3-7: Results from Two-Stage Least Squares Regression*

	EXTERNAL			INTERNAL		
Variable	E(+/-)	Estimate	P-Value	E(+/-)	Estimate	P-Value
Intercept		0.6528	<.0001		1.8232	<.0001
Internal Reinsurance	-	-0.2578	<.0001		N/A	N/A
External Reinsurance		N/A	N/A	-	2.3709	0.1412
Company-to-Group Size Ratio	+	0.0111	<.0001	-	-0.0453	0.0571
Size	-	-0.0329	<.0001	-	-0.1169	<.0001
Leverage	+	0.1658	<.0001	+	0.2449	0.0349
Tax-Exempt Investment Income	+	0.0164	0.1527	+	0.1382	0.0029
Line-of-Business Concentration	+/-	-0.0054	0.7036	+/-	-0.2921	0.0005
Geographic Concentration	+/-	-0.0474	<.0001	+/-	-0.0346	0.4840
Catastrophe Exposure	+	-0.0015	0.8458	+	0.0577	0.0618
Publicly Traded	+/-	-0.0226	0.0003		N/A	N/A
Number of Affiliates		N/A	N/A	+	0.1773	0.0006
Year 1997		0.0027	0.7400		0.0201	0.4773
Year 1998		0.0139	0.0877		0.0117	0.7003
Year 1999		0.0195	0.0154		0.0008	0.9814
Mutual		0.0069	0.4864		0.0643	0.0649
Lloyds		0.0822	0.0004		0.4246	<.0001
Reciprocal		-0.0536	0.0127		0.0861	0.3958
R^2			0.134			0.115
Adjusted R^2			0.127			0.108
LOB F-Test**			17.59			4.06

* Results for 23 line-of-business variables are available from the authors. We omit one line of business (commercial multiple peril), one year dummy (1996), and one organization form dummy (stock) to avoid singularity in the regression matrix.

** F-value from test of hypothesis that all of the coefficients on the line-of-business variables are equal to zero. This hypothesis can be rejected at the .0001 level for both equations.

The coefficient on *Geographic Concentration* is significant and negative in the external equation, but not significant in the internal equation. This result supports our hypothesis that insurers cede external reinsurance to utilize a reinsurer's comparative advantage in real service production. However, if sharing these real services among group members adds value to the group it should occur regardless of internal reinsurance contracts. Mayers and Smith (1990) point out that insurers with geographically concentrated exposure may systematically concentrate in areas or lines of business with less exposure to catastrophic loss. This would also explain a negative relationship between geographic concentration and reinsurance ceded. Therefore, controlling for exposure to catastrophic losses adds support for our interpretation of this result.

The coefficient on *Line-of-Business Concentration* is not significant in the external reinsurance equation; however, it is significant and negative in the internal reinsurance equation. This result may show that insurers with exposure concentrated in few lines of business choose to write insurance in lines of business with less volatile expected losses. While the measure of catastrophe exposure used in the dissertation is well suited to address the issue of geographic concentration, it may be less applicable to line of business concentration. The measure is primarily concerned with exposure to natural disasters such as hurricanes and earthquakes. Such exposure is a major concern to many insurers, but insurers also realize differences in loss volatility across states and lines of insurance based on factors such as differences in tort laws and exposure to asbestos claims. NAIC data does not provide this level of detail.

Number of Affiliates displays a significant positive relationship with demand for internal reinsurance. This may be due to specialization at the company level, resulting in

increased internal reinsurance activity in order to achieve a better spread of risk within each company. It may also be the result of affiliated insurers using a nexus of internal reinsurance contracts to bond themselves from allowing a group member to fail while the others continue to operate. Finally, it may reflect an increase in the supply of internal reinsurance for insurers with more affiliates.

The coefficient on the proxy for information costs, *Publicly Traded*, is significant and negative in the external reinsurance equation. This result does not support the hypothesis that additional monitoring efforts on the part of investment analysts, and additional reporting requirements imposed by the Securities and Exchange Commission, decrease information asymmetries between publicly traded groups and external reinsurers. The result is consistent with Mayers and Smith's (1990) hypothesis that widely-held stock insurers demand less reinsurance because individual investors can hedge firm-specific risk by holding a diversified portfolio.

In our model, and in that of Garven and Lamm-Tennant (2000), the coefficient for the measure of an insurer's concentration of invested assets in tax-favored securities is not significant in the external reinsurance equation. However, in the equation for internal reinsurance the coefficient on *Tax-Exempt Investment Income* is significant and positive. These results are consistent with internal reinsurance costing less than external reinsurance. The cost of internal reinsurance may be less than the expected cost of not realizing the tax shield on tax-favored securities; however, information and agency problems may raise the cost of external reinsurance above the expected cost of not realizing tax shields.

Internal reinsurance ceded (*Internal Reinsurance*) is significant and negative in the equation for external reinsurance, but external reinsurance ceded (*External Reinsurance*) is not significant in the internal reinsurance equation. If internal and external reinsurance are perfect substitutes, then an increase in demand for one should cause a decrease in demand for the other. The results found here are not surprising in light of the structural and cost-based differences in demand for internal and external reinsurance discussed above. These results are consistent with the cost of internal reinsurance being less than the cost of external reinsurance, and with insurers demanding external reinsurance in order to take advantage of the reinsurer's comparative advantage in real services such as claims settlement and rate making.

In their study of demand for reinsurance, Mayers and Smith (1990) find that including variables representing each line-of-business in the regression equation greatly improves the explanatory power of their model. We also find that controlling for the lines of business in which the insurer participates helps explain its demand for both internal and external reinsurance. However, we find that controlling for lines of business is much more important when estimating demand for external reinsurance than when estimating demand for internal reinsurance. For each regression equation we perform an F-test on the hypothesis that the coefficients on all of the line-of-business variables are equal to zero (see LOB F-test in Table 3-7). In the external reinsurance equation, the F-value equals 17.59, compared to an F-value of 4.06 in the internal reinsurance equation.

This difference in explanatory power added by the line-of-business variables may be due to transparency in the underwriting process among affiliated insurers. The insurer may have more information about the risks insured by its affiliates than it has about risks

insured by other companies. It may also be the case that aligned interests of affiliates reduces the incentive for primary insurers to deceive reinsurers about the characteristics of insured risks, which would decrease their incentives to monitor one another. Each scenario is likely to decrease the cost of internal reinsurance relative to the cost external reinsurance.

Finally, the significant and positive relationship between *Company-to-Group Size Ratio* and use of external reinsurance, and the significant and negative relationship between *Company-to-Group Size Ratio* and use of internal reinsurance, may be consistent with efficient internal capital market activity. In an efficient internal capital market the insurer that can acquire external capital at the lowest cost should do so on behalf of the rest of the group. Reinsurers consider company level factors in pricing reinsurance. All else equal, insurers with more assets are likely to be charged lesser premiums for reinsurance (Phifer, 1996). Therefore, these results are consistent with larger insurers accessing external capital markets by ceding premiums to unaffiliated reinsurers, then sharing this capital with its affiliates by assuming reinsurance internally.

It might also be the case that smaller insurers' have limited financial capacity to assume a significant portion of the larger insurers' written premiums. Thus, larger insurers may face supply-side constraints on internal capital relative to their needs, while smaller insurers do not.

One potential limitation of this study is manifest in the observed cyclical behavior of the insurance industry, and the duration of the sample period. The period is from 1996 to 1999. Historically, the insurance industry has exhibited what are known as hard market and soft market periods. A hard market is characterized by decreasing capacity to write

insurance and increasing premiums. In a soft market, premiums are decreasing and capacity is increasing. While the cause of changes in market conditions has not been resolved in the insurance literature, the effect of these changes on the capital structure decisions of insurers is likely to follow a distinct pattern. During a hard market, the cost of external capital is likely to increase relative to that of internal capital due to the industry-wide decrease in underwriting capacity.

Ultimately, one would like to use data that spans an entire market cycle. However, because data from prior reporting periods does not contain the necessary level of detail, and more recent data is not yet available, the dissertation analyzes data from a period completely contained in a soft market. The most recent shift from a hard market to a soft market occurred in the early 1990's. Many industry experts agree that only now, in the wake of the September 11, 2001 World Trade Center tragedy, are insurance markets beginning to harden again.

Fortunately, the sample period employed is such that any bias introduced by changes in market conditions would decrease the likelihood of finding the results discussed in this study. Evidence is presented that is consistent with internal capital costing less than external capital during a period when the difference between the two should be minimized.

3.4) Conclusions:

Our examination of affiliated insurance companies provides evidence that internal and external reinsurance are not perfect substitutes. Some results also apply to the more general hypothesis that internal and external sources of capital are not perfect substitutes. It appears that there are both structural and cost differences between internal and external

reinsurance. We also reaffirm the findings of previous studies of demand for external reinsurance.

The amounts of both internal and external reinsurance ceded are affected by expected costs of bankruptcy and investment incentives. Smaller insurers are more concerned with expected costs of bankruptcy. All else equal, highly levered insurers are more likely to default, and more susceptible to the underinvestment problem. Consistent with our hypotheses, we find that insurers with more total assets cede less reinsurance, and insurers with higher financial leverage cede more reinsurance.

Insurers may purchase external reinsurance to take advantage of the reinsurer's comparative advantage in real service production. If sharing real service expertise adds value to the group then affiliates may benefit from each other's real service efficiencies regardless of internal reinsurance contracts. Geographic concentration displays a significant and negative relationship with external reinsurance ceded, but not with internal reinsurance ceded. Following Mayers and Smith (1990) we attribute this result to the reinsurer's potential advantage in real service production.

We cannot reject the hypothesis that internal and external reinsurance are not perfect substitutes. This result is apparent explicitly in the results from our model, and may also be inferred from the structural differences in demand discussed above. We present evidence consistent with internal reinsurance costing less than external reinsurance. Concentration of assets in tax-favored securities is positively related to demand for internal reinsurance. One explanation of this result is that the cost of internal reinsurance is less than the expected cost of not realizing the tax shield on tax-favored investments,

while information and agency problems raise the cost of external reinsurance above that of wasted tax shields.

Finally, we show that an insurer's size relative to the rest of its group affects its equilibrium reinsurance activity in opposite directions for internal and external reinsurance. Results are consistent with larger insurers in a group ceding more external reinsurance, while smaller insurers cede more premiums internally. One explanation of these results is that larger group members access external capital markets on behalf of the group, and redistribute this capital to smaller affiliates by assuming internal reinsurance. Such behavior is consistent with efficient internal capital market activity among affiliated insurers. An alternative explanation is that smaller insurers do not have the financial capacity to assume a significant portion of the larger insurers' premiums. This would explain the large insurers' reliance on external capital, and the smaller insurers' ability to acquire capital from its affiliates.

CHAPTER 4

INTERNAL CAPITAL MARKET EFFICIENCY AMONG FINANCIAL INTERMEDIARIES: EVIDENCE FROM THE INSURANCE INDUSTRY

4.1) Introduction

Williamson (1975) defines an internal capital market as a situation where cash flows in the M-form firm are not automatically returned to their sources, but instead are allocated to the segments of the firm with the best investment opportunities. This concept of an internal capital market is consistent with that considered in the dissertation. Prior studies have examined internal capital market activity across a spectrum of industries. Shin and Stulz (1998) use segment data for the COMPUSTAT universe of diversified firms. Others have focused on internal capital markets in a particular industry. Lamont (1997) finds evidence of oil companies and their non-oil subsidiaries acting as internal capital markets. Houston, James, and Marcus (1997) find that bank holding companies act as internal capital markets, distributing scarce capital among member banks. Klein and Saidenberg (1998) present evidence consistent with efficient internal capital markets within bank holding companies.

Insurance companies present a unique framework for analyzing internal capital market activity. When an insurer increases premiums written it must also do at least one of four things, (1) hold more capital, (2) increase premiums ceded to reinsurers, (3) alter its loss exposure, or (4) increase its probability of insolvency. The first two alternatives may be accomplished within an internal capital market in the form of reinsurance ceded

to affiliates, or other intra-group capital transactions. Alternatively, an insurer can use retained earnings or publicly issued equity to increase surplus, or cede reinsurance to an insurer outside of its group. A company can alter its loss exposure by diversifying its premiums written by line of business or geographic location. It can also adjust its exposure to catastrophic losses via its choice of location and line of business. The final option for an insurer is to increase its probability of insolvency. If an insurer increases its investment without adjusting its surplus, reinsurance ceded, or loss exposure it must increase its probability of insolvency.

Houston, James, and Marcus (1997) test for internal capital market activity in a sample of bank holding companies. The authors point out an important distinction between their study of internal capital markets and studies using data from other industries. It is based on a bank's role as a financial intermediary. Stein (1997) speculates that incentives to establish internal capital markets may be strongest among firms that are narrowly focused and whose assets present difficulty in valuation. Financial intermediaries display both of these characteristics. Most would agree that financial intermediaries play an important role in mitigating capital market frictions, including information problems, that make external financing costly. It follows intuitively that a financial intermediary's assets may be difficult for outside investors to value. Diamond (1984) offers that financial intermediation may create an additional layer of agency problems, which creates the need for contracts and institutions to 'monitor the monitor'. For example, when a bank makes a loan it designs the terms of the loan based on its proprietary knowledge of the borrower. Those outside the bank, without the privilege of this information, may find it difficult to make an accurate

evaluation of the bank's merits as borrower. Insurance companies face a similar issue. An insurer essentially borrows policyholders' funds in return for its promise to make payments in the event of a covered loss. It follows that insurers assimilate proprietary information involving their liabilities that may affect outsiders' ability to value an insurer, similar to the situation faced by other financial intermediaries.

Some indirect evidence exists that affiliated insurers manage capital at the group level. Mayers and Smith (1992) find that executive compensation at parent companies depends on asset performance, while at subsidiary firms executives are compensated based on sales measures such as volume of premiums written. The authors attribute these results to assets being managed at the group level, and other aspects of insurer operations being the responsibility of each affiliate. This is obviously consistent with Williamson's (1975) description of an internal capital market. Dumm and Hoyt (1999) investigate the use of surplus notes among insurance companies. They find evidence consistent with insurers using surplus notes to transfer capital among affiliates.

Affiliated insurance companies provide an excellent opportunity to investigate internal capital market efficiency. Internal capital market transactions among members of insurance holding companies are reported in statutory filings. These transparent internal capital markets allow us to execute a more direct test on the efficiency of internal capital markets than has been possible in previous efforts.

4.2) Hypotheses Development

4.2.1) Insurance Company Investment

First we introduce a simple model of insurer investment. Throughout this chapter insurance company investment is defined as premiums written by the insurer. We model

investment as a function of change in capitalization and change in underwriting exposure. Our model may be written as follows:

$\Delta INVESTMENT = f[\Delta CAPITAL, \Delta EXPOSURE]$; where

$\Delta INVESTMENT$ = Change in premiums written by the insurer from one period to the next.

$\Delta CAPITAL$ = Change in capitalization of the insurer.

$\Delta EXPOSURE$ = Change in the insurer's underwriting exposure.

We expect a positive relationship between investment and change in capital, and a negative relationship between change in investment and change in underwriting exposure. Changes in capitalization may occur via two separate activities within an insurance company. The insurer can either change the level of surplus it holds, or it can change the amount of reinsurance it cedes. Explanations of the relationships between investment and surplus, and investment and reinsurance ceded are straightforward. Surplus serves as a buffer fund for the insurer so that the insurer will be able to pay claims even if actual losses are greater than expected losses. Instead of, or in addition to, holding more surplus an insurer may cede risks to another insurer called a reinsurer. In return for a portion of the direct premium the reinsurer becomes liable for a portion of losses incurred. Thus, both an increase in surplus and an increase in the proportion of premiums ceded to reinsurers effectively increases an insurer's capacity to underwrite risks.

The explanation of our anticipated negative relationship between change in investment and change in underwriting exposure may not be as intuitive as that of the relationships discussed above. There are many types of insurance that a property-liability

insurance company can write. Risks may differ across lines of business. For example, the expected losses from a property insurance policy are likely to be different from the expected losses from a liability insurance policy. Risks may also differ across geographic regions within a line of business. For example, expected losses for an automobile insurance policy written in California are likely to differ significantly from a policy insuring the same auto and driver in Montana. All else equal, an insurer may reduce its probability of insolvency by diversifying its exposures across lines of business and geographic locations, or by choosing to write business in lines of business and geographic areas that are not subject to a great risk of catastrophic losses. Therefore, an insurer can increase its investment without ceding more reinsurance or increasing its surplus if it decreases its underwriting exposure.

An insurer may also choose to increase its probability of insolvency by increasing premiums written without adjusting capitalization or underwriting exposure. Because increasing probability of insolvency has been shown to significantly decrease the price an insurer can charge for insurance (Sommer, 1996), we do not expect insurers to do so if it can be avoided. By the extent to which insurers choose to increase probability of insolvency when increasing premiums written, our model will be biased against finding significant relationships between change in investment and change in capitalization, and change in investment and change in exposure to underwriting risk.

Our hypothesized model of insurer investment is characterized by the following relationships: The change in investment of an insurer is positively related to change in capitalization, and negatively related to change in underwriting exposure.

4.2.2) Internal Capital Market Efficiency

Companies form an internal capital market to share capital. Shin and Stulz (1998) describe an efficient internal capital market as one where funds are transferred to the companies with the best investment opportunities. Alternatively, capital could be shifted to affiliates that have performed poorly and need to be subsidized.

In the previous section we defined a model of insurance company investment behavior. To test for internal capital market efficiency we must modify parts of the model. We disaggregate the insurer's change in capital based on whether or not it was the result of an internal capital market transaction. The resulting analytical model may be written as follows:

$\Delta INVESTMENT = f[\Delta ICMCAPITAL, \Delta OWNCAPITAL, \Delta EXPOSURE]$; where

$\Delta INVESTMENT$ = Change in premiums written by the insurer from one period to the next.

$\Delta ICMCAPITAL$ = Change in capitalization of the company that is the result of internal capital market transactions.

$\Delta OWNCAPITAL$ = Change in capitalization of the company that is not the result of internal capital market transactions.

$\Delta EXPOSURE$ = Change in the insurer's underwriting exposure.

Investigating the relationship between internal capital market transactions and investment will allow us to test the hypothesis that internal capital markets are efficient. If internal capital market transactions are positively related to investment, while controlling for changes in capital originating from the insurer's operations and changes in

underwriting exposure, then insurance groups are using internal capital market transactions to shift capital to the affiliates with the best investment opportunities. This would be consistent with Shin and Stulz (1998) definition of an efficient internal capital market. Alternatively, evidence that the relationship between investment and internal capital market transactions is non-positive would not be consistent with the hypothesis that these internal capital markets are efficient.

4.3) Data and Empirical Tests

4.3.1) Sample Selection

The sample includes company-level observations for affiliated insurers for data years 1996 - 1999 obtained from the National Association of Insurance Commissioners (NAIC). To be included in our sample, companies must have been formed before 1996 and must be observed in each year of the sample period. A company that is entering the market as a group member is likely to receive a large initial capital infusion from its affiliates. While these are internal capital market transactions, they do not represent the focus of this study. We are interested in capital transactions among established affiliates while operating as going concerns.

Finally, obvious outliers were removed based on examination of studentized residuals. Our sample includes three temporal observations for each of 445 affiliated insurance companies, a total of 1335 observations.

An important distinction between this study of internal capital markets, and other studies (Shin and Stulz, 1998; Houston, James, and Marcus, 1997; Klein and Saidenberg, 1998) is that internal capital market transactions in our sample can be observed directly from statutory filings collected by the NAIC. Thus, we do not test for internal capital

market activity; rather we use data reflecting internal capital market activities to test for internal capital market efficiency.

4.3.2) Sample Description

Each of the variables used in our analysis is defined in Table 4-1. The dependent variable in each of our regression models is a proxy for change in investment, *ΔInvestment*. We define change in investment as the percent change in premiums written by the insurer from year t-1 to year t. Following the reasoning of Houston, James and Marcus (1997), we believe this measure is appropriate because writing insurance is the primary function of an insurance company. While insurers, like banks, also participate in activities such as the management of their asset portfolios, these activities are ancillary to insuring risks.

Our model of insurer investment employs two measures of change in capitalization. The first is, *ΔSurplus*, the insurers change in surplus from period t-2 to period t-1. Surplus in an insurance company is synonymous with capital for firms in other industries. It is calculated as the difference between assets and liabilities. The insurer's surplus serves as a buffer fund for paying losses in the event that actual losses are greater than expected losses. We use a lagged measure of change in surplus for two reasons. First, we expect insurers to adjust surplus before adjusting premiums written so that they do not receive unwanted attention from rating agencies or regulators. Second, surplus may depend on the amount of premiums written in a given year; therefore, we use a lagged measure of change in surplus to avoid contemporaneous correlation with the error term in our regression models.

Table 4-1: Variable Definitions

$\Delta Investment_{i(t)} = [PW_{i(t)} - PW_{i(t-1)}] / PW_{i(t-1)}$

$PW_{i(t)}$ = Premiums written by insurer i in year t. Includes direct premiums written and reinsurance premiums assumed.

$\Delta Surplus_{i(t)} = [SURPLUS_{i(t-1)} - SURPLUS_{i(t-2)}] / SURPLUS_{i(t-2)}$

$SURPLUS_{i(t)}$ = The difference between insurer i's assets and its liabilities in year t.

$\Delta Icm\ Surplus_{i(t)} = [SRFA_{i(t-1)} - STTA_{i(t-1)}] / SURPLUS_{i(t-2)}$

$SRFA_{i(t)}$ = Surplus received from affiliates by insurer i in year t.

$STTA_{i(t)}$ = Surplus transferred to affiliates from insurer i in year t.

$\Delta Own\ Surplus_{i(t)} = [SURPLUS_{i(t-1)} - (SRFA_{i(t-1)} - STTA_{i(t-1)})] / SURPLUS_{i(t-2)}$

$\Delta Reinsure_{i(t)} = [(RC_{i(t)} - RA_{i(t)}) / PW_{i(t)}] - [(RC_{i(t-1)} - RA_{i(t-1)}) / PW_{i(t-1)}]$

$RC_{i(t)}$ = Reinsurance ceded by insurer i in year t.

$RA_{i(t)}$ = Reinsurance assumed by insurer i in year t.

$\Delta Icm\ Reinsure_{i(t)} = [(RCTA_{i(t)} - RAFA_{i(t)}) / PW_{i(t)}] - [(RCTA_{i(t-1)} - RAFA_{i(t-1)}) / PW_{i(t-1)}]$.

$RCTA_{i(t)}$ = Reinsurance ceded to affiliates by insurer i in year t.

$RAFA_{i(t)}$ = Reinsurance assumed from affiliates by insurer i in year t.

$\Delta Own\ Reinsure_{i(t)} = [(RCTNA_{i(t)} - RAFNA_{i(t)}) / PW_{i(t)}] - [(RCTNA_{i(t-1)} - RAFNA_{i(t-1)}) / PW_{i(t-1)}]$.

$RCTNA_{i(t)}$ = Reinsurance ceded to non-affiliates by insurer i in year t.

$RAFNA_{i(t)}$ = Reinsurance assumed from non-affiliates by insurer i in year t.

$\Delta Geographic\ Concentration_{i(t)} = HERFGEO_{i(t)} - HERFGEO_{i(t-1)}$

$$HERFGEO_{i(t)} = \sum_{s=1}^{51}\left[\left(\frac{PW_S}{PW}\right)^2\right].$$ PW_S = Premiums written in state S.

$\Delta Line\text{-}of\text{-}Business\ Concentration_{i(t)} = HERFLOB_{i(t)} - HERFLOB_{i(t-1)}$.

$$HERFLOB_{i(t)} = \sum_{L=1}^{23}\left[\left(\frac{PW_L}{PW}\right)^2\right].$$ PW_L = Premiums written in line of business L.

$\Delta Catastrophe\ Exposure_{i(t)} = CATEX_{i(t)} - CATEX_{i(t-1)}$.

$CATEX_{i(t)}$ = The ratio of premiums written for property coverage in eastern coastal states and earthquake coverage in California to total premiums written by insurer i in year t.

$Mutual_i$ = One if insurer i is a mutual insurance company, and zero otherwise.

We also measure changes in capitalization by observing change in the percentage of premiums written that are ceded by the insurer net of reinsurance assumed from year t-1 to year t (*ΔReinsure*). We treat this variable as predetermined because reinsuring arrangements, called treaties, are most often negotiated annually as a percentage of the primary insurer's losses in the following period that will be reimbursed by the reinsurer. By ceding reinsurance, the primary insurer insulates itself from a portion of the risk that actual losses are greater than expected losses. The ratio of reinsurance ceded to total premiums written is appropriately treated as a capital structure decision because by increasing the proportion of premiums ceded to reinsurers the primary insurer can write more insurance without increasing its surplus.

Both measures of change in insurance company capitalization discussed above may be disaggregated based on whether or not the change is the result of an internal capital market transaction. We use the resulting four variables to test our hypothesis of internal capital market efficiency. *ΔIcm Surplus* is a measure of change in surplus resulting from an internal capital market transaction. It is calculated as the company's net capital transaction with affiliates in period t-1, as a percentage of its surplus at the end of period t-2. *ΔOwn Surplus* is a measure of the change in an insurer's surplus that is not the result of an internal capital transaction. These changes in surplus could be the result of retained earnings being added to surplus. They could also result from the insurer raising new capital from external sources, such as a public equity offering. *ΔIcm Reinsure* represents the change in the percentage of total written premiums ceded to affiliated insurers. It is calculated as the change in reinsurance ceded to affiliated insurers, less reinsurance assumed from affiliates, divided by total premiums written from period t-1 to period t.

ΔOwn Reinsure represents change in reinsurance ceded to companies that are not affiliated with the primary insurer from period t-1 to period t.

We use three measures to control for changes in underwriting exposure, *ΔGeographic Concentration*, *ΔLine-of-Business Concentration*, and *ΔCatastrophe Exposure*. *ΔGeographic Concentration* is a proxy for change in geographic concentration of risks covered by the insurer. It is calculated as the difference in the Herfindahl index of premiums written by state in period t and period t-1. *ΔLine-of-Business Concentration* is a proxy for change in concentration of an insurer's exposure in lines of business. It is calculated as the difference in the Herfindahl index of premiums written by line of business in period t and period t-1. *ΔCatastrophe Exposure* is another proxy for change in the insurer's exposure to catastrophic loss. It is meant to capture change in the company's exposure to loss from perils of natural disaster, such as hurricanes and earthquakes. Similar to the measure used by Gron (1999), it is calculated as the difference in the proportion of total premiums that are written in property lines in coastal states, and earthquake coverage in California, in period t-1 and period t.

We include a proxy for the age of the insurer to control for life-cycle effects on investment. A recently formed insurer may be focused on increasing premiums written, while a seasoned company may be content to retain market share. *Age* is equal to the number of years since the insurer commenced operation, up to a maximum of five years.[13] Finally, we control for the organizational form of the insurer with a dummy variable, *Mutual*, equal to one if the insurer is organized as a mutual. Table 4-2 presents summary statistics for the key variables used in the regression analysis.

[13] Alternative cut-offs of 7 and 10 years produce similar results in the following empirical tests.

Table 4-2: Sample Description

Variable	Mean	Std Dev	Median
ΔInvestment	0.0647	0.3017	0.0252
ΔIcm Reinsure	0.0010	0.1242	0
ΔOwn Reinsure	-0.0002	0.0786	0
ΔIcm Surplus	0.0225	0.1069	0
ΔOwn Surplus	0.0640	0.1337	0.0602
ΔGeographic Concentration	-0.0092	0.0656	0
ΔLine-of-Business Concentration	-0.0045	0.0671	-0.0019
ΔCatastrophe Exposure	-0.0005	0.0734	0

4.3.2.1) Insurers Displaying ICM Activity

Summary statistics for the following four sub-samples are presented in Table 4-3. In 110 observations an insurer receives a net inflow of surplus from one or more of its affiliates (*ΔIcm Surplus*>0). Among these companies the average transfer was equal to twenty-five percent of the receiving insurer's surplus in the prior period (median=25%). The average investment for this sub-sample of insurers is an increase of ten percent (median=5.6%).

In 66 observations an insurer displays a net capital outflow to its affiliates (*ΔIcm Surplus*<0). Among these companies the average transfer size is two percent of the insurer's surplus in the prior period (median=1.7%). On average, insurers in this sub-sample increased premiums written by four percent (median=2%). The difference in mean investment between providers and receivers of capital is positive, but not statistically significant at customary levels in a two-tailed test (z=1.51).

Table 4-3: Comparison of Sub-samples

Comparing change in investment (*ΔInvestment*) between providers and receivers of internal capital market surplus transactions

	Receivers	Providers
N	110	66
Mean (μ)	0.10	0.04
Median	0.056	0.02
Variance	0.125	0.029
Z-statistic for H_0: $\mu_R = \mu_P$		1.51

Comparing change in investment (*ΔInvestment*) between companies that increased and decreased net reinsurance ceded to affiliates

	Increased	Decreased
N	497	479
Mean (μ)	0.14	0.02
Median	0.08	0
Variance	0.10	0.06
Z-statistic for H_0: $\mu_I = \mu_D$		6.63

In 497 observations net internal reinsurance ceded as a proportion of direct premiums written increased (Δ*Icm Reinsure*>0). The average increase in net internal reinsurance ceded is nine percent of premiums written (median=3%). On average, insurers in this sub-sample increased premiums written by fourteen percent (median=8%).

In 479 observations net internal reinsurance ceded as a proportion of direct premiums written decreased (Δ*Icm Reinsure*<0). The average decrease in net internal reinsurance ceded is six percent of premiums written (median=2.5%). On average, insurers in this sub-sample increased premiums written by two percent (median=0). The difference in investment between these two sub-samples is highly significant and positive (z=6.63).

The results described above are generally consistent with insurance groups using internal capital market transactions to redistribute capacity to affiliates with the best investment opportunities. Thus, our preliminary test results are consistent with insurance groups forming efficient internal capital markets.

4.3.3) Regression Analysis

We use a two-step approach to test for internal capital market efficiency that emulates the theoretical test described in Sections 4.2.1 and 4.2.2. First we test a model of insurance company investment behavior to establish relationships between investment and change in capitalization, and investment and change in underwriting exposure. Then we alter the right-hand side of the regression equation to separate changes in capitalization based on whether or not they were the result of internal capital market transactions. A positive relationship between investment and changes in capital resulting from internal capital market transactions would be consistent with efficient internal capital markets redeploying assets to the companies with the best investment opportunities. If these coefficients are non-positive we cannot reject the alternative hypothesis that these internal capital markets are transferring capital to insurers in order to subsidize them when they experience poor operating performance.

4.3.3.1) Determinants of Insurance Company Investment

The first step in examining internal capital market activity is to establish the relationship between insurance company financing and investment behavior. Our primary model of financing and investment behavior in insurance companies presents investment as a function of change in policyholder surplus, change in reinsurance ceded, and change in underwriting exposure. The dependent variable, $\Delta Investment$, is the company's

percent change in premiums written from period t-1 to period t. Our measure of change in surplus, *ΔSurplus*, is the change in policyholders' surplus from period t-2 to period t-1. This change in surplus represents a change in the insurer's capacity to write additional premiums without ceding more reinsurance or adjusting its underwriting exposure. We lag this variable one period relative to investment because surplus may depend on premiums written in a given period. Change in net reinsurance ceded, *ΔReinsure*, is measured by the difference in the ratio of net reinsurance premiums ceded to total premiums written in periods t and t-1. Although the amount of premiums ceded depend on the amount of premiums written, we assume that the *ratio* was determined at the beginning of the period, before premiums were written.

We use three measures to proxy for underwriting exposure. The first two are Herfindahl indices of premiums written by state and by line of business. A higher index value indicates premiums are more concentrated in a geographic region or line of business; therefore, an increase in either index may represent an increase in underwriting exposure. However, it may be the case that the insurer is concentrating its premiums written in lines of business or geographic areas subject to less exposure to catastrophic losses. To partially account for these possible differences in exposure to catastrophic losses we include the proxy for catastrophe exposure described above. Changes in these measures from the end of period t-1 to the end of period t are used in empirical tests and are labeled *ΔGeographic Concentration*, *ΔLine-of-Business Concentration*, and *ΔCatastrophe Exposure*. We also control for age and ownership structure by including in the regression the variables *Age* and *Mutual* described above.

Following Houston, James, and Marcus (1997), we use a Between-Effects (BE) regression methodology to control for autocorrelation. Because of the short sample period, this methodology may be more appropriate than a Fixed-Effects regression. Between-Effects regression pools the observations for each company using the mean values of both the right- and left-hand-side variables. This methodology is also useful because a transfer of capital in one period might affect investment in multiple periods. For example, a company could receive capital in period one and then take several years to complete any corresponding change in premiums written. For comparison purposes, results using Ordinary Least Squares (OLS) regression and controlling for each period using dummy variables are also presented in Table 4-4 below. The two methodologies produce qualitatively similar results with respect to our key explanatory variables.

Table 4-4: Investment Model Results*

Dependent variable = *ΔInvestment*

	BE Regression		OLS Regression	
	Estimate	P-value	Estimate	P-value
Intercept	0.1165	0.2372	0.3522	0.0001
ΔReinsure	0.5782	0.0034	0.2213	0.0075
ΔSurplus	0.2309	0.0531	0.1116	0.0731
ΔGeographic Concentration	-1.9678	0.0001	-0.8426	0.0003
ΔLine-of-Business Concentration	0.5673	0.1200	-0.1580	0.4622
ΔCatastrophe Exposure	-0.4033	0.6117	-0.0907	0.3464
Mutual	-0.0344	0.1194	-0.0682	0.0010
Age	-0.0196	0.3120	-0.0572	0.0013
Period 2			-0.0304	0.1285
Period 3			-0.0545	0.0057
R^2		0.1870		0.0911
Adjusted R^2		0.1713		0.0849

* All regression results are calculated using White's consistent standard errors

The positive and significant relationships between investment and surplus and investment and reinsurance are consistent with the hypothesized model presented in Section 4.2.1. An increase in reinsurance ceded is associated with an increase in investment. Also, an increase in an insurer's surplus is associated with an increase in investment.

Another noteworthy result from the estimation of this regression equation is the significant and negative relationship between investment and geographic concentration. This is consistent with insurers increasing premiums written by entering new geographic markets. This growth strategy may reduce the insurer's exposure to catastrophic losses.

In light of the results presented above, we may be reasonably confident in our previous statement that, when an insurer increases premiums written it must also do at least one of four things, (1) hold more capital, (2) increase premiums ceded to reinsurers, (3) alter its loss exposure, or (4) increase its probability of insolvency. Having validated these hypothesized relationships we are now prepared to evaluate the efficiency of internal capital markets in insurance groups.

4.3.3.2) Internal Capital Market Efficiency

In the previous section we validated a model of insurance company investment. In this section we apply this model of investment to test for internal capital market efficiency in insurance groups.

We begin by disaggregating the capitalization variables as described in Section 4.3.2. We separate *ΔSurplus* based on the origin of surplus funds. The new variable *ΔIcm Surplus* includes changes in surplus resulting from internal capital market transactions. Its counterpart, *ΔOwn Surplus*, includes changes in surplus generated within the company. We separate *ΔReinsure* based on whether or not the assuming and ceding companies are affiliated. *ΔIcm Reinsure* is equal to the change in net reinsurance ceded to affiliated companies. *ΔOwn Reinsure* measures the change in net reinsurance ceded to non-affiliated insurers.

The four new variables are substituted for the two aggregate variables representing change in capitalization. By estimating the new regression model we can test the hypothesis that insurance groups use internal capital markets to transfer capital to companies with the best investment opportunities. Support for this hypothesis would include significant and positive coefficients on *ΔIcm Surplus* and *ΔIcm Reinsure*. The

alternative is that they could transfer capital to insurers that need a capital infusion to rebuild surplus after experiencing greater than expected losses. Again we employ both BE and OLS regression methods, and the results from each are similar with respect to our key explanatory variables. Results are presented in Table 4-5.

The results are overwhelmingly consistent with efficient internal capital markets in insurance groups. Both types of internal capital market transactions display a significant and positive relationship with investment. The coefficients on *ΔIcm Surplus* and *ΔIcm Reinsure* are significant and positive. Moreover, the magnitudes of the coefficients on the internal capital market variables are greater that that of their counterparts, *ΔOwn Surplus* and *ΔOwn Reinsure*, implying that internal capital market transactions play an economically significant role in the investment behavior of affiliated insurance companies.

Table 4-5: ICM Efficiency Results*
Dependent variable = *ΔInvestment*

	BE Regression		OLS Regression	
	Estimate	P-value	Estimate	P-value
Intercept	0.0966	0.3393	0.3493	0.0001
ΔIcm Reinsure	0.5750	0.0058	0.2692	0.0015
ΔOwn Reinsure	0.5449	0.0624	-0.0341	0.8468
ΔIcm Surplus	0.6409	0.0015	0.2653	0.0178
ΔOwn Surplus	0.0382	0.7043	0.0287	0.6502
ΔGeographic Concentration	-1.7742	0.0004	-0.7991	0.0003
ΔLine-of-Business Concentration	0.5116	0.1628	-0.1864	0.3833
ΔCatastrophe Exposure	-0.2727	0.7317	-0.0924	0.3224
Mutual	-0.0321	0.1471	-0.0670	0.0015
Age	-0.0144	0.4723	-0.0566	0.0015
Period 2			-0.0287	0.1577
Period 3			-0.0513	0.0087
R^2		0.1870		0.1019
Adjusted R^2		0.1693		0.0944

* All regression results are calculated using White's consistent standard errors

Our results directly contradict the conclusions of Shin and Stulz' (1998) study of firms across multiple industries, which excludes the financial sector. The authors conclude that internal capital markets play only a limited role in the financing and investment behavior of firms, and they find no evidence consistent with internal capital market efficiency. Our results also contradict Lamont's (1997) study of oil conglomerates. Lamont finds that oil subsidiaries in these conglomerate firms were subsidized by subsidiaries in other industries following the 1986 oil price decrease. This is not consistent with Shin and Stulz' (1998) definition of an efficient internal capital market. However, our results concerning the importance of internal capital market

transactions with respect to a company's investment behavior are consistent with the conclusions of Houston, James, and Marcus (1997) and Klein and Saidenberg (1998, 2001). The samples in these studies were limited to members of bank holding companies. Collectively, these efforts point to financial intermediation activities as a catalyst for active and efficient internal capital markets. This observed difference in behavior between financial intermediaries and firms in other industries may be due to increased information asymmetries likely to exist between financial intermediaries and external sources of capital (Diamond, 1984; Houston, James, and Marcus, 1997). These information asymmetries may increase the cost of capital from external sources relative to internal capital and, as a result, financial firms may rely more on internal funds to finance investment.

One potential limitation of this study is manifest in the observed cyclical behavior of the insurance industry, and the duration of the sample period. The period is from 1996 to 1999. Historically, the insurance industry has exhibited what are known as hard market and soft market periods. A hard market is characterized by decreasing capacity to write insurance and increasing premiums. In a soft market, premiums are decreasing and capacity is increasing. While the cause of changes in market conditions has not been resolved in the insurance literature, the effect of these changes on the capital structure decisions of insurers is likely to follow a distinct pattern. During a hard market, the cost of external capital is likely to increase relative to that of internal capital due to the industry-wide decrease in underwriting capacity.

Ultimately, one would like to use data that spans an entire market cycle. However, because data from prior reporting periods does not contain the necessary level of detail,

and more recent data is not yet available, the dissertation analyzes data from a period completely contained in a soft market. The most recent shift from a hard market to a soft market occurred in the early 1990's. Many industry experts agree that only now, in the wake of the September 11, 2001 World Trade Center tragedy, are insurance markets beginning to harden again.

Fortunately, the sample period employed is such that any bias introduced by changes in market conditions would decrease the likelihood of finding the results discussed in this study. We find that internal capital markets are important to insurance companies during a period when their effect should be less important compared to periods defined as a hard market.

4.4) Conclusions

Using data from affiliated insurance companies we investigate the efficiency of internal capital markets in financial intermediaries. Diamond (1984), Houston, James, and Marcus (1997), Klein and Saidenberg (1998), and others have proposed that financial intermediaries may rely more on internal sources of capital to finance investment due to increased information problems borne of the nature of financial intermediation. Therefore, the question of internal capital market efficiency is especially relevant to our sample industry.

One of the greatest benefits of studying a sample of insurers is that the internal capital market transactions of insurers are reported in Annual Statements collected by the NAIC. These transparent internal capital markets allow us to execute a more direct test of internal capital market efficiency than has been possible in previous efforts.

First, we present summary statistics that appear consistent with efficient internal capital markets. We show that the average investment of companies receiving funds via internal capital market transactions is greater than that of companies providing capital to other members of their groups. While encouraging, this evidence is far from conclusive.

We develop and test a model of insurance company investment behavior. We find that the investment of an insurer is positively related to variables representing its capitalization, and negatively related to its underwriting risk exposure. Specifically, we show that insurer investment is positively related to changes in its surplus and reinsurance ceded, and negatively related to the geographic concentration of insured exposures.

Finally, we disaggregate the capitalization variables in the model based on whether or not the changes in capitalization result from internal capital market transactions. A new regression model, formed by replacing the two aggregate capitalization variables with the four new variables, is then estimated. The two variables representing internal capital market transactions both display a significant and positive relationship with investment. We interpret these results as consistent with efficient internal capital markets in insurance groups. The relatively large coefficients on the internal capital market variables imply that internal capital market transactions play an economically significant role in the investment decision of affiliated insurers.

As noted above, these results directly contradict the conclusions of previous studies of firms across multiple industries, excluding the financial sector. However, our results concerning the importance of internal capital market transactions with respect to a company's investment behavior are consistent with the conclusions of Houston, James,

and Marcus (1997) and Klein and Saidenberg (1998). The samples in these studies were limited to members of bank holding companies. Collectively, these efforts point to financial intermediation activities as a catalyst for active and efficient internal capital markets. This observed difference in behavior between financial intermediaries and firms in other industries may be due to increased information asymmetries likely to exist between financial intermediaries and external sources of capital (Diamond, 1984; Houston, James, and Marcus, 1997). These information asymmetries may increase the cost of capital from external sources relative to internal capital and, as a result, financial firms may rely more on internal funds to finance investment.

CHAPTER 5

CONCLUSIONS

5.1) Introduction

The dissertation investigates the use of internal capital market transactions within insurance groups. Using a sample of affiliated insurers from 1996-1999, the dissertation explores the insurers' choices between internal reinsurance, which the primary insurer purchases from its affiliates, and external reinsurance, which the primary insurer purchases from a company outside of its group. Then we test the relationships between an insurer's investment and financing decisions to determine if internal capital markets are operating efficiently within insurance groups.

5.2) Contributions

There are two ways in which the dissertation contributes to the existing literature. First, by using a more recent sample of insurers, we are able to investigate the insurer's choice between internal and external reinsurance. Even though affiliated insurers are involved in ninety-eight percent of reinsurance transactions, prior studies have, for the most part, excluded affiliated companies. Second, the available data on insurance company transactions among affiliates allows us to observe internal capital market transactions. These transparent internal capital markets allow us to perform more direct tests on the efficiency of internal capital markets than has been possible in previous studies of other industries.

5.2.1) Internal versus External Reinsurance

Prior studies have not investigated the insurer's choice between internal and external reinsurance. While an overwhelming majority of reinsurance transactions take place among affiliated insurers, this study is the first to incorporate the choice between internal and external reinsurance into the explanation of an insurer's decision to cede reinsurance. Earlier studies used sample periods that predate 1989, the first year in which internal and external reinsurance premiums ceded were separated on the statutory reporting form. In these studies, affiliated companies were either excluded, or controlled for using a binary indicator.

While merely including affiliated insurers is a contribution to the literature, we also use a simultaneous equations model to explore the choice between internal and external reinsurance. By examining this choice, we are able to draw conclusions about internal and external reinsurance, which also apply to the more general finance topic of internal versus external capital markets, a topic which has received very little attention in the insurance literature.

5.2.2) Testing Internal Capital Market Efficiency

The theoretical framework for explaining the implications of internal capital markets has been visited by several authors beginning with Alchian (1969) and Williamson (1975). Only in the last decade have scholars begun to empirically for internal capital market activity and efficiency. The most significant barrier to directly testing for internal capital market efficiency is evident in the need to test for internal capital market activity noted above. In most industries, firms are not required to report internal capital market

transactions, and this lack of transparency in internal capital markets makes it difficult for one to study their efficiency.

The dissertation uses data from firms in the insurance industry, which includes capital transactions among affiliated insurers. The data provides an opportunity to directly test the efficiency of internal capital markets by examining the relationship between an insurer's investment and the amount of capital it receives in the form of internal capital market transactions. To our knowledge, no prior study of internal capital market efficiency has employed such a direct test.

Conclusions of the dissertation complement those of several other studies, both theoretical and empirical, on the topic of internal capital markets. Stein (1997) posits that internal capital markets may be more useful to companies that possess many characteristics common in financial intermediaries. Shin and Stulz (1998) study a sample of firms from a broad cross-section of industries, excluding financial services. They find limited evidence of internal capital market activity, and no evidence of internal capital market efficiency in these firms. Lamont (1997) finds that non-oil subsidiaries of conglomerates participating in the petroleum industry subsidized the activities of affiliated oil companies following the drastic decline in oil prices that occurred in the mid-1980's. This activity is consistent with inefficient internal capital market activity, where a headquarters reallocates funds to subsidize a failing subsidiary, instead of reallocating funds to affiliates with the best investment opportunities.[14] In sharp contrast

[14] Note that, while such activity is consistent with inefficient internal capital market activity as defined in the dissertation, it may also be the case that the expected future investment opportunities of the oil subsidiaries were superior to the current investment opportunities available to the other subsidiaries in the conglomerate.

to the conclusions of the studies described above, studies conducted using data from financial intermediaries find evidence consistent with active and efficient internal capital markets. Houston, James, and Marcus (1997), and Houston and James (1998), find strong evidence of active internal capital markets within a sample of bank holding companies. Klein and Saidenberg (1998) find that multiple-bank holding companies, which have the ability to create an internal capital market, outperform a simulated portfolio of their unaffiliated, "pure-play" counterparts in several aspects related to the efficient use of capital. This evidence is consistent with efficient internal capital markets within bank holding companies.

The dissertation complements the studies referenced above by conducting a more direct test of internal capital market efficiency among financial intermediaries. Also, evidence presented in the dissertation is consistent with efficient internal capital markets. This finding validates several interpretations Stein's (1997) theory, in which other authors have acknowledged the similarities between financial intermediaries and firms that Stein predicts will exhibit active and efficient internal capital markets.

5.3) Major Findings

Several significant findings are presented in the dissertation. In Chapter Three, we reaffirm evidence from prior studies of the reinsurance purchase behavior of unaffiliated firms by studying a larger, more representative sample of insurers. We also break new ground by finding evidence consistent with differences in the supply and demand of internal versus external reinsurance. In Chapter Four, we develop and empirically test a model of the relationships between insurance company investment and financing behavior. Then we modify the model to recognize the source of changes in insurer

capitalization, and we use this model to test for internal capital market efficiency among affiliated insurers.

5.3.1) Internal versus External Reinsurance

In Chapter Three of the dissertation, we use a two-stage least squares regression model to control for possible endogeneity while testing for factors that affect the insurer's decision to cede reinsurance. As noted above, prior studies of the demand for reinsurance do not include affiliated insurers in the primary sample. The first major contribution of the dissertation is to validate the findings of previous studies of external reinsurance purchase decisions by examining a larger sample that is more representative of the insurance industry. The dissertation presents results pertaining to the purchase of external reinsurance similar to those of Mayers and Smith (1990) and Garven and Lamm-Tennant (2000). We also find that some of the factors that affect the decision to purchase external reinsurance affect the internal reinsurance purchase decision in the same way.

The most interesting findings in the third chapter of the dissertation involve the factors that have different affects on the consumptions of internal and external reinsurance. Some appear to be structural differences, based on the underlying reason for purchasing the reinsurance, while others are consistent with a difference in costs and availability of internal versus external reinsurance.

The major structural difference is the ability of the primary insurer to access the reinsurer's comparative expertise in real services. We find that insurers with exposures that are more geographically concentrated cede fewer premiums to external reinsurers, but do not differ significantly in internal reinsurance ceded. These results are consistent with insurers ceding external reinsurance to take advantage of the reinsurer's comparative

advantage in activities such as claims handling and rate making in different geographic areas, rather than to hedge the exposure catastrophic loss inherent in geographically concentrated exposures. It makes sense that this factor does not affect the demand for internal reinsurance because, if affiliated insurers share the common goal of maximizing the value of the group, such expertise should be shared among affiliates without the need for a reinsurance contract.

The primary evidence of a difference in the costs of internal and external reinsurance is the significant and positive coefficient on our proxy for the proportion of an insurer's investment income that is exempt from federal income taxes. Garven and Lamm-Tennant (2000) propose that an insurer will demand more reinsurance if it holds more assets in tax-favored securities. We find this to be true for internal reinsurance, but, like Garven and Lamm-Tennant (2000), we find that the same does not hold for external reinsurance. We attribute this distinction to increased loading costs included in external reinsurance premiums. These loading costs are likely to be the result of information and agency problems involved in dealing with unaffiliated companies, which should not be as severe for internal reinsurance transactions.

Finally, while discussion in the dissertation is primarily structured in the context of demand for reinsurance, to facilitate comparison to previous studies, the dissertation is the first study, to our knowledge, that recognizes possible supply-side factors that may influence the insurer's decisions related to the purchase of reinsurance. We control for differences in internal reinsurance capacity available to the insurer by including a variable that measures the insurer's size relative to the rest of its group. If the insurer is very large relative to the rest of its group, there may not be adequate capacity available

for the insurer to cede a significant portion of its written premiums to its affiliates. Results are consistent with these supply-side factors influencing the insurer's consumption of reinsurance. We also recognize that several of the factors used in this study, and previous studies, to explain the primary insurers demand for reinsurance are also likely to effect the price a reinsurer would charge for reinsurance.

5.3.2) Internal Capital Market Efficiency in Financial Intermediaries

The fourth chapter of the dissertation concludes that internal capital markets operate efficiently within insurance groups. Our definition of internal capital market efficiency is consistent with that of Shin and Stulz (1998), where a central governing authority reallocates capital to the group members with the best investment opportunities. Insurance company investment is defined as the change in premiums written from one period to the next. If the internal capital market allocates funds to the companies with the best investment opportunities, then the companies that receive capital from other group members should display a corresponding positive investment. Alternatively, the internal capital market could be used to subsidize insurers that have performed poorly in previous periods. In this case the corresponding change in premiums written should be non-positive.

We begin by testing a model of the relationships between an insurer's investment and financing behavior. We posit that, in order to increase premiums written, an insurer must also do at least one of four things: (1) hold more capital, (2) cede more reinsurance, (3) decrease its exposure to underwriting risk, or (4) increase its probability of insolvency. Because increasing probability of insolvency has been shown to significantly decrease

the price an insurer can charge for insurance (Sommer, 1996), we do not expect insurers to routinely choose the fourth alternative.

Empirical results support the hypotheses of our model. We find a significant and positive relationship between changes in an insurer's capitalization and changes in premiums written. We also find a significant and negative relationship between an insurer's investment and changes in its exposure to underwriting risk. Specifically, we find that when insurers increase (decrease) reinsurance ceded, or increase (decrease) the amount of surplus they hold, they increase (decrease) the amount of premiums they write. We also find a negative relationship between the geographic concentration of premiums written, one of our proxies for exposure to underwriting risk, and investment.

Our next step is to adjust the model to separately account for changes in capitalization that result from internal capital market transactions, and those that result from the company's own operations, such as ceding external reinsurance, transferring retained earnings to surplus, or issuing new equity. Internal capital market transactions include changes in the ratio of net internal reinsurance premiums ceded to total premiums written. They also include changes in the insurer's net position in surplus notes transacted with affiliated insurers. We replace the two variables representing changes in capitalization in our original model with four variables, two that measure changes in capitalization resulting from internal capital market transactions, and two that measure changes in capitalization that are not the result of internal capital market transactions.

Results from estimating the new equation are consistent with efficient internal capital markets within insurance groups. The coefficients on the variables measuring internal capital market activity are significant and positive. Moreover, the coefficients

themselves are of greater magnitude than their counterparts representing changes in capitalization from sources other than internal capital markets. Thus, we conclude that not only are internal capital markets operating efficiently within insurance groups, but that internal capital market activity plays an economically significant role in the operations of affiliated insurers. As mentioned above, in Section 5.2.2, results in this chapter of the dissertation may represent the most direct evidence of internal capital market efficiency recorded to date.

5.4) Limitations of the Dissertation and Areas for Future Research

The dissertation investigates differences in cost between internal and external capital, as well as the efficient distribution of capital among group members. One factor not directly incorporated in this study involves the cyclical nature of the insurance industry. Historically, the insurance industry has exhibited what are known as hard market and soft market periods. A hard market is characterized by decreasing capacity to write insurance and increasing premiums. In a soft market, premiums are decreasing and capacity is increasing. While the cause of changes in market conditions is a subject of great controversy in the insurance literature, the effect of these changes on the capital structure decisions of insurers is likely to follow a distinct pattern. During a hard market, the cost of external capital is likely to increase relative to that of internal capital due to the industry-wide decrease in underwriting capacity.

Ultimately, one would like to use data that spans an entire market cycle. However, because data from prior reporting periods does not contain the necessary level of detail, and more recent data is not yet available, the dissertation analyses data from a period completely contained in a soft market. The most recent shift from a hard market to a soft

market occurred in the early 1990's. Many industry experts agree that only now, in the wake of the September 11, 2001 World Trade Center tragedy, are insurance markets beginning to harden again.

Fortunately, the sample period employed in the dissertation is such that any bias introduced by changes in market conditions would decrease the likelihood of finding the results discussed in this study. Evidence is presented that is consistent with internal capital costing less than external capital during a period when the difference between the two should be minimized. Also, we find that internal capital markets are important to insurance companies during a period when their effect should be less important compared to periods defined as a hard market.

In the future, it may be interesting to explore the effects of industry-wide changes in underwriting capacity on the relative costs of internal versus external capital, and the importance of internal capital markets within insurance groups. In addition to the changes in insurer behavior following the World Trade Center tragedy, another interesting catalyst in the market is the passing of the Gramm-Leach-Bliley Financial Services Modernization Act (GLBA). The GLBA allows companies participating in other aspects of the financial services industry to sell insurance. This change in regulation may result in significant changes in capitalization in the insurance industry, as well as changes in the distribution channels of insurance products.

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