

## **A REEXAMINATION OF THE CORPORATE DEMAND FOR REINSURANCE**

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### **ABSTRACT**

This study examines the effect of the state of the international reinsurance market on the demand for reinsurance by U.S. insurers using data from the years 1993 through 2000. Both the overall demand for reinsurance and the utilization of foreign reinsurance by U.S. insurers are explored. In addition to supporting the findings of prior literature related to the traditional motives for the corporate demand for insurance, evidence indicates that the state of the U.S. reinsurance industry impacts the amount of reinsurance demanded by U.S. insurers. The study also investigates reasons why U.S. insurers utilize a reinsurance program composed of both U.S. and foreign reinsurers. The results indicate that the decision to utilize some percentage of foreign reinsurance is driven primarily by the financial and operational characteristics of the ceding company such as firm size, group affiliation, and organizational form. However, no support is found for the hypothesis that possible differences between the foreign and U.S. reinsurance markets impact the decision to utilize foreign reinsurance.

### **INTRODUCTION**

The reinsurance industry has undergone several major changes in recent years. For example, recent research indicates that there is increasing concern about adequate capacity as a result of several large wide-scale losses including Hurricane Andrew, the Northridge Earthquake, Typhoon Mireille, and most recently, the terrorist attack on the World Trade Center (e.g., Cummins and Weiss, 2000; Swiss Re, 2002; Standard and Poor's, 2002). In addition, there has been consolidation observed within the reinsurance industry. Finally, recent underwriting losses coupled with a decrease in investment returns also have impacted the reinsurance industry. These changes have

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resulted in reductions in both capacity and profitability within the global reinsurance market. With lower levels of capacity and potential increases in insolvency risk, the decision of how much reinsurance to purchase and how to construct an overall reinsurance program is of critical importance to insurers.

This study seeks to answer the question of whether the state of the reinsurance industry is related to the demand for reinsurance. Additionally, the article analyzes the way in which reinsurance programs are constructed by investigating the decision of U.S. insurers to utilize the foreign reinsurance market. By examining both the impact of the state of the reinsurance market on the demand for reinsurance and the utilization of foreign reinsurance by U.S. insurers, the study seeks to provide a more complete examination of the demand for reinsurance by U.S. insurers.

Reinsurance is an important transaction for primary insurers. Adiel (1996) finds that it can be used to increase insurer capital and earnings and to reduce regulatory costs. However, if a reinsurer becomes insolvent, due to some firm-specific cause or some external force, it can have severe adverse effects for a variety of stakeholders. For example, if a reinsurer is unable to pay for losses, the ceding company is then responsible for the losses. This can lead to one or more of the following: (1) decreased capacity and financial strength of the ceding company; (2) financial distress and/or increased costs of capital for insureds that may be without coverage; (3) a strain on remaining insurers if guaranty fund assessments are required to pay the claims of insolvent primary insurance companies; and/or (4) overall increased insurance costs and costs of capital related to further reductions or strains in the insurance markets.

In 2001, North America accounted for 56 percent of the cessions, the majority of this originating from U.S. insurers (Swiss Re, 2002). As such, the premiums ceded by U.S. insurers represent a large portion of total reinsurance in the global marketplace. Because of the size of the U.S. insurance marketplace and the large amounts of reinsurance required, some U.S. insurers depend on foreign reinsurance in constructing their overall reinsurance programs. Thus, the behavior of U.S. insurers is of interest to reinsurance and insurance regulators around the world.

Given that almost half of all U.S. reinsurers utilize some amount of reinsurance from foreign reinsurers, the potential for reinsurer insolvency is of concern to U.S. regulators as it could ultimately affect the pricing and availability of insurance to U.S. consumers as well as adversely impact the U.S. economy as a whole. This concern may be heightened by the use of foreign reinsurance since U.S. regulators have limited regulatory control over foreign reinsurers. Currently, the United States requires that foreign reinsurers either be licensed and therefore subject to regulatory requirements, or provide collateral based on the amount of reinsurance assumed from U.S. insurers. Rossi and Lowe (2002) point out that many countries indirectly regulate foreign reinsurers by: (1) restricting the amount of coverage domestic insurers can purchase from foreign reinsurers or the particular reinsurers domestic insurers can use; (2) requiring capital be held in national funds as a safety net; and/or (3) requiring large amounts of information on the reinsurers.

The financial health of reinsurers has been affected by severe, wide-scale losses that have occurred in the past few years. Standard and Poor's estimates for the combined ratio for the reinsurance industry for 2000 was approximately 114 percent. The average

combined ratio of the top four reinsurers was higher at slightly more than 116.1 percent (Standard and Poor's, 2001).<sup>1</sup> Though ratings for top reinsurers remained stable during this period, more recently, several large reinsurers have experienced rating downgrades, including every one of the reinsurers ranked in the top five based on 2003 net reinsurance premiums. In 1997, more than 30 percent of the top 125 reinsurers were either AAA or AA+ rated. In 2000, this had dropped to 20 percent.

In response to the potential global effects of financial distress and/or insolvencies of international reinsurers, the International Association of Insurance Supervisors (IAIS) set out to develop common supervisory standards for reinsurers. The standards, approved at the IAIS meeting in 2003, involve requirements in the area of financial strength, supervisory review, and disclosure (International Association of Insurance Supervisors, 2003). The hope is that countries will incorporate these common standards into their regulatory requirements. Though the goal of regulating reinsurers is to protect the domestic insurance market, reinsurance regulation can have some adverse affects. These effects may include increasing the cost of reinsurance and limiting the pool of potential sources of reinsurance (Rossi and Lowe, 2002).

Prior studies on the demand for reinsurance by U.S. insurers model the corporate demand for insurance by considering motives such as investment incentives, the probability of bankruptcy, tax effects, and the availability of real services (e.g., Mayers and Smith, 1990; Garven and Lamm-Tennant, 2003). However, these studies do not explicitly control for the potential influence of the state of the reinsurance industry on the decision to purchase reinsurance. The first portion of this study extends prior literature by controlling for changes in the U.S. reinsurance market in addition to insurer-specific characteristics when modeling the demand for reinsurance.

Although it is commonly accepted that the reinsurance market is a global one, an initial analysis of reinsurance ceded by U.S. insurers reveals that nearly half of U.S. insurers (48.9 percent) utilize some foreign reinsurance as a part of their overall reinsurance program. As noted in Weiss and Chung (2004), since a significant amount of reinsurance is ceded to foreign reinsurers, a better understanding of the characteristics of the world reinsurance market, including capacity of the non-U.S. market, is of heightened importance. The second portion of the study examines the firm-specific factors that motivate insurers to utilize foreign reinsurance. It also explores potential differences in the foreign and U.S. reinsurance markets to determine if these differences account for the use of foreign reinsurance when compared to U.S. reinsurance. By analyzing the decision to utilize some component of foreign reinsurance in constructing a reinsurance program, the article expands upon prior demand for insurance research by providing an understanding of the ways in which U.S. insurers interact with the global insurance market. A better understanding of the types of U.S. insurers entering the foreign reinsurance markets as well as some insight into the effects of the state of the reinsurance industry on the structuring of reinsurance programs can help regulators more effectively monitor and/or control the potential impact of a large capital shock in the foreign market on U.S. insurers and consumers. The importance

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<sup>1</sup> Since this information is not available for Lloyd's, the calculation of the average combined ratio only includes the top four reinsurers.

of these issues is evident by the push to develop international regulatory standards for reinsurers by the IAIS member countries.

The remainder of the article is divided into four sections. The following section of the article presents the hypotheses and variable development. Next, the data utilized and the empirical framework of the article are described. The results of the research questions are presented in the fourth section. Finally, the conclusions and implications of the article are discussed.

### **HYPOTHESES AND VARIABLE DEVELOPMENT**

Based on the two major research questions of the article, the hypotheses focus on issues related to both the overall demand for reinsurance and the utilization of foreign reinsurance. The hypotheses and variable development are divided into three major categories: (1) the traditional motives for the corporate demand for insurance based on the financial and operational characteristics of the ceding companies; (2) the state of the U.S. reinsurance industry; and (3) the potential differences in the foreign and the U.S. markets. Table 1 presents a complete variable list including variable definitions and predicted signs for the hypotheses outlined in this section. In many cases, the factors impacting the overall demand for reinsurance also influence the decision to include foreign reinsurance in the overall reinsurance program. However, the impact and importance of these factors may differ. These issues are outlined along with the variables that are utilized in the empirical portion of the article.

#### **Traditional Motives for the Corporate Demand for Insurance**

Prior studies, such as Mayers and Smith (1990) and Garven and Lamm-Tennant (2003), find that several firm-specific factors affect the corporate demand for insurance. These factors include the probability and cost of bankruptcy, investment incentives, tax effects, and the availability of real services. The following section discusses these factors relative to prior research and describes the proxies used in this study to test their impact on the corporate demand for insurance and the decision to utilize foreign reinsurance.

*Bankruptcy.* A study by Hoerger, Sloan, and Hassan (1990) finds that the probability of bankruptcy influences a firm's decision to purchase reinsurance. The purchase of reinsurance shifts some portion of the insurer's risk to the reinsurer, thus reducing the probability and/or expected cost of bankruptcy. In his study of direct bankruptcy costs of railroads, Warner (1977) finds evidence that implies these costs are not proportional to size, suggesting that bankruptcy costs are higher for smaller firms. Several studies test the effect of bankruptcy costs on the corporate demand for insurance using size as a proxy (e.g., Mayers and Smith, 1990; Hoyt and Khang, 2000; Garven and Lamm-Tennant, 2003; Weiss and Chung, 2004). All studies find that size negatively impacts the purchase of insurance, suggesting that an indirect relationship exists between size and the decision to purchase insurance. Like prior papers, this study includes the natural logarithm of admitted assets to test the hypothesis that smaller insurers are more likely to purchase reinsurance. This same argument is not expected to hold for the use of foreign reinsurance. As larger insurers work to place an overall reinsurance program, the firms will likely need the extra capacity present in the foreign markets, as the domestic market may not have sufficient capacity to meet the needs of these

**TABLE 1**  
Summary of Hypotheses

| Variable                             | Impact on Demand for Reinsurance | Impact on Use of Foreign Reinsurance | Definition                                                                                                                                                                  |
|--------------------------------------|----------------------------------|--------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Insurer Factors</b>               |                                  |                                      |                                                                                                                                                                             |
| Return on assets                     | —                                | —                                    | Return on assets                                                                                                                                                            |
| Direct business/surplus              | +                                | +                                    | Direct business written/surplus                                                                                                                                             |
| Tax-exempt inv. inc./total inv. inc. | +                                | +                                    | Tax-exempt investment income/total investment income                                                                                                                        |
| 2-yr loss Development                | +                                | +                                    | The development in estimated losses and loss expenses incurred 2 years before the current year and prior year scaled by policyholders' surplus                              |
| Size                                 | —                                | +                                    | Natural logarithm of admitted assets                                                                                                                                        |
| Group dummy                          | +                                | +                                    | Dummy variable equal to 1 if affiliated, 0 otherwise                                                                                                                        |
| Line-of-business Herfindahl          | —                                | ±                                    | Line-of-business Herfindahl index                                                                                                                                           |
| Stock dummy                          | —                                | —                                    | Dummy variable equal to 1 if stock company, 0 otherwise                                                                                                                     |
| Geographic Herfindahl                | ±                                | ±                                    | Geographic Herfindahl index                                                                                                                                                 |
| <b>Reinsurance Industry Factors</b>  |                                  |                                      |                                                                                                                                                                             |
| Reinsurers' price                    | —                                | N/A                                  | Net premiums written to the present value of accident year incurred losses adjusted for underwriting expenses, loss adjustment expenses, and dividend payments              |
| Reinsurers' liquidity                | ±                                | N/A                                  | Cash and invested assets/total liabilities of the reinsurance industry                                                                                                      |
| Reinsurers' 2-yr loss development    | —                                | N/A                                  | The development in estimated losses and loss expenses incurred 2 years before the current year and prior year scaled by policyholders' surplus for the reinsurance industry |
| Diff. in combined ratios             | N/A                              | ±                                    | Difference in the average combined ratio of the foreign market and the U.S. market                                                                                          |
| Diff. in log of net tech. reserves   | N/A                              | +                                    | Difference in the natural logarithm of the net technical reserves of the foreign market and U.S. market                                                                     |

firms. As a result, the relationship between the size of the firm and the use of foreign reinsurance is expected to be positive.

Leverage also is expected to affect the probability of bankruptcy. Carson and Hoyt (1995) find that there is an optimal level of leverage, after which additional increases in leverage actually decrease firm value. As with other studies, they also find that higher levels of leverage are often associated with an increase in the probability of

bankruptcy. This study examines the potential effect of leverage on the demand for reinsurance by including a variable measuring a firm's direct business written to surplus. Garven and Lamm-Tennant (2003) suggest that reinsurance is a substitute for surplus. Therefore, a positive relationship is expected between direct business written to surplus and corporate demand for insurance. This result would suggest that firms writing more business relative to surplus would have a greater need for reinsurance because they have a higher probability of insolvency.<sup>2</sup> This argument is likely to hold for both the overall purchase of reinsurance as well as the purchase of foreign reinsurance.

Finally, several studies document the manipulation of loss reserves as a means of meeting financial objectives (e.g., Petroni, 1992; Weiss, 1985; Grace, 1990; Christensen, Hoyt, and Paterson, 1999; Gaver and Paterson, 1999). Petroni (1992) finds that financially troubled insurers are more likely to understate loss reserves. This study uses the 2-year loss development to determine if adjustments to loss reserves affect the demand for reinsurance.<sup>3</sup> This variable indicates whether the insurer has been under- or over-reserving. If an insurer has a positive loss development, or has been under-reserving, then the insurer is likely to demand more reinsurance in an effort to mitigate potential financial constraints. This same incentive is likely to drive insurers into foreign markets. The effect may be even more pronounced with the use of foreign reinsurance if foreign reinsurers are less able to detect reserving errors due to increased levels of asymmetric information and/or have less stringent requirements for ceding companies than U.S. reinsurers.

*Investment Incentives.* Myers (1977) theorizes that, under certain circumstances, firms may have the incentive to reject positive net present value projects due to the conflicts of interest that exist between shareholders and debt holders. Since policyholders, like debt holders, have claims to the assets of the firm, managers also may have cause to reject positive net present value projects if the possibility of a large unexpected loss exists. Mayers and Smith (1990) hypothesize that the use of reinsurance can potentially reduce underinvestment by transferring some of the uncertainty resulting from the potential for large losses to the reinsurer. Both Mayers and Smith (1990) and Powell and Sommer (2002) use leverage to test this hypothesis. The current study uses both leverage and profitability. Highly leveraged firms are expected to utilize more reinsurance due to the greater risk of insolvency. Additionally, firms that are more profitable should be better able to absorb large unexpected losses and therefore be less affected by the underinvestment problem. As a result, it is expected that more profitable insurers will demand less reinsurance, including foreign reinsurance. This study uses return on assets as its measure of profitability. Since return on assets can vary by line, size, and line of business, additional variables are included in part to control for this variation.

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<sup>2</sup> Additionally, higher leverage may increase the underinvestment problem due to the increase in the likelihood of insolvency. This is further discussed in the next section.

<sup>3</sup> This variable is taken from the 5-year historical page of the *NAIC Property-Casualty Database*. It is defined as the development in estimated losses and loss expenses incurred 2 years before the current year and prior year scaled by policyholders' surplus. If this proxy is positive, this is evidence of under-reserving.

*Taxes.* Prior studies suggest that the structure of the tax code affects an insurer's decision to purchase insurance. This can occur for two reasons. First, since the corporate tax structure is progressive in nature, a firm can reduce its expected tax liabilities through a reduction in earnings volatility (Smith and Stulz, 1985). Mayers and Smith (1990) find evidence of this being a motive for the purchase of reinsurance. They find that the use of reinsurance can reduce fluctuations in earnings, thereby reducing the insurer's expected tax liability.

Second, Garven and Lamm-Tennant (2003) suggest that since the use of reinsurance can reduce the effects of large unexpected losses, it increases the probability that an insurer would gain some benefit from investment in tax-favored assets. For this reason, they examine the effect of tax-exempt investment income relative to total investment income on the corporate demand for insurance. A similar measure is used by D'Arcy and Garven (1990). It is expected that the greater the percentage of investment income generated from tax-favored assets, the greater the incentive to smooth earnings through the use of reinsurance to preserve this tax shield. As a result, firms with more tax-favored assets are expected to demand more foreign and domestic reinsurance. In addition to this variable, two alternative measures of tax are examined to assess the overall impact of taxation on the hypothesis that higher levels of taxation would lead to an increased incentive to smooth earnings and thus purchase higher levels of reinsurance. These alternate variables are a tax dummy equal to one in years in which insurers paid federal taxes and zero otherwise as well as the total amount of federal taxes paid relative to firm assets.

*Real Services.* Reinsurers provide real services to the ceding companies such as claims handling and pricing. In some cases, reinsurers have a comparative advantage over insurers due to specialized knowledge and/or economies of scale. The extent of this comparative advantage is thought to be linked to the concentration of the insurer. If an insurer is less concentrated in terms of business mix or geographic concentration, it is likely to benefit from the expertise and real services of the reinsurer. As a result, a negative relationship is expected. However, this may not always be the case. Since the use of reinsurance can increase diversification of risk, insurers wishing to increase diversification due to either high concentrations in a given line of business or geographic area, may have an increased incentive to use reinsurance, and to a greater extent, foreign reinsurance to achieve this goal. Thus, high levels of concentration may lead to a higher demand for reinsurance in which case a positive relationship between concentration and the use of both reinsurance and foreign reinsurance is expected. In order to test the impact of an insurers level of diversification, two common measures of concentration are included. The measure of geographic concentration used is a geographic Herfindahl index.<sup>4</sup> A line-of-business Herfindahl index is used as a proxy for line-of-business concentration.

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<sup>4</sup> As an additional robustness test, the negative of the number of states in which the firm is licensed is used in place of the geographic Herfindahl. This measure is used in some prior studies which examine reinsurers (e.g., Mayers and Smith, 1990; Garven and Lamm-Tennant, 2003). This issue is further discussed in the results section of the article.

*Additional Factors.* In addition to the motives outlined above, prior studies have suggested that factors such as organizational form, business mix, and group affiliation may impact the demand for reinsurance. Other studies find that the organizational form of the insurer has an impact on the firm's level of risk, business mix, and operations (Mayers and Smith, 1981; Lamm-Tennant and Starks, 1993; Pottier and Sommer, 1997). In an effort to control for potential agency costs related to organizational form, a dummy variable indicating whether the firm is a stock or mutual company is included.<sup>5</sup> Due to the fact that mutuals are likely to have greater difficulty accessing sources of new capital in the event of a large loss, it is expected that they will purchase more reinsurance.

Differences in the lines of business sold affect a firm's investment opportunities, earnings volatility, and overall level of risk. To control for these effects as well as the potential effect of variations in lines of business on the demand for reinsurance, variables measuring the proportion of premiums written in each line of business are included in the models. In certain lines of business, such as liability-related lines, where agency costs may be higher, there may be increased incentives to cede higher levels of insurance. In property lines, if geographic concentration is higher, insurers also may cede more. Prior studies control for this effect in a similar manner (e.g., Mayers and Smith, 1990). This is especially important in the equation modeling the purchase of foreign reinsurance as much of the placement of certain lines of coverage is likely related to the capacity and specialization of specific reinsurers rather than a preference for domestic versus foreign reinsurance.<sup>6</sup>

Finally, group affiliation can be important to the firm for several reasons. Specifically relating to the purchase of reinsurance, Mayers and Smith (1990) hypothesize that insurance companies that are members of groups are expected to reinsure more. This is because the use of reinsurance can shift profits within the group and ultimately reduce the taxes the group pays as a whole. Their study, as well as that of Powell and Sommer (2002), finds some support for this hypothesis. Since our sample includes both affiliate and unaffiliate insurers, a group affiliation dummy is included in the models to control for the potential affiliation effect.

As a robustness test, additional models are constructed examining the demand for reinsurance by unaffiliate firms. This is done to determine if the results obtained

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<sup>5</sup> This measure was used by Garven and Lamm-Tennant (2003). Other papers such as Mayers and Smith (1990) and Powell and Sommer (2002) include more detailed classification schemes for organizational form. As a robustness test, a series of dummy variables similar to those used by Powell and Sommer (2002) were included. Results of these tests are discussed in the results section of the article. Due to data limitations, the classification scheme of Mayers and Smith (1990) is not reproduced.

<sup>6</sup> A somewhat related issue is the difference in the placement of facultative and treaty reinsurance. Although both types of reinsurance are likely to be driven in part by the same firm-specific and industry factors, it is likely that facultative reinsurance will be impacted by line-of-business concerns as well as special traits of a given risk. In part, the line-of-business controls should help to control for some of the effects of these transaction-specific contracts. However, the authors do acknowledge that this is not a perfect control and that the difference in motivations for the use of facultative reinsurance might bias against the finding of significance due to additional noise.

in the primary models are attributable in some portion to the movement of funds within groups' internal capital markets that is not adequately controlled for with the group affiliation dummy. The potential impact of group affiliation also is important in the equation examining the demand for foreign reinsurance, as variations in the results could indicate that these transactions are driven primarily by affiliations with foreign reinsurers, and not insurer-specific factors or differences in the U.S. and foreign reinsurance markets. Mayers and Smith (1990) note that this type of "business group pooling" could bias results, primarily with the relationship between reinsurance and firm size, concentration, and line-of-business controls. As a result, Mayers and Smith (1990) and Garven and Lamm-Tennant (2003) screen out affiliate insurers from their samples. In order to provide comparability to these studies, as well as to test the robustness of this study's results, the models in this study also are run using only unaffiliate reinsurers.

#### The Impact of the State of the Reinsurance Industry—U.S. Market

In addition to the firm-specific factors discussed above, the state of the U.S. reinsurance market is expected to affect the demand for reinsurance by U.S. insurers. The reinsurance industry variables are based on yearly data for all U.S. reinsurers and include factors measuring the average price, loss reserving status, and liquidity of the U.S. reinsurance industry. The method used to classify firms as reinsurers as well as additional details on construction of these variables are discussed in the data section.

*Price.* Price is one of the major factors expected to affect the amount of reinsurance purchased. As seen in the wake of the World Trade Center attack, both insurance and reinsurance can become unaffordable when the industry is subjected to large wide-scale losses. Based on the capacity constraint theory, wide-scale loss shocks can limit the overall supply of reinsurance, temporarily driving up prices (e.g., Winter, 1994; Cummins and Danzon, 1997; Weiss and Chung, 2004). It also is expected that as the cost of reinsurance increases, the amount of reinsurance demanded will decrease. This relationship can be somewhat limited by the risky debt hypothesis, which provides that more financially stable reinsurers are able to charge higher prices for coverage (e.g., Cummins and Danzon, 1997; Weiss and Chung, 2004). Thus, the overall flight to less expensive coverage may be mitigated by the importance of financial quality. This effect is measured by examining the inverse of the economic loss ratio of the reinsurance industry. This ratio is defined as net premiums written to the present value of accident year incurred losses adjusted for underwriting expenses, loss adjustment expenses, and dividend payments. This type of price measure has been used in several other studies and is considered a more accurate measure of price in that losses are adjusted for varying payout patterns by line of business.<sup>7</sup>

*Development of Loss Reserves.* The development of loss reserves of the U.S. reinsurance industry is expected to affect the demand for insurance. Since the ceding company

<sup>7</sup> For a detailed discussion of the benefits of using economic loss ratios as well as constructing the ratio see Winter (1994); Sommer (1996); Chidambaran, Pugel, and Saunders (1997); Cummins and Danzon (1997); and Weiss and Chung (2004).

is ultimately responsible for the losses if the reinsurer becomes insolvent, it is in its best interest to place coverage with financially sound reinsurers. The loss development variable indicates whether the original reserves established by the reinsurers are adequate, or in effect, if the reinsurers are under- or over-reserving. This study uses the average 2-year loss development for the reinsurers to capture this effect. If the reinsurance industry as a whole has been under-reserving, as would be evident by a positive value for this variable, it is expected that the demand for reinsurance will decrease. As described in the insurer section above, under-reserving can be used to mask poor performance.

*Liquidity.* The liquidity of the reinsurance market can have multiple implications. First, if the reinsurance industry is liquid, or has a sufficient amount of cash and invested assets on hand, insurers will likely consider the industry more stable and financially sound and reinsure more. Second, liquidity can be a sign of excess capacity, which could increase reinsurers' incentive to supply more reinsurance. Alternatively, as suggested by the capacity constraint hypothesis, reinsurers may hold on to excess capacity in an effort to have available capital for use in times of tighter markets.<sup>8</sup> The liquidity of the U.S. reinsurance industry is used to measure this effect. This variable is defined as the average cash and invested assets scaled by total liabilities for U.S. reinsurers. It is expected that the liquidity of the reinsurers will be positively related to the amount of reinsurance demanded.

#### Reinsurance Industry Factors—World Market

The state of the foreign reinsurance market in relation to the U.S. market is expected to influence the decision to use foreign reinsurance. Since the type of information available on foreign reinsurers is limited, this study uses the combined ratio and the net technical reserves of the foreign and U.S. markets to determine the impact of potential differences in these markets on the utilization of foreign reinsurance. Additional information regarding the construction of these variables is provided in the data section.

*Combined Ratio.* The combined ratio provides information about the performance of the foreign and U.S. reinsurance markets as well as the price of reinsurance. This ratio captures the profitability of the markets, as it encompasses the reinsurer's underwriting expenses and loss ratios. As such, the combined ratio is negatively correlated to the inverse loss ratio or price. If cost is of primary concern for insurers, it is expected that insurers will move toward the reinsurance market with the lower price. However, as suggested by prior authors, price is often positively correlated to financial quality (e.g., Weiss and Chung, 2004). If this is the case, insurers are not likely to automatically select the lowest price coverage due to the importance of the financial strength of the reinsurer. This study uses the difference in the average combined ratio of the foreign market and the U.S. market to test these competing hypotheses. If lower price is deemed more important than financial quality and foreign reinsurance is cheaper

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<sup>8</sup> See Weiss and Chung (2004) for a recent discussion and empirical examination of the capacity constraint hypothesis in the reinsurance market.

(the difference variable is positive), U.S. insurers will utilize more foreign reinsurance. Alternatively, if financial quality is deemed more important and foreign reinsurance is cheaper (the difference variable is negative), U.S. insurers will choose to reinsure more with the U.S. market.<sup>9</sup>

*Technical Reserves.* The technical reserve variable is a measure of the portion of premiums held to pay future claims. Since reinsurers that write more business will have larger reserves, this can be thought of as a proxy for the size of the market. In the case where the market is larger, price may be more competitive and there may be a difference in the quality of the real services received from the reinsurers. As explained by Weiss and Chung (2004), size also may be reflective of the financial strength of reinsurers, as all else being equal, larger reinsurers can absorb larger losses. Additionally, larger reinsurers may be better diversified and thus, in a competitive market better able to offer lower prices. The difference in the technical reserves variable measures the difference in the natural logarithm of the net technical reserves of the foreign and U.S. markets.<sup>10</sup> Since both price and real services would likely be important to U.S. reinsurers, it is expected that the difference in the natural logarithm of the net technical reserves will be positive and significant. Although the total size of technical reserves does provide some measure of the size of the market, prior research such as that of Winter (1994), Cummins and Danzon (1997), and Weiss and Chung (2004), highlights the importance of relative capitalization. For example, Weiss and Chung (2004) find that the price for nonproportional property reinsurance is positively related to the relative capacity in the U.S. reinsurance market as well as somewhat related to reinsurance capacity in other parts of the world. For this reason, a robustness test using an alternate measure is conducted.<sup>11</sup>

## DATA DESCRIPTION AND EMPIRICAL FRAMEWORK

### Data Description

Financial data for the insurers and reinsurers are collected from the *National Association of Insurance Commissioners Property and Casualty Database* for the period 1993 through 2000.<sup>12</sup> Companies with nonlogical values such as nonpositive values for assets, liabilities, surplus, or premiums are excluded. The remaining companies then were classified as either insurers or reinsurers. Reinsurers are defined as firms whose

<sup>9</sup> Due to the competitive nature of the international reinsurance market and the potential changes in pricing related to market cycles, price is not a perfect measure of financial quality of reinsurers. However, given the limited nature of the data available for the international reinsurance market, it does provide a proxy for this attribute.

<sup>10</sup> The net technical reserves is calculated by Standard and Poor's as "gross technical reserves, less reinsurers share of technical reserves and deferred acquisition costs."

<sup>11</sup> Due to data limitations, the alternate variable (which is measured as technical reserves to policyholders surplus), is only available for the years 1998 through 2000. To maximize the sample period, this variable is not included in the main models. However, the findings of the model including this variable are discussed in the results section.

<sup>12</sup> The NAIC financial data for the reinsurers described here is used in the first set of models only. Data from Standard and Poor's are used in the models examining the differences between the foreign and U.S. markets and are described in the following paragraph.

reinsurance assumed from nonaffiliates was more than 75 percent of the direct business written plus reinsurance assumed from affiliates.<sup>13</sup>

The aggregate U.S. reinsurance industry variables related to the price of reinsurance, the liquidity of the reinsurance industry, and the adequacy of the loss development patterns of reinsurers were generated based on yearly averages for firms classified as reinsurers. The final sample consisted of 2,183 unique insurers, 849 of which are unaffiliate firms, and 143 reinsurers, 65 of which are unaffiliate firms.

The data used to construct the difference variables for the foreign versus U.S. markets are obtained from Standard and Poor's *Global Reinsurance Highlights* (1998–2001 editions). These publications rank the top 100–150 reinsurers around the world based on net reinsurance premiums written. According to the 2000 edition, this sample accounted for almost 95 percent of the reinsurance premiums written in 1999. Composite data composed of all foreign markets are generated using a weighted average based on reinsurance premiums written in each country. These include the combined ratio, the net technical reserves, and the ratio of the net technical reserves to policyholders' surplus used to compare the foreign versus U.S. markets.<sup>14</sup>

### Empirical Framework

As mentioned previously, this study addresses two major questions. First, does the state of the U.S. reinsurance market relate to the overall demand for reinsurance? Second, what factors are associated with the placement of reinsurance in the foreign markets by U.S. insurers? To answer the first question, the following OLS regression is constructed to determine what factors affect the decision of insurers to purchase reinsurance:

$$\text{REINS}_{ij} = \alpha + \Sigma \beta X_{ij} + \Sigma \beta Y_j + \varepsilon_{ij}, \quad (1)$$

where,

REINS = reinsurance ceded/(direct business written plus reinsurance assumed);

$X$  = a vector of variables representing the insurer-specific characteristics of the  $i$ th insurer, including variables related to the traditional motives for the demand for reinsurance and firm-specific control variables, for the  $j$ th year;

$Y$  = a vector of variables representing the state of the reinsurance industry for the  $j$ th year.

<sup>13</sup> This is the classification scheme used by A. M. Best in its publications regarding reinsurers.

<sup>14</sup> Although the firms in the sample for the Standard and Poor's publications vary over time, more than 22 percent of the reinsurers are present in every year of the sample period and close to 70 percent are present in half the sample years or more, which suggests that the major players do not appear to change drastically during the sample period. The focus of this study is based on a composite measure of the U.S. versus foreign markets rather than firm specific changes related to the reinsurers and the Standard and Poor's publication indicates that these reinsurers consistently represent a large volume of the reinsurance premiums written. As such, these reinsurers provide a good representative sample of the overall state of the reinsurance market in various countries and it is unlikely that movement of reinsurers during the sample period will strongly bias the results.

As described in the hypotheses section, this model includes the traditional firm-specific factors found in prior studies to influence the corporate demand for insurance as well as the variables capturing price and the financial health of the U.S. reinsurance market. The dependent variable is the amount of reinsurance ceded to direct business written plus reinsurance assumed. The primary models include proxies for the ceding companies' loss reserving patterns, return on assets, size, leverage, use of assets with a favorable tax status, geographic concentration, line-of-business concentration, organizational form, group membership, and business mix. The state of the U.S. reinsurance industry is characterized by average price, development of loss reserves, and liquidity. Alternate models are constructed using a more detailed description of organizational form, an alternate measure of geographic concentration, and alternate tax variables. Results of these additional tests are described in the results section.

The model is examined for possible econometric problems. No evidence of multicollinearity or autocorrelation is found. Robust standard errors are presented in the results section to correct for heteroscedasticity. Additionally, tests for endogeneity indicate a potential problem among the firm level variables. In an effort to correct for that problem, lags are utilized for the firm level independent variables as suggested by Greene (1997) and Kennedy (1998).

The second set of models explores factors that influence the use of foreign reinsurance. Given that only approximately half of U.S. insurers use some foreign reinsurance, it is important to control for potential selection bias based on systematic differences in the types of firms that utilize some foreign reinsurance versus those that do not. Therefore, the following system of equations is estimated using a Heckman two-step estimation procedure:

$$\text{FOREIGN}_{ij} = \alpha + \Sigma \beta_1 X_{ij} + \varepsilon_{ij}, \quad (2)$$

$$\% \text{FOREIGN}_{ij} = \alpha + \Sigma \beta_2 X_{ij} + \Sigma \beta_3 Z_j + \beta_4 \lambda_{ij} + \varepsilon_{ij}, \quad (3)$$

where,

FOREIGN = 1 if the ceding company uses foreign reinsurance, 0 otherwise;

%FOREIGN = percentage of premiums ceded to foreign reinsurers/total premiums ceded<sup>15</sup>;

$X$  = a vector of variables representing the insurer-specific characteristics of the  $i$ th insurer, including variables related to the traditional motives for the demand for reinsurance and firm-specific control variables, for the  $j$ th year<sup>16</sup>;

$Z$  = a vector of variables representing the differences in the state of the foreign and U.S. reinsurance markets for the  $j$ th year;

$\lambda$  = inverse Mill's ratio of the  $i$ th insurer for the  $j$ th year;

$\varepsilon_{ij}$  = error term of the  $i$ th insurer for the  $j$ th year.

<sup>15</sup> The classification of foreign versus U.S. reinsurers is based on the Domiciliary Jurisdiction listed for the reinsurers in Schedule F—Part 3 of the annual statement.

<sup>16</sup> In an effort to fully identify the models, the 2-year loss development is only included in Equation (3).

Equations (2) and (3) provide a system of equations designed to better explain the factors related to the decision to utilize reinsurance from foreign reinsurers.<sup>17</sup> In Equation (2), a decision equation is estimated using a probit regression to model the decision to use or not to use foreign reinsurance. This provides information on the effects of insurer-specific characteristics that impact the decision to use foreign reinsurance. In the second equation, the percentage of foreign reinsurance ceded is modeled using both variables that measure insurer-specific characteristics as well as differences in the foreign and U.S. markets in an effort to characterize the extent to which foreign reinsurance is demanded by U.S. insurers. Through the use of the Heckman two-step procedure, the potential impact of selection bias in the second equation is controlled for, thus providing a more accurate assessment of the factors impacting the utilization of foreign reinsurance by U.S. insurers.

As with the models in the first half of the empirical framework, the firm-specific characteristics of the ceding firms included are variables capturing loss reserving patterns, return on assets, size, leverage, use of assets with a favorable tax status, geographic concentration, line-of-business concentration, organizational form, group membership, and business mix.<sup>18</sup> The variables serving as proxies for the potential differences in the foreign and U.S. reinsurance markets include the difference in combined ratios and the difference in net technical reserves. The results of all the models are discussed in the following section.

## RESULTS

### Summary Statistics

*Characteristics of the Ceding Companies.* Table 2 provides the summary statistics for the variables used in the demand and selection models. Statistics are reported for the full sample of insurers as well as the subsamples of those firms that cede some amount to foreign reinsurers and those that do not. This is done in an effort to provide an initial assessment of potential differences in the two subsets.

As mentioned in the previous section, this study uses both affiliate and unaffiliate insurers. While more than 60 percent of the 2,183 insurers in the sample are affiliate firms, these firms account for nearly 95 percent of the direct business written and 98 percent of the volume of reinsurance ceded.<sup>19</sup> By including both affiliate and unaffiliate firms in the sample and controlling for systematic differences with a group dummy variable, the sample size of the study is significantly increased and a more complete picture of the demand for reinsurance is developed. In addition, robustness tests of only unaffiliate insurers were conducted similar to prior studies (e.g., Mayers and Smith, 1982; Mayers and Smith, 1990; Garven and Lamm-Tennant, 2003).

<sup>17</sup> Tests for autocorrelation and multicollinearity did not indicate either was present. Robust standard errors are used to correct for heteroscedasticity. As with the models in Equation (1), lags of the firm-specific independent variables are included in an effort to mitigate the potential effects of endogeneity.

<sup>18</sup> In an effort to fully identify the models, the 2-year loss development is only included in Equation (3). Inclusion of the variable in both Equations (2) and (3) does not significantly change the results.

<sup>19</sup> When reinsurance ceded to affiliate firms is removed, the volume of premiums is 92 percent.

**TABLE 2**  
Summary Statistics

| Variable                                 | Full Sample | No Foreign | Some Foreign |
|------------------------------------------|-------------|------------|--------------|
| <b>Insurer Factors</b>                   |             |            |              |
| Return on assets                         | 0.0219      | 0.0216     | 0.0224       |
| Direct business/surplus                  | 2.5051      | 3.0097     | 1.9782       |
| Tax-exempt inv. inc./total inv. inc.*    | 0.2420      | 0.2347     | 0.2459       |
| 2-yr loss development <sup>a</sup>       | 2,707.86    | 5,251.43   | 52.09        |
| Size*                                    | 17.8268     | 17.2446    | 18.4556      |
| Group dummy*                             | 0.6735      | 0.5950     | 0.7554       |
| Line-of-business Herfindahl*             | 0.6391      | 0.6792     | 0.5973       |
| Stock dummy                              | 0.7291      | 0.7244     | 0.7342       |
| Geographic Herfindahl*                   | 0.5793      | 0.6593     | 0.4974       |
| Percent reinsurance ceded*               | 0.3662      | 0.3554     | 0.3774       |
| Percent reinsurance ceded to affiliates* | 0.1954      | 0.2091     | 0.1811       |
| Percent reinsurance ceded foreign        | 0.0945      | N/A        | 0.1931       |
| <b>Reinsurance Industry Factors</b>      |             |            |              |
| Reinsurers' price                        |             |            | 7.8386       |
| Reinsurers' liquidity                    |             |            | 8.4418       |
| Reinsurers' 2-yr loss development        |             |            | 1.3346       |
| Diff. in combined ratios                 |             |            | 0.8735       |
| Diff. in log of tech. reserves           |             |            | -0.5473      |

The study covers the period from 1993 through 2000.

\*An asterisk indicates that the mean values of the variables for insurers that use some foreign reinsurance are statistically different from those that do not use any foreign reinsurance at the 0.05 level or greater.

<sup>a</sup>This variable is defined as the development in estimated losses and loss expenses incurred 2 years before the current year and prior year scaled by policyholders' surplus. The mean of this variable is driven by several large observations. As a robustness test, models are reestimated removing these observations. The results are consistent with those reported in Table 3.

For the total sample, the average amount of reinsurance ceded to total direct business written plus reinsurance assumed is 0.3662. The minimum value for the variable is -0.6858, whereas the maximum is nearly 1. Intuitively, this variable should be bounded by 0 and 1. However, as noted by Mayers and Smith (1990), if premium dollars returned to an insurer exceed premium dollars ceded by the insurer in a particular year, a negative value can result.<sup>20</sup>

The average percentage of foreign reinsurance used is more than 9 percent. However, when considering only those insurers that use some foreign reinsurance, the average percentage of foreign reinsurance used more than doubles, to 19.3 percent. Most of the foreign reinsurance utilized is with unaffiliate reinsurers. For firms using some percentage of foreign reinsurance 16 of the 19.3 percent is from unaffiliate foreign reinsurers. This means that over 80 percent of reinsurance ceded by U.S. insurers is

<sup>20</sup> These observations account for less than 1 percent of the sample. Robustness tests removing these observations did not change the results of the model.

ceded to foreign unaffiliate reinsurers, suggesting that the use of foreign reinsurance is not merely a function of U.S. insurers ceding to their foreign parents or affiliates.

*T*-tests are performed to compare the financial and operational characteristics of insurers that use some percentage of foreign reinsurance with those that use none. The majority of the means are statistically different, including the percentage of income generated from tax-exempt assets, size, group affiliation, line-of-business concentration, geographic concentration, and percentage of reinsurance used. These results indicate that there are differences in firms that utilize foreign versus U.S. reinsurance.

*The International Reinsurance Market.* The market leaders remain fairly consistent over the sample period, with reinsurers in Europe and North America maintaining nearly 80 percent of the market share. Africa consistently has less than 1 percent of the market share during the sample period. Germany, Switzerland, France, and the United Kingdom control the majority of the European market share, while the majority of the North American market share is controlled by the United States.

Pair-wise comparisons are performed to compare the means of the combined ratio and net technical reserves of reinsurers in all foreign markets relative to the U.S. market. The foreign market data are aggregated and weighted using reinsurance premiums written. The *t*-tests do not indicate any differences exist relative to profitability or size of the aggregate foreign market versus the U.S. market.

As mentioned earlier, the reinsurance market is becoming increasingly concentrated due to consolidation. Based on information collected by Standard and Poor's, the top 10 reinsurers have consistently held more than 40 percent of the market share over the last 6 years. However, in some years, such as 1997, the market share of the top reinsurers is as high as 61 percent. When examining reinsurance groups, this concentration is even greater with the top five groups holding more than 50 percent of the market share in 2001 and 2002. Of these top groups, 80 percent are foreign insurers with the majority being reinsurers based in the European Union (seven of the ten in 2001, and six of the ten in 2002). This highlights both the important role that non-U.S. reinsurers play in the global reinsurance marketplace and the need for an understanding of the factors that motivate nearly half of the U.S. insurers to participate in the international reinsurance market whereas the remaining only utilize domestic reinsurance.

### The Corporate Demand for Insurance

Table 3 reports the results for Equation (1), which models the corporate demand for insurance.<sup>21</sup> The first set of variables describes the traditional motives based on the

<sup>21</sup> As a robustness test, the models are replicated with a sample of only unaffiliate reinsurers, in an effort to test the potential confounding effects of affiliate reinsurance on the results. The results of these tests are statistically similar with the addition of a significant and negative relationship between the level of tax-exempt assets and the purchase of reinsurance as well as a significant and positive relationship between the level of leverage and the purchase of reinsurance. The 2-year loss development variable is not significant in these models. These results suggest that there are some differences in the factors that influence the amount of reinsurance used by affiliate and unaffiliate insurers and suggest that additional research in this area is warranted.

**TABLE 3**  
Demand Model Results—U.S. Market

|                                        | Coeff.  | Std. Err. |
|----------------------------------------|---------|-----------|
| Intercept                              | 1.3336  | 0.0516*   |
| Insurer Factors <sup>a</sup>           |         |           |
| Return on assets                       | −0.3365 | 0.0435*   |
| Direct business/surplus                | 0.0001  | 0.0001    |
| Tax-exempt inv. inc./total inv. inc.   | 0.0035  | 0.0114    |
| 2-yr loss development <sup>b</sup>     | 0.0002  | 0.0000*   |
| Size                                   | −0.0450 | 0.0023*   |
| Group dummy                            | 0.1016  | 0.0068*   |
| Line-of-business Herfindahl            | −0.2989 | 0.0114*   |
| Stock dummy                            | 0.0683  | 0.0072*   |
| Geographic Herfindahl                  | −0.0946 | 0.0183*   |
| Reinsurance Industry Factors           |         |           |
| Reinsurers' price                      | −0.0009 | 0.0003*   |
| Reinsurers' liquidity                  | 0.0001  | 0.0002    |
| Reinsurers' 2-yr loss development      | 0.0005  | 0.0008    |
| Line-of-Business Controls <sup>c</sup> |         |           |
| Fire                                   | −0.0337 | 0.0292    |
| Allied lines                           | 0.0639  | 0.0459    |
| Ocean marine                           | 0.1079  | 0.0455**  |
| Earthquake                             | 0.4362  | 0.1379*   |
| Aircraft                               | 0.2383  | 0.0971**  |
| Burglary and theft                     | −0.2695 | 0.3379    |
| Boiler and machinery                   | 0.1286  | 0.1734    |
| Financial guaranty                     | 0.0436  | 0.0526    |
| Fidelity                               | −0.2949 | 0.0960*   |
| Surety                                 | −0.1581 | 0.0196*   |
| Credit                                 | −0.1385 | 0.0491*   |
| Medical malpractice—occurrence         | 0.0462  | 0.0235**  |
| Medical malpractice—claims made        | 0.0083  | 0.0187    |
| Other liability—occurrence             | −0.0211 | 0.0274    |
| Other liability—claims made            | 0.1456  | 0.0234*   |
| Product liability—occurrence           | 0.5718  | 0.0937*   |
| Product liability—claims made          | 0.2905  | 0.0916*   |
| Workers compensation                   | −0.0093 | 0.0161    |
| Private passenger auto liability       | 0.0417  | 0.0195**  |
| Commercial auto liability              | −0.0721 | 0.0243*   |
| Auto physical damage                   | −0.1188 | 0.0230*   |
| Homeowners multiple peril              | −0.0787 | 0.0207*   |
| Farmers multiple peril                 | −0.1435 | 0.0350*   |
| Group accident and health              | −0.1250 | 0.0261*   |
| Other accident and health              | −0.1449 | 0.0409*   |
| Reinsurance—property                   | −0.4350 | 0.0801*   |
| Reinsurance—liability                  | −0.0282 | 0.0798    |
| Reinsurance—financial lines            | −2.1358 | 1.6266    |
|                                        | $R^2$   | 0.2097    |

The study covers the period from 1993 through 2000.

<sup>a</sup>Insurer-specific variables are lagged to control for potential endogeneity.

<sup>b</sup>This variable is defined as the development in estimated losses and loss expenses incurred two years before the current year and prior year scaled by policyholders' surplus.

<sup>c</sup>All line-of-business controls represent the proportion of business written in that line of business. The line-of-business controls are lagged to control for potential endogeneity.

\*Significant at 1%, \*\*significant at 5%, and \*\*\*significant at 10%.

characteristics of the ceding company. The results support most of the hypotheses discussed earlier and are fairly consistent with the results of prior studies. For example, size is significant and negative, suggesting that bankruptcy costs are not proportional to size. The return on assets variable is significant, suggesting that less profitable firms demand more reinsurance.<sup>22</sup> This result supports the theory that reinsurance is used to combat the underinvestment problem by reducing the likelihood that managers will reject positive net present value projects due to the existence of possible large unexpected losses. The 2-year loss development variable is significant, indicating that firms which under-reserve also tend to purchase higher levels of reinsurance, adding support to the hypothesis that potential financial distress increases the demand for reinsurance. Both line-of-business concentration and geographic concentration are significant and negative.<sup>23</sup> These results support the real services hypothesis, suggesting that the more focused the insurer is relative to line-of-business and geographic concentration, the less reinsurance it will demand.

The organizational form and affiliation variables are significant. These results indicate that stock insurers and insurers affiliated with groups demand more reinsurance. Garven and Lamm-Tennant (2003) did not find any significance based on organizational form whereas Mayers and Smith (1990) did, but in the opposite direction. Their results suggest that stocks utilize less reinsurance than other organizational forms. It is possible that the difference in the results may be a function of the classification scheme used, the time periods examined, or the firms included in the data sets.<sup>24</sup> The result for the group dummy variable is consistent with that found by Mayers and Smith (1990), indicating that affiliate insurers demand more reinsurance. In addition, 18 of the 28 line-of-business control variables were significant, including a positive and significant relationship for many of the liability lines of business, indicating the importance of the types of business written in the overall decision to purchase reinsurance.<sup>25</sup> The tax variable is not significant in this model.<sup>26</sup>

In addition to the significance of most of the traditional insurer-specific factors, one of the variables representing the state of the U.S. reinsurance industry is significant.

<sup>22</sup> Although general tests for multicollinearity did not indicate a problem, there is some concern related to the inclusion of both return on assets and leverage in the models. The model presented is replicated by individually dropping return on assets and leverage. The results remained unchanged.

<sup>23</sup> The negative of the number of states in which the insurer operates is substituted as an alternative measure of geographic concentration for these models. The results were unchanged.

<sup>24</sup> Mayers and Smith (1990) use all types of insurers for the year 1981 in which they had data. The current study only includes stock and mutual insurers and covers the period from 1993 through 2000. It should be noted that when an expanded model is run including all organizational forms, the results discussed above remain unchanged with the exception of the loss of significance on the 2-year loss development variable. Also, the mutual dummy variable is significant and negative and both the stock and the Lloyd's dummy variables are significant and positive.

<sup>25</sup> As a robustness test, the models are replicated without the line-of-business controls. The results of the firm-specific and industry aggregate variables are unchanged.

<sup>26</sup> Additional models are constructed using the alternate measures of tax defined earlier. When these alternate measures of tax are included, the results remain consistent with the exception of the tax variables being significant and negative.

The price of reinsurance is significant and negative. This suggests that the demand for reinsurance decreases the higher the cost of coverage.<sup>27</sup>

### The Utilization of Foreign Reinsurance

The next models analyze the factors that influence the decision to utilize foreign reinsurance as well as the amount of foreign reinsurance demanded. The results of the selection models are reported in Table 4.<sup>28</sup> The results of the decision equation (Equation (2)) support the hypotheses that there are differences in the types of insurers that choose to enter the foreign reinsurance market. The results of Equation (3) suggest that insurer-specific factors affect the amount of foreign reinsurance used.

The results of the model described in Equation (2) indicate that larger insurers are more apt to utilize foreign reinsurance. This supports the hypothesis that the need for increased capacity may be a motivating factor in the demand for foreign reinsurance. Contrary to expectations, insurers that choose to use foreign reinsurance compared to those that do not tend to have less income generated from tax-exempt assets. Although the preservation of tax shields and/or the minimization of tax liability is not a significant factor in the overall decision to use reinsurance, it does appear to have some impact on the demand for foreign reinsurance. The group affiliation variable and the stock variable are significant, indicating that affiliate and mutual insurers are more likely to use foreign reinsurance. The geographic Herfindahl also is significant indicating that more concentrated insurers are less likely to use foreign reinsurance which supports the real services hypothesis. Additionally, firms with lower levels of leverage are associated with the use of foreign reinsurance. Finally, several of the line-of-business control variables are significant, suggesting that the types of business written by the insurer affect the decision of whether or not to use foreign reinsurance.

Equation (3) models the percentage of foreign reinsurance ceded controlling for potential selection bias. As in the prior model, size is significant and positive. This suggests that larger firms use more foreign reinsurance, underscoring the importance of capacity in this decision. Additionally, a negative relationship exists between tax-exempt assets and the percentage of foreign reinsurance utilized. This suggests that firms using a higher percentage of foreign reinsurance do not have as strong a need to preserve

<sup>27</sup> Due to the significant correlation of the measures of price and loss development of the reinsurance industry, this model was re-run, alternately dropping these variables. The results are fairly consistent with those reported here. The only difference is when the price of reinsurance is dropped, the reinsurance industry loss development variable is significant and positive.

<sup>28</sup> As a robustness test, these models are run with only unaffiliate insurers. There are some differences of note in the results. For Equation (2), when only unaffiliate insurers are used the leverage and geographic Herfindahl variables as well as the stock dummy variable are no longer significant. In addition, the line-of-business concentration variable is significant and negative which supports the real services hypotheses for unaffiliate insurers. In Equation (3), the line-of-business concentration and leverage variables are no longer significant. However, the return on assets variable and the stock dummy variable are significant and positive. These results suggest that the factors that affect both the decision to use foreign reinsurance and the amount of foreign reinsurance utilized do vary between affiliate and unaffiliate insurers. This may be partially attributable to the use of reinsurance by affiliate insurers as a means of shifting resources and risk among members of the group and demonstrates the need for further research in this area.

**TABLE 4**

Heckman Model Results—World Market

|                                        | Equation (2): Use<br>Foreign Dummy |           | Equation (3):<br>% Foreign Used |           |
|----------------------------------------|------------------------------------|-----------|---------------------------------|-----------|
|                                        | Coeff.                             | Std. Err. | Coeff.                          | Std. Err. |
| Intercept                              | -5.4347                            | 0.2492*   | -1.9726                         | 0.6887*   |
| Insurer Factors <sup>a</sup>           |                                    |           |                                 |           |
| Return on assets                       | -0.2549                            | 0.2715    | 0.0916                          | 0.1393    |
| Direct business/surplus                | -0.0110                            | 0.0053**  | -0.0056                         | 0.0033*** |
| Tax-exempt inv. inc./total inv. inc.   | -0.4138                            | 0.0688*   | -0.2010                         | 0.0556*   |
| 2-yr loss development <sup>b</sup>     | N/A                                | N/A       | 0.0000                          | 0.0001    |
| Size                                   | 0.2653                             | 0.0121*   | 0.0818                          | 0.0273*   |
| Group dummy                            | 0.1823                             | 0.0431*   | -0.0121                         | 0.0307    |
| Line-of-business Herfindahl            | 0.0749                             | 0.0698    | 0.2274                          | 0.0364*   |
| Stock dummy                            | -0.1424                            | 0.0443*   | -0.0452                         | 0.0262*** |
| Geographic Herfindahl                  | -0.0686                            | 0.0416*** | -0.0181                         | 0.0209    |
| Lambda                                 | N/A                                | N/A       | 0.5120                          | 0.1564*   |
| Market Difference Factors              |                                    |           |                                 |           |
| Diff. in combined ratios               | N/A                                | N/A       | 0.0007                          | 0.0061    |
| Diff. in log of tech. reserves         | N/A                                | N/A       | 0.0077                          | 0.0358    |
| Line-of-Business Controls <sup>c</sup> |                                    |           |                                 |           |
| Fire                                   | 0.3645                             | 0.1716**  | 0.2989                          | 0.0945*   |
| Allied lines                           | 1.4250                             | 0.2690*   | 0.3320                          | 0.1922*** |
| Ocean marine                           | 1.3212                             | 0.2873*   | 0.8797                          | 0.1916*   |
| Earthquake                             | 8.0941                             | 1.6315*   | 2.3245                          | 0.8654*   |
| Aircraft                               | 0.1336                             | 0.5960    | 0.3165                          | 0.3039    |
| Burglary and theft                     | 1.6300                             | 1.1766    | 0.8031                          | 0.9064    |
| Boiler and machinery                   | 0.4275                             | 1.6733    | 0.1441                          | 0.6229    |
| Financial Guaranty                     | 0.5961                             | 0.5481    | 0.2084                          | 0.2279    |
| Fidelity                               | 0.1340                             | 0.8096    | 0.1313                          | 0.3742    |
| Surety                                 | -0.0779                            | 0.1601    | -0.1422                         | 0.0917    |
| Credit                                 | 0.5467                             | 0.2834*** | 0.6139                          | 0.1538*   |
| Medical malpractice—occurrence         | -0.3801                            | 0.2453    | 0.1157                          | 0.1392    |
| Medical malpractice—claims made        | 1.2389                             | 0.1423*   | 0.6478                          | 0.1406*   |
| Other liability—occurrence             | 0.6825                             | 0.1638*   | 0.2462                          | 0.1150**  |
| Other liability—claims made            | 1.6145                             | 0.1539*   | 0.7731                          | 0.1751*   |
| Product liability—occurrence           | 2.3672                             | 0.6494*   | 0.5880                          | 0.3232*** |
| Product liability—claims made          | 1.8719                             | 1.3989    | 0.2827                          | 0.5119    |
| Workers compensation                   | -0.0502                            | 0.1007    | -0.0431                         | 0.0528    |
| Private passenger auto liability       | 0.0402                             | 0.1063    | -0.2688                         | 0.0578*   |
| Commercial auto liability              | 0.8527                             | 0.1460*   | 0.2746                          | 0.1258**  |
| Auto physical damage                   | 0.3565                             | 0.1433**  | 0.3081                          | 0.0836*   |
| Homeowners multiple peril              | 0.8649                             | 0.1201*   | 0.1870                          | 0.1102*** |
| Farmers multiple peril                 | 0.7655                             | 0.2874*   | 0.1403                          | 0.1663    |
| Group accident and health              | 0.1657                             | 0.1691    | 0.0903                          | 0.0952    |
| Other accident and health              | -1.0180                            | 0.3645*   | 0.0232                          | 0.2362    |
| Reinsurance—property                   | -0.4114                            | 0.7905    | -0.0585                         | 0.3961    |
| Reinsurance—liability                  | -0.3382                            | 0.4435    | -0.0825                         | 0.2241    |
| Reinsurance—financial lines            | -6.3893                            | 14.1183   | -2.4404                         | 7.1325    |

The study covers the period from 1993 through 2000.

<sup>a</sup>Insurer-specific variables are lagged to control for potential endogeneity.

<sup>b</sup>This variable is defined as the development in estimated losses and loss expenses incurred two years before the current year and prior year scaled by policyholders' surplus.

<sup>c</sup>All line-of-business controls represent the proportion of business written in that line of business. The line-of-business controls are lagged to control for potential endogeneity.

\*Significant at 1%, \*\*significant at 5%, and \*\*\*significant at 10%.

this tax shield. Firms utilizing a higher percentage of foreign reinsurance are more concentrated in terms of business mix, indicating they do not have as great a need for real services and/or have a greater need for diversification into foreign markets. The inverse Mill's ratio, or Lambda, also is significant, indicating that selection bias is present. However, the inclusion of this variable corrects for the selection bias. Finally, as with the other model, several line-of-business variables are significant. In this setting, many of the liability lines as well as several of the property lines are significant and generally positive, emphasizing the importance of variation in business focus on both the use of and extent of use of foreign reinsurance.

Though several of the firm-specific factors are found to influence the utilization of foreign reinsurance, the proxies included to measure the differences in the foreign and U.S. reinsurance markets do not. Neither the combined ratio nor net technical reserves of the difference variables are significant.<sup>29</sup> These results are not surprising given that the *t*-tests do not indicate that there are any differences in the means of the combined ratio and the technical reserves of the foreign and U.S. markets when the foreign markets are aggregated. Additionally, the insignificant result found for the difference in the combined ratio of the foreign versus U.S. market may be the result of the competing hypotheses related to price and profitability.

## CONCLUSION

This study adds to the literature modeling the corporate demand for reinsurance by considering the effects of the international reinsurance industry on the demand for insurance by U.S. firms. The results relating to the firm-specific characteristics support the results of prior studies in this area. In addition, the study finds that the state of the U.S. reinsurance market significantly impacts the overall demand for reinsurance. Based on the variables in this study, there is no support found for the hypothesis that possible differences in the foreign and U.S. markets impact the decision to utilize foreign reinsurance. However, the study does find that there are insurer-specific differences that affect the utilization of foreign versus U.S. reinsurance. Larger insurers, as well as those with less income generated from tax-exempt assets, are more likely to use foreign reinsurance. Also, mutual insurers and affiliate insurers are more likely to use foreign reinsurance.

The size of the insurer is highly significant in both the model examining the use of foreign reinsurance and the model examining the extent of use of foreign reinsurance. This suggests that perhaps these insurers need to enter the foreign market to secure enough reinsurance. Collectively, the results of the study indicate that further examination of the use of foreign reinsurance by U.S. insurers is needed. With the possible implementation of new international regulatory standards and a wave of financial downgrades of reinsurers around the world, these issues are becoming increasingly important to U.S. insurers.

<sup>29</sup> Similarly, when the relative capacity measure, measured as the difference in the net technical reserves to policyholders' surplus, is substituted for the difference in technical reserves variable, it is not significant. In addition, both the leverage variable and the stock dummy variable are insignificant. Due to data limitations, when this measure is used, the sample period is reduced to 1998–2000.

This study has several important public policy implications. Since U.S. regulators do not have control over the operations of foreign reinsurance companies, it is critical that they have an understanding of the types of insurers utilizing foreign reinsurance. The results of this article find that larger U.S. insurers are more likely to enter the foreign markets and tend to cede a greater portion of reinsurance to foreign companies. Thus, the monitoring of these insurers is critical to ensure that shocks in the foreign reinsurance markets do not adversely affect the solvency of the U.S. primary insurance market.

The finding that the state of the U.S. reinsurance market affects the corporate demand for insurance implies that changes in the U.S. reinsurance market ultimately impact the U.S. primary insurance market. Additionally, the existence of postassessment guarantee funds increases insurers' incentive to better understand and monitor the actions of other insurers to ensure that the use of foreign reinsurance does not adversely impact the solvency of the U.S. insurance market. This information also is important to U.S. reinsurers in terms of creating a better understanding of the factors that motivate U.S. insurers to augment their reinsurance programs with foreign reinsurance. This information may be used to help U.S. reinsurers target these insurers in an effort to induce them to reallocate to the U.S. market. As such, the collective results of this study hold implications for U.S. insurers and reinsurers and well as regulators and consumers.

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