

# Adverse Selection in Reinsurance Markets

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ABSTRACT. The reinsurance literature has a rich theoretical heritage, and in recent years a number of important empirical contributions have been made. This paper adds to that literature by testing Jean-Baptiste and Santomero's (2000) adverse selection hypotheses after controlling for factors that are known from previous studies to influence the demand for reinsurance. Our tests involve a data panel consisting of U.S. property-liability insurance firms which reported to the National Association of Insurance Commissioners (NAIC) during the period 1995-2000. *Journal of Economic Literature* Classification Numbers: G22, G13, L15, D81.

# Adverse Selection in Reinsurance Markets

## Introduction

The reinsurance literature has a rich theoretical heritage, and in recent years a number of important empirical contributions have been made.<sup>1</sup> Traditionally, the analysis of the demand for reinsurance has been modeled in an expected utility framework and emphasized the risk management aspect of the reinsurance decision.<sup>2</sup> Other studies analyzed the demand for reinsurance from a risk management and capital structure perspective.<sup>3</sup> In these literatures, reinsurance is typically characterized as a mechanism which enables insurers to achieve more efficient risk sharing; thus supplementing underwriting capacity. As a risk management tool, theory suggests reinsurance enables insurers to mitigate and control costs related to various factors such as agency problems, bankruptcy risk, and taxes.

This paper empirically explores some implications of adverse selection for the demand for reinsurance. In most reinsurance transactions, the primary insurer ceding the risk (the “cedent”) will likely have better information about the underlying risk than the reinsurer. The extent to which information is asymmetric depends upon the nature of the underlying risk. For example, we would expect less information asymmetry concerning high frequency, low severity risk such as automobile physical damage than low frequency, high severity such as commercial liability. The greater the information asymmetry, the greater is

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<sup>1</sup> E.g., see Adams and Hossain (1998), Adiel (1996), Berger, Cummins, and Tennyson (1992), Cole and McCullough (2006), Doherty and Smetters (2006), Garven and Lamm-Tennant (2003), Hoerger, Sloan, and Hassan (1990), Mayers and Smith (1990), Outreville (1994), and Powell and Sommers (2007), among others.

<sup>2</sup> E.g., see Borch (1960, 1962), Blazenko (1986), Eden and Kahane (1988, 1990), Samson and Thomas (1983), and Tapiero and Zuckerman (1981).

<sup>3</sup> E.g., see Cummins and Mahul (2003), Doherty and Tiniç (1981), Froot (2001, 2007), Garven and Lamm-Tennant (2003), Garven and Loubergé (1996), Hoerger, Sloan, and Hassan (1990), Loubergé (1983), and Mayers and Smith (1990).

the cost of adverse selection to the ceding insurer. However, adverse selection costs may be mitigated through long-standing relationships,<sup>4</sup> joint risk sharing or improved information flows. Therefore, we may expect differences in insurer risk policy and strategy depending on the nature of the underlying risk written by the ceding insurer.

Jean-Baptiste and Santomero (2000) provide a formal theoretical analysis of how information problems affect the efficiency of the allocation of risk between cedents and their reinsurers. Their theory shows that long-term implicit contracts between cedents and reinsurers allow the inclusion of new information in the pricing of both future and past reinsurance coverage. Because of these features (long-term contractual relationships and the inclusion of new information in the pricing of future and past coverage), Jean-Baptiste and Santomero show that long-term implicit contracts or relationships between the insurer and the reinsurer enable the cedent to purchase a more efficient quantity of reinsurance at a more favorable price. The comparative statics of their model suggest the following set of empirical predictions:

- Hypothesis 1: Other things equal, long-term reinsurance contracting relationships will be associated with higher levels of reinsurance coverage;
- Hypothesis 2: Other things equal, long-term reinsurance contracting relationships will be associated with higher insurer profits; and
- Hypothesis 3: Other things equal, long-term reinsurance contracting relationships will be associated with a lower of bankruptcy.

Our objective in this paper is to specifically test the Jean-Baptiste and Santomero

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<sup>4</sup> This may very well be why industry folklore emphasizes the importance of long-term relationships in reinsurance markets; such relationships likely play an important role in mitigating adverse selection.

hypotheses after controlling for various other factors that are known from previous studies to influence reinsurance contracting behavior. We analyze panel data consisting of U.S. property-liability insurance firms which reported to the National Association of Insurance Commissioners (NAIC) during the period 1995-2000. To our knowledge, ours is the first paper to fully implement empirical tests of all three of the Jean-Baptiste/Santomero hypotheses. Thus, we believe that our paper provides an important contribution to the empirical literature concerning the impact of adverse selection on the operation and industrial organization of insurance firms and markets.

## **Data and Methodology**

### *Measuring long-term reinsurance contracting behavior and the demand for reinsurance*

An important consideration is how to best proxy for the extent to which long-term implicit contracts or relationships exist between cedents and reinsurers. We refer to this as “contract sustainability”. Since most reinsurance theory (including Jean-Baptiste and Santomero) analyzes third party risk transfer; i.e., “external” reinsurance between separately owned cedents and reinsurers, this is our focus in this study.

It is important to note that insurers regularly cede and assume reinsurance with other insurers and reinsurers. Furthermore, insurers which are affiliated with insurance groups commonly engage in intercompany pooling, or “internal” reinsurance.<sup>5</sup> Therefore, we need to be particularly careful about the manner in which we construct the left-hand side variable

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<sup>5</sup> See Powell and Sommers (2007) for their analysis of the demand for internal versus external reinsurance. They note that roughly eighty percent of the reinsurance premium volume captured by the NAIC database occurs within insurance groups rather than between cedents and external reinsurers. It seems reasonable to expect that cedents with exposure to internal reinsurance may behave differently in terms of contract sustainability with external reinsurers. Consequently, we include internally ceded reinsurance as a control variable in the reinsurance demand equation implied by Hypothesis 1.

for the reinsurance demand equation implied by Hypothesis 1. Previous studies (e.g., Mayers and Smith (1990), Garven and Lamm-Tennant (2003), and Cole and McCullough (2006) have used the following definition for this variable (referred to here as “*REINS*”):

$$REINS = \frac{\text{internal \& external ceded reinsurance}}{\text{direct premiums written + internal \& external assumed reinsurance}}. \quad (1)$$

For the purposes of this paper, we believe that a more appropriate measure for *REINS* is the one given by equation (2):

$$REINS = \frac{\text{external ceded reinsurance} - \text{external assumed reinsurance}}{\text{direct premiums written + internal \& external assumed reinsurance}}. \quad (2)$$

In equation (2), a negative value implies that the firm is acting (on a net basis) as a reinsurer for unaffiliated insurance companies. Equation (2) essentially creates a continuous variable bounded from below at -1 and bounded from above at +1.<sup>6</sup>

Our external ceded reinsurance premium variable is taken directly from Schedule F, Part 3 of the annual statement. There, reinsurers are classified as being either authorized or unauthorized. Unauthorized reinsurers are accorded this status because they have typically not posted letters of credit. However, from the perspective of the cedent, unauthorized reinsurers are legitimate risk transfer agents, so we include both authorized and unauthorized reinsurers.<sup>7</sup> Within these two major categories, reinsurers are further subdivided into various

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<sup>6</sup> Note that a value of -1 for *REINS* could occur if there was only external assumed reinsurance and all other values in the ratio were zero. A value of +1 could occur if the firm had no external assumed reinsurance and it externally reinsured all of its direct premiums and its internally assumed reinsurance premiums.

<sup>7</sup> Approximately 24% of all external ceded reinsurance premium volume captured by the NAIC database during 1995-2000 involves transactions with unauthorized reinsurers. Although we do not empirically account for differences in

other sub-categories which make it possible to identify external versus internal reinsurance transactions. We include the following set of sub-categories in our definition for external ceded reinsurance:

1. Authorized reinsurance

- a. Other US unaffiliated insurers (e.g., major specialist U.S. reinsurers such as Genre) - codes 0500001-0599998
- b. Voluntary pools (e.g., the National Flood Insurance Program) - codes 0700001-0799998
- c. Other non-US (unaffiliated) insurers (e.g., Lloyds syndicates) - codes 0800001-0899998

2. Unauthorized reinsurance

- a. Other US unaffiliated insurers - codes 1400001-1499998
- b. Voluntary pools - codes 1600001-1699998
- c. Other non-US (unaffiliated) insurers - codes 1700001-1799998

While theory does not provide an obvious data definition for contract sustainability, we rely upon two proxies in order to capture this effect. The first proxy is called “*SUSTAIN*”, and it measures the percentage of premiums ceded over a three-year period to external reinsurers which are present in all three years. This provides us with an idea of how important the longer term contracting relationships are as a percent of total external reinsurance premiums ceded. In our analysis, we consider six different three-year windows: 1993-1995, 1994-1996, 1995-1997, 1996-1998, 1997-1999, and 1999-2000. Thus the 1995 value for *SUSTAIN* for a given cedent is based upon the 1993-1995 window; the 1996 value for *SUSTAIN* for a given cedent is based upon the 1994-1996 window, etc.

Our second proxy for contract sustainability measures the degree to which the cedent

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reinsurance quality (i.e., authorized vs. unauthorized) in this draft, we plan to do so in a future draft.

tends to have “focused” versus diffuse contractual relationships with external reinsurers. In order to capture this effect, we construct a Herfindahl index for each year and then average these values over the six three-year windows described above, resulting in a variable which we call “*RHERF*”. Thus, we can say how important the cedent’s relationship is with a given set of external reinsurers. For example, is the cedent focused on only a few reinsurers, or is it spread over numerous reinsurers?

*Reinsurance Demand Equation (for testing Hypothesis 1)*

Since we wish to study the effect that contract sustainability has upon *REINS* (as defined by equation (2)), we are primarily interested in the coefficients and standard errors associated with *SUSTAIN* and *RHERF*. However, we must also control for other determinants of the demand for reinsurance which have been documented by previous empirical studies (e.g., Cole and McCullough (2006), Mayers and Smith (1990), Garven and Lamm-Tennant (2003), and Powell and Sommers (2007)). Thus our regression includes the following set of right-hand side control variables:

- *SIZE* = natural logarithm of the cedent’s size, measured in terms of admitted assets;
- *PSRATIO* = ratio of direct premiums written to surplus for the cedent;
- *STDE* = standard deviation of the cedent’s equity;<sup>8</sup>
- *LONGTAIL*= proportion of the cedent’s premiums written in long tail lines;<sup>9</sup>

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<sup>8</sup> Following Garven and Lamm-Tennant (2003),  $STDE = \sqrt{\sigma_p^2 + \sigma_L^2 - 2\sigma_p\sigma_L\rho_{pL}}$ , where

$$\rho_{pL} = \frac{\sum_{i=1}^{14} \sum_{\substack{k=1 \\ i \neq k}}^{17} X_i W_k COV(r_i, L_k)}{\sigma_p \sigma_L};$$

$X_i$  = proportion of the cedent’s assets invested in asset class  $i$ ;  
 $r_i$  = the return on the cedent’s  $i^{\text{th}}$  investment;  
 $r_p$  = the return on the cedent’s portfolio of investments =  $\sum X_i r_i$ ;  
 $\sigma_p$  = standard deviation of  $r_p$ ;  
 $W_k$  = proportion of the cedent’s written premiums due to line  $k$ ;  
 $L$  = the cedent’s claims costs =  $\sum W_k L_k$ ; and  
 $\sigma_L$  = standard deviation of  $L$ .

- $TAXRATE$  = the cedent's effective tax rate, computed as  $\tau = 1 - NI_t/BTNI_t$ , where  $NI_t$  = after-tax net income in period  $t$ , and  $BTNI_t$  = before-tax net income in period  $t$ <sup>10</sup>
- $PHERF$  = the cedent's Product Herfindahl; equals 1 if monoline company, converges toward zero if it is widely diversified in terms of product offerings;
- $GHERF$  = geographical Herfindahl; and
- $STOCK$  = 1 if the cedent is a stock company, 0 otherwise;
- $MUTUAL$  = 1 if the cedent is a mutual, 0 otherwise; and
- $D1996 - D2000$  = year indicators for 1996-2000; e.g.,  $D_{yyyy}$  if year =  $yyyy$ , 0 otherwise.

We also include control variables that were not considered in previous empirical studies. As noted earlier, we include internally ceded reinsurance as a control variable in the reinsurance demand equation; specifically, we define a variable called "*INTERNAL*", where

$$INTERNAL = \frac{\text{internal ceded reinsurance} - \text{internal assumed reinsurance}}{\text{external ceded reinsurance} - \text{external assumed reinsurance}}; \text{ in other words,}$$

this variable is the ratio of net ceded internal reinsurance divided by net ceded external reinsurance. We would expect that the larger *INTERNAL* is, the smaller *REINS* should be, other things equal. We also interact a number of variables with *SIZE*; i.e., *SUSTAIN*, *RHERF*, *SIZE*, *STOCK*, *MUTUAL*, *PHERF*, and *GHERF*.

#### *Profitability Equations (for testing Hypothesis 2)*

We measure cedent profitability in two ways: *ROA* (after-tax return on total admitted assets), and *ROE* (after-tax return on surplus). Thus, we use these measures as left-hand side

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<sup>9</sup> We define long tail lines in the same manner as Phillips, Cummins and Allen (1998); i.e., long tail lines include Farmowners Multiple Peril, Homeowners Multiple Peril, Commercial Multiple Peril, Ocean Marine, Medical Malpractice, International, Reinsurance, Workers' Compensation, Other Liability, Products Liability, Aircraft, Boiler and Machinery, and Automobile Liability.

<sup>10</sup>The implicit assumption here is that if a firm has a low effective tax rate, then it is also more likely to be in the convex portion of the tax schedule and consequently demand more reinsurance, other things equal.

variables for our profitability equations. On the right-hand side, we include our contract sustainability variables *SUSTAIN* and *RHERF*.

Although our primary interest is in the effect that contract sustainability has upon profitability, we must also control for other determinants of the profitability which have been documented by previous empirical studies. For example, Lamm-Tennant and Starks (1993) show that net underwriting profit is significantly related to ownership structure, with stock insurers being more profitable (and riskier) on average than mutual insurers.

Therefore we include the indicator variables for ownership structure mentioned previously (i.e., *STOCK* and *MUTUAL*). Berger, Cummins and Weiss (1997) find that independent agency firms are less cost efficient than direct writers, although this does not result in profit inefficiencies. Thus we include indicator variables for the type of distribution system employed by the cedent insurers in our sample; specifically, the variable *AGENCY* equals 1 if the cedent insurer employs an independent agent marketing system and 0 otherwise, whereas the variable *DIRECT* equals 1 if the cedent insurer employs an direct writer marketing system and 0 otherwise. Firm size (*SIZE*) is included because of the possibility that economies or diseconomies of scale could affect profitability. Finally, we employ the *LONGTAIL* variable which was discussed earlier in our description of control variables for the reinsurance demand equation. With length of tail, most of the financial pricing model literature suggests that there is an investment income/underwriting profitability tradeoff. We also interact *SIZE*, *STOCK*, *MUTUAL*, and *RHERF* with *SIZE*.

#### *Bankruptcy Risk Equation (for testing Hypothesis 3)*

In order to measure the bankruptcy risk of the insurer, we rely upon A. M. Best's

Ratings. A. M. Best assigns financial strength ratings to companies using a discrete alphabetic scale; specifically, by applying letter ratings A<sup>++</sup>, A<sup>+</sup>, A, A<sup>-</sup>, B<sup>+</sup>, etc., and they record the letter rating for each firm  $i$  in each year  $t$ . For the purposes of this study, we adopt the Doherty and Phillips (2002) method which maps the various A. M. Best financial strength ratings with numerical scores ranging from 0 to 4. Thus if the firm is rated A<sup>++</sup> or A<sup>+</sup>, it is assigned a score of 4, 3 if the firm is rated A, 2 if it is rated A<sup>-</sup>, 1 if it is rated B<sup>++</sup> or B<sup>+</sup>, and 0 if it is rated B or lower.

We estimate the bankruptcy risk equation using an ordered probit model. The ordered probit model is appropriate because there are only 5 possible discrete values that can be assumed by the left-hand side variable, ranging from 0 (low) to 4 (high). Consequently, ordinary least squares should not be used since it would produce inefficient coefficient estimates. Furthermore, a fixed or random effects model is inappropriate here since the firm identifiers are collinear with the A. M. Best rating.

In selecting the right-hand side control variables for our bankruptcy risk equation, we follow the lead of Lamm-Tennant, Starks, and Stokes (1996). The Lamm-Tennant, Starks, and Stokes paper shows that liquidity, capital adequacy, and premium growth are important determinants of insurer bankruptcies, as are the asset-liability management strategies employed by such firms. Thus our bankruptcy risk regression equation includes the following set of right-hand side control variables:

- *LIQUIDITY* = total liabilities divided by liquid (i.e., marketable) assets for the cedent;<sup>11</sup>

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<sup>11</sup> Since lower values for this variable imply that the cedent is more liquid and therefore in a better to pay its liabilities, one would expect an inverse relationship to exist between this variable and the cedent's A. M. Best rating.

- *CAPITAL\_ADEQUACY* = percent change in capital (surplus) during the prior year;
- *PREMIUM\_GROWTH* = percent change in net premiums written during the current year;<sup>12</sup> and
- *STDE*.<sup>13</sup>

Other right-hand side variables (besides *SUSTAIN* and *RHERF*) include *SIZE*, *PSRATIO*, *MUTUAL*, *STOCK*, *ROA*, *LONGTAIL*, and *D1996-D2000*. We also interact a number of variables with *SIZE*; specifically, *SUSTAIN*, *SIZE*, *STOCK*, and *MUTUAL*.

## **Empirical Results**

The descriptive statistics for our sample are provided in Table 1. Several variables; specifically, *INTERNAL*, *CAPITAL\_ADEQUACY*, *PREMIUM\_GROWTH*, *REINS*, *ROA*, *ROE*, *SUSTAIN*, and *TAXRATE* were winsorized at the 1<sup>st</sup> and 99<sup>th</sup> percentiles in order to reduce the impact of outliers and data errors.<sup>14</sup> We have up to 6,995 observations in our data (depending on the regression) over the period 1995-2000. We would like to point out a few variables for particular discussion here. First, our measure of external reinsurance demand (*REINS*) has a mean of approximately 11 percent of external (net) reinsurance to total premiums written. Our sustainability index (*SUSTAIN*) has a mean of 0.178, which means that the average firm places slightly less than 20 percent of its reinsurance business with the same reinsurers over a three year period. Third, complementing our sustainability measure we have a variable measuring the concentration of business with reinsurers averaged

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<sup>12</sup> The logic here is that particularly rapid growth in premiums may be an indicator of underpricing, which in turn may increase the likelihood of bankruptcy.

<sup>13</sup> *STDE* is included since it provides a summary statistic of the overall effects of the cedent insurer's asset-liability management strategies.

<sup>14</sup> See Cox (1998) for a discussion of winsorizing and for references to the relevant statistical literature.

over the three year period. This measure *RHERF* has a value of 0.46. Since it is a Herfindahl index, we can use its inverse as a measure of the number of equivalent size firms the cedent deals with as external reinsurance partners, which is 2.2. Thus, the average firm focuses on just 2.2 reinsurers over a three year period. Finally, our measure of internal reinsurance (*INTERNAL*) is the ratio of net ceded internal reinsurance to the net ceded external reinsurance. The average firm in our sample has approximately 46.5 percent of its reinsurance from internal (group) sources.

### *Reinsurance Equation*

Table 2 presents our regression results for our reinsurance equation described above. We estimated a random effects model using *REINS* (as defined in equation (2)) as our dependent variable.<sup>15</sup> We estimated a number of models (not shown for the sake of brevity) which did not include interaction terms. The model shown in Table 2 has two major sets of interaction terms based on size and sustainability. Without the interaction with size, the sustainability index was not significant. However, after including size interactions we find that there are significant marginal effects.

In our results, we find that the log of total assets and its square are statistically significant, as is the reinsurance sustainability index as well as a number of other variables. Panel B describes the marginal effects with respect to the variables (measured at the mean) with interaction terms. First, there is a negative relationship (in general) between size measured by the log of total assets and the amount of reinsurance purchased. This is

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<sup>15</sup> We used a Hausman test to determine whether to employ a fixed effect or a random effects model. At first glance, a fixed effects approach might appear to be preferred because we have a large sample of firms (but not an entire census). However, after performing the Hausman test, we found that the random coefficient model dominates the fixed effects in terms of efficiency and consistency of results (at the 0.000 level).

consistent with large firms needing less reinsurance. We also estimate a marginal effect for stock and size and mutual and size, and find that there is little difference in the size effect based on organizational form.

We also estimate the marginal effect for the sustainability index and find that sustainability is positively and statistically related to the amount of external reinsurance demanded.<sup>16</sup> This is consistent with our hypothesis 1 that long term contracting relationships will be associated with higher levels of reinsurance coverage. Our measure of reinsurance focus (*RHERF*) is negatively related to the external reinsurance purchases. Thus, as the focus of the cedent increases, less reinsurance is purchased. While this is not part of Jean-Baptiste and Santomero's theory, it does suggest a potential for a reduction in the need for monitoring for those cedents with lower external reinsurance needs. Alternatively, it could also be that cedents with lower reinsurance needs tend not to deal with as many reinsurers.

Of the other marginal effects, only the geographical Herfindahl index is significant. Its negative sign is consistent with the literature which suggests that there is a trade-off between real services provided by reinsurers and geographical diversification and that it appears that reinsurance services can be more valuable than geographic diversification (Mayers and Smith (1990), Cole and McCullough (2006), and Powell and Sommers (2007)).

In panel A, we can examine some measures of firm risk. First, we see that the amount of reinsurance ceded is positively related to the premium to surplus ratio (*PSRATIO*). This is consistent with theory and previous literature as riskier firms can reduce

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<sup>16</sup> While the two tailed t-statistic is marginally significant at the 0.09 level, given our hypothesis a one tailed test (that sustainability is positively related to external reinsurance) is appropriate.

risk through reinsurance. Second, we see the standard deviation of equity return (another measure of firm risk) with a positive sign, suggesting that riskier firms obtain higher levels of external reinsurance. A third measure of risk, the cedent's percentage of liabilities that are long-tailed, is also significant and positive. Finally, in Panel A we find that the amount of reinsurance ceded is negatively related to our internal reinsurance measure, which is consistent with the notion of substitutability between these two sources of reinsurance coverage.

### *Profit Equation*

Table 3 presents the results of our random effects estimation of the profit equation. Recall our second hypothesis: long term reinsurance contracting will be associated with higher insurer profits. We employ two statutory methods for determining profitability: *ROA* and *ROE*. The *ROA* is defined as the ratio of net income after tax to total admitted assets and *ROE* is the ratio of the after tax net income to surplus. The results are consistent with our second hypothesis as the marginal effect of the sustainability index (shown in Panel B) is positive and significant for both *ROA* and *ROE*. Again, we estimated various specifications of this model and the sustainability index's relationship to profits (either *ROA* or *ROE*) was quite robust to changes in specification. The elasticity between the *ROA* and the sustainability index was 0.05 and for *ROE* was 0.07 and significant at the 0.05 level for both profit measures, suggesting the effect is inelastic. This implies that a 10 percent change in the sustainability index can translate into a modest 0.5-0.7 percent change in statutory profitability.

### *A. M. Best Rating Equation*

Table 4 shows the ordered probit estimates for the rating equation. In this model we analyze the effect of sustainability on A. M. Best ratings. Our third hypothesis was that firms with longer contract sustainability would have a lower risk of bankruptcy. In this case, we use the A. M. Best credit rating as a proxy for bankruptcy risk. We compress the various ratings into a five point ordinal scale as discussed above with “4” being the highest and “0” being the lowest.

Again, our hypothesis is a one-tailed test (that sustainability will have a positive effect on credit rating) and under this test, the result is significant at the .10 level. In addition, our measure of focus is highly significant and negative, which suggests a penalty for lack of reinsurance monitoring, other things equal.

We estimated other specifications (not shown here for the sake of brevity), and our results are not as robust as in the reinsurance and profit regressions. The coefficient on our sustainability index is often just out of the range for significance for a one-tailed test, but the coefficient on the reinsurance index is always quite significant. We also estimated the ordered probit equation year by year and obtained quite divergent results over the time period.

### **Conclusions and Discussion**

In this paper, we attempted to examine three hypothesis proposed by Jean-Baptiste and Santomero regarding the influence of reinsurance contract sustainability on the operations of cedent insurance companies. The first hypothesis is that contract sustainability

influences the amount of reinsurance obtained by the cedent. Operationally, we examined the effect on external reinsurance obtained excluding internal reinsurance in part because adverse selection is more likely to exist between unrelated parties. We found that cedents who pursue longer term relationships with “external” reinsurers obtain more reinsurance coverage, other things equal. This empirical result is consistent with Jean-Baptiste and Santomero’s theory.

The second hypothesis considers the relationship between contract sustainability and profitability. Two definitions of profitability were employed, and both suggest a strong positive relationship between contract sustainability and profitability, a result which is consistent with Jean-Baptiste and Santomero’s theory.

Our third hypothesis was that bankruptcy risk diminishes as the result of the sustained reinsurance relationships. Our results are not as strong here, although we obtained significance using a one-tailed test under some specifications. Our A. M. Best rating classification may not be correct in the sense that we may have classified companies into too small or too large of a category. We used five discrete rating categories to bring the number of categories down to a manageable level, but more analysis of this needs to be undertaken.

In general, our results support the role that long-term cedent/reinsurer relationships have in enhancing firm profitability. Further, we developed a new index of concentration of ceded premiums among reinsurance premiums. We found in particular that reinsurer focus was negatively related to the amount of reinsurance ceded and negatively associated with the A. M. Best rating that we employed. In all of the specifications this result was quite robust.

**Table 1. Descriptive Statistics**

<b>Variable</b>	<b>N</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>
External Reinsurance Measure ( <i>REINS</i> )	6,995	0.110	0.238	-1.000	0.993
Reinsurance Sustainability Index ( <i>SUSTAIN</i> )	6,995	0.178	0.334	0.000	1.002
Agency Marketing System ( <i>AGENCY</i> )	6,995	0.667	0.471	0.000	1.000
A. M. Best Rating ( <i>AMBEST</i> )	6,935	2.136	1.435	0.000	4.000
Direct Writer Marketing System ( <i>DIRECT</i> )	6,995	0.190	0.392	0.000	1.000
Geographic Herfindahl Index ( <i>GEOHERF</i> )	6,995	0.573	0.383	0.030	1.000
Reinsurance Herfindahl Index ( <i>RHERF</i> )	5,936	0.463	0.323	0.027	1.000
Internal Reinsurance Measure ( <i>INTERNAL</i> )	6,990	0.465	0.748	-2.099	3.452
Liquidity ( <i>LIQUIDITY</i> )	6,908	0.824	1.317	0.003	68.384
Percent Long Tail Liabilities ( <i>LONGTAIL</i> )	6,995	0.683	0.277	0.000	1.000
Mutual Indicator ( <i>MUTUAL</i> )	6,995	0.229	0.420	0.000	1.000
Product Herfindahl Index ( <i>PHERF</i> )	6,995	0.571	0.213	0.258	1.000
Pct. Change in Surplus ( <i>CAPITAL_ADEQUACY</i> )	6,950	0.101	0.243	-0.524	1.381
Percentage Change in Premiums ( <i>PREMIUM_GROWTH</i> )	6,870	0.265	1.260	-0.684	10.428
Return on Assets ( <i>ROA</i> )	6,995	0.021	0.056	-0.211	0.227
Return on Equity ( <i>ROE</i> )	6,995	0.048	0.170	-0.878	0.607
Premiums to Surplus Ratio ( <i>PSRATIO</i> )	6,995	2.132	3.688	0.000	105.100
Log of Total Assets ( <i>SIZE</i> )	6,995	18.047	1.891	12.159	25.107
Standard Deviation of Equity Return ( <i>STDE</i> )	6,995	0.307	0.181	0.015	4.660
Stock Indicator ( <i>STOCK</i> )	6,995	0.727	0.446	0.000	1.000
Effective Tax Rate ( <i>TAXRATE</i> )	6,988	0.213	0.377	-1.771	1.842

**Table 2. Random Effect Estimation. Dependent Variable is External Reinsurance**  
**Panel A. Random Effects Results**

<b>Variable</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-stat</b>	<b>prob.</b>
Intercept	<b>2.042</b>	0.522	3.910	0.000
Stock Indicator	-0.076	0.180	-0.420	0.676
Mutual Indicator	-0.012	0.195	-0.060	0.951
Log of Total Assets	<b>-0.152</b>	0.050	-3.030	0.002
Log of Total Assets Squared	<b>0.002</b>	0.001	1.960	0.050
Reinsurance Sustainability Index	<b>0.027</b>	0.016	1.690	0.092
Reinsurance HHI	-0.160	0.113	-1.410	0.157
Product HHI	<b>-0.883</b>	0.178	-4.950	0.000
Geographic HHI	0.172	0.144	1.190	0.234
Stock * Log of Total Assets	0.003	0.010	0.270	0.785
Mutual * Log of Total Assets	0.001	0.011	0.140	0.891
Reinsurance HHI* Log of Tot. Assets	0.007	0.006	1.080	0.281
Product HHI * Log of Tot. Assets	<b>0.048</b>	0.010	4.770	0.000
Geographic HHI * Log of Tot. Assets	-0.012	0.008	-1.480	0.140
Reinsurance Sustainability Index * Log of Tot. Assets	-0.001	0.001	-1.370	0.170
Premiums to Surplus Ratio	<b>0.006</b>	0.001	6.400	0.000
Standard Deviation of Equity Return	<b>0.177</b>	0.021	8.600	0.000
Effective Tax Rate	0.000	0.004	0.060	0.953
Percent Long Tail Liabilities	<b>0.066</b>	0.016	4.080	0.000
Measure of Internal Reinsurance	<b>-0.016</b>	0.003	-5.670	0.000
Indicator for 1996	0.001	0.004	0.250	0.806
Indicator for 1997	0.000	0.005	0.040	0.971
Indicator for 1998	0.000	0.005	-0.040	0.972
Indicator for 1999	0.002	0.005	0.370	0.711
Indicator for 2000	<b>0.016</b>	0.008	1.870	0.062
R <sup>2</sup>	19.20%			
N	5,925			

Random Effects chosen over Fixed Effects Model as a result of Hausman test significant at 0.000.

<b>Panel B. Marginal Effects (Measured at the Means)</b>	<b>Coefficient</b>	<b>Std. Error</b>	<b>t-stat</b>	<b>prob.</b>
Log of Total Assets	<b>-0.041</b>	0.010	-4.300	0.000
Log of Total Assets (Stock Companies)	<b>-0.039</b>	0.004	-10.090	0.000
Log of Total Assets (Mutual Companies)	<b>-0.040</b>	0.005	-7.360	0.000
Reinsurance Sustainability Index	<b>0.026</b>	0.016	1.690	0.091
Reinsurance HHI	<b>-0.037</b>	0.012	-3.110	0.002
Product HHI	-0.025	0.019	-1.340	0.182
Geographical HHI	<b>-0.038</b>	0.013	-2.860	0.004
Mutual	0.015	0.025	0.600	0.551
Stock	-0.026	0.023	-1.120	0.261

**Table 3. Random Effects Estimation. Dependent Variable is Return on Assets or Return on Equity**

Panel A. Random Effects Results

	<i>Return on Assets</i>				<i>Return on Equity</i>			
	Coefficient	Std. Error	t-stat	prob.	Coefficient	Std. Error	t-stat	prob.
Intercept	<b>0.033</b>	0.008	3.990	0.000	<b>-0.889</b>	-0.889	-3.730	0.000
Stock Indicator	<b>-0.001</b>	0.000	-3.550	0.000	-0.078	-0.078	-0.690	0.491
Mutual Indicator	0.003	0.038	0.090	0.931	0.027	0.027	0.220	0.826
Log of Total Assets	-0.002	0.041	-0.040	0.970	<b>0.089</b>	0.089	3.630	0.000
Log of Total Assets Squared	0.000	0.002	0.050	0.956	<b>-0.002</b>	-0.002	-3.100	0.002
Reinsurance Sustainability Index	0.000	0.002	0.070	0.946	<b>0.036</b>	0.036	1.980	0.047
Reinsurance Sustainability Index * Log of Tot. Assets	0.005	0.003	1.630	0.102	-0.001	-0.001	-0.710	0.478
Stock * Log of Total Assets	<b>0.013</b>	0.004	3.620	0.000	0.005	0.005	0.850	0.395
Mutual * Log of Total Assets	<b>-0.018</b>	0.004	-5.010	0.000	-0.001	-0.001	-0.100	0.918
Percent Long Tail Liabilities	0.010	0.006	1.630	0.104	<b>-0.036</b>	-0.036	-3.360	0.001
Agency Marketing System	0.000	0.000	-0.530	0.595	0.005	0.005	0.500	0.614
Direct Writer Marketing System	<b>-0.007</b>	0.002	-4.540	0.000	0.026	0.026	2.340	0.019
Indicator for 1996	0.004	0.002	2.030	0.043	<b>-0.028</b>	-0.028	-5.490	0.000
Indicator for 1997	-0.001	0.002	-0.620	0.535	0.004	0.004	0.790	0.430
Indicator for 1998	<b>-0.007</b>	0.002	-4.320	0.000	-0.010	-0.010	-1.980	0.048
Indicator for 1999	<b>-0.013</b>	0.004	-3.280	0.001	<b>-0.036</b>	-0.036	-7.030	0.000
Indicator for 2000	<b>-0.312</b>	0.079	-3.920	0.000	<b>-0.067</b>	-0.067	-5.490	0.000
R <sup>2</sup>	0.0553				0.0664			
N	6,995				6,995			

Random Effects chosen over Fixed Effects Model as a result of Hausman test significant at 0.000.

Panel B. Marginal Effects (Measured at the Means)

Log of Total Assets	<b>1.209</b>	0.303	3.990	0.000	<b>3.301</b>	0.909	3.630	0.000
Log of Total Assets (Stock)	<b>1.209</b>	0.303	4.000	0.000	<b>3.306</b>	0.908	3.640	0.000
Log of Total Assets (Mutual)	<b>1.209</b>	0.302	4.000	0.000	<b>3.300</b>	0.907	3.640	0.000
Sustainability Index	<b>0.007</b>	0.002	3.080	0.002	<b>0.024</b>	0.007	3.630	0.000
Stock	0.005	0.005	1.100	0.272	0.019	0.015	1.270	0.203
Mutual	0.001	0.005	0.230	0.816	0.014	0.016	0.900	0.369

**Table 4. Ordered Probit Results. Dependent Variable is A. M. Best Rating**

Panel A.

	Coefficient	Std. Error	t-stat	prob.
Log of Total Assets	<b>1.758</b>	0.133	13.230	0.000
Log of Total Assets Squared	<b>-0.033</b>	0.003	-10.050	0.000
Premiums to Surplus Ratio	<b>-0.038</b>	0.009	-4.340	0.000
Stock Indicator	0.054	0.073	0.740	0.459
Mutual Indicator	0.092	0.076	1.210	0.225
Return on Assets	<b>3.232</b>	0.308	10.500	0.000
Reinsurance HHI	<b>-0.342</b>	0.052	-6.530	0.000
Standard Deviation of Equity Return	<b>0.535</b>	0.155	3.460	0.001
Liquidity (Liabilities/Liquid Assets)	<b>-0.292</b>	0.031	-9.420	0.000
Percentage Change in Surplus	0.001	0.065	0.010	0.991
Percentage Change in Total Premiums	-0.014	0.013	-1.090	0.274
Percent Long Tail Liabilities	<b>0.267</b>	0.061	4.360	0.000
Reinsurance Sustainability Index	0.061	0.046	1.330	0.184
Indicator for 1996	-0.054	0.045	-1.200	0.231
Indicator for 1997	0.036	0.050	0.720	0.470
Indicator for 1998	-0.029	0.045	-0.650	0.516
Indicator for 1999	0.021	0.046	0.460	0.648
Indicator for 2000	0.033	0.081	0.400	0.687
<hr/>				
A. M. Best Rating = 4	19.202	1.134		
A. M. Best Rating = 3	18.424	1.135		
A. M. Best Rating = 2	17.710	1.133		
A. M. Best Rating = 1	17.056	1.131		
<hr/>				
Log likelihood = -7849.1152	Pseudo R <sup>2</sup>	=	0.1448	
N = 5,722				

Panel B. Marginal Effects (Measured at the Means)

Log of Total Assets	<b>59.728</b>	4.565	13.080	0.000
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## References

- Adams, M. and M. Hossain, 1998, Managerial Discretion and Voluntary Disclosure: Empirical Evidence from the New Zealand Life Insurance Industry, *Journal of Accounting and Public Policy* 17, 245-281.
- Adiel, R., 1996, Reinsurance and the Management of Regulatory Ratios and Taxes in the Property-Casualty Insurance Industry, *Journal of Accounting and Economics* 22(1-3), 207-240.
- Berger, L. A., Cummins, J. D. and S. Tennyson, 1992, Reinsurance and the Liability Insurance Crisis, *Journal of Risk and Uncertainty*, pp. 253–272.
- Blazenko, G., 1986, The Economics of Reinsurance, *Journal of Risk and Insurance* 53, 258–277.
- Borch, K., 1960, The Safety Loading of Reinsurance Premiums, *Scandinavian Actuarial Journal* 163-184.
- Borch, K., 1962, Equilibrium in a Reinsurance Market, *Econometrica* 30, 424-444.
- Cole, C. R. and K. A. McCullough, 2006, A Reexamination of the Corporate Demand for Reinsurance, *Journal of Risk and Insurance* 73(1), 169–192.
- Cox, N., 1998, WINSOR: Stata module to Winsorize a variable, available at <http://ideas.repec.org/c/boc/bocode/s361402.html>.
- Cummins, J. D. and O. Mahul, 2003, Optimal Insurance with Divergent Beliefs about Insurer Total Default Risk, *Journal of Risk and Uncertainty*, 27(2), 121–138.
- Doherty, N. A., and R. D. Phillips, 2002, Keeping up with the Joneses: Changing Rate Standards and the Buildup of Capital by U.S. Property-Liability Insurers, *Journal of Financial Services Research*, 21(1/2): 55-78.
- Doherty, N. A. and K. Smetters, 2006, Moral Hazard in Reinsurance Markets, *Journal of Risk and Insurance* 72(3), 375-391.
- Doherty, N. A. and S. M. Tiniç, 1981, Reinsurance under Conditions of Capital Market Equilibrium: A Note, *Journal of Finance* 36, 949-952.
- Eden, Y., and Y. Kahane, 1988, Reinsurance contracts: A Utility Approach vs. Insurance Capacity Considerations, *Journal of Banking and Finance* 6, 247-269.
- Eden, Y., and Y. Kahane, 1990, Moral Hazard and Insurance Market Structure, in *Risk, Information and Insurance* (H. Loubergé, Ed.), Kluwer Academic, Boston.
- Froot, K. A., 2001, The Market for Catastrophe Risk: a Clinical Examination, *Journal of Financial Economics* 60, 529-571.

- Froot, K. A., 2007, Risk Management, Capital Budgeting, and Capital Structure Policy for Insurers and Reinsurers, *Journal of Risk and Insurance* 74(2), 273-299.
- Garven, J. R. and J. Lamm-Tennant, 2003, The Demand for Reinsurance: Theory and Empirical Tests, *Insurance and Risk Management*, 71(2), 217-237.
- Garven, J. R., and H. Loubergé, 1996, Reinsurance, Taxes, and Efficiency: A Contingent Claims Model of Insurance Market Equilibrium, *Journal of Financial Intermediation*, Vol. 5, Issue 1 (January): 74-93.
- Hoerger, T. J., Sloan, F. A. and M. Hassan, 1990, Loss Volatility, Bankruptcy and the Demand for Reinsurance, *Journal of Risk and Uncertainty* 3 (September), 221-245.
- Jean-Baptiste, E. L. and A. M. Santomero, 2000, The Design of Private Reinsurance Contracts, *Journal of Financial Intermediation* 9, 274-297.
- Lamm-Tennant, J., Starks, L., and L. Stokes, 1996, Considerations of cost trade-offs in insurance solvency surveillance policy, *Journal of Banking and Finance*, 20(5), 835-852.
- Loubergé, H., 1983, A Portfolio Model of International Reinsurance Operations, *Journal of Risk and Insurance* 50, 44-60.
- Outreville, J. F., 1994, The Demand for Reinsurance in Developing Countries, UNCTAD Working paper, United Nations, Geneva.
- Powell, L. S. and D. W. Sommer, 2007, Internal Versus External Capital Markets in the Insurance Industry: The Role of Reinsurance, *Journal of Financial Services Research* (forthcoming).
- Mayers, D. and C. W. Smith, 1982, On the Corporate Demand for Insurance, *Journal of Business* 55(2), 281-296.
- Mayers, D. and C. W. Smith, 1990, On the Corporate Demand for Insurance: Evidence from the Reinsurance Market, *Journal of Business* 63(1), 19-40.
- Phillips, R. D., Cummins, J. D., and F. Allen, 1998, Financial Pricing of Insurance in the Multiple-Line Insurance Company, *Journal of Risk and Insurance* 65(4), 597-636.
- Samson, D. and H. Thomas, 1983, Reinsurance Decision Making and Expected Utility, *Journal of Risk and Insurance* 50, 249-264.
- Tapiero, C. S., and D. Zuckerman, 1981, Optimum Excess-Loss Reinsurance: a Dynamic Framework, *Stochastic Processes and their Applications* 12, 85-96.