THE ROLE OF LOSS RESERVE ERRORS IN THE SMOOTHING OF POLICYHOLDER SURPLUS

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Abstract

The penchant for insurers to engage in loss reserve earnings management has been well-established in the extant literature. Less well understood is the existence of a pattern in the systemic loss reserves errors found in the U.S. property-casualty insurance industry. This research examines that behavior and investigates the relationship between loss reserve errors and the cost of alternative sources of capital in the marketplace. We hypothesize that during times of relatively higher cost of alternative sources of capital insurance management will use its loss reserve estimates as a means of smoothing reported surplus for accounting purposes. We collect data from the U.S. property-casualty insurance industry over the period 1996 to 2011 and use GMM modeling techniques to control for dynamic responses. In addition to an aggregated industry analysis, we also perform separate analyses based on the insurer's form of ownership. We find evidence that insurers use loss reserves to modulate reported surplus to compensate for changes in the relative cost of other sources of capital. Our results also show that these relationships vary depending on the ownership structure of an insurer.

Keywords: Insurance industry, reserve errors, policyholders' surplus

บทคัดย่อ

การตกแต่งกำไรในส่วนของเงินสำรองสำหรับการขาดทุน (Loss Reserve) เป็นที่นิยมอย่างมากสำหรับบริษัทประกันภัย ตามที่ปรากฏในงานวิจัยที่ผ่านมา แต่สิ่งที่ยังเป็นที่สงสัยกันก็คือการเกิดความคลาดเคลื่อนอย่างมีระบบในเงินสำรองสำหรับการขาดทุนที่พบในอุตสาหกรรมประกันวินาศภัยในประเทศสหรัฐฯ งานวิจัยฉบับนี้ทำการศึกษาถึงพฤติกรรมและความสัมพันธ์ระหว่างความคลาดเคลื่อนของเงินสำรองสำหรับการขาดทุนกับต้นทุนของแหล่งเงินทุนในตลาด โดยตั้งสมมติฐานว่าในช่วงเวลาที่ต้นทุนของแหล่งเงินทุนเพิ่มสูงขึ้น ผู้บริหารบริษัทประกันภัยจะใช้ค่าประมาณการของเงินสำรองสำหรับการขาดทุนในการที่ทำปรับค่าส่วนเกินมูลค่าที่รายงาน (Reported Surplus) ให้สม่ำเสมอเพื่อวัตถุประสงค์ทางบัญชี งานวิจัยฉบับนี้อาศัยข้อมูลเกี่ยวกับอุตสาหกรรมประกันวินาศภัยในประเทศสหรัฐฯ ในช่วงระหว่างปี ค.ศ. 1996

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ถึง ค.ศ. 2011 และใช้เทคนิค GMM ในการควบคุม Dynamic Response โดยนอกจากจะมีการวิเคราะห์อุตสาหกรรมในภาพรวม ยังได้ทำการวิเคราะห์แยกตามรูปแบบความเป็นเจ้าของของบริษัทประกันภัย ผลลัพธ์ที่ได้แสดงถึงหลักฐานว่าบริษัทประกันภัยใช้เงินสำรองสำหรับการขาดทุนเพื่อปรับค่าส่วนเกินมูลค่าที่รายงานเพื่อนำไปชดเชยกับต้นทุนของแหล่งเงินทุนที่สูงขึ้น ผลลัพธ์ที่ได้ยังแสดงว่าความสัมพันธ์ดังกล่าวนั้นขึ้นอยู่กับรูปแบบความเป็นเจ้าของของบริษัทประกันภัยด้วย

INTRODUCTION

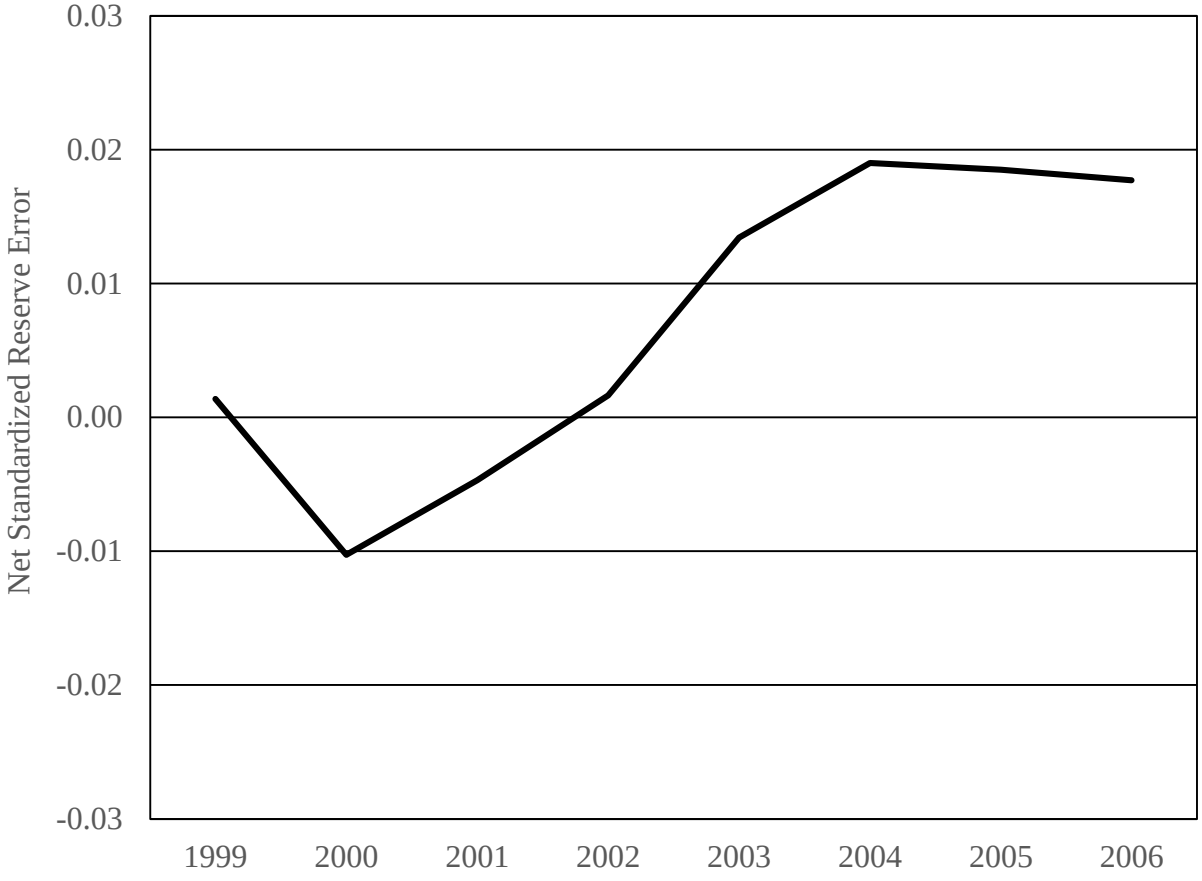
The motivations and inclination for insurers to engage in earnings management through the manipulation of loss reserves estimates have been well documented in the extant literature. Empirical research has identified relationships between insurer loss reserve errors and the smoothing of earnings, share price, executive remuneration, analyst expectations, etc. While many of the motivations for firm-level earnings management may seem self-evident, the motivations for the *industry as a whole* to engage in systemic loss reserve earnings management are less clear.

Figure 1 shows the behavior of loss reserve errors for the U.S. property-casualty insurance industry over the 1999-2006 period. The average industry reserve error is powerfully patterned with a trough occurring around 2000 and a peak around 2005. Even after controlling for some obvious drivers of such systemic behavior, e.g., unanticipated inflation, these patterns persist. The existence of a *systemic* error in the aggregate industry loss reserve error is readily evident. The pattern of reserve errors suggest that one or more environmental factors are affecting industry reserving practices as a whole - encouraging the industry to over/under-reserve in accordance with some external influence in the marketplace. However, very little research has addressed the issues surrounding systemic influence on the broader insurance market.

In search of explanations for this phenomenon, this research pursues the issue within the context of the supply and demand for insurance capital at the industry level. Given the degree of discretion afforded insurer management in setting loss reserve estimates for financial reporting purposes, this research examines the relationship between loss reserve errors and the relative cost of other traditional sources of insurance capital. We hypothesize that insurers use their loss reserve estimates as a means of smoothing reported policyholder surplus in response to varying levels of other capital. We expect the use of other traditional forms of insurance capital to vary corresponding to the relative changes in the cost of such capital. Using data from the property-casualty insurance industry over the period 1996 to 2011, our generalized method of moments (GMM) estimators provide evidence that insurers exercise their discretionary authority to better manage its aggregate cost of capital. Our main findings remain robust after controlling for various firm-level factors that may affect loss reserve errors. When we re-estimate the models separately for publicly traded stock insurers, privately held stock insurers and mutual insurers, our findings suggest that the extent of interaction between other source of capitals and loss reserve manipulation also vary by type of organizational structures.

This research addresses the accounting implications associated with loss reserve earnings management in response to the cost of insurer capital. While economic capital, i.e., the actual funds procured and employed in the operations of an insurer's business, serves as the insurer's life-blood, assessment of the insurer's performance are mainly focused on the information provided in the insurer's financial reports, e.g., summaries of the insurer's accounting capital. The findings of this research contribute to two core streams of insurance literature: loss reserve estimation and cost of capital management. Additionally, this study uses a more sophisticated methodology (when compared to earlier similar analyses) that controls for dynamic responses by including lagged dependent variable, which is an improvement over previous studies in this area

Figure 1. U.S. Property-Casualty Insurance Industry: Historical Loss Reserve Errors



Source: NAIC Annual Statement Data

that have used static models. Given the recent financial crisis and the impact loss reserve estimates have on any assessment of insurer performance, our findings are of significant interest to not only regulators, but also shareholders and other stakeholders.

The next section of the paper provides background information and literature on earning management and insurer capital structure. Next, we present our hypotheses, methodology, data and empirical models for testing hypotheses. Our empirical results are then presented, followed by our conclusion.

BACKGROUND & LITERATURE REVIEW

Loss Reserve Estimation

Given the fiduciary nature of the insurance business, insurers hold significant funds that are anticipated to be eventually paid out as claims. Accordingly, accounting rules require that those funds be recognized as liabilities on the insurer's financial statements. These loss reserve accounts typically represent about 60-70 percent of an insurer's total liabilities. When coupled with the insurer's unearned premium reserves, they comprise about 80-90 percent of an insurer's total liabilities. The combined sum of the U.S. property/casualty insurance industry's unearned premium and loss reserves was 168% of the industry's policyholder surplus in 2009.

The accounting for loss reserves is an imprecise science. While significant actuarial and regulatory guidelines are provided in facilitating "reasonable" estimates of those loss reserves, errors are to be expected. What constitutes a "reasonable" estimate has been the source of significant discussion within the industry (Shapland, 2007). Accounting principles typically encourage conservative estimation in matters allowing for management discretion. For example, the Statutory Accounting Principles (SAP) specifically states that, when no estimate within a range is better than any other, the midpoint of the range should be chosen. Even more conservative is the admonition of the Generally Accepted Accounting Principles (GAAP) that states when no estimate is better than any other within a given range, the most conservative estimate in the range should be chosen. Given the relative magnitude of those accruals, even small errors in those estimates may have material effects on the insurer's financial reports. The precise meaning of "reasonable" has been the subject of significant debate; management is afforded some degree of discretion in the final selection of those estimated loss values. In theory, actuarial modeling of estimated loss reserves would control for environmental factors that affect the accuracy of loss reserve estimates resulting in a random error pattern at the industry level; some insurer estimates are higher, some are lower, but on average they should appear to be randomly fluctuating around zero. Instead, what we find in Figure 1 is a distinct pattern of systemic error over the 1999-2006 period. A systemic error might suggest a system-wide failure to account for some relevant factor; a seemingly unlikely occurrence at the industry level. The motivation for senior insurance management to engage in earnings management at the firm level has been the subject of significant earlier investigation and we briefly summarize that extant literature below.

Earnings Management and Loss Reserve Errors

Evidence suggesting the manipulation of loss reserves by senior management to smooth insurer earnings and/or achieve specific outcomes on financial reports have been well documented (Anderson, 1973; Smith, 1980; Weiss, 1985; Grace, 1990; Petroni, 1992; and Beaver, McNichols, and Nelson, 2003). According to Petroni (1992), the primary motivation to under-estimate loss reserves is a decreasing function of the financial position of the insurer, i.e., under-reserving positively affects insurer profitability in the current period. Browne, Ma, and Wang (2009) and Eckles and Halek (2010) provide evidence that the managers of publicly traded insurers manipulate loss reserves to impact share prices and maximize their personal compensation. With regard to the stock market reaction to variation in loss reserve errors, Anthony and Petroni (1997) find that financial markets provide smaller earnings response coefficients to insurers with more variable reserve estimation errors. Gaver and Paterson (2001) assess the relationship major actuarial consulting groups as oversight entities share with insurer reserve errors. They conclude that major consulting groups (relative to smaller, less influential actuarial consulting firms) insist on relatively more conservative loss

reserving behavior. Browne, Ju, and Lei (2012) further report reserve errors to be related to reinsurance usage and contingent commissions. While that body of literature contributes significantly to an understanding as to why a given insurer may engage in loss reserve earnings management, it does not explain the systemic behavior revealed in Figure 1. Certainly, some factors at the macro-level might immediately spring to mind as possible explanations for the patterns evident in Figure 1, e.g., unanticipated inflation, however, our preliminary analysis of the data suggests other factors are also driving the industry's behavior.

Loss Reserves and their Impact on Financial Reports

This research investigates the possibility that insurers may engage in loss reserve earnings management as a means of smoothing policyholder surplus in response to their use of other sources of insurer capital. The basic premise relies on simple economics relating price and demand; the demand for a given source of capital is inversely related to its cost. As the cost of one source of traditional capital increases, insurers may seek out lower cost alternatives in the marketplace. Given the magnitude of the loss reserve account relative to policyholder surplus, insurer management is able to materially impact reported policyholder surplus values by over or under-estimating loss reserves in any given year. Thus, management has the ability to manipulate external assessments of its overall performance through its exercise of discretionary estimates of loss reserves.

Sources of Insurer Capital

Insurers rely on capital for three main reasons: to carry out operational tasks, to meet regulatory expectations, and to satisfy the demands/expectations of stakeholders, e.g., investors. Insurers can raise necessary capital through both external and internal channels. Traditional external sources of capital for publicly traded *non-insurance* firms include debt and equity offerings. Due to a number of factors, the insurance industry's reliance on these traditional sources of capital is modified to some degree. First, given the significant funds held as loss reserves (i.e., debt), insurers typically carry very little traditional debt to support its need for capital. Also, the general lack of publicly traded companies in the U.S. property-casualty insurance industry clouds the role of equity within the industry. Publicly traded insurers (who can raise through equity offerings) represent only about 22 percent of the market. Another 22 percent of the market employs a mutual ownership form that lacks similar access to the capital markets. The remaining 56 percent are privately held insurers whose ownership character may vary and whose access to traditional sources of equity in the capital markets may be inhibited.

Another aspect of the traditional insurance model that serves to differentiate its capital structure from non-insurance firms is the use of reinsurance and other unique sources of capital. Reinsurance may impact an insurer's operations in a number of ways. First, reinsurance represents an "off-balance sheet" source of capital for insurers. It operates much like a line of credit for non-insurance entities and only becomes available through the occurrence of a qualifying event and therefore, isn't formally recognized as existing capital in an insurer's financial reports. Reinsurance may also be used to transfer complete portfolios of potential liabilities to other insurers. Additionally, certain types of reinsurance contracts, i.e., proportional reinsurance, often include ceding commissions paid by the reinsurer to the ceding insurer and are recognized as surplus relief on the latter's financial statements. More recently, the development of catastrophe bond markets have provided yet another source of capital for the insurance industry, although that source of capital is still evolving and has yet to assume a larger role as a source of capital for the industry.

An insurer's retained earnings, i.e., the accumulated after-tax net income not otherwise distributed in the form of stakeholder dividends, represent a source of internally generated capital. Those funds are generated through an insurer's underwriting and investment operations. The underwriting capital is a function of the core operations undertaken by an insurer and is captured in the insurer's statement of income. The capital associated with its investment operations are typically derived from returns on investments and the gains/losses that are recognized when an insurer sells a portion of its equity holdings. Less obvious is the impact of the reevaluation of loss reserves and the recognition of the market value of investments that are marked-to-market, i.e., unrealized capital gains/losses that are recognized on an insurer's balance sheet.

Our analysis tests for changes in the cost of those traditional sources of insurer capital and their relationship with loss reserving behavior. It should be clear that this investigation does not enjoin any debate as to whether insurance debt represents insurer capital in the more technical sense of the term. For example, Launie (1971) analogized the traditional non-insurance firm cost of capital structure with the insurance accounting model. He argued that insurance debt (i.e., unearned premiums and loss reserves) essentially assumes the traditional role of debt within an accounting treatment of a cost of capital analysis. Cummins and Lamm-Tennant (1994) similarly recognize the analogous role insurance debt fulfills within the insurance framework when comparing it to the role more traditional debt plays in non-insurance firms. Our position is that reserving behavior has an undeniable and objective impact on the accounting recognition of an insurer's policyholder surplus and our research seeks to establish an empirical linkage.

Hypotheses Development

We assess an insurer's reliance on various sources of traditional capital indirectly by assessing that source's cost; invoking classic economic rationale that cost and demand are inversely related. A primary motivation for this method of assessment is the inability to assess the amount of capital a reinsurance contract represents given its off-balance sheet nature. Using the cost of the capital as a proxy allows us to include this important source of insurer capital while maintaining some consistency of measure across other sources of capital. Additionally, given our objective of assessing the systemic loss reserve errors at the industry-level (as opposed to the firm-level) we endeavor to use industry level proxies for the cost of the capital. While we recognize that a more refined analysis would allow us to control for the cost of equity at the firm level, such measures of cost of capital do not allow us to address the question as the reasons for the systemic errors observed at the industry level. The basic economic premise we rely on is that as the price of a commodity (capital) increases/decreases the demand will simultaneously decrease/increase. In response to decreases/increases in the usage of capital, insurers will increase/decrease their loss reserve estimates to achieved desired levels of reported policyholder surplus. This intuition highlights the anticipated positive relationship between under-reserving reserving errors and the cost of capital in the marketplace. We recognize four major sources of capital used by insurers and subsequently discuss each in more detail below.

Insurance Debt

Insurance debt represents the single largest source of capital available to an insurer in carrying out its operations. Insurance debt is the liabilities recognized on an insurer's balance sheet that are a result of the sale of policies. The results of an insurer's underwriting operations significantly impact its net income which contributes to its retained earnings. Launie (1972) invokes the rationale that insurance price proxies the cost of insurance debt

when he argues that price and cost are inversely related. When the price of insurance increases (i.e., the cost of insurance debt decreases), an insurer may rely more heavily on that source of capital in funding its surplus accounts. If insurers use loss reserve estimates to smooth the reported levels of capital in their financial statements, low cost in obtaining funds from insurance debt will encourage insurers to reserve more accurately or even over-reserve, as encouraged by regulators. Thus, we expect a positive relationship between the price of insurance and over-reserving errors.

Capital Markets

Both investment income and realized capital gains/losses are a function of the general strength of the capital markets. While percentages fluctuate significantly, these sources of capital may represent in excess of 50 percent of an insurer's net revenue in any given year. Additionally, unrealized capital gains/losses directly impact the capital and surplus account on an insurer's balance sheet. Therefore, the general conditions in the capital markets are of significant importance with respect to an insurer's capital structure. The cost of obtaining capital through investment is relatively cheaper when market yields high return. All else equal, insurers should be inclined to heed the admonitions of regulators to err on the conservative side in their estimates and over-reserve during periods when the cost of capital in the capital markets are lower, i.e., returns are higher. These dynamics imply a positive relationship between over-reserving errors and investment return from the capital markets.

Shareholder Equity

Shareholder equity represents a major source of capital for stock insurers. The value of equity offerings and the associated cost of bringing those offerings to the market are inversely related. As industry return-on-equity (*ROE*) increases, the cost of raising capital from selling more stock decreases. The lower costs associated with equity capital alleviate stock insurer's need to inflate surplus through balance sheet manipulation and insurers (i.e., under reserve). Thus, we expect a positive relationship between the market's average *ROE* and over-reserving errors. Given their lack of shareholder structure, mutual insurers are not subject to fluctuations in the equity markets.

Reinsurance

Reinsurance represents a special case as a source of capital. As a direct provider of insurer capital, when reinsurance is affordable and readily available, it represents a good opportunity for insurers to obtain additional surplus through reinsurance transaction. Surplus relief provided by proportional reinsurance further affords the insurer the opportunity to escape the need to under-reserve and possibly even reserve more conservatively, i.e., over-reserve. Conversely, as the cost of reinsurance increases, primary insurers are likely to rely less heavily on it as a source of capital and instead, artificially inflate its capital and surplus by under-reserving the value of its anticipated losses. Thus, we expect the cost of reinsurance to share a negative relationship with over-reserving errors in the insurance industry.

RESEARCH METHODOLOGY AND DATA

This study examines determinants of insurers' reserve errors by considering both macro-level influences as well as firm-specific factors. Following earlier studies (e.g., Petroni, 1992; Beaver, McNichols, and Nelson, 2003), the size of a reserve error is defined as:

$$Error_{i,t} = [Incurred\ Losses_{i,t} - Incurred\ Losses_{i,t+5}]$$

where *Incurred Losses*$_{i,t}$ is insurer *i*'s estimated incurred losses and allocated expenses at the end of year *t* for premium earned in year *t*. *Incurred Losses*$_{i,t+5}$ is the re-estimation of the incurred losses and expenses made five years later for premiums earned in year *t*, i.e., we use a five-year loss development assessment. A positive (negative) value of *Error*$_i$ indicates insurer *i* has overstated (understated) reserve errors. Our approach here is consistent with that of Grace and Leverty (2012) and Eckles and Halek (2010). Previous studies have found that a five-year period is sufficient to observe statistically significant reserve errors (e.g., Smith, 1980 and Kazenski, Feldhaus, and Schneider, 1992). As in earlier studies, to control for the variation in insurer size, the loss reserve error will be scaled using a firm's total admitted assets (e.g., Petroni, 1992 and Gaver and Paterson, 2001).

From year to year, an insurer's loss reserve estimation may be highly correlated. To capture the dynamic effect of economic behavior, we include a lagged loss reserve error along with other exogenous variables as our explanatory variables. Even though the coefficient of the lagged dependent variable may not be of direct interest, estimation using dynamic models may be crucial for obtaining consistent estimates of other parameters. Therefore, we estimate the following equation:

$$y_{i,t} = \alpha y_{i,t-1} + \phi k_t + \gamma x_{i,t} + \delta \mu_i + \varepsilon_{i,t} \quad (1)$$

where $y_{i,t}$ represents the loss reserve error for firm *i* in year *t* and $y_{i,t-1}$ is its lagged value. *k* and *x* are matrices of industry level and firm level variables, respectively. μ_i is set of dummy variables that identify the organizational structure of insurers and $\varepsilon_{i,t}$ is the error term. Our key variables of interest are the four alternative sources of insurer capital discussed earlier: insurance debt; shareholder equity; returns from the capital markets; and reinsurance proceeds. We proxy the cost of insurance debt using the prevailing price of insurance in the marketplace as determined by the inverse of the industry average loss ratio (*INS_PRICE*). This calculation has been frequently employed as a proxy for insurance price in earlier literature; see for example Frech and Samprone (1980) and Outreville (1997). We proxy cost of capital market funds using the annual rate of return for S&P 500 (*S&P*). We also tried long-term government bond rate as an alternative to annual rate of return for S&P 500. The main results remain consistent regardless of the choice of proxies. We use the U.S. property-casualty insurance industry's average return on equity (*ROE*) as a proxy for the cost of shareholder equity – as the average ROE increases the relative cost of that equity decreases. As with the case with our calculation of the price of insurance above, we use the inverse of the reinsurance industry's average loss ratio as a proxy for the price of reinsurance (*RE_PRICE*). Given that the reinsurance industry is highly dispersed and global in nature, the identification of specific metrics reflective of the entire industry are sometimes a challenge. However, the reinsurance industry is also highly concentrated – the top 25 reinsurers control approximately 90 percent of the marketplace. Therefore, we rely on the data of the top 25 global reinsurance groups in identifying the industry's average loss ratio.

Given that cost of capital variables are market-level measures, we also include firm-level control variables to account for an insurer's exposure to each source of capital, respectively. Specifically, we control for:

- the ratio of gross premiums written to policyholder's surplus,
- percentage of investment in risky assets including stocks, real estate and mortgages,

- an insurer's equity to policyholder's surplus, and
- one minus reinsurance retention ratio.

Additionally, we include several other firm level factors that have been found to affect reserve errors in the academic literature, including:

- firm size,
- group affiliation,
- contingent commission usage,
- line of business as well as geographic diversification,
- organization form,
- income smoothing, and
- tax minimization motives.

Previous studies have also reported that reserve errors can be due to an insurer's inability to accurately predict inflation (see for example, Ansley, 1979; Weiss, 1985; Grace, 1990; and Browne *et al*., 2009) and thus, we also control for the unanticipated inflation encountered when generating loss reserve estimates. We present the summary statistics of our model variables and their associated definitions in Table 1.

When a lagged dependent variable is included in the model, OLS and static panel data methodologies are biased and inconsistent due to the correlation between the lagged dependent variable and company specific effects. Thus, we use generalized method of moments (GMM) estimators to estimate equation (1), as proposed by Arellano and Bond (1991) and Arellano and Bover (1995). The GMM estimator uses first-differences to transform equation (1) into

$$y_{i,t} - y_{i,t-1} = \alpha(y_{i,t-1} - y_{i,t-2}) + \phi_1(k_{i,t} - k_{i,t-1}) + \gamma(x_{i,t} - x_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1}) \qquad (2)$$

where the individual fixed effects are eliminated from the equation and lagged values of the repressors are now instruments. With the first-differences method, the lagged dependent variable is also instrumented with its past levels. Under GMM the error term ε is serially uncorrelated and differenced regressors are uncorrelated with the unobserved country-specific effect. Thus, GMM estimators produce consistent and unbiased coefficient estimates when lagged dependent variables are present. While a pattern of loss reserve errors is obvious at the industry-level, the intensity of the experience differs between insurers employing different organizational forms. As can be seen in Figure 2, the cyclical pattern is significantly dampened for mutual insurers when the data is segmented based on the form of ownership. To capture the varying effects environmental factors have on insurer's reserving behavior for different types of firms, we also re-estimate equation (1) separately for publicly traded stock insurers (public), privately held stock insurers (private), and mutual insurers.

Our data are collected from several sources. The NAIC annual statement contains information that allows for the construction of the variable that measures the insurer's reserve errors as well as other control variables. Insurance industry level data and capital market data are obtained from the SNL database and *S&P*, respectively. Data used to measure unanticipated inflation are obtained from the Board of Governors of the Federal Reserve System and the Bureau of Labor Statistics. Insurer rating information is available from the Best's Key Rating Guide. Our sample includes all property-casualty insurers that report

positive values on assets and net premium written over the 1996 to 2011 period. This sample period allows us to calculate loss reserve errors for the operating years 1999 to 2006, as well as the average return on assets over the past three years for each operating year. This time span encompasses both relatively harder and softer markets, which allows us to examine the impact of various market conditions on insurer reserving behavior.

DATA SUMMARY

Table 1 provides descriptive statistics of variables used in our models. As can be seen, reserve errors (*ERROR*) range from -1.17 to 0.39, with an average of 0.007. Those figures suggest firms over-reserve to the extent of 0.7 percent of total assets, on average. However, over-reserving errors for a firm could be up to 39 percent of total assets and under-reserving errors can be up to 1.17 times of total assets. The next four variables represent the cost of alternative sources of capital in the insurance industry. The industry average loss ratio ranges from 65.2 percent (in 2006) to 88.1 percent (2001) resulting in a range of 1.1 to 1.5 for the price of insurance (*INS_PRICE*), with an average price of 1.3. The annual rate of return for S&P 500 (*S&P*) is used to reflect the cost of investment capital and the annual returns range from a negative 22.1 percent to 28.7 percent gain. The average return on equity (*ROE*) for the industry ranges from a 1.2 percent loss to 12.7 percent gain with an average of 6.8 percent. The cost of reinsurance (*RE_PRICE*) is measured by the inverse of the average loss ratio of the top 25 global reinsurance groups. Loss ratios for our observation period range from 59.4 percent to 100.4 percent, resulting in a range of reinsurance prices varying between 1.0 and 1.7.

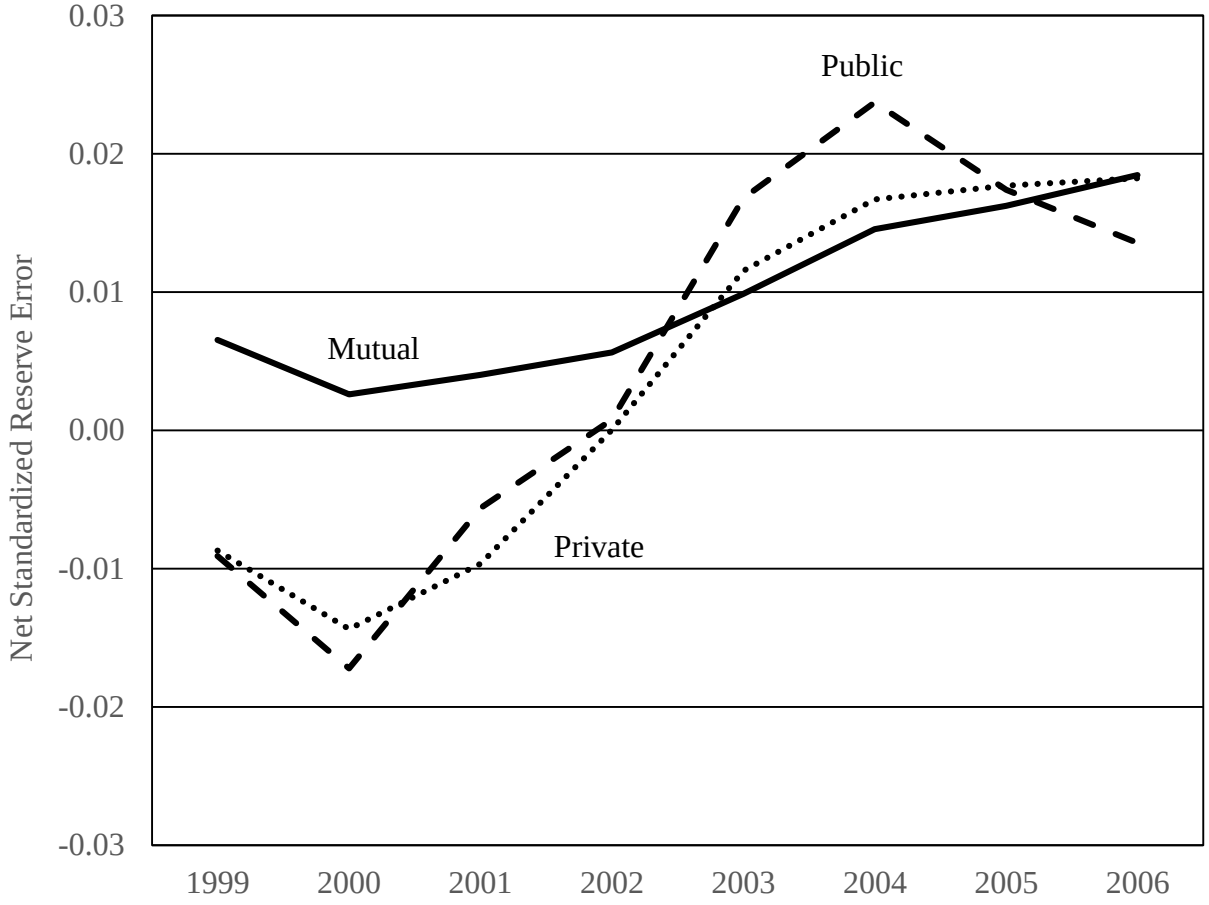
The next four variables measure an insurer's exposure to each source of alternative capitals. Gross premium written (*GPW_PHS*) and firm equity levels (*EQUITY_PHS*) are used to capture an insurer's reliance on premium and shareholder equity capital, respectively. We standardize each source using policyholder's surplus. Because both variables are highly skewed, we take the natural logarithmic transformation of the values. Before applying for the transformation, the average gross premium-to-policyholder's surplus is 222.6 and the average equity-to-policyholder's surplus is 8.9

Table 1: Summary Statistics (N=10,132)[†]

Variable	Mean	Std. Dev.	Skewness	Kurtosis	Min	Max
ERROR	0.007	0.042	-5.035	111.606	-1.167	0.393
INS_PRICE	1.312	0.112	0.489	-0.182	1.135	1.534
S&P	0.050	0.165	-0.224	-1.211	-0.221	0.287
ROE	0.068	0.042	-0.548	-0.664	-0.012	0.127
RE_PRICE	1.312	0.188	0.431	0.020	0.996	1.685
GPW_PHS	5.056	0.953	-1.293	4.388	-2.659	6.907
INVEST	0.111	0.121	1.384	1.800	0.000	0.668
EQUITY_PHS	0.079	0.107	1.858	3.653	0.000	0.672
TRANSFER	0.369	0.278	0.466	-0.978	0.000	0.998
PUBLIC	0.224	0.417	1.327	-0.240	0.000	1.000
MUTUAL	0.230	0.421	1.285	-0.349	0.000	1.000
GROUP	0.716	0.451	-0.957	-1.085	0.000	1.000
SIZE	4.712	1.838	0.411	0.062	-0.089	11.496
COMMISSION	0.534	0.499	-0.137	-1.982	0.000	1.000
SMOOTH	0.026	0.045	0.759	19.213	-0.464	0.590
TAX	0.169	0.059	3.041	7.739	0.150	0.390
LONGTAIL	0.463	0.319	0.094	-0.990	0.000	1.000
GOODRATING	0.192	0.394	1.564	0.448	0.000	1.000
HERF_LINE	0.471	0.292	0.701	-0.822	0.089	1.000
HERF_GEO	0.541	0.379	0.060	-1.660	0.031	1.000
UI	-0.044	0.052	-0.038	-1.491	-0.121	0.020

[†] Variable definitions are as follows: *ERROR* = (incurred $loss_{i,t}$ – incurred $loss_{i,t+5}$)/total assets; *INS_PRICE* = natural log transformation of 1/(industry average loss ratio); *S&P* = annual rate of return for *S&P* 500; *ROE* = industry average return on equity; *RE_PRICE* = 1/loss ratio of top 25 global reinsurance groups; *GPW_PHS* = natural log transformation of gross premium written divided by policyholder's surplus; *INVEST* = nature log transformation of percentage of investment in stocks, real estate and mortgages; *EQUITY_PHS* = natural log transformation of (equity/policyholder's surplus+1); *TRANSFER* = 1 – (net premiums written/gross premiums written); PUBLIC = dummy variable which equals to one if the firm belongs an ultimate owner that is a publicly traded company, and 0 otherwise; *MUTUAL* = dummy variable which equals to one if the firm is a mutual insurer, and 0 otherwise; *GROUP* = dummy variable which equals to one if the firm belongs to a group, and 0 otherwise; *SIZE* = natural log transformation of total admitted assets; *COMMISSION* = dummy variable which equals to one if the firm uses contingent commission, 0 otherwise; *SMOOTH* = average return on assets over the previous three years; *TAX* = marginal tax rate corresponding to the net income plus reserve errors; *LONGTAIL* = percentage of net premiums written in long-tailed lines; *GOODRATING* = dummy variable which equals to one if rating from AM Best is A- or above, 0 otherwise; *HERF_LINE* = line of business Herfindahl Index; *HERF_GEO* = geographical Herfindahl Index; *UI* = unanticipated inflation, calculated as $(CPI_{t+3} - CPI_t)/ CPI_t - T3Y_t$ where T3Y = accumulated yield on 3-year Treasury over three-year period.

Figure 2. Historical Loss Reserve Errors: Segmented by Form of Ownership



Source: NAIC Annual Statement Data

percent. The percentage of an insurer's investment in stocks, real estate and mortgages (*INVEST*) is used to measure an insurer's exposure to stock market returns and on average our sample firms have 11.1 percent of assets in those categories. The *TRANSFER* variable measures the percentage of an insurer's gross premiums that are transferred to reinsurers and is calculated as 1 minus the ratio of net premiums written to gross premiums written. On average, an insurer transfers 36.9 percent of its gross premiums to reinsurers.

We also control for the form of insurer ownership. Privately held insurers comprise 53.6 percent of our sample while publicly traded insurance companies (*PUBLIC*), represent 21.4 percent of the pool. Mutual insurers (*MUTUAL*) comprise the remaining 25.0 percent of the pool. The majority of the insurers (71.6 percent) belong to a group (*GROUP*). In addition to other firm level control variables that are commonly included in previous studies, we also include unanticipated inflation (*UI*) to capture the degree of reserving error that is due to an insurer's inability to accurately predict inflation. We use the accumulated yield of three-year Treasury Bonds as a proxy for projected inflation and calculate unanticipated inflation by taking the difference between actual inflation and the projected inflation. Our data show that in most years, insurers overestimate inflation, overestimating inflation by 4.4 percent on average (over a three-year period).

EMPIRICAL RESULTS

Tables 2 and 3 report our regression results from GMM estimations. Table 2 contains the results from the basic models that include only the cost of capital variables while Table 3

reports the results from our analyses that also include firm-level control variables, as well as unanticipated inflation. There are four sets of models in each table. In addition to the analyses that contain all firms (All), we also perform separate analyses for publicly traded stock insurers, mutual insurers, and privately held stock insurers. Our main findings remain robust after controlling for various firm level factors and unanticipated inflation that may affect loss reserve errors. Consistent covariance matrix estimation to adjust for heteroskedasticity, we use White's test for heteroskedasticity (White, 1980) for all of our models.

Table 2. GMM Estimation: Effects of Alternative Source of Capital on Reserve Errors[†]

	All firms	Public	Mutual	Private
Intercept	-0.036*** (0.012)	0.022 (0.024)	-0.003 (0.016)	-0.080*** (0.019)
Sources of capital				
INS_PRICE	0.054*** (0.014)	-0.024 (0.027)	0.034* (0.018)	0.099*** (0.022)
S&P	0.008*** (0.002)	0.020*** (0.005)	0.010*** (0.003)	0.001 (0.004)
ROE	0.060*** (0.022)	0.090* (0.048)	0.014 (0.031)	0.064* (0.035)
RE_PRICE	-0.024*** (0.004)	0.006 (0.009)	-0.023*** (0.006)	-0.037*** (0.007)
$Error_{t-1}$	-0.071*** (0.010)	0.191*** (0.023)	-0.220*** (0.022)	-0.125*** (0.014)
Wald X^2	298.80	205.41	139.24	219.93
Number of Observations	7417	1588	1851	3978

Notes: * significance at 10% level ** significance at 5% level *** indicate significance at 1% level

[†] Standard errors are heteroscedasticity and autocorrelation consistent. Robust standard errors are reported in the parentheses below coefficient estimates. Variable definitions are as follows: *ERROR* = (incurred $loss_{i,t}$ – incurred $loss_{i,t+5}$)/total assets; *INS_PRICE* = natural log transformation of 1/(industry average loss ratio); *S&P* = annual rate of return for *S&P* 500; *ROE* = industry average return on equity; *RE_PRICE* = 1/loss ratio of top 25 global reinsurance groups.

Table 3. GMM Estimation: Effects of Alternative Source of Capital on Reserve Errors with Firm Level Control Variables†

	All	Public	Mutual	Private
Intercept	-0.134***	-0.170***	-0.179***	-0.175***
	(0.017)	(0.033)	(0.033)	(0.026)
Sources of capital				
INS_PRICE	0.040**	0.163***	-0.039	0.064**
	(0.019)	(0.037)	(0.031)	(0.030)
S&P	0.007***	-0.001	0.018***	0.001
	(0.003)	(0.005)	(0.004)	(0.004)
ROE	0.079***	0.055	-0.003	0.088***
	(0.023)	(0.046)	(0.032)	(0.035)
RE_PRICE	-0.026***	-0.073***	0.008	-0.031***
	(0.006)	(0.013)	(0.010)	(0.010)
Weight of capital sources				
GPW_PHS	-0.002	0.001	0.013***	-0.005***
	(0.001)	(0.002)	(0.003)	(0.002)
INVEST	-0.032***	0.010	-0.040***	-0.030**
	(0.011)	(0.024)	(0.018)	(0.015)
EQUITY_PHS	-0.025*	0.044		-0.010
	(0.014)	(0.031)		(0.021)
TRANSFER	-0.010**	-0.001	-0.038***	-0.012**
	(0.004)	(0.008)	(0.009)	(0.006)
PUBLIC	0.009***			
	(0.003)			
MUTUAL	0.002			
	(0.005)			
GROUP	-0.003	-0.001	0.001	0.002
	(0.003)	(0.014)	(0.004)	(0.005)
SIZE	0.018***	0.009***	0.021***	0.023***
	(0.002)	(0.004)	(0.006)	(0.003)
COMMISSION	0.003***	-0.001	0.002	0.003*
	(0.001)	(0.002)	(0.002)	(0.002)
SMOOTH	-0.100***	-0.143***	-0.013	-0.099***
	(0.013)	(0.026)	(0.024)	(0.019)
TAX	0.092***	0.117***	0.036*	0.064***
	(0.011)	(0.016)	(0.021)	(0.019)
LONGTAIL	0.001	-0.056***	0.002	0.018**
	(0.006)	(0.012)	(0.019)	(0.009)
GOODRATING	-0.008***	0.007	-0.010***	-0.007*
	(0.002)	(0.006)	(0.003)	(0.004)

Table 3 cont'd

	All	Public	Mutual	Private
HERF_LINE	0.042***	0.060***	0.106***	0.035***
	(0.006)	(0.011)	(0.016)	(0.009)
HERF_GEO	0.035***	-0.003	0.054***	0.051***
	(0.005)	(0.009)	(0.014)	(0.008)
UI	0.039***	0.203***	-0.081***	0.032**
	(0.009)	(0.019)	(0.015)	(0.014)
$ERROR_{t\text{-}1}$	-0.085***	0.096***	-0.239***	-0.129***
	(0.011)	(0.022)	(0.023)	(0.015)
Wald X^2	874.73	660.96	278.16	450.8
Number of Observations	7417	1588	1851	3978

Notes: * significance at 10% level ** significance at 5% level *** indicate significance at 1% level

† Standard errors are heteroscedasticity and autocorrelation consistent. Robust standard errors are reported in the parentheses below coefficient estimates. Variable definitions are as follows: *ERROR* = (incurred $loss_{i,t}$ – incurred $loss_{i,t+5}$)/total assets; *INS_PRICE* = natural log transformation of 1/(industry average loss ratio); *S&P* = annual rate of return for *S&P* 500; *ROE* = industry average return on equity; *RE_PRICE* = 1/loss ratio of top 25 global reinsurance groups; *GPW_PHS* = natural log transformation of gross premium written divided by policyholder's surplus; *INVEST* = nature log transformation of percentage of investment in stocks, real estate and mortgages; *EQUITY_PHS* = natural log transformation of (equity/policyholder's surplus+1); *TRANSFER* = 1 – (net premiums written/gross premiums written); PUBLIC = dummy variable which equals to one if the firm belongs an ultimate owner that is a publicly traded company, and 0 otherwise; *MUTUAL* = dummy variable which equals to one if the firm is a mutual insurer, and 0 otherwise; *GROUP* = dummy variable which equals to one if the firm belongs to a group, and 0 otherwise; *SIZE* = natural log transformation of total admitted assets; *COMMISSION* = dummy variable which equals to one if the firm uses contingent commission, 0 otherwise; *SMOOTH* = average return on assets over the previous three years; *TAX* = marginal tax rate corresponding to the net income plus reserve errors; *LONGTAIL* = percentage of net premiums written in long-tailed lines; *GOODRATING* = dummy variable which equals to one if rating from AM Best is A- or above, 0 otherwise; *HERF_LINE* = line of business Herfindahl Index; *HERF_GEO* = geographical Herfindahl Index; *UI* = $(CPI_{t+3} - CPI_t)/ CPI_t - T3Y_t$ where T3Y = accumulated yield on 3-year Treasury over three-year period.

Table 2 shows the relationship between the cost of alternative sources of capital and reserve errors, without controlling for other factors. As can be seen, in the aggregate model (All) the expected relationships with each of the cost of capital variables are found to be statistically significant; the coefficients for *INS_PRICE*, *S&P* and *ROE* are positively significant and the coefficient for *RE_PRICE* is negatively significant. When using a segmented approach based on the form of ownership, we find some variation across the results. The coefficients for *S&P* are positively significant for both public insurers and mutual insurers, indicating that both are likely to over reserve when returns are relatively higher in the capital market (i.e., the cost of obtaining capital from the capital markets is relatively lower). Additionally, the coefficients for *RE_PRICE* are found to be negatively significant and the coefficients for *INS_PRICE* are found to be positively significant for mutual and private insurers, suggesting mutual and private insurers tend to under- reserve when the price of reinsurance is relatively higher and over-reserve when the market price for insurance is relatively higher (i.e., cost of insurance debt is lower), which is consistent with the hypotheses. Our results also show that stock insurers, both publicly traded and privately held stock firms, are the only ones affected by *ROE*. Given the inability of mutual insurers to raise capital through equity channels, these findings are not surprising. Worth noting is also the fact that the lagged reserve error variable is statistically significant in all models, suggesting reserve errors from the previous year are correlated with reserve errors in the current year. While the coefficient of the lagged reserve error variable is not central to the purpose of this study, the statistical significance of the

lagged dependent variable confirms that the use of dynamic models that control for lagged effects may be necessary for these types of analyses.

Table 3 presents the empirical results when we include firm-level and unanticipated inflation control variables. At the aggregate level (All), the coefficients of all four variables identifying sources of capital are statistically significant with the expected sign, which confirm our hypotheses that industry wide loss reserve practices correspond to the cost of alternative sources in the broad marketplace. However, an examination of the decomposed models, i.e., public, mutual, and private, reveals some statistically differing relationships once other factors are also controlled. Most notably, the public and mutual models experience some differing, albeit not contradictory, results in the cross model comparison. The results of the private insurer analysis are largely consistent across the analyses presented in Tables 2 and 3.

Our findings indicate that loss reserve errors of public insurers and privately held stock insurers are related to insurance price and reinsurance price. Specifically, we find that public insurers and privately held stock insurers are likely to seek alternative capital sources such as by under-reserving when reinsurance price is higher. Additionally, these insurers tend to over-reserve when they are able to charge higher prices for their insurance product. This finding is consistent with our hypothesis that as the price of insurance increases, the relative cost of that source of capital decreases which results in an insurer over-reserving loss estimates. Privately held stock insurers are also found to over-reserve when return on equity is higher. Combined together, these findings support our hypotheses that insurers adjust their loss reserve estimates corresponding to the relative costs in obtaining capitals from alternative sources. On the other hands, mutual insurers' loss reserves are found to be corresponding to only the return in the capital market once other factors are accounted for. Our results show that mutual insurers tend to over-reserve when investment opportunities are favorable but their reserving practice do not seem to be affected by other sources of capital. One possible explanation is that shareholder pressure encourages the management of stock companies to engage in earnings management in an endeavor to smooth reported surplus for accounting purposes while such pressure is not immediately obvious in the mutual insurance operational form. While the existence of shareholder pressure is not new within this context, the fact that it manifests itself as a function of the cost of various sources of capital is a unique contribution to the existing body of literature.

CONCLUSION

This research examines and seeks to explain the systemic error inherent in the U.S. property-casualty insurance industry's loss reserve estimates. While a significant body of literature has already identified the existence of earnings management at the firm-level, the motivations for similar behavior at the industry-level are far less understood. This research hypothesizes that industry-wide loss reserve error patterns are a function of the broader relative cost of various sources of insurer capital; the insurance industry engages in loss reserve earnings management in an effort to smooth the recognition of capital and surplus in its financial reports. Using data from the property-casualty insurers over 1996 to 2011, we find support for our hypotheses.

Our results reveal that, as an industry, insurers tend to use loss reserves as a means of modulating reported surplus to compensate for changes in the relative cost of other sources of capital, i.e., insurance debt, participation in the capital markets, shareholder equity, and reinsurance. We also find that these relationships vary depending on the ownership structure

any given insurer employs; mutual insurers are less likely to engage in loss reserve earnings management in light of relative changes in the cost of alternative sources of insurer capital. Additionally, our use of GMM modeling techniques confirms the value of the use of dynamic modeling methodologies when assessing highly correlated values across time, such as when considering loss reserve errors.

These findings will be of particular interest to insurance industry regulators who are charged with promoting the transparent and accurate presentation of financial performance of the insurance industry. Additionally, other stakeholders such as shareholders and potential investors will also find these results of special interest. This research highlights the need for further research on the general topic of earnings management within the insurance industry. Significant opportunities for further investigation of the general topic exist. For example, a more refined and succinct analysis limited to specific lines of insurance or comparisons across various lines would prove insightful. Alternatively, a more sensitive approach focused on illuminating the differences in behavior across insurers with differing forms of ownership would also represent significant and new information within this stream of literature.

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