INFLUENCES OF ORGANIZATIONAL FORM ON MEDICAL MALPRACTICE INSURER OPERATIONS

Yu Lei
Joan T. Schmit[*]

ABSTRACT

Medical malpractice insurance is a highly specialized and risky business. Over the past three decades, the market has experienced three dramatic periods of rising prices and shrinking supply. For medical care providers subject to such market volatility, a response has been the development of physician-owned and physician-run entities as their insurance providers. Yet regulators and rating agencies demonstrate concern over geographic and business risk concentration of these entities, encouraging them to diversify across state lines as well as across lines of business. We hypothesize that physician-directed insurers are inherently more conservative and better informed than non-physician directed insurers, calling into question the value of such diversification, which we believe reduces their informational advantage. We test this hypothesis through analysis of insurer loss reserving practices and find that physician-directed insurers are more likely to over reserve and less likely to under reserve than are non-physician-directed insurers. We also find that physician-directed insurers that do under-reserve have smaller relative errors than their non-physician-directed counterparts. Importantly, we also observe that rapidly growing insurers have demonstrated risky reserving practices. We consider these results as relevant to regulators and rating agencies in assessing medical malpractice insurer riskiness.

---

[*] We thank participants at the 2008 Searle Symposium as well as the 2006 American Risk and Insurance Association Annual Meeting (Washington, DC) for their comments. We give special thanks to J. Tyler Leverty for his comments as discussant on the paper. Carrie Hirst assisted with editing this paper. Yu Lei gratefully acknowledges the financial support of the Barney School of Business at the University of Hartford.

INTRODUCTION

Medical Malpractice insurance is a highly volatile product in terms of price and supply. It also provides coverage against liabilities that are often specific to location and medical specialty. A natural outgrowth of these underlying conditions is that the majority of premiums written in medical malpractice are earned by insurers that focus on this particular line of coverage, that operate in only one or a few states, and that are owned by health care providers themselves. Yet from a risk standpoint, such specialization should lead to increased volatility because of lack of diversification. Indeed, we have observed that regulators and rating agencies encourage such insurers to expand their geographic market as well as the lines of coverage offered.[1] We believe that such encouragement may be counter-productive; we test our belief in the research reported here. Our purpose is to analyze differences in reserving practices between medical malpractice insurers defined as physician-directed versus those that are not. Since reserving practices provide an indication of an insurer's stability and strength, we hypothesize that specialized physician-directed insurers will be more conservative in their liability estimates than will less specialized widely-owned insurers.

Many readers will think of "bed-pan mutuals" in our discussion of physician-directed insurers. These readers are correct in their thinking, yet the list of physician-directed insurers extends beyond bed-pan mutuals. Bed-pan mutuals began in the 1970s in response to the initial "crisis" in medical malpractice insurance. They are small mutual insurers owned by health care providers to offer medical malpractice insurance to their members. These insurers will be included in our group of physician directed insurers. In addition to the bed-pan mutuals, risk retention groups, which became possible in the 1980s following the passage of the Federal Liability Risk Retention Act of 1986,[2] also will be considered "physician-directed insurers" in our analysis if they focus on medical malpractice insurance and are owned by health care providers. Importantly, some stock insurers also fit within our definition of "physician directed." These are insurers formed by medical societies or others for the purpose of offering their members and owners medical malpractice coverage. They differ from mutuals, however, in that they are organized as corporations with ownership distributed through corporate stock. Importantly, not all mutual

---

1 A review of Best's Insurance Reports demonstrates this practice.

2 Federal Liability Risk Rention Act, 15 U.S.C. §§ 3901-3906 (2000).

insurers selling medical malpractice insurance are considered "physician directed." Large, diversified entities, such as Liberty Mutual, which participate in the medical malpractice market but which are not managed by nor focused on health care providers will not be considered physician directed. Because of their special characteristics, physician-directed insurers have formed their own industry trade group, the Physician Insurers Association of America (PIAA).[3] The PIAA has created a listing of physician-directed versus non-physician directed insurers. We use this listing as generously provided by Patricia Danzon, Andrew Epstein and Scott Johnson. We supplement this listing with information from the Risk Retention Reporter.

Our underlying premise is that physician-directed insurers provide a significant service to the market, one not typically observed in mutual insurers, which usually provide coverage on less-complex risks. We anticipate that physician-directed insurers will operate differently from non-physician directed insurers for two reasons: they have differing organizational goals; and they have differing informational opportunities. While non-physician-directed insurers can be expected to set their primary organizational goal as maximization of the firm's value or profit, physician directed insurers are generally formed with the purpose of offering a stable insurance environment and even to try to alter the underlying tort system. A personal review of numerous physician-directed insurer Web pages indicates that their mission statements generally focus on supporting the health care community through legal advocacy, strong loss-control support, and other mechanisms designed to alter the underlying loss conditions rather than simply to finance those losses.[4] As stated above, physician-directed insurers are often owned by or at least initiated by state medical societies. Their objective tends not to be profit maximization. Moreover, in many instances, these two types of insurers are subject to different levels of

---

[3] *See generally* Patricia Danzon, Andrew J. Epstien, & Scott J. Johnson, *The Crisis in Medical Malpractice Insurance*, BROOKINGS-WHARTON PAPERS ON FIN. SERVICES, 2004, at 56, 68. *See also* Medical Liability Insurers—U.S., http://www.piaa.us/directory/public/results.asp?st=member&mt=primary&loc=usa (last visited Nov. 9, 2008); Directory of RRGs and PGs, http://www.rrr.com/rrgspgs/advancedSearchResults.cfm (last visted Nov. 9, 2008).

[4] A review of numerous physician-directed insurer websites reveals these priorities. *See, e.g.,* The Applied Medico-Legal Risk Retention Group *available at*, http://www.amsrrg.com/ (last visited Nov. 9, 2008); Centurion Medical Liability Protective http://www.cmlpins.com/over_history.html (last visited Nov. 9, 2008); The Emergency Physicians Insurance Company, http://www.epicrrg.com/index.asp (last visited Nov. 9, 2008); Novus Insurance Company Risk Retention Group, http://www.novusrrg.com/ (last visited Nov. 9, 2008); Premier Physicians Insurance Company, http://www.ppicdocs.com/about_history.html (last visited Nov. 9, 2008).

regulation. For instance, medical malpractice risk retention groups, which usually are physician-directed, are established under the Federal Liability Risk Retention Act of 1986, which preempts certain aspects of state laws regulating the activities of risk retention groups.[5] As a result, operating practices are likely to differ between the two types of organizations.

One possible variation comes in the area of loss reserve practice. Prior research has hypothesized that insurers may manage loss reserve estimates to achieve organizational goals, including reducing taxes, enhancing apparent financial strength to avoid regulatory actions, and smoothing income for the benefit of investor preferences.[6] Managers of physician-directed insurers, however, generally do not face the same pressure to maximize profits because they do not have to answer to investors preoccupied with maximizing profits. Additionally, these insurers tend to be subject to less stringent regulation than are most non-physician-directed insurers. We anticipate, therefore, that physician-directed insurers will approach operational decisions such as loss reserving practices differently from non-physician-directed insurers.

Moreover, physician-directed insurers may have informational or risk-sharing advantages over other insurers in writing medical malpractice insurance, which makes it more plausible that physician-directed insurers differ from non-physician-directed insurers in loss reserving accuracy.[7] This informational advantage is generated from the insurer's strong connection to the medical community, and by its focus on the medical malpractice line of business. While some physician-directed insurers offer general liability coverage to their participating insureds, it is rare for those insurers to sell property coverage or other major lines of liability insurance, unlike many non-physician directed medical malpractice carriers, whether stock or mutual. Certainly non-physician-directed insurers can hire health care providers to close some of this informational gap, but we contend that physician-directed insurers possess such informational advantage throughout the entity because of their focus on affecting the underlying

---

[5] 15 U.S.C. § 3603 (2000).

[6] *See*, *e.g.*, Kathy R. Petroni, Stephen G. Ryan & James M. Wahlen, *Discretionary and Non-discretionary Revisions of Loss Reserves by Property-Casualty Insurers: Differential Implications for Future Profitability, Risk and Market Value*, 5 REV. OF ACCT. STUD. 95, 96 (2000).

[7] *See* Danzon Rule 15 *supra* note 3, at 56; Neil A. Doherty & Georges Dionne, *Insurance with Undiversifiable Risk: Contract Structure and Organizational Form of Insurance Firms*, 6 J. OF RISK AND UNCERTAINTY 187, 197 (1993).

exposure itself. In short, physician-directed insurers have a different underlying purpose.

To test our hypothesis that physician-directed insurers are more conservative in their business practices, and therefore more financially secure, than non-physician-directed insurers, we test for differences in loss reserving across physician-directed and non-physician directed insurers. We also consider the influence of geographic and business specialization. In the following section of the paper, we review the literature on loss reserve development, and follow with a discussion of organizational form. With this background as a foundation, we present our data and methodology, leading to results. The last section concludes the paper with a summary of our findings and suggestions for future research.

LITERATURE ON LOSS RESERVE DEVELOPMENT

Insurance companies are required to hold loss reserves to account for all unpaid losses and loss adjustment expenses. These reserves are first established in the year of coverage and then updated with new information as time passes. Because many years may pass between an initial malpractice event or claim and ultimate payment for the underlying injury, and because not all events are known when they occur, insurers must estimate their future liabilities with quite a bit of uncertainty. This requirement leads to inevitable errors along the way. The difference between the initially reported *estimate* of ultimate loss payments (the "loss reserve") for any given coverage year and the ultimate *realized* paid losses for that coverage year is known as the loss reserve error (or loss reserve development), which reflects the estimation error in the originally reported reserve. This amount can be positive or negative. Loss reserves are important representations of insurance company financial performance, directly affecting current profits. How they are estimated, therefore, creates significant implications for insurers.

Two major theories have been proposed in the rich literature regarding the underlying influences on the size and direction of reserve errors. The first theory is that reserve errors simply represent mistakes in original loss estimates due to uncertainty regarding future claims.[8] As new information about claims becomes available, loss reserves are frequently revised until all claims are settled. Differences between the original estimates and

---

[8] Mary Weiss, *A Multivariate Analysis of Loss Reserving Estimates in Property-Liability Insurance Companies,* 52 J. OF RISK & INS. 199, 204 (1985).

ultimate payments represent the reserve error. Grace and Leverty conclude that mis-estimation is the dominant cause of reserve errors in the long run.[9] The second major theory regarding causes of reserve errors is that management consciously manipulates them to manage earnings.

Three sub-categories of theories or propositions have been developed to explain the practice of earnings management using reserve errors. The first proposition is the income-smoothing theory. According to the income-smoothing theory, management may be encouraged to set reserves in a way that minimizes earnings variability from period to period. Prior research indicates that indeed reserve errors are not random and tend to stabilize underwriting income, [10] including evidence that the firms in the left tail of the earnings distribution understate reserve errors while those in the right tail overstate reserve errors.[11]

The second proposition associated with reserve management is the tax-reducing theory. As noted above, early efforts to understand reserving practices focused on income smoothing. Such focus was due in part to regulatory concern with transparency and the concern that manipulating an insurer's financial status could harm shareholders and consumers alike. A full understanding of reserve management, however, required development of an overall theory about insurer reserving practices. An early approach to a full-picture analysis of reserve management assumes insurers follow a cash flow maximization objective, with income smoothing constraints. In such a model, tax deferral can become significant.[12] Empirical examination of property-liability insurers is supportive, finding that the examined insurers' reserving practices aided in reduction of tax liabilities.[13]

The third proposition associated with reserve management is the regulatory constraint theory which holds that insurers may revise loss

---

[9] Martin Grace & J. Tyler Leverty, *Property-Liability Insurer Reserve Errors-Motive, Manipulation, or Mistake*, SOC. SCI. RES. NETWORK, May 31, 2007, at 25-26, *available at* http://ssrn.com/abstract=964635 (The authors also test rate regulation incentives, but given that we are considering a single line of insurance, this issue is not relevant in the current study).

[10] *See* Barry D. Smith, *An Analysis of Auto Liability Loss Reserves and Underwriting Results*, 47 J. OF RISK & INS. 305, 317 (1980); Weiss, *supra* note 8, at 203.

[11] William H. Beaver, Maureen F. McNichols & Karen K. Nelson, *Management of the Loss Reserve Accrual and the Distribution of Earnings in the Property-Casualty Insurance Industry,* SOC. SCI. RES. NETWORK, October 2000, *available at* http://ssrn.com/abstract=247702 or DOI: 10.2139/ssrn.247702.

[12] Elizabeth Grace, *Property-Liability Insurer Reserve Errors: A Theoretical and Empirical Analysis*, 57 J. OF RISK & INS. 28, 33 (1990).

[13] Grace, *supra* note 12, at 42.

reserves to enhance financial strength to avoid regulatory actions. According to the theory, financially weak insurers may tend to understate their reserves more than other insurers. Empirical study supports the theory with findings that insurers "close to" receiving regulatory review do underestimate their reserves considerably. [14] Furthermore, Beaver, McNichols, and Nelson show that both financially healthy and distressed firms manage earnings to avoid financial losses, and that both types of firms contribute to an overall appearance of income smoothing and opportunistic regulatory reporting.[15]

INFLUENCE OF PHYSICIAN-DIRECTED INSURERS

Insurance industry organizational form has been the subject of numerous studies, likely spurred by the strong presence of both mutual and stock insurers.[16] Most of the literature to date has focused on conditions appropriate for each form to dominate the market. The majority of these studies conclude that the mutual form tends to dominate insurance lines that require limited managerial control, given the absence of shareholder pressure on performance. Mutuals, therefore, are expected to be more common in the standardized personal insurance products such as homeowners, while commercial liability lines are considered better suited to the stock insurance form. Generally these expectations are met in the market.

The medical malpractice insurance industry, however, presents an anomaly to the underlying theory, with mutual and mutual-like physician-directed insurers representing a large portion of the premium volume. We are interested in understanding this situation better. Our expectation is that the owners of physician-directed medical malpractice insurers differ from policyholder owners of the traditional mutual insurers in other lines because as physicians themselves they are in a better position to understand the potential for loss, to underwrite business and adjust claims, and

---

[14] *See* Kathy R. Petroni, *Optimistic Reporting in the Property-Casualty Insurance Industry*, 15 J. ACCT. & ECON. 485, 486 (1992).

[15] Beaver et al., *supra* note 11 at 1, 2, 4, 21-22 .

[16] Paul Joskow, *Cartels, Competition and Regulation in the Property-Liability Insurance Industry*, 4 BELL J. OF ECON. & MGMT. SCI. 375, 377-79, 391 (1973). Joskow offers an early discussion of organizational form, with Mayers and Smith providing the impetus for much of the research that followed. *See also* David Mayers & Clifford W. Smith, Jr., *Contractual Provisions, Organizational Structure, and Conflict Control in Insurance Markets*, 54 J. OF BUS 407, 412 (1981).

generally to manage the coverage. Whether or not this position is true is quite important for regulatory and rating agency review. Regulators and rating agencies tend to recommend that small physician-directed insurers expand their book of business for diversification purposes. If we find, however, that physician-directed, specialized, and geographically concentrated medical malpractice insurers tend to show greater levels of conservatism (i.e., more likely to over reserve) with their reserving practices, as we hypothesize, such encouragement may be counter to its purpose.

Recent work by Harrington, Danzon, and Epstein[17] highlights the importance of our research. They consider whether or not under-reserving in medical malpractice markets during the 1990s led to under-pricing, which in turn led to a market "crisis." Their intent is to discern the effects of under-pricing versus actual increases in underlying losses on later periods of rapidly rising prices (i.e., "crises" periods). They discover that insurers who specialize in medical malpractice insurance grew less rapidly in soft markets than did non-specialists. They also observe that specialists tended to experience better loss development than did the non-specialists. Consistent with these results, Danzon, Epstein, and Johnson find that physician-directed firms tend to be less likely to exit the market than are non-physician directed firms, particularly in comparing small insurers. They conclude that the physician-directed insurers appear to help stabilize the medical malpractice market.[18] These empirical investigations are consistent with Baker's explanation for the underwriting cycle in medical malpractice.[19] Baker outlines the importance of uncertainty due to the long tail quality of medical malpractice claims, as well as behavioral elements of decision makers within this market.

As stated *supra*, therefore, the loss reserving practices of physician-directed insurers are likely to be different from those of non-physician directed insurers. The informational or risk-sharing advantages of physician-directed insurers along with organizational objectives associated with market stability may lead them to report more accurate loss reserve than non-physician-directed insurers. Therefore, we hypothesize that physician-directed insurers are more likely to over-reserve and less likely

---

[17] Scott Harrington, Patricia M. Danzon, & Andrew J. Epstein, *'Crises' in Medical Malpractice Insurance: Evidence of Excessive Price-Cutting in the Preceding Soft Market*, 32 J. BANKING & FIN. 157, 168-169 (2008).

[18] *See* Danzon et al., *supra* note 3, at 87.

[19] Tom Baker, *Medical Malpractice and the Insurance Underwriting Cycle*, 54 DEPAUL LAW REV. 393, 436 (2005).

to under-reserve than non-physician-directed insurers. We further hypothesize that physician-directed insurers are more likely to have smaller absolute reserve errors than are non-physician-directed insurers.

DATA AND MODEL

From the above, we anticipate that medical malpractice insurer reserves will be affected by: organizational form, geographic and business specialization, incentives to smooth income, opportunities to minimize tax liabilities, and a desire to limit regulatory intervention. To test our hypotheses, we rely primarily on the National Association of Insurance Commissioners (NAIC) database which contains information reported on insurers' annual statements. As discussed in the prior literature, a limitation of the NAIC database is that it does not include all medical malpractice insurers. Despite these limitations, the NAIC database remains the single best source of insurer financial information available. We use data from 1994 to 2006.

DEFINITION OF MEDICAL MALPRACTICE INSURERS

Our focus in this study is on the medical malpractice insurance market, primarily on organizational form of insurers in that market. To conduct our analyses, we first need to define a "medical malpractice insurer." One possible definition of a medical malpractice insurer for inclusion in our study is any insurer with positive direct premiums written (DPW) in the medical malpractice line. Using this definition would yield 491 insurers for our sample period; however, as pointed out by Nordman, Cermak and McDaniel,[20] this sample selection criterion may pose difficulty. Specifically, the NAIC database does not distinguish between active and inactive insurers, resulting in unrepresentative observations from very small insurers that may not be seeking new business.

To address this problem, we follow Danzon, Epstein and Johnson[21] by defining a medical malpractice insurer as one with at least $100,000 in direct premiums written in medical malpractice (in 2001 dollars) in at least one state. This definition gives us data from 324 insurers over the sample

---

[20] ERIC NORDMAN, DAVIN CERMAK, AND KENNETH MCDANIEL, MEDICAL MALPRACTICE INSURANCE REPORT: A STUDY OF MARKET CONDITIONS AND POTENTIAL SOLUTIONS TO THE RECENT CRISIS 17 (2004).

[21] *See* Danzon et al.*, supra* note 3, at 60.

period, although not all insurers have observations from each year. When missing data are considered, the sample involves 230 insurers, 59 of which are physician-directed.

RESERVE ERROR

In order to examine differences in loss reserving practices between physician-directed and non-physician directed insurers, we conduct our analysis at the firm-year level. We follow the literature by measuring reserve error as the difference between the total incurred losses as estimated in the year of coverage and the total incurred losses as estimated in some future period t+j:[22]

$Error_{i,t}$ = Incurred Losses $_{i,t}$ - Incurred Losses $_{i,t+j}$

where

$Error_{i,t}$ = insurer i's medical malpractice loss reserve error for losses incurred in year t;

Incurred $Loss_{i,t}$ = insurer i's medical malpractice reserve for losses incurred in year t and reported in year t; that is, insurer i's incurred losses as estimated in the year associated with coverage for those losses;

Incurred $Losses_{i,t+j}$ = insurer i's revised estimate of the year t medical malpractice loss reserve as reported in year t+j; that is, the updated value of losses covered by policies in year t but updated in year t+j as additional information is available, including most of the claims being closed by the time of our ultimate evaluation.

In the above equation, estimated incurred losses are obtained from Part 2F of Schedule P of insurers' financial statements. A positive (negative) *Error* indicates that the originally reported loss reserve was overstated (understated).

In order to calculate loss reserve errors, we need to specify the development period j. In this study, we use a five-year development period (j=5) which we apply to all the sample years. Due to data availability issues, some researchers have used shorter time periods; the shorter development period, however leaves the value less certain. Therefore, we employ the longer five year development period, which others argue is a

---

[22] In Grace and Leverty, *supra* note 9, this measure is referred to as the "P" estimate for Petroni. Petroni proposed this measure in Petroni, *supra* note 14. An alternative is to compare the original estimate with cumulative developed losses paid at some future date, known as the Weiss , or "W," error for Mary Weiss. *See* Weiss, *supra* note 8. Both measures have benefits and detriments. We found similar results for both P and W errors and report only the P error analyses.

sufficient development period for analyses such as ours.[23] The most recent NAIC data currently available is for year 2006; hence, the initial observation period examined in our study is 1994 through 2001.

Based on the variable *Error*, we construct four dependent variables for four distinct analyses. The first is an indicator variable *Over*, which takes the value of 1 if *Error* is positive and 0 otherwise. The second dependent variable is an indicator *Under*, which takes the value of 1 if *Error* is negative and 0 otherwise. We conduct these two tests to observe whether physician-directed insurers are more or less likely than non-physician-directed insurers to err in the positive or negative direction.

Yet, this kind of analysis is incomplete because it does not account for the size of error; therefore, we conduct two additional tests with the dependent variable *log (Abserror/Assets)*, which is the logarithm of the absolute value of the error variable divided by net admitted assets.[24] We create two tests with this dependent variable in order to separate positive errors from negative errors. Other literature on reserve error has suggested that behavior may differ for positive and negative errors, leading us to conduct two distinct tests, one for positive errors, and the second for negative errors.[25] Our results support the suggestion that positive and negative errors are influenced by differing factors.

We now have four equations to test. For each, the dependent variable is assumed to be a function of two sets of independent variables. The first set of independent variables reflects the difference between physician-directed

---

[23] *See* Smith, *supra* note 6, at 308; and Paul M. Kazenski, William R. Feldhaus and Howard C. Schneider, *Empirical Evidence for Alternative Loss Development Horizons and the Measurement of Reserve Error*, 59 J. OF RISK & AND INS. 668-69, 675 (1992). While final claim value is not yet known after 5 years, evidence presented in these papers indicates that reserve error has developed sufficiently to be able to test the sorts of theories considered in here. We know of no prior study that uses a longer development period to study reserve error.

[24] Other scaling measures associated with revenue volume such as net premium written (NPW) or direct premium written (DPW) were also employed. Differences were not significant. We scale the value of the error because it is relevant only in relation to the overall size of the insurer.

[25] We would have liked to be able to run a fixed effects and/or random effects model, but were unable to estimate the coefficient of *Physician Direct*. The reason is that firm-specific intercepts have absorbed the effect of *Physician Direct (PD)*, which is also firm-specific and does not vary with time. The model takes the form: Log (Abserror/assets) $= a_i + b(PD_i) + cX_{i,t}$, where a_i are the firm-specific intercepts. Since our PD variable is also firm-specific and does not change with time (t), when we run regression, a_i and PD will be combined, producing just one set of coefficients. There is no value for b generated from regressions.

and non-physician-directed malpractice insurers in terms of organizational form, geographic focus, medical malpractice concentration and riskiness. The second set of independent variables represents factors that are linked to other theories about reserve errors in the literature: income-smoothing theory, tax-reducing theory, and regulatory constraint theory. Table 1 lists all the dependent and independent variables used in the study, along with a detailed description of each variable and its expected relationship with the dependent variable. Our discussion below indicates that some of the variables appear relevant in one or two of the models but not all four. We report the results with the selected control variables within the manuscript. In the Appendix, we also show results with the full model for each analysis. The reader will note that results are substantially the same.

Table 1: Variable Definitions and Anticipated Sign

Variables	Description	Expected Sign			
		Over	Under	log(Abserror/Assets)	
				Positive[a]	Negative[b]
LOG(ABSERROR/ ASSETS)$_{i,t}$	Logarithm of the absolute value of firm i's medical malpractice loss reserve error assessed as of year t+j for the reserve reported in year t, divided by its net admitted assets in year t	N/A			
OVER$_{i,t}$	Dummy variable equals 1 if ERROR>0; 0 otherwise	N/A			
UNDER$_{i,t}$	Dummy variable equals 1 if ERROR<0; 0 otherwise	N/A			
PHYSICIAN DIRECT$_i$	Dummy variable equals 1 if firm i is physician-directed; 0 otherwise	+	-	-	-
GeographicConcentration $_{i,t}$	Firm-level Herfindahl-Hirschman Index for firm i in year t	+	-	-	-

$SPECIALIZATION_{i,t}$	Firm i's premiums written in medical malpractice divided by total premiums written	+	-	-	-
$REINS_{i,t}$	reinsurance ceded in medical malpractice/(direct business written in medical malpractice + reinsurance assumed in medical malpractice) for insurer i in year t.	-	*	*	*
$GROWTH_{i,t}$	[DPW in med mal at (t) – DPW in med mal at (t-1)]/ DPW in med mal at (t-1)	-	+	*	+
$GROUP_i$	Dummy variable equals 1 if firm i belongs to a group; 0 otherwise	-	+	-	+
$TAX_{i,t}$	(net income + prior year's loss reserve)/assets	+	-	+	*
$SMOOTH_{i,t}$	Pre-managed earnings – target earnings	+	-	+	-
$RBCLow_{i,t}$	Dummy variable equals 1 if firm i's risk-based capital ratio in year t is less than 2.	*	+	*	+
$RBCClose_{i,t}$	Dummy variable equals 1 if firm i's risk-based capital ratio in year t is within [2, 2.5]	-	+	*	*
$NPW_{i,t}$	Firm i's net premiums written in year t	-	+	-	+
Yi (i=1995,…,2001)	Year dummy if year=i	+/-			

a: for firms that have positive reserve errors; b: for firms that have negative reserve errors
*Not included in given equation

FACTORS AFFECTING THE SIZE AND DIRECTION OF RESERVE ERRORS

The variable of primary interest to our study is organizational form. We differentiate between medical malpractice insurers considered *Physician directed* or not, using a dummy variable equal to 1 if considered physician directed. While the NAIC database classifies insurers as stock, reciprocal, mutual, risk retention group, or "other," we consider this categorization insufficient. For example, a number of physician-directed medical malpractice insurers are stock companies, with the stock held by the state Medical Society and/or health care providers. Alternatively, some mutual insurers clearly are not physician directed, such as Boston-based, multi-line insurer, Liberty Mutual. We take the conservative approach of designating as physician directed only those insurers identified as physician directed by the Physician Insurers Association of America (PIAA),[26] or for which we have other clear evidence of such status (for example, a review of Best's Reports or firm web page). The resulting sample includes 59 insurers designated as *Physician directed*. We anticipate that physician-directed insurers will be more likely to over-reserve, less likely to under-reserve, and to have smaller absolute value of reserves either positive or negative.

MARKET SPECIALIZATION

Our hypotheses regarding physician-directed insurers rest on the notion that these insurers have differing organizational objectives. They also may possess better information than their counter-parts, a possibility we account for with several variables. Superior information may generate from market specialization, both in terms of knowledge of the specific legal context for their exposure and in terms of the medical malpractice line of insurance itself. To capture these factors, we include measures of geographic concentration and business focus. The majority of physician-directed insurers focuses on medical malpractice insurance rather than sell a full range of coverage. Additionally, these insurers tend to focus their business in one or a few states. We incorporate measures of these qualities in order to separate the effect of specialization from the effect of organizational ownership. Without including these variables, we might see an effect of

---

[26] We thank Patricia Danzon, Andrew Epstein and Scott Johnson for generously sharing this PIAA list.

physician-directed insurers, when the real effect is due to market specialization.

Given the state basis of medical malpractice law, both in terms of the legal doctrines as well as medical practices, we use geographic concentration as one measure of superior knowledge. Specifically, we use the firm-level geographic Herfindahl-Hirschman Index, defined as the sum of the squares of the percentage direct premiums written (DPW) market share in each state by each firm, to measure *GeographicConcentration*. A higher value of *GeographicConcentration* implies more concentration; that is, the firm operates in fewer states. More geographically concentrated insurers could be riskier because they are exposed to the systematic risk of all of their exposures affected simultaneously to expansions of liability, such as when a new precedent is set through plaintiff success with a novel legal theory. Rating agencies comment on their concern over such risk in their company discussions, and often recommend expansion to additional states.[27] We anticipate, however, that such insurers will compensate for such potential riskiness by over-reserving more often and under-reserving less often. We also anticipate that the superior knowledge we hypothesize these insurers possess will lead to more accurate reserves in absolute value of their error. Hence, they will have smaller relative over- and under-reserve errors.

We also measure an insurer's superior knowledge by the extent to which an insurer focuses on medical malpractice or offers a wide range of coverage. Specifically, S*pecialization* equals the dollar value of an insurer's premiums written in medical malpractice divided by total premiums written. The higher the value, the larger the percent of business devoted to medical malpractice insurance. We anticipate a very similar effect and for the same reasons as for geographic concentration. That is, we anticipate that *Specialization* will be positively associated with over-reserving and negatively associated with under-reserving and the size of their reserve errors.

RISK PROFILE

Reserving practices in effect represent part of an insurer's risk management. Higher reserves generally yield lower risk, all else equal. Another important aspect of insurer risk management is its use of

---

[27] *See*, *e.g.*, the discussion of any single-state medical malpractice insurer in the A.M. Best's Ratings Reports.

reinsurance. We incorporate a *Reinsurance* variable equal to reinsurance DPW ceded in medical malpractice divided by the sum of all direct premiums written (DPW) in medical malpractice plus reinsurance DPW assumed in medical malpractice. We anticipate that use of reinsurance will mitigate the need to be conservative with reserving practices; hence, the greater the relative level of *Reinsurance*, the less likely is an insurer to over-reserve. We do not anticipate an effect either on under- or over-reserving in absolute relative value.

Harrington, Danzon and Epstein observe that rapidly growing medical malpractice insurers likely do so at the expense of taking greater risk in their underwriting decisions.[28] We therefore include a *Growth* variable to account for this condition. We define *Growth* as the relative change in medical malpractice direct premiums written (DPW) from year t-1 to t.[29] Our expectation is that firms with rapid growth will be more likely to under- and less likely to over-reserve. We further expect higher levels of under-reserving with greater growth but no necessary effect on over-reserving.

Two additional variables associated with firm risk are included: size and whether or not the insurer is a member of a group of companies. We consider reserving practice a form of risk management. Over (under) reserving is a method to reduce (increase) risks, and would be included within an insurer's overall risk strategy. Large firms and those affiliated with a group generally have a variety of risk management techniques available to them; hence, we would anticipate that they could take more risk in their reserving practices. For both, therefore, we would anticipate greater (lesser) frequency of under (over) reserving, and larger (smaller) under (over) reserves when they do occur. Our size variable is net premiums written (*NPW*)[30] and we designate *Group* for those firms with group affiliation.

TAX, SMOOTHING, REGULATORY THEORIES

In addition to these measures of anticipated superior knowledge (organizational form, geographic concentration, and business

---

[28] *See* Harrington et al., *supra* note 17, at 167.

[29] We also conducted the analysis standardizing for overall market growth. Results are substantially the same in either analysis. We thank an anonymous reviewer for suggesting this addition.

[30] Conducting the analysis with total assets as our size variable instead does not alter the basic results.

specialization) and risk (reinsurance purchases, growth, size, and group affiliation), we anticipate a variety of other factors may affect reserve errors. These factors relate to the loss reserving theories discussed above. Tax issues, income smoothing, and regulatory concerns represent the bulk of the literature on hypothesized opportunities for managerial discretion to influence loss reserving practices. We do not anticipate that these incentives will differ between physician-directed insurers and non-physician-directed insurers, and include control variables in order to try to highlight the effect of ownership form on differences in reserve estimation practices.

Regarding taxes, we expect to observe over-reserving more often among firms with large tax liabilities, which can be deferred through current reserves. We further anticipate a positive relationship between *Tax* and the size of over-reserving, given that the larger the tax benefit, the larger would be the likely reserve. We anticipate no relationship between taxes and the size of under reserving. The tax variable is defined as[31]:

Tax = (net income + prior year's loss reserve)/assets

In addition to tax benefits, reserving management may be desirable in order to smooth out income for the debt and equity markets. According to the smoothing hypotheses, if a firm's current year's earnings are unexpectedly higher (lower) than target earnings, then it tends to over (under) reserve. Following Baker, Collins and Reigenga,[32] we define the smoothing variable as:

Smooth = pre-managed earnings – target earnings

Where pre-managed earnings are the earnings purged of estimated reserves.

= (net income + loss reserve)/assets;

Target earning uses a historical growth model to estimate next period's earnings:

= [Net income$_{t-1}$+ (Net income$_{t-1}$- Net income$_{t-4}$)/4]/assets if Net income$_{t-1}$> Net income$_{t-4}$ otherwise Net income$_{t-1}$/assets

---

[31] We use the prior year's loss reserve because of possible endogeneity issues; however, we conducted the analysis using the current year's loss reserve as used by Elizabeth Grace. Grace, *supra* note 12, at 37. We found no major differences in regression results.

[32] Terry Baker, Denton Collins, & Austin Reitenga, *Stock Option Compensation and Earnings Management Incentives*, 18 J. OF ACCT. AUDITING & FIN. 557, 580 (2003). We also conducted the analysis with two alternative smoothing variables previously used in the literature, ROA (return on assets) as employed by Petroni, et al*., supra* note 6, and the average value of net income adjusted by assets as used by Grace and Leverty, *supra* note 9. Our results are substantially the same with each of these measures.

Our expectation is that *Smooth* will be positively (negatively) related to the likelihood of over- (under-) reserving. We also anticipate that the larger (smaller) the value of *Smooth*, the greater will be the value of over- (under-) reserving errors.

In addition to preferences for smooth earnings and lower (or deferred) taxes, managers are also believed to prefer less regulatory oversight and therefore may be encouraged to pursue a particular loss reserving strategy consistent with minimizing regulatory attention. To capture this incentive, we use a dummy variable derived from the NAIC risk-based capital (*RBC*) ratio, which is total adjusted capital divided by authorized control level risk-based capital. Our variable, *RBCClose*, takes the value of 1 if the risk-based capital ratio is no less than two (below which is the first level of regulatory action) and no greater than 2.5, considering this region "close to" regulatory action, indicating firms which might have incentive to find means to limit regulatory attention. The risk-based capital ratio is used by regulators to indicate whether or not a firm should be subject to a certain level of regulatory action.[33] We anticipate greater likelihood of under-reserving and less over-reserving in this region for the appearance of greater surplus. We do not anticipate a relationship with size of error.

We also anticipate that firms below 2.0 may differ from those above, perhaps signaling that the state regulator is scrutinizing their actions. We use a second dummy variable, *RBCLow* for all firms with RBC below 2 to designate these insurers, and expect it to be positively related to under-reserving. Assuming financial difficulty for these firms, we also expect larger size of under-reserving errors.

In addition to the firm-specific characteristics considered this far, economic conditions have also been shown to affect reserve errors.[34] We believe that a variety of economic conditions, including inflation, the

---

[33] The NAIC recommends five different levels of actions against a company depending on the value of its risk-based capital ratio, as shown in the following table.

risk-based capital ratio >=2	OK, no action taken
2> risk-based capital ratio >=1.5	Company action level
1.5> risk-based capital ratio >=1	Regulatory action level
1> risk-based capital ratio >=0.7	Authorized control level
0.7>= risk-based capital ratio	Mandatory control level

[34] Both Weiss, *supra* note 8, at 212, and Grace, *supra* note 12, at 42 provide empirical evidence that reserve errors are associated with unanticipated inflation.

underwriting cycle, and other factors, are likely to affect reserve errors over time; hence, we include year dummy variables for each year of analysis.

For firms to be included in our sample, they first must be identified as medical malpractice insurers according to our definition mentioned earlier. They also must have complete information to calculate all the dependent and independent variables. After applying these screens, 1142 firm-year observations remain in our final sample.

SUMMARY STATISTICS

Summary statistics for the entire sample are shown in Table 2. The entire sample is used to test whether or not physician-directed insurers are more likely to over-reserve and less likely to under-reserve. We also created two sub-samples to test the size of any error as related to insurer organizational structure. The first sub-sample consists of observations that have positive reserve errors (i.e., over-stated errors), and we call it Positive. The second sub-sample includes those that have negative reserve errors (i.e., under-stated errors), and we call it Negative. We anticipate differences between insurers that over-reserve- from those that under-reserve, which is the purpose of using the two samples. Summary statistics for the sub-samples of Positive and Negative are shown in Tables 3 and 4 respectively, and as discussed below we do observe differences between them.

As shown in Table 2, insurers in our sample are far more likely (65% to 35% approximately) to over reserve than under reserve. They also tend to be specialized in the medical malpractice line, with an average of 55.52% of total direct premiums written going toward this specific line. Our sample insurers are also geographically concentrated, with a geographic Herfindahl of almost .60. In terms of premium growth, we see notable variability among insurers, with the mean being 0.7043 and the median only at 0.0579. Most insurers seem to have a very healthy RBC ratio. Only 6.83% of the observations report RBC ratio below 2 and 5.43% of them fall within 2 and 2.5. Also we notice 66.73% of the observations belong to a group. Approximately one-third (33.19%) of the observations are from physician-directed insurers.

Table 2: Summary Statistics of Full Sample (N = 1142)					
Variables	MIN	MAX	MEAN	MEDIAN	STD
LOG(ABSERROR/ASSETS)	-12.5251	0.7243	-4.0818	-3.6760	2.2738
OVER	0	1	0.6480	1	0.4778
UNDER	0	1	0.3520	0	0.4778
PHYDIRECT	0	1	0.3319	0	0.4711
GEOGRAPHIC CONCENTRATION	0.0359	1	0.5935	0.6426	0.3693
SPECIALIZATION	0	1	0.5552	0.7782	0.4455
REINS	-178.7576	1.2001	0.2495	0.3180	5.3134
GROWTH	-106.9752	84.82778	0.7043	0.0579	6.2976
GROUP	0	1	0.6673	1	0.4714
TAX	0	7.9982	0.3101	0.2226	0.4611
SMOOTH	-147.653	123.0438	-4.0948	0.0017	16.7344
RBCLow	0	1	0.0683	0	0.2524
RBCClose	0	1	0.0543	0	0.2267
NPW ($X10^8$)	-0.0847	55.4442	2.4756	0.3375	6.9149

As can be seen from Tables 3 and 4, sample Positive has a different profile from sample Negative. About 40% of the observations in sample Positive are associated with physician-directed insurers, whereas in sample Negative the percentage is only 20%. We also see higher average values of geographic concentration and specialization in sample Positive. It is interesting to note that on average insurers in sample Negative experienced higher premium growth and are more likely to belong to a group. They also have a larger size in terms of net premiums written.

Table 3: Summary Statistics of Sample Positive (N = 740)					
Variables	MIN	MAX	MEAN	MEDIAN	STD
LOG(ABSERROR/ASSETS)	-12.5251	0.7243	-3.9375	-3.1419	2.3251
OVER	1	1	1	1	0
UNDER	0	0	0	0	0
PHYDIRECT	0	1	0.4014	0	0.4905
GEOGRAPHIC CONCENTRATION	0.0412	1	0.6236	0.7593	0.3747
SPECIALIZATION	0.0001	1	0.5998	0.9114	0.4418
REINS	-178.7576	1.0536	0.1344	0.2657	6.5953
GROWTH	-106.9752	56.9746	0.3696	0.0451	5.0734
GROUP	0	1	0.6270	1	0.4839
TAX	0	7.9982	0.3353	0.3168	0.4015
SMOOTH	-147.6531	123.0438	-5.3206	0.0243	19.2818
RBCLow	0	1	0.0676	0	0.2512
RBCClose	0	1	0.0432	0	0.2035
NPW ($X10^8$)	-0.0847	52.1785	1.8627	0.3184	5.3417

Table 4: Summary Statistics of Sample Negative (N = 402)					
Variables	MIN	MAX	MEAN	MEDIAN	STD
LOG(ABSERROR/ASSETS)	-11.8255	0.2805	-4.3474	-4.2258	2.1539
OVER	0	0	0	0	0
UNDER	1	1	1	1	0
PHYDIRECT	0	1	0.2040	0	0.4035
GEOGRAPHIC CONCENTRATION	0.0359	1	0.5381	0.5158	0.3530
SPECIALIZATION	0.0000	1	0.4732	0.4467	0.4413
REINS	-0.2429	1.2001	0.4612	0.3970	0.3127
GROWTH	-18.1491	84.8278	1.3203	0.0952	8.0515
GROUP	0	1	0.7413	1	0.4385
TAX	0	6.7555	0.2637	0.0884	0.5519
SMOOTH	-101.279	58.9131	-1.8385	-0.0363	10.1874
RBCLow	0	1	0.0697	0	0.2549
RBCClose	0	1	0.0746	0	0.2631
NPW ($X10^8$)	-0.0023	55.4442	3.6037	0.4118	9.0278

REGRESSION ANALYSIS

We conducted four separate regression analyses. The first models the likelihood of a medical malpractice insurer to over reserve; the second models the likelihood to under reserve. For these analyses, we use logistic regression.[35] The third and fourth dependent variables equal the logarithm of the absolute value of loss reserve error divided by net assets, one for those instances when insurers over-reserve, and the other when they under-reserve. We use ordinary least squares (OLS) regression for this model.[36] As indicated in Table 1, we conducted the analyses with differing sets of independent variables; however, we also conducted the tests with all variables included. Results are substantively the same and are shown for the full set of independent variables in the Appendix. For each equation, Variance Inflation Factors are all below 2.5, eliminating concern regarding overall multi-collinearity. The likelihood ratio tests of the two Logistic regression equations reject the null hypothesis that the global regression coefficients are zero, indicating a good overall fit. The F-tests of the two OLS regression equations also imply a reasonable fit, with an adjusted R-square of 63.77% and 43.11%, respectively.

Results of the logistic regression using the dependent variable *Over* are shown in Table 5; those associated with the dependent variable *Under* are shown in Table 6. Both coefficient estimates and marginal effects are reported for the two logistic regressions.[37] Results of the OLS analyses

---

[35] Logistic regression is an appropriate statistical tool when the dependent variable takes on the value of zero or one, and the intention is to predict the probability of an occurrence of an event. In this case, we are interested in predicting the probability of a firm over or under reserving. Importantly, in logistic regression, no assumption that the relationship between the dependent and independent variables is linear exists.

[36] Ordinary Lease Squares, or OLS, analysis is a statistical technique often used when the dependent variable is continuous, as is true for our analyses of the size of positive and negative errors. The technique finds the curve which matches the relationship between the dependent variable and the group of independent variables with the smallest amount of squared error (or "residual," which is the difference between predicted and observed values).

[37] Logistic regression takes the form of $\log[p/(1-p)]=b'X$ where p is the probability of an event (in our case it's either over reserving or under reserving), and b is the coefficient matrix. The estimated value of b is the coefficient estimate. Because the equation is of the logistic form, however, the coefficient estimate does not indicate the size of effect for each variable; therefore, we also report marginal effects. Marginal effects represent the change in p when the independent variable increases by one unit. For instance, in Table 5, the marginal effect for geographic concentration is 0.0969, which means a one unit increase in "geographic concentration" increases the probability of over reserving by 0.0969.

using the relative absolute error as the dependent variable are shown in Tables 7 and 8 for those instances of over- and under-reserving respectively.

Table 5: Logistic Regression of OVER (N = 1142)			
Variable	Estimate	Marginal Effects	Standard Error
Intercept	1.0219		0.3134
PHYSICIAN DIRECT	1.1682	0.2544	0.1931***
GEOGRAPHIC CONCENTRATION	0.4450	0.0969	0.1966**
SPECIALIZATION	-0.2916	-0.0635	0.2266
REINS	-0.1780	-0.0388	0.2239
GROWTH	-0.0320	-0.0070	0.0134**
GROUP	-0.0661	-0.0144	0.1751
TAX	0.0629	0.0137	0.1641
SMOOTH	-0.0120	-0.0026	0.0056**
RBCClose	-0.7963	-0.1734	0.2963***
NPW ($X10^8$)	-0.0212	-0.0046	0.0103**
Y95	0.5049	0.1100	0.2989*
Y96	-0.4130	-0.0899	0.3169
Y97	-0.5259	-0.1145	0.2736*
Y98	-0.9451	-0.2058	0.2703***
Y99	-0.9109	-0.1984	0.2714***
Y00	-1.3513	-0.2943	0.2729***
Y01	-1.6043	-0.3494	0.2761***
Likelihood Ratio Test			
Chi-Square		182.1639	
Pr > ChiSq		<.0001	
***, **, * indicate statistical significance at the 1%, 5% and 10% levels, respectively.			

LOGISTIC REGRESSION OF OVER

As discussed above, we hypothesize that physician-directed medical malpractice insurers are more likely to over-reserve than are non-physician-directed insurers. Therefore, our primary variable of interest is *Physician Direct*, and results are consistent with our hypothesis that these insurers tend to be more conservative than others. As can be seen from the table, the marginal effect for *Physician Direct* is 0.2544, which suggests that a firm that is physician directed is 25.44% more likely to over reserve than a firm that is non-physician-directed. We had anticipated that more geographically

concentrated and specialized insurers also would tend to over-reserve to account for the greater risk associated with such lack of diversification, but only geographic concentration appears statistically significant.

As anticipated, fast-growing insurers are less likely to over-reserve than are their counterparts. We consider the results on growth to offer regulators and rating agencies additional reason to pay close attention when medical malpractice insurers show rapid growth.[38]

According to income-smoothing theory, if a firm's current year's earnings are higher than target earnings, it tends to over reserve. The negative coefficient on *Smooth* suggests the other way around. In other words, our results do not support the income-smoothing theory.

We further observe that insurers with RBC ratios close to the benchmark for regulatory attention are less likely to over reserve. This result is consistent with the literature on reserve management for limiting regulatory scrutiny. We also find that size, as measured by net premiums written (NPW) is statistically significant in the direction anticipating, allowing insurers to take on more risk as the firm grows in size.

[38] These results support those of Harrington, et al., *supra* note 17, at 169.

Table 6: Logistic Regression of UNDER (N = 1142)			
Variable	Estimate	Marginal Effects	Standard Error
Intercept	-0.9800		0.2940
PHYSICIAN DIRECT	-1.1643	-0.2556	0.1907***
GEOGRAPHIC CONCENTRATION	-0.5097	-0.1119	0.1988**
SPECIALIZATION	0.2573	0.0565	0.2248
GROWTH	0.0322	0.0071	0.0133**
GROUP	0.1530	0.0336	0.1800
TAX	-0.1090	-0.0239	0.1659
SMOOTH	0.0123	0.0027	0.0056**
RBCLow	0.4694	0.1031	0.2841
RBCClose	0.8606	0.1889	0.2997***
NPW ($X10^8$)	0.0198	0.0043	0.0102*
Y95	-0.5020	-0.1102	0.2994*
Y96	0.4310	0.0946	0.3162
Y97	0.5405	0.1187	0.2738**
Y98	0.9563	0.2100	0.2706***
Y99	0.9000	0.1976	0.2708***
Y00	1.3561	0.2977	0.2730***
Y01	1.6190	0.3554	0.2765***
Likelihood Ratio Test			
Chi-Square	182.8377		
Pr > ChiSq	<.0001		
***, **, * indicate statistical significance at the 1%, 5% and 10% levels, respectively.			

LOGISTIC REGRESSION OF UNDER

As already noted, we hypothesize that physician-directed insurers are more conservative than are non-physician directed insurers and therefore will be less likely to under-reserve. Our variable of interest, therefore, remains *Physician Direct* and here too we see a statistically significant relationship between ownership form and reserving practices. In this case, there is a negative relationship, consistent with our hypothesis of conservative behavior on the part of physician-directed insurers. Geographic concentration and business line specialization again are included in the analysis to measure superior knowledge of the underlying risk, which we anticipate will be negatively related to under-reserving practices. As with over-reserving, geographic concentration supports our

hypothesis. Specialized insurers, however, show no difference to more diverse insurers.

Consistent with expectations, rapidly growing insurers are more likely to under-reserve than are others. As above, this result offers reason for regulators and rating agencies to give special scrutiny to high-growth insurers. Firms with RBC ratios "close to" regulatory attention also are more likely to under-reserve, as we had anticipated. They might be attempting to avoid regulatory scrutiny; or perhaps they are already in poor financial condition. Firms with low RBC ratios, however, do not show a statistically significant tendency to under-reserve more than do others. We had anticipated a stronger relationship with this factor. We could be picking up unusual results from firms in significantly poor financial position. In the analysis of the likelihood of under-reserving, we also find that smoothing again has the opposite sign from anticipated, in this case showing a positive relationship between smoothing and the likelihood of under-reserving.

OLS REGRESSION OF THE LOGARITHM OF THE ABSOLUTE VALUE OF ERRORS/ASSETS

We hypothesize that physician-directed insurers are more conservative than others and that they have superior knowledge compared with others. While this leads to expectations of greater likelihood of over-reserving and lesser likelihood of under-reserving, we also anticipate more overall accuracy in reserving, based on superior knowledge. To test this hypothesis, we conduct OLS analyses on the logged relative size of error independently for both those firms that over reserve, and those firms that under-reserve. Results, shown in Table 7 for firms that over reserve, and in Table 8 for those that under-reserve, are consistent with our hypotheses for under-reserving, but show no statistical difference in the OLS on firms that over-reserve. Geographic concentration shows the same pattern. Both factors, therefore, can be said to be related to somewhat conservative, but mostly stable reserving practices.

Table 7: OLS Regression of LOG (ABSPERROR/ASSETS) (N = 740) – Sample Positive		
Variable	Estimate	Standard Error
Intercept	-5.4994	0.2140
PHYSICIAN DIRECT	0.1212	0.1401
GEOGRAPHIC CONCENTRATION	0.0242	0.1463
SPECIALIZATION	3.2896	0.1889***
GROUP	-0.5327	0.1273***
TAX	0.8225	0.1565***
SMOOTH	-0.0004	0.0035
NPW ($X10^8$)	-0.0058	0.0104
Y95	-0.2019	0.1816
Y96	-0.3853	0.2238*
Y97	-0.3659	0.1957*
Y98	-0.5847	0.2053***
Y99	-0.7869	0.2058***
Y00	-0.6907	0.2204***
Y01	-0.6587	0.2306***
F-Value	93.91	
Pr>F	<.0001	
Adjusted R-square	0.6377	
***, **, * indicate statistical significance at the 1%, 5% and 10% levels, respectively.		

Specialized insurers, however, demonstrate less accuracy in their reserve errors, showing larger errors in both samples of over- and under-reserving insurers. Having already accounted for an insurer's status as physician directed or not, a specialized insurer seems to have some disadvantage. We note that specialization did not show significance in the likelihood of over- (under-) reserving.

The extent of growth appears unrelated to an insurer's accuracy regarding reserving, somewhat contrary to our expectations. Insurers with greater opportunities for tax deferral do seem to over-estimate reserves by larger amounts, consistent with our hypothesis.

We did not find the variable of *Group* to be significant in the likelihood of over (under) reserving. However, our results show that in both samples of over- and under-reserving insurers, firms that belong to a group report smaller absolute value of reserve errors, contrary to our expectation that such firms may be less accurate in their reserving practice.

For firms that under reserved, those that have RBC ratio below 2 report larger reserve errors, a result consistent with our hypothesis that firms in

financial difficulty tend to under reserve more in order to appear stronger to avoid regulatory actions. We have also found that larger size firms in terms of net premiums written are able to take more risks, as evidenced by their larger reserve errors.

Table 8: OLS Regression of LOG (ABSPERROR/ASSETS) (N=402) – Sample Negative		
Variable	Estimate	Standard Error
Intercept	-5.4448	0.3693
PHYSICIAN DIRECT	-0.6216	0.2400**
GEOGRAPHIC CONCENTRATION	-0.5180	0.2555**
SPECIALIZATION	3.0095	0.2509***
GROWTH	-0.0050	0.0103
GROUP	-0.7605	0.2247***
SMOOTH	0.0075	0.0096
RBCLow	1.0173	0.3457***
NPW ($X10^8$)	0.0248	0.0098**
Y95	-0.0111	0.4220
Y96	-0.3110	0.4275
Y97	0.1819	0.3665
Y98	0.7176	0.3499**
Y99	1.0300	0.3507***
Y00	0.8737	0.3427**
Y01	0.6058	0.3388*
F-Value	21.26	
Pr>F	<.0001	
Adjusted R-square	0.4311	
***, **, * indicate statistical significance at the 1%, 5% and 10% levels, respectively.		

CONCLUSION

Dramatic market structure changes have occurred in the medical malpractice insurance market in response to the high cost of medical malpractice insurance and the shrinking supply of carriers. Many health care providers have formed their own companies to offer malpractice coverage. Given that physician-directed firms are likely to have different organizational goals than traditional insurers, their loss reserving practices are likely to differ as well.

We test the hypothesis that physician-directed medical malpractice insurers differ in their loss reserving practices, using the NAIC data base for the years 1994-2006. Our results show consistent differences between physician-directed and non-physician-directed medical malpractice insurers. Those which are closely aligned with physicians appear to be more conservative and more accurate in their reserving practices. We therefore encourage rating agencies and regulators to consider the positive influence of these insurers in evaluating their risk profile.

We also note the importance of rapid premium growth on reserve errors. As Harrington, Danzon and Epstein[39] already indicated, market problems may be due at least in part to insurers who are making poor underwriting decisions, thereby growing too rapidly and causing market dislocations. Whether these are pure mistakes or intentional decisions is not discernable from our analysis, but deserves additional investigation.

[39] *Id.* at 168-169

APPENDIX: REGRESSION RESULTS USING FULL SET OF VARIABLES IN ALL EQUATIONS

Logistic Regression of OVER (N = 1142)			
Variable	Estimate	Marginal Effects	Standard Error
Intercept	1.0545		0.3149
PHYSICIAN DIRECT	1.1564	0.2522	0.1932***
GEOGRAPHIC CONCENTRATION	0.4953	0.1080	0.2001**
SPECIALIZATION	-0.2885	-0.0629	0.2270
REINS	-0.1317	-0.0287	0.2252
GROWTH	-0.0319	-0.0070	0.0133**
GROUP	-0.1422	-0.0310	0.1825
TAX	0.0973	0.0212	0.1679
SMOOTH	-0.0120	-0.0026	0.0056**
RBCLow	-0.4442	-0.0969	0.2867
RBCClose	-0.8541	-0.1863	0.2998***
NPW ($X10^8$)	-0.0207	-0.0045	0.0103**
Y95	0.5045	0.1100	0.2994*
Y96	-0.4202	-0.0916	0.3168
Y97	-0.5354	-0.1168	0.2739*
Y98	-0.9537	-0.2080	0.2707***
Y99	-0.9090	-0.1983	0.2716***
Y00	-1.3491	-0.2942	0.2732***
Y01	-1.6133	-0.3519	0.2766***
Likelihood Ratio Test			
Chi-Square	184.5209		
Pr > ChiSq	<.0001		
***, **, * indicate statistical significance at the 1%, 5% and 10% levels, respectively.			

(Note: We do not show the results for UNDER because they are just the opposite of those of OVER, given that we are using the identical set of variables in these two analyses. In other words, for each variable, the absolute value of the coefficient is still the same, but the sign is just the opposite.)

OLS Regression of LOG (ABSPERROR/ASSETS) (N = 740) – Sample Positive		
Variable	Estimate	Standard Error
Intercept	-5.4430	0.2172
PHYSICIAN DIRECT	0.1041	0.1409
GEOGRAPHIC CONCENTRATION	0.0513	0.1478
SPECIALIZATION	3.2762	0.1903***
REINS	0.0000	0.0079
GROWTH	-0.0052	0.0102
GROUP	-0.5883	0.1317***
TAX	0.8612	0.1583***
SMOOTH	-0.0003	0.0035
RBCLow	-0.3588	0.2202
RBCClose	-0.1833	0.2557
NPW ($X10^8$)	-0.0057	0.0104
Y95	-0.2012	0.1819
Y96	-0.3911	0.2240*
Y97	-0.3718	0.1958*
Y98	-0.5965	0.2056***
Y99	-0.7842	0.2073
Y00	-0.6872	0.2205***
Y01	-0.6578	0.2307***
F-Value	73.14	
Pr>F	<.0001	
Adjusted R-square	0.6373	
***, **, * indicate statistical significance at the 1%, 5% and 10% levels, respectively.		

OLS Regression of LOG (ABSPERROR/ASSETS) (N=402) – Sample Negative		
Variable	Estimate	Standard Error
Intercept	-5.3772	0.3850
PHYSICIAN DIRECT	-0.6245	0.2427**
GEOGRAPHIC CONCENTRATION	-0.5540	0.2558**
SPECIALIZATION	2.8556	0.2625***
REINS	-0.1105	0.2860
GROWTH	-0.0042	0.0103
GROUP	-0.7647	0.2276***
TAX	0.2896	0.1732
SMOOTH	0.0080	0.0096
RBCLow	1.0039	0.3536***
RBCClose	0.1080	0.3341
NPW ($X10^8$)	0.0241	0.0099**
Y95	-0.0051	0.4219
Y96	-0.2780	0.4280
Y97	0.1867	0.3678
Y98	0.7024	0.3518**
Y99	1.0000	0.3525***
Y00	0.8536	0.3428**
Y01	0.6275	0.3389*
F-Value	18.01	
Pr>F	<.0001	
Adjusted R-square	0.4330	
***, **, * indicate statistical significance at the 1%, 5% and 10% levels, respectively.		