

Kalchev, Georgi

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THE DEMAND FOR DIRECTORS' AND OFFICERS' LIABILITY INSURANCE BY US PUBLIC COMPANIES

George D. Kaltchev

Southern Methodist University

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Abstract

This paper uses a unique US dataset to analyze the demand for Directors' and Officers' liability insurance. This insurance protects managers mostly from shareholder litigation. Corporate insurance presents a much different environment than individual insurance and calls for in-depth empirical investigation of the reasons why corporations buy insurance at all. Risk aversion by itself is not sufficient to explain the behavior of corporations. Mayers and Smith (1982), MacMinn and Garven (2000), among others, propose that corporate insurance plays a role in mitigating agency problems within the corporation, bankruptcy risk as well as provides real-services efficiencies, among others. Applying dynamic panel data models, these theories are the basis for the empirical tests in this paper. Boyer's (2003) hypothesis that D&O insurance is entirely habit driven is rejected, while some role for persistence is still confirmed. I confirm the real-services efficiencies hypothesis and the role of insurance in mitigating bankruptcy risk. Firms with higher returns appear to demand less insurance. Although alternative monitoring mechanisms over management and corporate governance do not appear to play a large role, I find some support that they are complements rather than substitutes. I fail to confirm the role of insurance in mitigating under-investment problems in growth companies. A size adjustment to the limits as a dependent variable is proposed for the first time and it is found to have implications for the results. The paper confirms some, but not all, well-established theories about the decision-making on corporate insurance and the significance of risk management using US panel data for the first time.

JEL Classification: G3, C23.

Keywords: liability insurance, corporate insurance and risk management, shareholder litigation, dynamic panel data models, GMM, corporate governance.

Correspondence: gkaltche@mail.smu.edu. (6166 Fisher rd #268, Dallas TX 75214). I am particularly grateful to the providers of confidential data who made this study possible.

1. Introduction

One aspect of corporate finance that has not received much empirical attention is corporate insurance. Mayers and Smith (1982) report that corporations on the aggregate spend more money on purchasing insurance than on paying dividends. Yet that area remains largely unexplored empirically, at least with US data. There is a particular type of insurance that is directly related to corporate governance and the relationship between shareholders and managers. This is Directors' and Officers' (D&O) Liability Insurance, regularly purchased in the US. This insurance plays a significant role in the corporate structure and protects against the risk of managers not fulfilling their contractual obligations towards shareholders and other stakeholders in the company. The present paper uses a unique data set from the US to analyze the demand for Directors' and Officers' Insurance and factors that explain the limits chosen by public companies, thus enriching the relatively small applied literature on these important issues. It examines coverage limits in light of past stock performance, corporate governance and financial risk, using very recent data. The paper manages to confirm some theories on the demand for corporate insurance and provides some evidence for Boyer's (2003) contention that persistence is a driving force behind it.

The greatest risk directors and officers of corporations are exposed to is that of being sued. That risk is especially acute after the recent corporate scandals in America and the Sarbanes-Oxley legislation of 2002. The importance of that risk is underscored by the fact that 97% of the surveyed US firms purchased D&O insurance in 2002 (Tillinghast-Towers Perrin 2003). The Sarbanes-Oxley Act was introduced in 2002 to increase the responsibility of managers and make it easier to prove wrongdoing in court. Directors and Officers can be held personally liable for the mishaps of the corporation, even though D&O liability can be also vicarious to the corporation. According to Tillinghast-Towers Perrin (2003), 58% of the claims against public corporations come from shareholders (the rest are filed by customers, employees, clients, or the government). Shareholders may sue managers, when they have violated their fiduciary duty

to the shareholders. The most common reasons that shareholders sue are related to corporate disclosure. Shareholder lawsuits are ultimately a question of corporate governance. Good corporate governance should decrease or eliminate the incidence of such litigation. If shareholders are able to effectively monitor managers and managers' interests are well aligned with those of shareholders, there would be no reasons for litigation.

D&O insurance covers the financial loss of managers from settlements, judgments and defense costs in the case of lawsuits. Even if the managers prevail in court, there could be substantial defense costs. Most companies indemnify their directors and officers for these expenses under an arrangement arising from state law or the corporate bylaws. Indemnification should typically occur only when the managers have acted in good faith and are not convicted in court. Sometimes there are expenses that are not indemnifiable, however. There are typically three parts to a D&O policy (Mahan and McCorquodale 2003). Part A pays directly to the directors and officers the non-indemnifiable expenses, covered by the policy, provided that they acted in good faith. Part B reimburses the corporation for the indemnifiable expenses they have paid to the directors and officers. In the 1990s part C, entity coverage, providing insurance to the corporate body, came into wider use. Please note that only part A refers to personal liability and the other parts refer to corporate liability. D&O insurance is not supposed to cover knowingly committing fraudulent actions. That issue is very sensitive now for insurers, when some have alleged such fraud on the part of the managers of Enron and other high profile cases. In the case of Worldcom, for instance, the insurance companies rescinded their policies.

Contracts in D&O insurance are typically written on a *claims-made basis*. They cover claims made and reported in the policy year(s), even though the incident may have occurred earlier. This is quite appropriate for securities litigation, where a lawsuit may be filed years after the respective actions of the

managers. Thus past behavior is very important in assessing the risk exposure of companies. Past behavior might provide clues as to whether claims may be filed against the company in the future.

D&O insurance presents a very rich environment for testing economic theories for behavior under risk and contracting. As Mahan and McCorquodale (2003 p.2) point out: “No two D&O policies are alike.” Insurers custom make each policy for each company, taking into account its specific risk characteristics. That is an opportunity to explore what insurers perceive as risky and how they price it. It is also an opportunity to study whether companies and their directors and officers behave rationally in their purchases of insurance. In a D&O insurance decision, the corporation typically decides how much coverage they need, while the insurer decides what risk the corporation poses and how to price the risk. And this type of insurance refers to an interesting risk, a risk that depends on the behavior of managers and their performance. It is not an earthquake risk that is entirely beyond their control. It is neither a risk that can be easily quantified, like the risk of losing a house. The loss due to fraud-on-the market is uncertain and depends on volatile factors, such as stock price. As the risk partially depends on their behavior and decisions, managers should be better able to assess their risk exposure and plan rationally. The theories described below explain what roles corporate insurance plays in mitigating bankruptcy risk, agency problems and providing real-services efficiencies and others. Rational managers would make their insurance decisions, based on these roles. On the other hand, not fully rational managers might use habit or persistence to guide their risk management decisions and thus behavioral explanations may apply. It is also important to understand why corporations buy insurance at all. Numerous theories exist about that, but they have been rarely tested due to the confidentiality of such data in the US. As MacMinn and Garven ((2000, p. 561) observe: “While a fair amount of attention has been paid to developing theories concerning the corporate demand for insurance, the empirical implications of these theories have largely

gone untested. This has primarily been due to the difficulty in obtaining data on corporate insurance purchases.”

This paper tests for the first time corporate insurance theory with US panel data. Using panel data has certain well-known advantages. Panel data control for firm heterogeneity. Cross section data, ignoring heterogeneity, may lead to biased results. In panel data, one can remove the unobservable firm-specific variables by taking differences. What is more, panel data allow us to study dynamics, changes over time and intertemporal relations. Following dynamic panel data models, the paper confirms some theories of Mayers and Smith (1982) and the effect of size. In particular, it confirms the role of financial distress and real-services efficiencies. Never before in the empirical literature has it been shown that smaller asset size companies buy more insurance, due to real-services efficiencies and proportionately higher bankruptcy costs. On the other hand, I find no support for the role of insurance in mitigating under-investment problems. Corporate governance variables, contrary to expectation, do not appear to play a major role, although some complementarity is found.

Section 2 provides a review of the theoretical and empirical literature in the field. An explicit theoretical model is presented in Section 3. It is followed by an explicit statement of the hypotheses to be tested. Section 5 discusses the methodology. The data and variables are described in Section 6. The results are presented in Section 7. Section 8 concludes.

2. The Role of Corporate Insurance

2.1 *Theory*

A traditional explanation to buy insurance in economics is the risk aversion of managers and subsequently the effort of the companies to preserve the best human capital. As directors and officers are risk averse and litigation can lead to catastrophic personal losses, managers demand protection from such losses, if they are to serve in the company. In an effort to align the interests of managers with

shareholders', managers are given part of their compensation in risky instruments, such as stock options or others related to company performance. Such compensation exposes managers to risk and they may desire a risk premium. Risk aversion, however, is not enough to explain the reasons why sophisticated companies purchase insurance and why the company is willing to pay for the insurance of its managers.

The seminal paper by Mayers and Smith (1982) develops insightful theory about the role of corporate insurance. They find functions that insurance serves to corporations, much more than just managing risk aversion. They point out transactions costs of bankruptcy as an inducing factor to buy insurance. Bankruptcy may carry substantial transaction costs, both direct, such as legal fees, and indirect, such as court administration of the firm's assets. In a bankruptcy, under the absolute priority rule shares become worthless and the creditors are the first ones to lay claims. What is more, under financial distress, the company may find it difficult to indemnify directors and officers in the case of a lawsuit. Insurance shifts the risk to the insurer, decreasing the probability that the costs are actually incurred. Warner (1977) indicates that bankruptcy transactions costs are less than proportional to company size. Suppose the density function for losses of a certain risk is the same for large and small firms. Then the probability of bankruptcy is higher for the small firm than the large (Mayers and Smith 1982). MacMinn and Garven (2000) show that when there are positive transactions costs associated with bankruptcy, insurance increases shareholder value.

Real-services efficiencies are another reason to buy insurance. Insurance and risk management companies are in the business of analyzing risk and they may be better suited than corporations to assess their risks. They can act as outside assessors of risk and recommend loss prevention and claims management programs. They may have a comparative advantage in risk evaluation due to economies of scale and specialization. The insurance company is likely to have a nationwide chain of insurance adjusters and centralized review process, as well as participate in the negotiation of settlements. What is

more, in liability claims, the insurance company may even provide legal representation by experts in these liability matters. Once again, small companies are more likely to benefit from real-services efficiencies, thus they are hypothesized to demand more insurance. Larger companies may employ more sophisticated risk management instruments, such as derivatives, etc., while small companies may be more dependent on insurance.

The next function for corporate insurance Mayers and Smith (1982) point out is monitoring. Corporate insurance may alleviate the agency problems between shareholders and managers. Jensen and Meckling (1976) define agency costs as the sum of the monitoring expenses of the principal (in this case shareholders), the bonding expenditures of the agent (manager) and the residual in the market value of the firm. Conflicts between managers and shareholders may motivate corporations to demand insurance. Managers work for limited time with the company and thus have a short-term horizon, while the corporation lives much longer. That may entice the manager to focus on short-term rather long-term interests and goals. All the more, the managers' compensation may be tied to short-term performance (earnings, stock returns), compelling them to work on short-term goals. Shareholders use a number of monitoring mechanisms to oversee the management, such as having large shareholders or higher insider stock ownership. Insurance is seen as an alternative monitoring mechanism. All the more, it involves insurance companies who act as outside monitors of the corporation. The insurer prices the coverage, based on the risk characteristics of the corporation. Thus here we have an objective outside monitor, which has a stake at the risks, posed by the corporation. This may indicate certain risks to the corporate managers, which they may have overlooked. Mayers and Smith (1982) hypothesize that managers with greater discretion over decision-making will be more likely to purchase insurance. I interpret this as meaning that firms with less independent boards will have a higher role for insurance, as managers receive less supervision and more opportunity for misconduct. Mismanagement and misrepresentation of

the situation of the company by self-interested managers, maximizing their own short-term income, may not be in the interest of shareholders. These are exactly the reasons that have increased litigation, filed by shareholders against directors and officers. And the personal and corporate account of managers here cannot be clearly separated as under the Fisher's separation theorem. Fisher's result (Garven and MacMinn 2000) shows that decisions made on the corporate account can be separated from decisions made on the personal account. When shareholders sue managers, however, they may go after their personal wealth. So managers may have to pay from the personal account for decisions they have made on the corporate account. That is where there is clearly a role for insurance.

Another type of agency costs are those between shareholders and bondholders. One of the problems that arises between shareholders and creditors is the under-investment problem. Shareholders have some control over the company through their ability to elect directors who appoint and compensate management. Creditors lend money to the company without such control over it. Limited liability creates asymmetry between the costs and benefits of risky investments and causes incompatible incentives between creditors and investors of a corporation, when bankruptcy is possible (MacMinn and Garven 2000). The managers might make decisions in the interest of one group that are detrimental to the other. Managers may reject investing in positive Net Present Value projects (or downsize their investments), when the benefits go to the creditors and the downsides go to the shareholders. That may make managers emphasize the downsides, resulting in under-investment. On the other hand, if the risks of a project are borne by creditors, managers may over-invest in risk projects, possibly even ones with negative NPV. If the risk is insured, managers might be able to better evaluate the merits of a project and avoid under- or over-investment.

Jensen and Smith (1985) observe that when the value of the firm depends largely on future investment opportunities, a firm with risky bonds might reject positive NPV projects if the benefits from

the project go to bondholders. In other words, growth companies are subject to much more risk, under investment is more likely, and they are more likely to demand more insurance. MacMinn and Garven (2000) demonstrate that insurance mitigates the under-investment problem and protects creditor values.

Based on of the theoretical background of Mayers and Smith (1982, 1987, 1990), the following testable propositions can be made. Higher probability of distress leads companies to purchase more insurance, as insurance decreases the expected cost of bankruptcy. Insurance also decreases the probability of loss, so companies with a higher probability of distress should have higher retentions. Smaller companies are more likely to buy D&O coverage due to real-service efficiencies and proportionately higher bankruptcy costs. Insurance is expected to eliminate the likelihood of under-investment by companies with growth opportunities, so they are expected to buy insurance. Substantial managerial ownership is expected to increase the likelihood of purchasing insurance because owner-managers are assumed to be more risk averse and possess less diversified portfolios. Rate-regulated utilities purchase insurance and include the premiums in their rates, thus including the expected future losses in their rates and passing the costs to the consumers.

Holderness (1990) suggests that corporate governance influences the demand of D&O insurance. His proposition is related to the monitoring discussion of Mayers and Smith (1982) above. D&O insurance plays a monitoring role in the relationship between management and owners. Insurance companies, on the other hand, play the role of monitors on the management, as they examine those to whom insurance is sold. A primary concern in governance is whether the interests of the managers are aligned with those of the owners. Some mechanisms to monitor the managers are having large shareholders (Schleifer and Vishny 1986), boards of directors (Fama and Jensen 1983), executive stock ownership (Jensen and Meckling 1976), etc. Some literature suggests that D&O insurance and other monitoring mechanisms may be substitutes (O'Sullivan 1997). According to the monitoring hypothesis,

if the monitoring demand stays constant, companies will purchase more D&O insurance as the cost of alternative monitoring mechanisms increases (O'Sullivan 1997). Holding the monitoring demand constant, if a company uses many alternative and effective monitoring means, then the demand for D&O insurance is likely to be less. Also, if a company employs effective monitoring, it is less likely to experience a lawsuit.

The board exists to protect and represent the interests of shareholders. The board hires and fires management, evaluates their performance and initiatives. Outside directors may be better able to exhibit impartiality and independence in their evaluation; inside directors, however, may bring more industry- and company-specific knowledge and expertise (Baysinger and Hoskisson 1990; Cadbury 1992). Thus both classes might be valuable members of the board. Related to the independence is the issue of whether the CEO is also chairman of the board. Since the board has to hire and fire the CEO and oversee them, it would appear less than objective for the CEO chairman to oversee themselves. In Britain, the Committee on the Financial Aspects of Corporate Governance (Cadbury 1992) has recommended separation of those functions. Similar actions are under way in the US after the corporate scandals.

Another view is that board composition and CEO-COB separation act as complements to D&O insurance (O'Sullivan 1997). As insurers act as monitors of corporate management, they may insist on more outsiders on the board and CEO-COB separation as a condition for offering coverage. Outside directors, in turn, may be more willing to sit on boards, if they are covered. Jensen and Meckling (1976) propose that having an ownership interest in the company aligns managers' interests with those of the shareholders. Then managers and directors will be owners who are involved in the decision-making. As insider ownership increases, Jensen and Meckling (1976) hypothesize that firm's value increases. Under such realignment of managers' and shareholders' interests, there would be less demand for D&O insurance. In large companies shareholders are expected to use D&O insurance and managerial ownership

as monitoring mechanisms. In smaller companies shareholders are expected to monitor through large ownership without the costly monitoring of D&O insurance.

2.2 Review of the Empirical Literature

One reason this issue has not been studied more empirically is that D&O insurance data are not publicly available in the US. That is why most past studies rely on Canadian and UK data. The US represents a different environment than UK or Canada, as D&O purchases are private information in the US and thus reveal the behavior of directors and officers, when they are not publicly observed. What is more, the US litigation environment is different than in Canada or the UK. In the US, litigation is so common, that it may be considered a normal business expense by some. This is not the case in Canada, however (Boyer 2003). Core (1997) was the first one to use (cross section) Canadian data to analyze D&O insurance demand. Analyzing his sample of 222 firms, he concludes that the risks of lawsuit and risks of financial distress are major determinants of D&O insurance purchase. His goodness of fit, however, is quite low. In a later study, Core (2000) analyzes the premiums for D&O insurance, finding that premiums are explained by about the same factors as the ones explaining D&O coverage. The finding that financial distress is a major determinant of the corporate insurance decision is in unison with the findings of Mayers and Smith (1990), focusing on the demand for reinsurance by property-casualty insurers (which is publicly available). They conclude that the probability of financial distress is a major determinant in the reinsurance decision. Using data on 366 UK companies, O'Sullivan (1997) finds that the same factors explain D&O purchases in the UK. He also concludes that executive stock ownership and D&O insurance are substitutes as corporate governance instruments. Boyer and Delvaux-Derome (2001) provide a more recent analysis of the demand for D&O insurance in Canada, using panel data from 1993-1999. Their explanatory variables are in five broad classes: corporation size, return characteristics, credit worthiness, litigation environment and corporate governance. My study is most closely related to

Boyer's (2003) study. However, my data are more recent and come from the US rather than Canada. Also, I employ different panel data methodology and a variation of the dependent variable.

Boyer (2003) concludes that the only significant variable explaining the insurance decision is last year's purchase. He interprets that as evidence of habit. He uses instrumental regression. None of the financial or economic explanatory variables appear to be significant. Boyer (2003) motivates his analysis by saying that habit tends to play a profound role in some aspects of human life. Smoking is one example. Campbell and Cochrane (1999) explain the equity premium puzzle through habit formation. They build on the observation that the marginal utility of consumers is very volatile when the consumption growth is low, so consumers need a higher risk premium. The fundamental observation in that and other models is that some people find it very costly to move away from a habit. Applying that fact in risk management, Boyer (2003) confirms it there as well, according to his method. He accounts for managerial habit formation in the following ways. Managers make an optimal decision at a point in time and wait to see the results in the future. Waiting to see results may take years and during that time they stick to habit and may even delay evaluating the decision, if the outcome may be unfavorable. And if the outcome is unfavorable, changing the decision may mean admitting that one is wrong. And in corporate and power structures admitting that one was wrong is not a great thing to do.

While Boyer (2003) interprets the significance of the lagged limit as solid evidence of habit, others take issue with that. They argue that this significance may mean that the risk exposure of companies may remain unchanged from year to year, that is why they purchase the same limit. You do not need habit for this to happen. I do not take sides in this debate. I simply tests whether the lagged limit is significant. If it is, I shall interpret this as evidence of "persistence" in the limits. I do not qualify it as habit or unchanged risk exposure. Even if persistence is due to unchanged risk exposure, controlling for persistence is a good

idea. There are many models in economics that test for persistence. I am not exactly investigating the causality of persistence, but its mere existence and whether it is the only significant variable.

On the other hand, the stock price behavior of the company seems to be related to whether the company and its directors and officers will be sued. As Chalmers et al. (2002, p. 621) observe, "... declines in raw stock price performance often lead to shareholder lawsuits..." Further, Chalmers et al. (2002) find out a negative relation between D&O insurance limits and ex post stock performance. Notably, Chalmers et al. (2002) is the only paper to my knowledge, using a US data set. It consists of 72 firms, all of them IPO's, including their D&O insurance amounts, premiums and others between 1992 and 1996. As the authors point out, this a small sample (due to the fact that such information is not public) and probably subject to potential sample selection biases. The authors primarily examine the managerial opportunism hypothesis, according to which the amount of D&O insurance, bought by an IPO firm, is inversely related to the firm's ex post stock price performance. That indicates that managers use their superior information to assess the probability of exposure to legal liability. The authors use similar characteristics as in Core (2000) to find factors normally influencing D&O insurance demand. They run cross-sectional regressions of D&O purchase amount to IPO size, leverage, average revenue, standard deviation of these revenues, average operating income, standard deviation of the operating income, age of the firm, percentage of outside directors, among others. The variable of interest, long-run stock performance, appears to be negatively related to the amount of insurance purchased (Chalmers et al. 2002). That holds for both raw returns and book-to-market and size-adjusted returns. They interpret these results as consistent with the managerial opportunism hypothesis, provided we treat the three-year future returns as a proxy for managers' private information. One issue that Chalmers et al. (2002) may have overlooked is that D&O insurance is claims-based. Thus perhaps it does not matter so much what

insurance IPO's had at inception; it is important what insurance they have at the time the claim is filed (this criticism is also raised by Boyer (2003)).

Vafeas (2000) points out governance and ownership factors that distinguish corporations that have been sued and corporations that have not. He finds that outside block ownership plays a significant monitoring role, suggesting that outside blockholdings and shareholder lawsuits are substitute mechanisms. Vafeas (2000) reports that the likelihood of a lawsuit decreases significantly with the increase in blockholdings. External blockholders are seen as an additional mechanism that monitors managers and renders litigation less likely. Firms that have been sued appear to “have fewer unaffiliated blockholders holding less stock. . .” (Vafeas 2000 p. 32).

The above theories have not been tested with US companies, except the Chalmers et al. (2002) study, which focuses exclusively on IPO's. It is an open question whether US companies follow the prescribed theories in their choice of insurance coverage. This study contributes to the literature by expanding the tests to a broad range of US companies over the years. It confirms Mayers and Smith's (1982) hypothesis about the effect of size on insurance and the importance of real-services efficiencies. Bankruptcy risk is also related to the insurance decision. All previous studies have used as dependent variable the logarithm of limit, unscaled for size. This paper demonstrates that results will be different when we adjust the dependent variables for size. A more appropriate dependent variables could be the logarithm of limit per MVE, which is an implication for future research or revisiting some of the previous studies. A methodological contribution of the paper is the use for the first time of GMM dynamic panel methods with D&O insurance data and probably with corporate insurance data in general. Dynamic panel models have shown a lot of promise in the growth literature, where a certain degree of persistence is expected. Since the risk exposure of companies may not vary dramatically from year to year and exhibits some persistence, these methods are particularly appropriate.

3. Theoretical Model

A theoretical framework is adopted from Urtiaga (2000), which is designed for directors but here it is expanded to apply to executives who owe fiduciary duties to shareholders. It considers a public corporation with dispersed ownership by shareholders. The purpose of this model is to motivate the existence of securities litigation and insurance. It does not provide clear guidance as to how much insurance companies should demand. Using shareholder funds, the CEO implements a risky project and the board of directors supervises him. Directors and officers (hereafter managers) are assumed to be risk-neutral with reservation utility equal to their initial wealth ω . Managers can choose to exert high level of care, c_h , or low level of care, c_l . For the CEO, level of care may mean truthfulness in financial disclosure, effort to increase firm value, etc. For directors, level of care may mean the effort with which they monitor management. The level of care is costly, in monetary terms or time. It is assumed that $c_h > c_l$, where c represents the disutility of care to managers. The discussion below follows Urtiaga (2000).

The risky project undertaken has a cost C and two outcomes: high return, x_h , or low return, x_l . For simplicity, let $x_h = 1$ and $x_l = 0$. P_i is the probability that the return is low when $i=h,l$ ($p_h < p_l$). The following assumptions are made:

$$c_h < p_l - p_h$$

(the cost of exerting a high level of care is lower than the expected increase in shareholder wealth, so that a high level of care is optimal)

$$(1 - p_l) < C$$

(when no care is exerted, the expected net return is negative; thus the shareholders will not invest in that case.)

After the project is implemented, shareholders observe the return from the project. If the shareholders are not satisfied, they may file a lawsuit against the managers. Shareholders may suspect low

level of care by the managers. Legal action can help them obtain a costly (though verifiable) signal about the managers' level of care. To start litigation, shareholders must incur legal fees K (which are substantial in the US). The managers' legal fees are typically initially covered through an indemnification from the corporation or covered by D&O insurance. Thus they are not explicitly included. Only when there is a low return, courts will honor a suit. This is because the court applies a negligence rule, meaning that there must be damage to the corporation due to negligence by the managers.

During its proceedings, the court observes a signal about the managerial level of care. There can be two signals: high, y_h , and low, y_l . The probability of obtaining a low signal when the level of care is $I = h, l$ is q_i . When the level of care is high, the probability of a low signal is low, $q_h \leq q_l$. The award for damages is fixed at D and is known to both parties. Managers are protected by limited liability, meaning that they will never be liable for more than their wealth ω .

There exist mechanisms to shift the level of liability of managers to varying degrees. A popular way, as discussed above, is Directors' and Officers' Liability Insurance, purchased by the corporation. The policy covers the financial losses of managers from litigation settlements and judgments, provided that they have acted in good faith. If the judgment or settlement requires the manager to pay D , then the insurance policy will pay $(1-\beta)D$ and the manager will pay $\min\{\omega, \beta D\}$. The managers are given a remuneration scheme, represented by vector $z = (s, \alpha, I, \beta)$, where s is base salary, α is share of returns from the project, and β and I represent protective measures. I stands for limited liability or other provisions the company may have; β is related to the insurance coverage. The timing of the game is as follows:

T=1: Shareholders offer contract z to the manager.

T=2: Project commences and the manager chooses level of care ($\mu \in [0, 1]$ is the probability of choosing c_h).

T=3: Returns of the project are realized (high or low). When returns are low, shareholders decide whether to sue (with probability λ). If they sue, go to t=4.

T=4: Court observes signal (high or low) and gives verdict. Payoffs realized.

Except the level of care, all other information is observable. This appears to be a three stage dynamic game of complete but imperfect information. First, shareholders offer a contract to the manager that satisfies their individual rationality constraint. Shareholders also want to attract a good manager, so they want to offer a good compensation package. Given the contract, in the second stage the manager chooses a level of care. In the third stage, shareholders observe the outcome and decide whether to sue. Information is imperfect since the shareholders observe an outcome only, not the level of care. The goal is to find a subgame perfect equilibrium for the optimal values of the vector (z, μ, λ) that maximize shareholders' profits subject to the manager accepting the contract and the characteristics of the legal system, given by I and β , representing legal liability provisions and insurance.

We work backwards to find a solution of the game. The court observes a high or low signal and finds the manager guilty when the signal is low. The probability that manager exerting a high (low) level of care is found guilty is q_l . Shareholders' strategy space is $A_s = \{S, N\}$, where S stands for 'sue' with probability $\lambda \in [0, 1]$ and N stands for 'not sue.' The strategy space of the manager is $A_m = \{c_h, c_l\}$ where c_h is associated with high level of care with probability μ and c_l is associated with a low level of care. The payoff function of the shareholders is:

$$U_s(z, \mu, \lambda) = (1-\alpha)[\mu(1-p_h) + (1-\mu)(1-p_l)] -s -C + \lambda[\mu p_h q_h + (1-\mu)p_l q_l] \min\{w, \beta D\} - \lambda[\mu p_h + (1-\mu) p_l]K \quad (1)$$

(where the first term is the return that goes to shareholders – management's salary and cost of the project + potential gains from a lawsuit – lawsuit costs).

The payoff function of the managers is:

$U_m(z, \mu, \lambda) = \alpha[\mu(1 - p_h) + (1 - \mu)(1 - p_l)] + s - \mu c_h + w - \lambda[\mu p_h q_h + (1 - \mu)p_l q_l] \min\{\omega, \beta D\}$ (where the first term is the return that goes to managers + their salary – the cost of effort + their initial wealth – potential lawsuit losses). (2)

The insurance markets are competitive and liability insurance can be purchased at actuarially fair prices. This implies that the premium is equal to the percentage size of damage to be paid by the insurer (limit) times the probability that litigation is started and damages awarded (as estimated by the insurance company). The insurance company reviews the financial statements, performance and corporate governance before offering coverage and determining the premium. Unfortunately, in the US the findings of the insurer and the premium charged are not known to shareholders but only to managers. The premium is equal to

$$\pi = \lambda[\mu p_h q_h + (1 - \mu) p_l q_l](1 - \beta)D. \quad (3)$$

We assume that the size of damage is common knowledge for simplicity. In reality, the size of damage will depend on market capitalization, number of shareholders, drop in the stock price. Having insider information, managers are expected to anticipate the size of damage and purchase insurance accordingly. It is the probability of successful litigation that is difficult to know.

At the third stage of the game, if low returns are observed, shareholders decide whether to sue. To this end, they compare the cost of litigation K with the expected damage award (and the value of corporate governance changes that may be initiated). They will sue only if they can at least recover the defense expenses in the litigation:

$$[\mu q_h + (1 - \mu)q_l][\min\{w, \beta D\} + I(1 - \beta)D] \geq K \quad (4)$$

The value of μ that leaves shareholders indifferent between the two strategies is

$$\mu_0 = [q_l[\min\{w, \beta D\} + I(1 - \beta)D] - K] / [(q_l - q_h)[\min\{w, \beta D\} + I(1 - \beta)D]] \quad (5)$$

When $\mu > \mu_0$, shareholders will not sue. When $\mu < \mu_0$, shareholders will always sue, $\lambda = 1$. When $\mu = \mu_0$, shareholders might use a mixed strategy $\lambda \in [0, 1]$. The managers are indifferent between their two strategies at

$$\lambda_0 = [c_h - \alpha(p_l - p_h)] / [(p_l q_l - p_h q_h) \min\{\omega, \beta D\}] \quad (6)$$

When $\lambda > \lambda_0$, managers exercise a high level of care. When $\lambda = \lambda_0$, the manager plays a mixed strategy ($\mu \in (0, 1]$). Note that the case of $\mu = 0$ is excluded, since when no care is exerted for sure the return is assumed to be negative.

Let $N(z)$ stand for the set of Nash equilibria for these two stages. There are three types of equilibria: both players have strict preferences for their actions, both players are indifferent, and one player has a strict preference, while the other is indifferent. There are two possible pure strategy equilibria of the first type: $(\mu = 1, \lambda = 0)$ and $(\mu = 1, \lambda = 1)$. The first equilibrium means that the manager strictly prefers a high level of care given that the shareholders do not sue. Similarly, the shareholders strictly prefer not to sue given that the manager exerts a high level of care with certainty. The second equilibrium means that the manager strictly prefers to exert a high level of care given that shareholders sue with certainty. And shareholders strictly prefer to sue given that managers exert a high level of care with certainty. Equilibria where both parties are indifferent between their actions obtain when $\mu = \mu_0$ and $\lambda = \lambda_0$.

There are three cases when one party strictly prefers an action and the other is indifferent. Let us consider first the case when shareholder strictly prefer not to sue, while managers are indifferent between levels of care. That implies that $\mu > \mu_0$ and $\lambda = 0 = \lambda_0$. Next, there are the equilibria when shareholders strictly prefer to sue, while managers are indifferent ($\mu < \mu_0$ and $\lambda = 1 = \lambda_0$). The third case occurs when managers strictly prefer to exert a high level of care, while shareholders are indifferent. In other words, $\lambda > \lambda_0$ and $\mu = \mu_0 = 1$.

Result 1. When protective measures (insurance and limited liability) are allowed, $N(z)$ is characterized by:

If $q_L D < K$, all equilibria are without litigation, i.e.

$$N(z) = \{(\mu, 0) \mid \mu \in (0, 1] \text{ if } \lambda_0 = 0 \text{ and } \mu = 1 \text{ if } \lambda_0 < 0\}. \quad (7)$$

If $K \leq q_L D$, then the probability of litigation is unrestricted; all equilibria above are possible.

Moving backwards now to the first stage of the game. Shareholders choose z, μ, λ to maximize

$$\text{Max } U_s(z, \mu, \lambda) \quad (8)$$

subject to

$$U_d(z, \mu, \lambda) \geq \omega$$

$$(\mu, \lambda) \in N(z)$$

$$s \geq 0, 0 \leq \alpha \leq 1, I \in \{0, 1\}, \beta \in [0, 1].$$

The first condition is the individual rationality constraint, guaranteeing that the manager will accept the contract. After substituting the utility functions and expressions from above, we obtain the following solution:

Theorem. The equilibrium is described as

- 1) If $q_L D < K$, managers choose high level of care with probability 1 and shareholders do not sue.
- 2) If $q_h \min\{\omega, D\} \leq K \leq q_l$, there are 2 cases:
 - 2a) For low values of $\min\{\omega, D\}$, the manager chooses high level of care with probability 1 and the shareholders do not sue.
 - 2b) For high values of $\min\{\omega, D\}$, the manager chooses high level of care with probability less than 1 and the shareholders sue with a positive probability. Also, when $\omega < D$, the optimal contract includes liability insurance ($I=1, \beta < 1$).

3) If $K < q_h \min\{\omega, D\}$, there are two cases, depending on the rent the manager can obtain:

3a) For low values of rent, the manager chooses high level of care with probability one and shareholders sue with positive probability. Also, the optimal contract includes a damage cap ($I=0$, $\beta < 1$).

3b) For high values of rent, the manager chooses high level of care with probability one and shareholders always sue.

(Proofs omitted; available upon request.)

An intuitive implication of the theorem is that having securities litigation is optimal and companies will purchase liability insurance. Also, the higher the returns, the lower the litigation risk. The optimal contract depends not only on the legal system (such as K and D), but also on company characteristics (such as probability of high and low returns, managerial effort). Thus returns tie this model to the above discussion. In practice, I measure returns by Returns on Assets and Stock Returns. High returns signify that managers are exerting high level of care and working in the interest of shareholders. Therefore, shareholders will not sue. On the other hand, low returns send the signal that managers are not exerting high enough effort and shareholders are likely to lose more and sue. The returns shareholders observe are the best signal for the behavior of managers. In addition, they are the best measure of the satisfaction of shareholders from the success of the project. Level of care is among the unobservable variables in the panel data model. It is treated as unobserved firm effect. There is no way to measure it. It is likely to be correlated with firm performance.

When $\min\{\omega, D\}$ is small relative to legal costs K , the shareholders prefer not to sue. Similar is the case when q_h is high. In other words, if the probability of getting a low signal, when the managers exerted a high level of care, is high, the shareholders prefer not to sue. When the possible award $\min\{\omega, D\}$ is very high relative to K , and there are no protective measures, shareholders sue with probability 1.

4. Hypothesis Development

Main Hypothesis 1. Companies with better returns demand less insurance. This hypothesis follows from Urtiaga's (2000) theoretical model. The higher the returns, the less likely the shareholders to sue. Also, the higher the returns, the lower the potential loss. Moreover, higher returns imply that managers are working in the interest of the shareholders (and creditors) and there are less agency costs. This implicitly supports the agency costs theory; the lower the agency costs, the lower the litigation risk and less insurance is demanded. Thus it is also connected to the theories of Mayers and Smith (1982) and MacMinn and Garven (2000) on the role of insurance in mitigating agency costs. As a result, this hypothesis blends several theories; that is partly the reason it is chosen as main hypothesis. Returns are measured by raw stock returns and returns on assets.

Subsidiary (Control) Hypotheses

Hypothesis 2. Corporate governance influences the D&O insurance limit. I test whether corporate governance and insurance are substitutes or complements. If they are substitutes, the better the corporate governance of a company, the less insurance is demanded, as the managers are better supervised and less likely to commit misconduct. If governance and insurance are complements, when extending insurance, the insurer encourages or requires the company to better their governance; thus insurance is associated with better corporate governance. And when extending more coverage, the insurer will insist even more on good governance, as they can lose more. Governance is measured by the number of members on the board, percent of insiders and outsiders, CEO/COB separation, percent blockholdings, number of blockholders, and directors' and officers' ownership (variables are defined in the Data and Variables section below and in the Appendix). If governance and insurance are complements, there will be a positive relationship; if they are substitutes there will be a negative relationship. For the rest of theories, the direction of the predicted sign is pretty clear.

Hypothesis 3. Financial risk influences the insurance limit. Companies in financial distress demand more insurance. The financial situation of companies is measured by financial risk, leverage, volatility. This hypothesis also implies that smaller companies (in term of asset size) demand more insurance, as they have higher bankruptcy risk.

Hypothesis 4 (size). A) Mayers and Smith (1982) suggest that smaller companies demand more insurance due to real-service efficiencies and proportionately higher bankruptcy costs. Size in this case is measured by $\ln(\text{assets})$. The existence of mergers and acquisitions is expected to increase the insurance limit.

4B) Another measure of size is $\ln(\text{Market Value of Equity})$. The higher the MVE, the higher the limit, as the higher would be the potential loss. I perceive this as rationality hypothesis: the higher the potential loss, the higher limit is chosen by the managers. Boyer (2003B) interprets this as shareholder protection hypothesis. The higher the MVE, the higher the potential loss for shareholders too. Thus purchasing higher insurance protects shareholder wealth. He forgets one thing, though. It is the managers, not shareholders, who choose insurance limits. Thus it has to be interpreted on the managers' side. Even if liability insurance protects shareholder wealth, the shareholders are not the ones who choose the limits, so how do we know that the limits were chosen to protect shareholder wealth? In fact, in the US such insurance purchases are confidential and managers are not even required to disclose them to shareholders. Thus shareholders may not even know the limits, while managers always know them.

Hypothesis 5. Insurance alleviates the under-investment problem (between creditors and managers), as shown by MacMinn and Garven (2000). As growth companies are likely to experience more under-investment problems, they are expected to demand more insurance. The variable to test this is growth. The predicted sign is positive.

Hypothesis 6. Consistent with Boyer's (2003) findings, it is expected to observe persistence in limits from year to year. Lagged dependent variable is expected to be significant.

To sum up, I will interpret Hypothesis 1 as confirming Urtiaga's model based on returns and the role of insurance in mitigating agency costs, as suggested by Mayers and Smith (1982) and Holderness (1990). Hypothesis 2 tests whether good governance and liability insurance are complements or supplements, as there are competing theories. I will interpret Hypothesis 3 as confirming the bankruptcy risk theory of Mayers and Smith (1982) and MacMinn and Garven (2000) and the role of insurance in mitigating bankruptcy costs. I will interpret Hypothesis 4A as providing support for the real-services and bankruptcy risk theory and 4B as providing support that managers rationally choose insurance limits based on the potential size of loss. If confirmed, Hypothesis 5 provides support that corporate insurance mitigates the under-investment problem, as stipulated by MacMinn and Garven (2000). Lastly, Hypothesis 6 reveals persistence in the limits. Boyer (2003) interprets this as evidence of habit. Others no doubt will interpret it as evidence of unchanged risk exposure through time and not necessarily of habit.

5. Methodology

The simplest estimation of the model is Ordinary Least Squares (OLS). OLS, however, exhibits some well-known problems in the presence of a lagged dependent variable as an explanatory variable. The lagged limit is included because of Boyer's (2003) findings of its significance and because the risk exposure of companies may remain constant from year to year, thus some persistence in the limits is to be expected. Whether this persistence is interpreted as evidence of habit or unchanged risk exposure is a different matter. The usual OLS technique does NOT work in this dynamic panel setting, because the exogeneity assumption is violated. The lagged dependent variable will always be correlated with the unobserved individual effect, as in time (t-1) $Limit_{i,t-1}$ will on the left side of the equation and later on the right side (see Wooldridge 2002). Thus OLS is not consistent. For consistency, it is required that there be

no contemporaneous correlation between the explanatory variables and the error terms, which in this case consist of individual effects and idiosyncratic errors. This fails when the lagged dependent variable is an explanatory variable. Since I find some significance of the lagged dependent variable later on, the dynamic model is preferred. This is the reason to focus on other estimation methods.

The next estimation of the model is fixed effects panel estimation. Fixed effects (within groups estimation) are chosen because they allow the explanatory variables to be correlated with the unobserved effects. The unobserved firm effects in this case could be managerial ability or corporate culture, which could well be correlated with firm performance and corporate governance. Random effects estimation assumes that the unobserved effects are uncorrelated with the explanatory variables, which is a strong assumption and unlikely to hold here. The drawback of fixed effects is that the explanatory variables cannot include time-constant variables. That means that industry, for instance, cannot be used as an explanatory variable, as it typically does not change over time. Since the unobservable effects can be arbitrarily correlated with the explanatory variables, we cannot distinguish the effects of time-constant observable variables from the effects of time-constant unobservable variables. The fixed effects model is

$$\text{Limit}_{i,t} = \alpha + \beta X_{i,t} + \eta_i + v_{i,t}, \quad (9)$$

where $X_{i,t}$ are the explanatory variables described below, η are unobserved fixed firm effects, $v_{i,t}$ are error terms (i indexes firms and t indexes time). The model requires strict exogeneity of the explanatory variables $E(v_{i,t} | X_i, \eta_i) = 0$ for all t . Fixed effects estimation is known to be downward biased, while OLS estimation is known to be upward biased in this case (Bond 2002).

The within groups estimator removes the firm effects by fixed effects transformation. It is obtained by first averaging equation (9) over $t=1, \dots, T$ to get a cross section equation (Wooldridge 2000). This equation then is subtracted from equation (9) to produce the fixed effects transformed equation. The resulting equation is estimated using pooled OLS. Even in this case, however, the transformation

produces a correlation between the transformed lagged dependent variable and the transformed error term. This negative correlation does not disappear with an increase in sample size. Thus the within estimator is biased downwards. Also, in dynamic panel data models, Verbeek (2000) shows that the fixed effects estimator is inconsistent. This is due to the fact that the transformed lagged dependent variable is correlated with the transformed error term for fixed T.

To more systematically test whether fixed or random effects are appropriate, I perform a Hausman (1978) test. It tests the null hypothesis that $X_{i,t}$ and the firm effects are uncorrelated. If they are correlated, the random effects estimator is inconsistent. The Hausman test compares the two estimators: the fixed effects approach is consistent under both the null and alternative, while the random effects estimator is consistent (and efficient) only when $X_{i,t}$ and the firm effects are uncorrelated (under the null). A systematic difference between the two estimators provides evidence against the null hypothesis. The test considers the difference vector between estimates $\beta_{FE}^* - \beta_{RE}^*$. We have to compute the covariance matrix of this difference. As the fixed effects estimator is efficient under the null, it can be shown that under the null (Verbeek 2000):

$$V(\beta_{FE}^* - \beta_{RE}^*) = V(\beta_{FE}^*) - V(\beta_{RE}^*). \quad (10)$$

Consequently, the Hausman test statistic takes the form:

$$\zeta_H = (\beta_{FE}^* - \beta_{RE}^*)' [V^*(\beta_{FE}^*) - V^*(\beta_{RE}^*)]^{-1} (\beta_{FE}^* - \beta_{RE}^*), \quad (11)$$

where V^* denotes estimates of the covariance matrices. Under the null, which implies $\text{plim}((\beta_{FE}^* - \beta_{RE}^*) = 0$, the Hausman statistic is Chi-2 distributed with K degrees of freedom, K being the number of elements in β . The Hausman test supports my choice of fixed effects, as I reject the null of no correlation between the explanatory variables and firm effects, as I expected earlier.

I also perform a test for heteroskedasticity in these data. I utilize a modified Wald statistic to test for groupwise heteroskedasticity in the residuals of a fixed effects model (Greene 2000). I estimate the fixed

effects model assuming homoskedasticity. The null hypothesis is that the variances of the residuals are constant for $i = 1, N$, where N is the number of cross sectional units. Under the null, this statistic is distributed Chi-2. The advantage of this statistic is that it is workable, at least asymptotically, under non-normality. The results are shown after Table 8, fixed effects estimation. I reject the null of constant variance and thus establish existence of heteroskedasticity in these data. Therefore, in subsequent estimations heteroskedasticity robust standard errors will be used.

A good technique to estimate a dynamic panel model is the Generalized Method of Moments (GMM) Model, developed by Arellano and Bond (1991). Bond (2002) observes that adopting a dynamic econometric framework can be beneficial for estimation of parameters, even when the dynamics are the not the primary interest. Their model is an instrumental estimation. Instruments are variables (or their lags) that are correlated with predetermined or endogenous variables, but are not correlated with the errors. While simpler instrumental approaches are available, the GMM estimator offers significant efficiency gains and results in well-determined estimates (Arellano and Bond 1991). In addition, GMM, in contrast to standard instrumental variable estimation, is more efficient in the case of heteroskedasticity of unknown form (Baum et al. 2003). In general, the Generalized Method of Moments has great advantages: 1. it does not require assumptions on the distribution, such as normality; 2. it allows for heteroskedasticity of unknown form; 3. it can estimate parameters even if the model cannot be solved analytically from the first order conditions (Verbeek 2000). What is more, the validity of the instruments is beyond question if the model produces a conditional moment restriction and the vector of instruments is in the conditioning set. Here the linear Arellano-Bond GMM first-differenced one-step estimator will be utilized first. The one-step estimator is used, because simulation studies have revealed very small efficiency gains from using the two-step estimator, even when there is substantial heteroskedasticity (Bond 2002) (however, the two-step Sargan statistic is used due to heteroskedasticity). Simulation studies

reveal that the asymptotic standard errors are too small, or the asymptotic t-ratios too large, with the two-step estimator, as the two-step weight matrix depends on estimated parameters. Thus one-step results are preferred for inference on coefficients, while two-step Sargan statistic is preferred for overidentification tests. The estimation equation is

$$\text{Limit}_{i,t} = \alpha \text{Limit}_{i,t-1} + \beta X_{i,t} + \eta_i + v_{i,t} \quad (12)$$

where X includes the variables described below, η are unobserved individual effects, unchanged over time, the $v_{i,t}$ are assumed to satisfy $E(v_{i,t}) = E(v_{i,t}v_{i,s}) = 0$ for $t \neq s$. In other words, the errors are assumed not to be serially correlated. The $X_{i,t}$ are allowed to be correlated with η_i . In fact, in this case it is quite plausible that the explanatory variables will be correlated with the unobserved effects. Variables measuring financial performance or corporate governance may well be correlated with some firm effects, like the good character of the management. What instruments can be used depends on the relationship between the $X_{i,t}$ and $v_{i,t}$. (Different instruments are used in different time periods.) The possibilities are:

1. the $X_{i,t}$ are strictly exogenous. $E(x_{i,s}v_{i,t}) = 0$ for $s = 1 \dots t; t=2 \dots T$. Letting y be the dependent variable, then the instrument vector will be block diagonal $Z_i = \text{diag} (y_{i1} \dots y_{is} \ x_{i1} \dots x_{iT}), s=1, \dots, T-2$.
2. the $X_{i,t}$ are weakly exogenous (predetermined). $E(x_{i,s}v_{i,t})=0$ for $s=1 \dots t; t=2 \dots T$; $E(x_{i,s}v_{i,t}) \neq 0$ for $s=t+1 \dots T; t=2 \dots T$. Predetermined variables are correlated with past errors. Then the instrument vector takes the form $Z_i = \text{diag} (y_{i1} \dots y_{is} \ x_{i1} \dots x_{i(s+1)}), s = 1, \dots, T-2$. We have fewer valid instruments.
3. the $X_{i,t}$ are endogenous. $E(x_{i,s}v_{i,t})=0$ for $s=1 \dots t-1; t=2 \dots T$. $E(x_{i,s}v_{i,t}) \neq 0$ for $s=t \dots T; t=2 \dots T$. Endogenous variables are correlated with past and present errors. Then $Z_i = \text{diag} (y_{i1} \dots y_{is} \ x_{i1} \dots x_{is}), s=1, \dots, T-2$. $X_{i,t}$ is treated like the lagged dependent variable. We have even less instruments available.

In this case, I shall initially assume that the explanatory variables are strictly exogenous and see whether the Sargan test supports the hypothesis of valid moment restrictions. The minimum number of observations I need per company is 3, $T \geq 3$, since first differences will be taken and instrumented with past levels of the variables. After testing, it appears that initially the Sargan statistic provides unsatisfactory results. Several of the variables will be treated as predetermined: leverage, raw returns, growth, and risk. Then the Sargan statistic fails to reject the null hypothesis of valid moment restrictions and the second order serial correlation test does not reject the null of no serial correlation. For the predetermined variables, we can use only the $0.5(T+1)(T-2)$ moment conditions $E(x_{i,t-s}\Delta v_{i,t}) = 0$, for $t=3 \dots T$ and $1 \leq s \leq t-1$ (Arellano and Bond 1991). In the case of strictly exogenous variables we can use the full set of moment conditions $E(x_{i,s}\Delta v_{i,t}) = 0$.

The difference GMM estimator first differences the equation:

$$\text{Limit}_{i,t} - \text{Limit}_{i,t-1} = \alpha(\text{Limit}_{i,t-1} - \text{Limit}_{i,t-2}) + \beta(X_{i,t-1} - X_{i,t-1}) + (v_{i,t} - v_{i,t}). \quad (13)$$

First-differencing introduces moving average structure in the error term. It is often used to remove the unobserved effects and thus omitted variable bias. Arellano and Bond (1991) demonstrate that values of the dependent and predetermined explanatory variables lagged two periods or more are valid instruments to estimate the equation in first differences, provided that there is no serial correlation in the error terms. For sufficiently large N (number of companies), the sampling distribution of GMM estimators approximates normal distribution (Arellano and Honore 2000). The vector of instruments is $(\text{Limit}_{i,1}, \dots, \text{Limit}_{i,t-2}, X_{i,1}, \dots, X_{i,t-2}, X_{i,t-1})$ in the case of predetermined variables. As Bond (2002) observes the validity of the assumptions on the predeterminedness or endogeneity of the variables can be tested using tests of overidentifying restrictions (which test the validity of instruments).

The GMM estimator is a two-step estimator (Windmeijer 2000). In the first step, we use an initial positive semidefinite matrix to obtain consistent parameter estimates. On the basis of these estimates, a

weight matrix is constructed, which is used for the asymptotically efficient two-step estimates. It is known that the two-step estimates have a small sample downward bias, thus one-step estimates are preferred for coefficient estimates. Blundell and Bond (1998) conclude that the one-step estimators produce more reliable inference, especially when non-normality or heteroskedasticity is suspected. It is common to use the inverse of the moment matrix of instruments as an initial weight matrix. The GMM estimator of coefficient vector (with (k-1) explanatory variables) δ takes the form

$$\delta^* = (\Delta X' Z A_N Z' \Delta X)^{-1} \Delta X' Z A_N Z' \Delta y \quad (14)$$

where ΔX is a stacked $(T-2)N \times k$ matrix of x_{it} observations and Z is the appropriate instrument choice based on whether the explanatory variables are exogenous; Δy refers to a vector of observations on the dependent variable. Alternative choices of the weighing matrix A_N will result in one-step or two-step estimators. The estimator is consistent, however, as long as A_N is positive definite, such as the identity matrix I . Most efficiency is gained by using the optimal weighting matrix, which gives the smallest asymptotic covariance matrix for δ^* . The optimal weighting matrix is asymptotically proportional to the inverse of the covariance matrix of sample moments (Verbeek 2000). The one-step estimator has:

$$A_N = [(1/N) \sum_i^N Z_i' H Z_i]^{-1} \quad (15)$$

In general, GMM does not impose that the errors are i.i.d. over firms. H is a $T-2$ square matrix with twos on the main diagonal, -1's on the first sub-diagonal and zeros elsewhere. It is designed to deal with the MA(1) error structure. In the two-step estimator:

$$A_N = [(1/N) \sum_i^N Z_i' \Delta u_i^* \Delta u_i^{*'} Z_i]^{-1} \quad (16)$$

where Δu_i^* are residuals from one-step estimation. This two-step GMM is known to perform poorly in small samples (Arellano and Bond 1991, Blundell and Bond 1998). The endogenous and predetermined variables in first differences are instrumented with suitable lags of their own levels (in this case $t-2$).

Exogenous variables, on the other hand, enter the matrix of instruments in conventional fashion: in first differences, with one column per instrument.

A critique of the original Arellano-Bond technique is that lagged levels can be poor instruments for first differences, especially for variables that resemble random walk. The quality of approximation for finite sample sizes varies greatly depending on the performance of the instruments. The number of instruments increases with T (since lags are used), and many overidentifying restrictions are available even for moderate T (time periods). The quality of these instruments is often poor. Numerous Monte Carlo simulations have been performed to assess the performance of GMM estimators (cf. Arellano and Bond 1991, Kiviet 1995, Blundell and Bond 1998). Their common conclusion is that differenced GMM estimators that use the full set of moments available can be severely biased, particularly in the case of weak instruments and large number of moments relative to the cross section sample size. Weak instruments can lead to serious finite sample biases. In highly autoregressive series and when the number of time-series observations is small, such as here, this estimator produces large finite sample bias and poor precision (Blundell and Bond 1998). Arellano and Bover (1995) derived additional moment conditions from adding the original *levels* equations to the system. In these equations, predetermined and endogenous variables in levels are instrumented with suitable lags of their first differences. Increasing the number of valid moment conditions increases the efficiency of the estimators.

Blundell and Bond (1998) articulated the assumptions for this procedure starting from $E(u_{it} \Delta L_{i,t-1})=0$, where $u_{it} = \eta_i + v_{i,t}$. They show that mean stationarity in AR(1) model is sufficient to use the lagged differences of the dependent variable as instruments for the levels equations (in addition to using lagged levels as instruments for first-differences equations). The additional moment conditions are available when we assume that $X_{i,t}$ are uncorrelated with the individual effects. If $X_{i,t}$ are predetermined and uncorrelated with the individual effects, there are additional T moment conditions:

$$E[X_{i,t}(\eta_i + v_{i,t})] = 0 \text{ for } i=1,2,\dots,N \text{ and } t=2,3,\dots,T. \quad (17)$$

$$E[X_{i,1}(\eta_i + v_{i,2})] = 0 \text{ for } i=1,2,\dots,N.$$

When we cannot assume that $X_{i,t}$ are not correlated with the individual effects, but we can assume that the first differences $\Delta X_{i,t}$ are not correlated with the individual effects, then suitable lagged values of $\Delta X_{i,t}$ can be used as instruments for the levels equation.

The estimation combines these additional moment conditions with the ones from first-differenced estimation. The resulting system GMM estimator is a combination of *differenced and levels* estimators. It presents substantial efficiency gains over the difference estimator. In addition to the instruments used in the differenced estimator, the system estimator uses $\Delta X_{i,t-1}$ and lagged differences of the predetermined variables as instruments for the levels equations. What we have in the end is lagged levels dated $t-2$ used as instruments in the differenced equations and lagged first-differences dated $t-1$ used as instruments in the levels equations. Blundell and Bond (1998) establish that as T increases the differenced GMM estimates get close to the system GMM estimates. In small sample periods, the system estimator does better. They stress that the finite sample bias for the system estimates is around 2% of the true parameter value (Blundell and Bond 1998). Blundell and Bond (2000) observe that the system estimator produces no bias and far better precision, even when the sample size is smaller and the process is highly autoregressive. One difference from the differenced estimator is that there is no known weight matrix to construct a one-step GMM estimator asymptotically equivalent to the optimal two-step estimator, even when disturbances are homoskedastic (Bond 2002).

Tests for overidentifying restrictions are performed, which test whether the instruments as a group appear exogenous and thus are valid instruments. For the difference estimation, the Sargan statistic is reported (chi-2 distributed) from two-step estimation, which is supposed to be more robust for that purpose. Arellano and Bond (1991) find the one-step Sargan test to reject too often in the presence of

heteroskedasticity. Unfortunately, the Sargan statistic is not robust to heteroskedasticity and autocorrelation. Therefore, for (system) one-step robust estimation and two-step estimation, the Hansen J statistic is reported, which is the minimized value of the two-step GMM criterion function. The two-step estimator is asymptotically more efficient, but its estimates of standard errors appear to be downward biased (Arellano and Bond (1991); Blundell and Bond (1998)). To correct this, Windmeijer's (2000) finite-sample correction to the two-step covariance matrix is implemented, which is known to dramatically increase accuracy. Bond and Winmeijer (2002) confirm that. (The standard error estimates of the one-step robust estimator are consistent in the presence of any heteroskedasticity and autocorrelation.)

Tests for autocorrelations of residuals are also performed. First-order autocorrelation is expected in first differences, as $\Delta v_{i,t}$ and $\Delta v_{i,t-1}$ are correlated, since $\Delta v_{i,t} = v_{i,t} - v_{i,t-1}$ and $\Delta v_{i,t-1} = v_{i,t-1} - v_{i,t-2}$. Higher-order autocorrelation, however, suggests that some lags of the dependent variable, which might be used as instruments, are in fact endogenous, and thus not good instruments ($y_{i,t-s}$ would be correlated with $v_{i,t-s}$ which in turn would be correlated with $\Delta v_{i,t-s}$, which would be correlated with $v_{i,t}$ in the case of higher order autocorrelation). I confirm that in my estimations there is no second order autocorrelation. Second-order autocorrelation tests, however, are only defined when $T \geq 5$ (Arellano and Bond 1991). Therefore I cannot carry such tests when I split the sample into two, at least in the differenced estimation.

Given that the panel is unbalanced, finally, a word about selection bias. I have no reason to believe that companies that leave the dataset do so in non-random fashion. I do not know the reason why they leave. Since I have data from particular brokers only, companies may leave because they go to purchase insurance from another broker. They do not necessarily drop out of the market. Also, Arellano and Bond (1991) note that their model easily extends to unbalanced panels. Using the full unbalanced set is more informative than just using a balanced subsample of it. In fact, in their paper, Arellano and Bond (1991)

use an unbalanced panel. As far as the fixed effects estimation is concerned, fixed effects are more robust to selection bias than random effects estimation (Verbeek 2000).

6.Data and Variables

The data set consists of unbalanced panel data for US companies, spanning the years 1997-2003. I have obtained proprietary and confidential data from two insurance brokerages, which consist of about 300 US companies over the years 1997-2003, both private and public. One of them is a leading insurance broker. Since this study focuses on the public companies (and public data are not easily available for private companies), I removed the private companies from the set, which reduces the set to about 180 companies. After removing companies unlisted on Compustat or CRSP, the data set gets reduced to about 150 companies. To use certain panel data techniques, such as fixed effects, I need at least 2 observations per company and for the Arellano-Bond estimation I need at least 3 observations per company. After removing the companies with single observations, the data set reduces to 113 companies. Thus I have 113 companies with insurance data for at least two years and 90 companies with insurance data for at least three years. The sample is small, but such data are not usually publicly available. In addition, there are researchers who apply the Arellano-Bond method on country models, and since the number of countries is finite, their samples are not large. For instance, Esho et al. (2004) apply GMM dynamic panel methods with $N=44$.

The data include D&O insurance amounts, some retentions, quote dates, effective dates, underwriters, SIC codes. This data set allows me to analyze the demand for D&O insurance in the US. Having panel data allows me to study the dynamic decision-making between years regarding corporate insurance, while Core (1997) and O'Sullivan (1997) use cross-section data. To my knowledge, this is the first study employing US panel data set of D&O insurance data. It is also the first set on which the Arellano-Bond techniques will be used. Additional data on other variables are coming from public

sources, as needed. Financial information is collected from Compustat. Data on board composition and company ownership are collected from proxy statements and other SEC filings of the companies. Stock performance data are collected from CRSP. Numerous explanatory variables are being collected to provide for comprehensive tests of the insurance demand. Summary statistics for the variables appear below in Table 4 in the Appendix. The industries represented and number of companies are shown in Table 6.

Table 5 in the Appendix below presents summary statistics by low/high limit subsamples. The low limit subsample includes companies for which the limit is \$20 million or below, the high limit subsample includes those above 20 million. The choice of \$20 is somewhat arbitrary; it is close to the average securities litigation settlement.

And here is the spread of data by years (showing the number of companies for which insurance data are available per year):

1997: 19

1998: 66

1999: 89

2000: 98

2001: 93

2002: 72

Correlations for the variables with the dependent variable appear in Table 3 in the Appendix. The variables most highly positively correlated with $\ln(\text{Limit})$ are $\ln(\text{MVE})$ and $\ln(\text{Assets})$, both of them measures of size. Volatility, leverage and risk, measures of financial risk, have the expected negative correlation with $\ln(\text{Limit})$. The higher the financial risk, the more insurance is demanded. The percentages

of board insiders and outsiders are negatively related to the insurance limits. Having CEO=COB contributes positively to the limits. The same person serving as CEO/COB apparently poses a higher risk for the corporation or the CEO/COB is more risk averse and demands more protection. The number of board members is positively related to $\ln(\text{Limit})$. The more members, the higher are the potential defense costs. Directors' and Officers' ownership appears with a large negative coefficient, confirming the hypothesis that higher managerial ownership aligns the interests and managers and shareholders and insurance and ownership are sort of substitutes. The years 1997-99 appear with a negative correlation coefficient, while the years 2000-02 appear with a positive coefficient. That suggests that there was clearly a time effect, and in the year 2000 and later, companies are demanding more insurance, as they are more aware of these risks.

As in Core (1997), it is assumed that officers, directors, shareholders, and insurers have symmetric beliefs about the probability and distribution of D&O losses. The insurer requires seeing the financial statements of the company before extending coverage. Misrepresentation on these financial statements may cause denial of coverage, as the company has misrepresented the risk they pose. This is becoming more common now, as insurance companies are more likely to deny coverage after the corporate scandals. The company chooses the limit it desires but the insurers have been raising substantially the premiums. The current market is described as a seller's or hard market. The litigation risk is perceived to have increased in recent years after the rise of lawsuits and corporate scandals. In response, the insurance companies have been raising premiums. Thus corporations need insurance at a time when it is pricey.

6.1. *Dependent variables*

The dependent variable I am trying to explain is the amount of insurance purchased (*limit*). The logarithm of the limit is used in the analysis ($\ln(\text{Limit})$). This helps curtail the influence of outliers. The use of logarithm helps alleviate some heteroskedasticity problems as well. It can be argued that agents

choose as the limit the highest possible loss. I have to include variables that explain the highest possible loss of a corporation from a lawsuit against directors and officers. But we have to remember that insurance is also increasingly costly. Subsequently the limit is adjusted for size and I have as a dependent variable $\ln(\text{Limit}/\text{MVE})$.

6.2. Explanatory variables

There are five groups of explanatory variables: Corporation size, Financial risk, Corporate governance, Persistence and Long-term contracting.

Corporation Size

Size is an important factor in determining the litigation risk of a corporation. Size is measured by the following variables:

Ln (Market Value of Equity) (ln(MVE)). Market Value of Equity (MVE) gives an indication of the size of potential settlement or judgment from a shareholder lawsuit. What a class of shareholders would have lost in a class period will be the difference between the true market value of their equity and the false value of their equity. That is, the difference between what the stock would have been in the absence of fraud and the actual price. I hypothesize a positive relationship between $\ln(\text{MVE})$ and the limit.

Ln(Total Assets). Chalmers et al. (2002) find that IPO size is a major determinant of coverage purchased. The larger the company, the more employees, shareholders and clients it is likely to have. In addition, management of a larger corporation may be more complicated and require more tricky supervision. On the other hand remember the hypothesis of Mayers and Smith (1982): Smaller companies are more likely to purchase insurance, bankruptcy costs being higher for them, as larger companies are more diversified and may have other ways to control for risk.

Mergers and acquisitions are known to increase the litigation risk. Tillinghast-Towers Perrin (2001) reports that the US survey participants with mergers, acquisitions, or divestitures had more than twice as a

high a probability to have a D&O claim. In addition, they experienced three to four times as many claims as those without mergers, acquisitions, or divestitures, on average. Thus a dichotomous variable Acquiror is constructed, equal to 1 if the company's assets have increased by 20% or more since last year. Another variable, Divestor, is equal to 1 if the company's assets decreased by more than 20% since the previous year, 0 otherwise. The expectation is that presence of large changes in asset size increases the limits.

Financial Risk

Financial Distress. Financial distress is an important factor to consider, when talking about the ability of the company to meet its indemnity obligations to its directors and officers. The higher the financial distress, the more insurance the company is expected to carry, as its own funds will not be enough to indemnify the managers in lawsuits. Thus measures of financial health should be included in the regression. A measure, similar to the one in Boyer (2003), will be used:

$$\text{Financial Risk} = -(\text{Book value of assets}/\text{Book value of liabilities}) * (1/\text{volatility}) \quad (18)$$

Financial risk is expected to raise both the limits and retentions. This variable indicates the probability that a put option on the company's assets will be exercised at the book value of debt as a strike price. Another measure of financial situation is Leverage, measured as the ratio of long-term debt to long-term debt plus market value of equity. The higher this measure, the higher the risk of financial distress. Therefore, the higher would be the limits.

$$\text{Leverage} = \frac{\text{LT Debt}}{\text{LT Debt} + \text{Market value of equity}} \quad (19)$$

Volatility. Compounded daily returns are used to calculate annual volatility of the stock, following Hull (2000). Sharp declines of the stock lead to higher shareholder losses. Thus it is hypothesized that higher volatility leads to a higher level of insurance.

Growth company. The type of company, growth or value, may also influence the insurance decision. For growth firms future earnings are more risky and those companies involve more complex decision-making, increasing the probability of lawsuits. The variable to measure growth opportunities is constructed as the ratio of market value of equity plus the book value of liabilities to the book value of total assets (market-to-book ratio). It is hypothesized that this variable (*growth*) is positively related to D&O insurance:

$$\text{Growth (market-to-book)} = \frac{\text{MVE} + \text{Book value of liabilities}}{\text{Book value of total assets}} \quad (20)$$

Return on Assets (ROA). This measure of firm's profitability will be included. It is hypothesized that the higher the return on assets, the happier the investors, clients and employees. Consequently, the lower will be the litigation risk. Also, higher returns imply that managers are exerting high level of effort to represent shareholders' interests, thus shareholders are less likely to sue. Thus there will be a negative relationship to limits. ROA is determined as the ratio of net income to total assets:

$$\text{ROA} = \frac{\text{Net income (excl. extra. items)}}{\text{Book value of total assets}} \quad (21)$$

Stock returns. Ultimately, shareholder litigation is a question of stock performance. Shareholder lawsuits are about investment losses investors have suffered, because of the poor stock performance of the company. Past stock performance may be one of the factors, telling managers how much insurance they need. Particularly, last year's performance may be in the mind of the managers, when they make the insurance decision. Thus one-year returns for the year, ending the day before the inception of insurance, will be used. It is hypothesized that as returns increase, exposure to shareholder lawsuits decreases. This variable is trying to test what impact past stock performance has on the D&O insurance decision. Better

stock performance is expected to be associated with lower limits and retentions. The buy-and-hold returns are measured as follows:

$$R_{iT} = \prod_t^{\min(T, \text{delist})} (1+r_{it}) - 1, \quad (22)$$

where T is equal to 356 calendar days to the day before the inception of insurance. If the stock was delisted from the particular exchange earlier than that, then returns only up to that date are used. Raw buy-and-hold returns of the company will be utilized. Raw returns are the best measure for the losses, suffered by the company's stock and shareholders' claimed damages. The hypothesis is that the higher the stock returns, the lower the limits.

Corporate Governance

As D&O performance and insurance is argued to be related to corporate governance, measures of governance will be included:

The number of members on the board indicates how many people will be insured. The more members, the higher the potential defense costs, as every one will have a right to a lawyer. Thus the higher would the expected limits.

Percent of outsiders on the board of directors. Outsider is anyone who is not a chief executive officer (CEO), chairman of the board (COB), officer, employee or a member of their family. The hypothesis is that the greater the number of outsiders on the board, the better the supervision by the board on the managers. Potentially managers should be able to commit less misrepresentation. Thus less insurance will be needed. On the other hand, D&O insurance is part of the compensation package. Sometimes to attract high quality board members, the corporation may need to offer better risk protection. This supposes a positive relationship between the percent of outside directors and D&O insurance through the compensation role. *The percent of insiders* (pctin) will also be included, as sometimes insiders serve a valuable role on the board, as they are closely familiar with the business.

CEO=COB. The key positions are those of the CEO (chief executive officer) and COB (chair of the board). There are implications for the governance of the company when the same person serves in both positions. That decreases the independence and control of the board and supposedly creates conditions for misrepresentation and thus lawsuits. On the other hand, an argument can be made about the risk aversion of the CEO, who is also a COB. Boyer and Delvaux-Derome (2001) suggest that such a person is less risk averse than a person that holds only one of the positions. The implication is that the need for insurance decreases with the decrease in risk aversion. A CEO-COB, however, may experience less control over him and get involved in more risky investments, thus needing more insurance protection. Boyer and Delvaux-Derome (2001) also advance the argument that when CEO=COB, the number of directors and officers is smaller, reducing the severity of potential lawsuits. This variable is equal to 1 if CEO=COB and 0 otherwise.

Some variables, measuring alternative monitoring mechanisms between managers and shareholders will be included. These are:

Directors' and Officers' Stock Ownership. The bigger the percent of stocks managers own, it is hypothesized that the less insurance is needed, as managers interests are more in line with shareholder interests and higher stock price. On the other hand, the risk aversion hypothesis suggests that the more stock directors and officers own, the more insurance they will demand. Thus the effect on limits and retentions is ambiguous. Large shareholders are supposed to monitor the management. The number of more than 5% external blockholders and the percentage owned by such shareholders (*pctblock*) will be included. The higher they, the less insurance is expected to be needed.

As Core (2000) argues, $\ln(\text{premium})$ should not enter as an explanatory variable, as it reflects the average cost of coverage and does not influence the company's choice of limit. The limit is a function of marginal cost and marginal benefit of coverage. Cost minimization by the firm involves a trade-off

between the marginal cost of extra coverage and the marginal benefit of decreasing the risk-averse directors and officers' premium (and potentially covering future losses). It is cheaper for the company to buy a group insurance policy rather than compensate each director and officer individually for the risk premium. The directors and officers' risk premium rises faster with litigation risk increases than the insurance premium (Holderness 1990). As a result, the net benefit of an extra limit are increasing in litigation risk and exceed the marginal cost, making it unnecessary to include marginal cost in that equation. Chalmers et al. (2000) advance another argument about non-inclusion of premiums related to the fact that companies choose limits first based on their risk exposure.

Persistence. Given that Boyer (2002) finds that the only significant variable explaining the insurance decision is last years' purchase, persistence is tested through inclusion of the lagged dependent variables in the estimations. Initially I include lagged $\ln(\text{Limit})$ and later lagged $\ln(\text{Limit}/\text{MVE})$. This way I test how the US results compare to Boyer's (2003) results and whether there is any persistence in the limits.

Some researchers do not interpret the significance of the lagged dependent variable necessarily as evidence of habit. They argue that the risk exposure of companies may remain unchanged from year to year, that is why they select the same insurance limit. That may be the case. However, this insurance refers to a very volatile environment, as compared to fire insurance for a house, for instance. While we expect the value of a house to remain relatively stable through time (subject to real estate market conditions), stock price and MVE are very volatile, managerial behavior could be unpredictable, thus it will be hard to argue that companies' risk exposure to D&O litigation remains constant through time. Nevertheless, the significance of the lagged limit can be seen as evidence of habit by some and as evidence of unchanged risk exposure by others. This is left up to the reader. Either way it can be called persistence. Therefore, I will use the term persistence to describe the importance of the lagged limits.

Long-Term Contracts. Insurance contracts vary from one year to three years. Having multi-year contracts may reinforce the persistence effect, if it exists. Under such contracts, next year's coverage may be the same as this year's simply due to the contract (unless of course the company purchases additional coverage). To differentiate the persistence effect from long-term contracting effect, a LongTerm variable will be included (similar to the one in Boyer (2003)), which counts the number of years, during which the contract remains unchanged. In the late 1990's, multi-year contracts were more common, as the market was doing well and insurance companies felt comfortable extending longer coverage. After the corporate scandals, that has changed. In the analysis, LongTerm will appear insignificant, and thus will be dropped.

7.Results

The OLS estimations appear in Table 7 in the Appendix. However, one is not to put much credibility in these results, as in the case with the lagged limit they are biased and inconsistent. The coefficient on the lagged $\ln(\text{limit})$ is .76, which we will see is the highest coefficient in all estimations, confirming the upward bias. In the model without lagged limit, some variables show significant signs as expected: $\ln(\text{MVE})$ is positive, ROA is negative, Raw returns are negative, D&O ownership is negative confirming one of its expected signs. $\ln(\text{assets})$ is positive here.

The results from the fixed effects estimation appear in the attached Table 8. The Hausman test appears in Table 8B and supports the choice of fixed effects model. The p-value for the F-test rejects the null hypothesis that all coefficients are zero. Most of the variables appear to be non-significant. Only two variables bear significance at any conventional level: leverage and the year 1997. The sign for the leverage coefficient is negative, opposite to expectations. Higher leverage implies higher risk, but it also implies that the managers or the company are more risk tolerant and are willing to take higher risk. Their willingness to take higher risks may translate into demanding less insurance. The time trend is clearly showing that companies demanded the least insurance in 1997 and increased their demand since then. The

coefficients on the years 1998 and 1999 are negative, while the coefficients on 2000 and 2001 are positive. The corporate scandals of 2000 and 2001 have apparently raised managers' awareness of litigation risk, thus these years have seen an increase in the insurance limits demanded.

The results from the Arellano-Bond estimation of the limit equation are shown in Table 9. The null hypothesis under the Sargan test is that the moment restrictions are valid and the model specification is correct. With the reported p-value, I do not reject the null (I use Sargan test from the two-step estimation). Similarly, for all estimations the Sargan or Hansen tests do not reject the null of valid instruments. Next is the Arellano-Bond test for second order serial correlation. The test statistic for second-order serial correlation produces a p-value that indicates no rejection of the null hypothesis of no serial correlation in all estimations.

First of all, the lagged dependent variable is very significant at the 99% level in all estimations. We can see the downward bias in the difference GMM estimation, as the coefficient there is much smaller than in the system estimations. Thus it is safe to assume that the coefficient on the lagged limit is .67 and is significant. Last years decision does influence strongly this year's decision on insurance. I achieve a result similar to Boyer's (2002), who also finds a significance of persistence (using an instrumental regression). The theory that persistence is one of the driving forces behind risk management decisions is supported here. In contrast to Boyer (2003), who finds no significance of any other variable, I find some other variables that also influence the decision, at least in the difference and one-step system estimations. The two-step system estimation is in agreement with Boyer(2003), as only the lagged limit appears to be significant. However, we know that the one-step estimator is preferred for coefficient inference.

Significant at the 99% level are growth and $\ln(\text{MVE})$ in both the difference and one-step system GMM estimations. The positive coefficient on Market Value of Equity confirms the effect of size and the importance of MVE as a major measure of the size of damages in a potential shareholder lawsuit.

Managers do look at their MVE to estimate potential losses and how much insurance they need. Growth appears with a negative but small coefficient. The sign is not as expected. That does not confirm the under-investment Hypothesis 5. But one can say that growth companies are tolerant of higher risks, their managers are less risk averse and thus demand less protection. That, of course, is opposite to the prediction of MacMinn and Garven's (2000) theory on under-investment and insurance. Leverage appears with the highest positive coefficient confirming the role of financial distress in choosing limits, but is significant only in the difference GMM estimation. The higher the financial distress, the higher the protection desired. Volatility also shows with a positive coefficient. Members too are only significant in the difference estimation. Members on the board, surprisingly, show with a negative (but small) coefficient. More members means potentially higher defense costs, but also more members might more effectively monitor management and bring a greater variety of skills or insider knowledge, thus reducing the incidence of litigation.

The other variable measuring alternative monitoring mechanisms over management that appears to be significant is percent of outsiders on the board. It is significant in the one-step system GMM estimation and the difference GMM estimation with a small positive coefficient. The more independent the board, the more insurance is demanded, which is more in line with the hypothesis that governance and insurance are complements. (In the difference estimation, the percent of insiders on the board is also significant with a small positive coefficient.) Insurance companies encourage their clients to make their board more independent. Of course, to attract high quality outside board members, companies have to offer better insurance coverage. In general, however, alternative monitoring mechanisms do not influence prominently the insurance decision. Perhaps there is no substitute for D&O insurance after all.

My preferred estimation method is the one-step system GMM. One-step estimation is typically preferred for inference on the coefficients. With small number of time-series observations, the differenced

GMM estimator is not reliable (downward-biased). Thus the system estimator is preferred. Here the two-step system estimator produces only the lagged limit as significant and none of the other variables, while the one-step estimator gives other variables as significant, consistent with theory. Among others, Return on assets shows with a negative sign: the higher the returns, the more satisfied the shareholders, the lower the litigation risk, and the less insurance is demanded. Volatility shows with a positive sign: more volatility leads to higher litigation risk and more insurance is demanded.

Some people have suggested that significance of the lagged limit is to be expected, since the risk exposure of some companies does not change from year to year; thus they will demand the same level of insurance. That is why I finally provide a system GMM estimation without the lagged limit to investigate what variables will be significant in that case. Some of the explanatory variables continue to be significant. Growth has a negative sign as before, Raw returns have a negative sign, $\ln(\text{MVE})$ shows with a positive sign, and ROA with a negative sign, as expected. Some researchers' suggestion that the significance of the explanatory variables will disappear in the absence of lagged limits is not supported here.

So far the hypotheses that have been confirmed are the Main hypothesis (through ROA, as higher returns lead to less insurance), the hypothesis that independence of the board and D&O insurance are complements, MVE is positively related to insurance limits, and volatility is negatively related to limits. I find no support at all for Hypothesis 5, under-investment, nor for Hypothesis 4A that smaller companies demand less insurance. Persistence is confirmed in this setup.

7.1. Sampling by year

The way litigation risk is perceived today is very different from the way it was perceived years ago. The corporate scandals of 2001 have brought a new awareness to this problem. Thus it is legitimate to investigate whether companies behaved differently before and after 2001. I split the sample into two

subsamples: 1997-2000 and 2000-2002 (using the lagged values from 2000 as instruments). Note that in the latter sample I can still use the Arellano-Bond techniques, as I still essentially have 3 years, since I use instruments dated 2000. There are 65 companies with insurance data in the years up to 2000 and 62 companies with insurance data in the years 2001-02. The expectation is that the persistence effect will be much more pronounced in the first subsample than in the second. If the companies made decisions based on habit in the 1990's, that should have changed in 2001, when other factors should be determining the insurance decision. Blundell and Bond (1998) illustrate that the system GMM estimator performs better as the number of time-series observations becomes smaller. When we split the sample, T becomes really smaller, thus the more relevant results are those from system estimation. The results for subsample 1997-2000 appear in Table 10 and for subsample 2000-02 in Table 11.

We can once again see that the differenced GMM method much underestimates the coefficient on the lagged dependent variable. The two system estimators produce similar results: in the early subsample, the coefficient is about 0.49, in the subsequent subsample it is about 0.64. Once again, the persistence effect is present and it has gotten stronger in later years, contrary to expectation. The significant variables in the first subsample according to the one-step system estimation are: $\ln(\text{MVE})$, growth, ROA, number of blockholders. Again, the size of potential loss measure, MVE, appears with a high positive coefficient. As before, the growth coefficient is negative, contrary to expectations. Returns on assets appear with the expected negative coefficient. Number of blockholders appears with a positive sign, contrary to expectations. That again supports the hypothesis that good governance and insurance are complements rather than substitutes.

Interestingly enough, in the differenced estimation $\ln(\text{Assets})$ now shows with a negative sign, suggesting for the first time that larger companies buy less insurance (in unison with Mayers and Smith's

(1982) hypothesis). Raw returns also show with the expected negative sign in that estimation and volatility with the expected positive sign.

MVE is really the more relevant measure of size here, because the size of losses in shareholder litigation refers to the value of equity rather than the assets of the company. Companies with higher MVE but smaller assets are expected to buy more insurance than companies with larger assets but smaller MVE. In the second subsample (results in Table 11) 2000-02, the two system estimations produce similar results. In the one-step estimation, the significant variables are: percent outsiders, $\ln(\text{MVE})$, volatility. Volatility figures with a sizeable positive coefficient. Financial risk has become the leading factor, influencing the insurance decision in recent years. That confirms the theoretical role of financial risk in making the insurance decision, when companies are very aware of litigation risk. $\ln(\text{MVE})$ also figures with a positive coefficient, as before. The only corporate governance variable that bears significance is percent of outsiders on the board. It appears with positive coefficient. The Sarbanes-Oxley Act (2002) proposed to fix the corporate scandals by imposing stricter rules on corporate governance. Corporate governance variables, however, do not appear to be treated as particularly important substitutes as a group by the corporations, when choosing insurance limits here.

In the difference estimation, the governance variable that is significant is Directors' and Officers' ownership with a positive sign. That suggests some complementarity of that monitoring mechanism to insurance. The other variables are with signs as seen before.

In both subsamples, I find slight evidence that corporate governance and insurance tend to be complements. The positive effect of Market Value of Equity is consistently confirmed. In the early subsample, returns are significant, while in the latter—volatility. That signifies a shift from a focus on returns to focus on volatility, as a more relevant measure of litigation risk in recent years, after the collapse of the stock market. I find no support once again for the role of insurance in mitigating

underinvestment. Persistence is confirmed. Surprisingly, though, the persistence effect has increased rather than decreased in recent years.

7.2 Size-Adjusted Limits Estimations (Sensitivity Analysis)

Some people argue that using $\ln(\text{Limit})$ as the dependent variable is not appropriate and it has to be adjusted for size. A larger company will be expected to buy more insurance. It is relevant how much of their MVE they insure, not just the absolute value of insurance, without a reference point. The most appropriate size measure to use for that adjustment is Market Value of Equity, as the investor loss depends on the Market Value of Equity. The company chooses how much of their MVE to insure. An appropriate adjusted variable would be limit per MVE. I construct such a variable as $\ln(\text{Limit}/\text{MVE})$. I remove now MVE from the independent variables, as it appears on the left side. I repeat the above estimations with $\ln(\text{Limit}/\text{MVE})$ as the dependent variable. The results appear in Table 12.

The differenced GMM estimator now looks quite different. The coefficient on the lagged size-adjusted limit is small and insignificant. Thus the significance of lagged limit in previous differenced GMM estimations can be attributed to the effect of size. The volatility of MVE in the denominator takes away the persistence effect. Once the limit is adjusted for size, there is no “habit effect” or persistence in the choice of limits. I suspect that that will explain the habit persistence in Boyer’s (2003) study. The highest significant positive coefficient is Leverage, confirming Mayers and Smith’s (1982) hypothesis that firms in financial distress will demand more insurance. Related to that, more profitable firms demand less insurance (ROA coefficient is negative). The most negative significant coefficient is $\ln(\text{Assets})$. This is the first time in the literature that I know of that confirms Mayers and Smith’s (1982) hypothesis that small companies will demand more insurance. Indirectly, that confirms the real-services efficiencies hypothesis, as small companies are more likely to benefit from real services. Indirectly, it also confirms Hypothesis 3, small companies are more subject to bankruptcy risk and thus demand more insurance

protection. Volatility, as a measure of financial risk, appears with a positive coefficient. The other significant variables with signs not as predicted are growth and risk. There is no confirmation for Hypothesis 5 for the role of insurance in mitigating under-investment. Two measures of corporate governance appear to be significant with opposite signs: percent of blockholdings (-) and number of blockholders (+). Thus we have mixed results about the role of corporate governance. One variable signifies it is a complement and the other—a substitute to insurance. Probably it plays a dual role.

The system GMM estimators reveal the lagged adjusted limit as significant, but the coefficient is much smaller than before (.27 compared to .66). Once again, persistence significantly diminishes once we control for size in the dependent variable. The limit itself may exhibit persistence, but the denominator (MVE) is more volatile. The ratio shows much less persistence than the limit alone. Companies choose a limit partly in relation to their MVE. The one- and two-step system estimators produce similar results, confirming that the results are robust. Growth has a negative effect in all estimations. Raw stock returns have the expected negative sign in all system estimations. Ln(Assets) has a sizable negative coefficient in all estimations, strongly supporting Mayers and Smith's hypothesis about small companies. It is also in contrast to Chalmers (2002) finding that ln(assets) is positively correlated to the insurance purchase of the IPO. Of course, Chalmers does not adjust the dependent variable for size. Also, IPO's decisions are different than those by companies that are already public. Returns on Assets consistently shows with a negative coefficient in all estimations. This and the significance of stock returns strongly confirm the Main hypothesis. It is an important measure of returns and profitability to shareholders. Once adjusted for size, the lagged dependent variable no longer figures prominently in the insurance decision. Instead, other variables play a significant role. The most important among them are returns, both Stock and Returns on Assets, and size as measured by assets. Like before, we find strong support for Hypotheses 1, 3 and 4A and no support at all for Hypothesis 5.

Some people have suggested that the inclusion of the lagged dependent variable influences the results and significance of other variables. Finally I provide a system estimation without the lagged adjusted limit in Table 12. We see that the results are not substantially different from the other system estimations. Thus the inference on these variables appears to be quite robust. The significant variables are: growth, leverage, raw returns, $\ln(\text{Assets})$, ROA with signs as seen before.

7.3 Sampling by year: Size-adjusted limits estimations

As before, I divide the sample into two: 1997-2000 and 2000-2002 (results in Tables 13 and 14). I focus on the one-step system GMM estimations, as they are most relevant here when T gets very small. In the first subsample, the lagged dependent variable is not significant and has negligible coefficient. Among the significant variables, leverage appears with a positive coefficient, confirming the bankruptcy risk hypothesis. Risk, however, appears with an unexpected negative sign. The negative sign on raw returns confirms Hypothesis 3. The negative sign on $\ln(\text{Assets})$ confirms Hypothesis 4A. One governance variable, number of blockholders, has a positive effect suggesting that governance and insurance are complements. The negative sign on growth once again refutes Hypothesis 5.

The results from the second subsample are not substantially different. $\ln(\text{Assets})$ once again has a negative sign, leverage has a positive sign, growth has a negative sign. A new thing is that Members appear with a negative significant coefficient, contrary to expectation. However, it is not quite clear whether more or less members on the board is a good or bad thing. More members may provide better monitoring, thus decreasing litigation risk, so less insurance is demanded. The lagged $\ln(\text{Limit}/\text{MVE})$ is now significant, but with a small coefficient. There is some persistence effect in the subsample 2000-2002 as opposed to the earlier one. That resembles the result we got in the unadjusted for size estimations above. In the more recent subsample, there was a more pronounced persistence effect. I find no support for

Mayers and Smith's (1982) hypothesis that firms with higher insider ownership will demand more insurance one way or the other due to insiders' risk aversion.

8. Conclusion

This paper provides much needed empirical tests of corporate insurance theory, using recent D&O data from the US. It is the first study to use US panel data and employ dynamic panel data methodology on such data. The methodological contribution is the application of difference and system GMM estimators to D&O insurance data. Given that persistence may be present in different areas of insurance behavior, it may be beneficial to apply these methods in other settings as well. In the initial size-unadjusted limits estimations, MVE appears to be directly related to limits, as a measure of the potential size of loss. MVE could measure actual losses from possible litigation. The fact that MVE figures prominently in the risk management decision is not surprising, given that it is based on information from financial statements, which is all too familiar to managers. In the size-adjusted limits estimations, I confirm Mayers and Smith's (1982) hypothesis that smaller companies (in terms of assets) demand more insurance. This is the first time in the literature that this hypothesis has been confirmed, to the best of my knowledge. Larger companies have more sophisticated instruments to control for risk (such as self-insurance), while smaller companies are more dependent on insurance. This confirms the real-services hypothesis and the benefits that smaller companies get from the insurance process. As smaller companies have proportionately higher bankruptcy risk, it also confirms that insurance has a role in mitigating bankruptcy risk.

My main hypothesis is confirmed: Returns are consistently significant in determining the desired insurance amount. Mostly Returns on Assets, but also Raw Stock Returns, have the expected negative effect on limits. Returns are indeed the best signal shareholders have for the performance of managers and a good litigation predictor used by managers. High returns usually indicate that managers are exerting high level of care in the interest of the stakeholders of the company. The presumptions of Urtiaga's (2003)

model, which is one of the few game theory models in this area, receives empirical validation here. Companies in financial distress are shown to demand higher insurance limits. That confirms Mayers and Smith's (1982) theory as well as the theory of Garven and MacMinn (2000) about the role of insurance in mitigating bankruptcy risk. Indicators of financial health such as leverage and volatility appear to be significant. Surprisingly, corporate governance does not play a prominent role in the choice of limit. Companies probably do not perceive litigation as a failure of corporate governance but rather as a result of poor performance. Thus the role of corporate insurance in mitigating the agency problems between managers and shareholders is dubious. However, I find more evidence that governance mechanisms and insurance are complements rather than substitutes. The growth variable does not show with the anticipated sign, thus I find no confirmation for the theory that this type of insurance mitigates the agency problems between creditors and shareholders. In fact, I consistently reject that theory. While this theory has some theoretical appeal, it received no empirical validation with this dataset.

In the initial setups of the model, I find some support for Boyer's (2003) finding of persistence in corporate risk management decisions in this sample. It is not clear, however, that the significance of the lagged dependent variable can be interpreted as evidence of habit or evidence of unchanged risk exposure. Habit persistence is not the only significant factor, however, as Boyer (2003) has suggested. I find that corporations use other factors as well to determine their exposure for the purposes of directors' and officers' insurance and the role of persistence varies through time. For instance, factors, such as financial risk and size, influence the insurance decision. In addition, the persistence effect largely diminishes when I adjust the dependent variable for size. The variables that are important vary through time, suggesting that there is dynamics in risk management decision-making by corporations and one-time observations might be misleading, which underscores the importance of panel data and dynamic models. Companies adjust to changing environments and emphasize considerations that have come to their attention. These

mechanisms do not entirely comply with the existing theories for the demand of corporate insurance, but they are not entirely random either.

An interesting result is that adjusting the limit for size produces different results. When the dependent variable is limit per MVE, persistence largely disappears. It is an important implication that adjusted limits may be the appropriate dependent variable, not absolute limits. When one insures a house, its value stays relatively constant through time. When one insures the value of a firm (MVE), that value could be very volatile. It is the insured portion of MVE that is relevant.

The results here do not entirely reject the role of persistence but point out a more diverse picture. While persistence plays a role, companies use also some mechanisms to control for risk rooted in insurance theory. The rationality of those decisions is illustrated in the importance of returns and MVE in the insurance decision. Thus corporate risk management serves some useful purposes. Most importantly, the paper finds some confirmation for the theories of Mayers and Smith (1982, 87), which are considered the cornerstone of modern corporate insurance theory.

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APPENDIX

Table 1. Variable Definitions

| Variable | Definition |
|-------------------------------|---|
| D&O limits | The amount of insurance coverage the company carries over a period of time. |
| Limits/MVE | Ratio of Limits over Market Value of Equity, limit per value of equity. |
| MVE | Market Value of Equity |
| Total assets | Total assets as reported in Compustat |
| Acquirer | Equal to 1 if company had an acquisition in the past year; 0 otherwise. |
| Divestor | Equal to 1 if company was acquired in the past year; 0 otherwise. |
| Financial Risk | $-(\text{Book value of assets})/(\text{Book value of liabilities})*(1/\text{volatility})$ |
| Leverage | $\text{Long term Debt}/(\text{Long term debt} + \text{MVE})$ |
| Volatility | Annual volatility prior to insurance purchase based on compounded daily returns. |
| Growth (market-to-book ratio) | $(\text{MVE} + \text{Book value of liabilities}) / (\text{Book value of total assets})$ |
| ROA | Return on Assets in the year of insurance = Net income (excluding extraordinary items)/Book value of total assets |
| Raw stock returns | Buy-and-hold raw returns for one year prior to date of insurance purchase. |
| Members | Number of members on the board of directors. |
| Percent of outsiders | Percent of independent directors on the board. |
| Percent of insiders | Percent of directors who are not independent, such as executives, COB, employees or members of their families. |
| CEO=COB | Chief Executive Officer is same as Chair of the Board. |
| D&O Ownership | Percent of firm's shares owned by directors and officers. |
| Number of blockholders | Number of non-affiliated shareholders who hold at least 5% of stock. |
| Percent blockholdings | Percent of company's stock held by blockholders. |

Table 2. Predicted Signs.

| Variable | Predicted effect on limits |
|-------------------------------|----------------------------|
| MVE | + |
| Total assets | - |
| Acquirer | + |
| Divestor | + |
| Financial Risk | + |
| Leverage | + |
| Volatility | + |
| Growth (market-to-book ratio) | + |
| ROA | - |
| Raw stock returns | - |
| Members | +/- |
| Percent of outsiders | -/+ |

| | |
|------------------------|-----|
| Percent of insiders | +/- |
| CEO=COB | +/- |
| D&O Ownership | +/- |
| Number of blockholders | - |
| Percent blockholdings | - |

Table 3. Correlations

| TABLE 3 | |
|-------------------------------|-------------------|
| | Ln(Limits) |
| Ln(Limits) | 1.0000 |
| Members | 0.2903 |
| Percent Insiders | -0.1516 |
| Percent Outsiders | -0.0556 |
| CEO=COB | 0.1468 |
| D&O Ownership | -0.3039 |
| Percent Blockholders | 0.0508 |
| Number of Blockholders | 0.0742 |
| Ln(Assets) | 0.6952 |
| Acquirer | 0.0740 |
| Divestor | -0.0928 |
| Ln(MVE) | 0.7476 |
| ROA | 0.2029 |
| Volatility | -0.2928 |
| Yr1997 | -0.0753 |
| yr1998 | -0.0162 |
| yr1999 | -0.0528 |
| yr2000 | 0.0396 |
| yr2001 | 0.0464 |
| yr2002 | 0.0207 |
| Growth | 0.1603 |
| Leverage | -0.1074 |
| Risk | -0.1143 |
| Raw Returns | 0.0564 |

Table 4. Summary statistics for all variables.

| Variable | Mean | Min | Max |
|-------------------------------|---------------|--------------|-----------------|
| Limits | 9.8 Million | 1 Million | 100 Million |
| Volatility | 0.888 | 0 | 3.753 |
| Raw returns | .211 | -.97 | 10.551 |
| Members | 6.698 | 2 | 15 |
| Percent Outsiders | 28.586 | 0 | 88.889 |
| Percent Insiders | 16.444 | .091 | 100 |
| CEO=COB | 0.541 | 0 | 1 |
| D&O Ownership | 26.405 | 0.14 | 100 |
| Percent blockholdings | 20.336 | 0 | 98.3 |
| Number of blockholders | 2.089 | 0 | 7 |
| Assets | 444 Million | .925 Million | 15,500 Million |
| MVE | 1,480 Million | .178 Million | 131,000 Million |
| Ln(MVE) | 18.584 | 12.089 | 25.601 |
| ROA | -0.177 | -6.068 | 0.838 |
| Growth | 3.018 | .223 | 105.090 |
| Leverage | 0.167 | -3.363 | 2.699 |
| Risk | -6.214 | -599.878 | 1.826 |

Table 5. Summary statistics by low/high limits subsamples.

| Variable | Mean (Low subsample n=363) | Mean (High subsample n=94) |
|-------------------------------|-----------------------------------|-----------------------------------|
| Limits | 7.1 Million | 34.7 Million |
| Volatility | .953 | .673 |
| Raw returns | .201 | .247 |
| Members | 6.397 | 7.778 |
| Percent outsiders | 25.617 | 39.232 |
| Percent insiders | 15.214 | 20.855 |
| Percent gray members | 1.458 | 1.452 |
| CEO=COB | .5 | .687 |
| % D&O Ownership | 27.365 | 22.992 |
| Percent blockholdings | 20.101 | 21.177 |
| Number of blockholders | 2.031 | 2.296 |
| Assets | 193 Million | 858 Million |
| Acquirer | .228 | .173 |
| Divestor | .121 | .037 |
| MVE | 278 Million | 3,520 Million |
| ROA | -.228 | -.094 |
| Growth | 2.785 | 3.402 |
| Leverage | .154 | .190 |

Table 6. Industries and number of companies.

| Industry | Number of companies |
|------------------------------------|----------------------------|
| Technology | 36 |
| Biotechnology and pharmaceuticals | 18 |
| Petroleum, mining and agricultural | 12 |
| Non-durable goods manufacturing | 12 |
| Merchandising | 9 |
| Non-banking financial services | 6 |
| Durable goods manufacturing | 5 |
| Transportation and communications | 3 |
| Personal and business services | 2 |
| Banking | 2 |
| Health services | 2 |
| Construction and real estate | 1 |
| Newspaper: publishing and print | 1 |
| Radio, TV Broadcast | 1 |
| Other | 3 |

Table 7. OLS estimations. Significant variables at 90% or better are in bold.

| | R-squared=.89, Adj. R-sq.= .88 | R-squared = 0.65 Adj. R-sq.= 0.63 |
|------------------------|------------------------------------|--------------------------------------|
| Ln(Limit) | Coefficient (std. err.) | Coefficient (std. err.) |
| Ln(Limit) lagged | .759 (.035) | |
| Members | -.025 (.012) | -.001 (.019) |
| Percent Insiders | -.003 (.002) | -.000 (.003) |
| Percent Outsiders | .003 (.001) | .003 (.002) |
| CEO=COB | .044 (.042) | .052 (.064) |
| D&O Ownership | -.001 (.001) | -.006 (.002) |
| Percent Blockholders | -.000 (.002) | .001 (.004) |
| Number of blockholders | .003 (.025) | .010 (.040) |
| Ln(Assets) | .008 (.039) | .173 (.056) |
| Acquirer | -.008 (.058) | -.092 (.09) |
| Divestor | -.036 (.078) | .01 (.122) |
| Ln(MVE) | .116 (.035) | .261 (.051) |
| ROA | -.079 (.046) | -.171 (.077) |
| Growth | -.019 (.013) | -.016 (.017) |
| Leverage | -.074 (.095) | -.174 (.155) |
| Risk | .000 (.001) | -.002 (.001) |
| Raw Returns | .013 (.017) | -.068 (.026) |
| Yr1999 | -.175 (.094) | -.113 (.17) |
| Yr2000 | -.137 (.094) | .023 (.169) |
| Yr2001 | -.226 (.092) | -.078 (.171) |
| Yr2002 | -.24 (.099) | -.145 (.187) |
| Constant | 1.95 (.454) | 8.14 (.518) |

Time dummies are included in all estimations.

Table 8. Fixed effects estimation.

| Ln(Limit) | Coefficients | Std. Err. |
|------------------------|---------------------|------------------|
| Growth | -.019 | .012 |
| Leverage | -.282 | .117 |
| Risk | -.000 | .001 |
| Raw Returns | -.023 | .015 |
| Members | -.035 | .025 |
| Percent Insiders | -.009 | .015 |
| Percent Outsiders | -.007 | .016 |
| CEO=COB | .093 | .077 |
| D&O Ownership | -.001 | .003 |
| Percent blockholdings | .000 | .003 |
| Number of blockholders | -.005 | .03 |
| Ln(assets) | .106 | .071 |
| Acquirer | -.014 | .058 |
| Divestor | .033 | .075 |
| Ln(MVE) | .057 | .049 |
| ROA | -.056 | .056 |
| Volatility | .036 | .061 |
| Yr1997 | -.258 | .117 |
| Yr1998 | -.085 | .079 |
| Yr1999 | -.064 | .074 |
| Yr2000 | .031 | .069 |
| Yr2001 | .019 | .068 |
| Constant | 13.73 | 1.29 |

N = 337. Time dummies included.

R-sq. overall = 0.2231

F(22,213) = 2.99

Prob > F = 0.0000

F test that all $u_i=0$: F(101, 213) = 10.22 Prob > F = 0.0000

Modified Wald test for groupwise heteroskedasticity in fixed effect regression model:

H_0 : $\sigma^2(i) = \sigma^2$ for all i

chi2 (102) = 6.6e+33

Prob>chi2 = 0.0000

Table 8B.Hausman Test for difference between fixed (FE) and random effects (RE) estimators.

| Variable | b)Coefficients from FE | B)Coefficients from RE | Difference (b-B) | Sqrt[diag(V(b)-V(B))] S.E. |
|------------------------|------------------------|------------------------|------------------|----------------------------|
| Growth | -.019 | -.014 | -.005 | .003 |
| Leverage | -.282 | -.261 | -.021 | .033 |
| Risk | -.000 | -.000 | .000 | . |
| Raw Returns | -.023 | -.037 | .014 | . |
| Members | -.035 | -.002 | -.033 | .015 |
| Percent Insiders | -.009 | -.002 | -.008 | .015 |
| Percent Outsiders | -.007 | .002 | -.008 | .016 |
| CEO=COB | .093 | .099 | -.006 | .038 |
| D&O Ownership | -.001 | -.003 | .002 | .002 |
| Percent blockholdings | .000 | .000 | .000 | .001 |
| Number of blockholders | -.005 | .009 | -.013 | .005 |
| Ln(assets) | .106 | .223 | -.117 | .05 |
| Acquirer | -.014 | -.056 | .042 | .01 |
| Divestor | .033 | .060 | -.027 | . |
| Ln(MVE) | .057 | .143 | -.086 | .025 |
| ROA | -.056 | -.136 | .08 | .017 |
| Volatility | .036 | .055 | -.018 | .008 |
| Yr1999 | -.064 | .039 | -.103 | . |
| Yr2000 | .031 | .132 | -.102 | . |
| Yr2001 | .019 | .089 | -.069 | . |

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

$$\text{chi2}(21) = (b-B)'[(V_b - V_B)^{-1}](b-B) = 61.48$$

$$\text{Prob} > \text{chi2} = 0.000$$

(V_b - V_B is not positive definite)

Table 9. Arellano-Bond dynamic panel-data estimations

Time variable (t): year; significant variable coefficients at 90% or better are in bold.

| | Difference GMM | System GMM (one-step) | System GMM (two-step) | System GMM (one-step) |
|------------------------|--|---------------------------------------|--|---------------------------------------|
| Ln(Limit) | Coefficient (Robust Std. Error) | Coefficient (Robust Std. Err.) | Coefficient (Corrected Std. Err.) | Coefficient (Robust Std. Err.) |
| Ln(Limit) Lagged | .267 (.085) | .660 (.065) | .667 (.102) | |
| Growth | -.063 (.021) | -.054 (.020) | -.05 (.256) | -.045 (.023) |
| Leverage | .653 (.336) | -.161 (.102) | -.164 (.828) | -.103 (.141) |
| Risk | -.000 (.000) | 1.54e-06 (.000) | 2.63e-06 (.007) | -.001 (.001) |
| Raw Returns | -.010 (.016) | .003 (.021) | .001 (.255) | -.052 (.021) |
| Members | -.056 (.03) | -.03 (.024) | -.026 (.216) | -.021 (.033) |
| Percent Insiders | .03 (.017) | -.003 (.004) | -.002 (.015) | -.006 (.006) |
| Percent Outsiders | .039 (.020) | .005 (.003) | .004 (.007) | .005 (.004) |
| CEO=COB | .097 (.085) | .091 (.079) | .105 (.619) | .104 (.108) |
| D&O Ownership | -.001 (.005) | .001 (.002) | .001 (.014) | -.001 (.005) |
| Percent blockholdings | -.002 (.003) | .000 (.004) | -.001 (.019) | .000 (.003) |
| Number of blockholders | .02 (.030) | .021 (.035) | .031 (.108) | .041 (.033) |
| Ln(assets) | -.079 (.09) | -.06 (.076) | -.054 (1.236) | .069 (.1) |
| Acquirer | -.017 (.046) | .01 (.048) | .012 (.507) | -.093 (.066) |
| Divestor | .002 (.068) | -.032 (.058) | -.038 (.095) | -.001 (.081) |
| Ln(MVE) | .238 (.069) | .214 (.062) | .201 (.833) | .297 (.087) |
| ROA | -.063 (.039) | -.097 (.046) | -.105 (.441) | -.169 (.056) |
| Volatility | .106 (.056) | .115 (.067) | .114 (.114) | -.021 (.076) |
| Yr1999 | .010 (.073) | .042 (.082) | .046 (.683) | .032 (.056) |
| Yr2000 | .068 (.073) | .078 (.071) | .077 (.533) | .102 (.077) |
| Yr2001 | -.022 (.072) | .000 (.073) | .006 (.373) | .04 (.089) |
| Constant | .029 (.025) | 2.66 (1.181) | 2.671 (8.05) | 9.42 (1.14) |

Time dummies are included in all estimations.

Corrected standard errors utilize Windmeijer's (2000) correction to the biased two-step errors.

Robust standard errors are robust to heteroskedasticity.

Difference GMM:

Sargan test of over-identifying restrictions (from two step):

$$\text{chi2}(69) = 48.80 \quad \text{Prob} > \text{chi2} = 0.9689$$

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

$$H_0: \text{no autocorrelation} \quad z = -2.50 \quad \text{Pr} > z = 0.0123$$

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:

$$H_0: \text{no autocorrelation} \quad z = -0.30 \quad \text{Pr} > z = 0.7612$$

System one-step GMM:

Hansen test of overid. restrictions: $\text{chi2}(90) = 72.63 \quad \text{Prob} > \text{chi2} = 0.910$

Arellano-Bond test for AR(1) in first differences: $z = -2.75 \quad \text{Pr} > z = 0.006$

Arellano-Bond test for AR(2) in first differences: $z = -0.28$ $Pr > z = 0.777$

 System two-step GMM:

Hansen test of overid. restrictions: $\chi^2(90) = 72.63$ $Prob > \chi^2 = 0.910$

Arellano-Bond test for AR(1) in first differences: $z = -1.29$ $Pr > z = 0.196$

Arellano-Bond test for AR(2) in first differences: $z = -0.11$ $Pr > z = 0.913$

 One-step GMM estimation:

Hansen test of overid. restrictions: $\chi^2(87) = 67.74$ $Prob > \chi^2 = 0.937$

Arellano-Bond test for AR(1) in first differences: $z = -1.81$ $Pr > z = 0.070$

Arellano-Bond test for AR(2) in first differences: $z = 1.06$ $Pr > z = 0.289$

Table 10. Arellano-Bond estimations 1997-2000

| | Difference GMM | System GMM (one-step) | System GMM (two-step) | System GMM (one-step) |
|------------------------|---------------------------------|---------------------------------|-----------------------------------|---------------------------------|
| Ln(Limit) | Coefficient (Robust Std. Error) | Coefficient (Robust Std. Error) | Coefficient (Corrected Std. Err.) | Coefficient (Robust Std. Error) |
| Ln(Limit) Lagged | .183 (.096) | .489 (.107) | .499 (.089) | |
| Growth | -.108 (.023) | -.115 (.031) | -.095 (.043) | -.02 (.022) |
| Leverage | .2 (.339) | -.079 (.546) | .211 (.576) | -.676 (.637) |
| Risk | -.001 (.000) | -.001 (.001) | -.000 (.001) | -.001 (.001) |
| Raw Return | -.082 (.024) | -.035 (.031) | -.003 (.039) | -.000 (.030) |
| Members | -.043 (.061) | -.027 (.050) | -.036 (.063) | -.009 (.042) |
| Percent Insiders | .022 (.025) | -.008 (.008) | -.013 (.01) | -.018 (.008) |
| Percent Outsiders | .022 (.030) | .005 (.004) | .005 (.006) | .008 (.004) |
| CEO=COB | .131 (.101) | .073 (.151) | .139 (.181) | .119 (.163) |
| D&O Ownership | -.004 (.005) | -.000 (.003) | .001 (.005) | .006 (.004) |
| Percent Blockholders | -.006 (.004) | -.004 (.005) | -.001 (.007) | .004 (.005) |
| Number of blockholders | .032 (.030) | .102 (.046) | .053 (.074) | .044 (.050) |
| Ln(Assets) | -.310 (.131) | -.162 (.13) | -.077 (.161) | .295 (.132) |
| Acquirer | .08 (.069) | .065 (.068) | .092 (.098) | -.139 (.084) |
| Divestor | .083 (.089) | .033 (.111) | .056 (.157) | -.004 (.122) |
| Ln(MVE) | .405 (.096) | .343 (.109) | .237 (.152) | .109 (.108) |
| ROA | -.055 (.044) | -.087 (.052) | -.063 (.07) | -.161 (.057) |
| Volatility | .148 (.055) | .062 (.073) | .062 (.072) | .056 (.078) |
| Yr1999 | -.014 (.05) | -.049 (.067) | -.041 (.082) | .011 (.057) |
| Constant | .166 (.061) | 5.20 (1.74) | 5.44 (1.72) | 8.497 (1.436) |

Difference GMM:

Sargan test of over-identifying restrictions:

chi2(22) = 25.75 Prob > chi2 = 0.2625

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

H₀: no autocorrelation z = -1.25 Pr > z = 0.2097

 One-step system GMM results:

Hansen test of overid. restrictions: chi2(33) = 34.84 Prob > chi2 = 0.381

Arellano-Bond test for AR(1) in first differences: z = -1.15 Pr > z = 0.251

 Two-step system GMM results:

Hansen test of overid. restrictions: chi2(33) = 34.84 Prob > chi2 = 0.381

Arellano-Bond test for AR(1) in first differences: z = -0.61 Pr > z = 0.543

 One-step GMM estimation:

Hansen test of overid. restrictions: chi2(39) = 33.95 Prob > chi2 = 0.699

Arellano-Bond test for AR(1) in first differences: z = -0.66 Pr > z = 0.511

Arellano-Bond test for AR(2) in first differences: z = 2.06 Pr > z = 0.039

.Table 11. Arellano-Bond estimations 2000-2002

| | Difference GMM | System GMM (one step) | System GMM (two step) | System GMM (one- step) |
|---------------------------|---------------------------------------|-----------------------------------|---|-----------------------------------|
| Ln(Limit) | Coefficient (Robust Std. Error) | Coefficient (Robust std. err.) | Coefficient (Corrected std. err.) | Coefficient (Robust std. err.) |
| Ln(Limit) Lagged | .06 .114 | .648 (.111) | .639 (.091) | |
| Growth | -.039 .023 | -.017 (.028) | -.014 (.03) | -.030 (.034) |
| Leverage | 1.434 .544 | -.101 (.102) | -.077 (.141) | -.002 (.168) |
| Risk | .018 .007 | -.002 (.004) | -.002 (.003) | -.01 (.005) |
| Raw Returns | -.010 .016 (.02) | .006 (.023) | .001 (.03) | -.044 (.022) |
| Members | .039 .024 | -.046 (.035) | -.043 (.036) | -.081 (.047) |
| Percent Insiders | .052 .051 | -.005 (.006) | -.007 (.006) | .001 (.007) |
| Percent Outsiders | .053 .050 | .007 (.003) | .009 (.004) | .004 (.004) |
| CEO=COB | -.007 .111 | .067 (.160) | .093 (.141) | .105 (.184) |
| D&O Ownership | .007 .004 | .001 (.005) | .002 (.005) | -.004 (.006) |
| Percent Blockholders | .001 .004 | -.004 (.004) | -.005 (.002) | -.005 (.004) |
| Number of Blockholders | .004 .047 | .012 (.052) | .029 (.040) | .023 (.055) |
| Ln(assets) | .122 .146 | .036 (.098) | .02 (.095) | .066 (.139) |
| Acquirer | -.016 .075 | -.065 (.081) | -.079 (.073) | -.175 (.089) |
| Divestor | -.002 .098 | -.142 (.118) | -.135 (.134) | .02 (.118) |
| Ln(MVE) | .191 .082 | .152 (.074) | .159 (.083) | .287 (.129) |

| | | | | |
|------------|------------------|--------------------|---------------------|---------------------|
| ROA | -.13 .066 | -.052 (.092) | -.033 (.090) | -.032 (.104) |
| Volatility | .039 .099 | .228 (.105) | .274 (.124) | -.055 (.168) |
| Yr2001 | -.072 .059 | -.074 (.056) | -.083 (.049) | -.021 (.055) |
| Constant | .023 .048 | 2.33 (1.82) | 2.53 (1.61) | 10.22 (1.69) |

Difference GMM:

Sargan test of over-identifying restrictions:

$$\chi^2(42) = 43.28 \quad \text{Prob} > \chi^2 = 0.4165$$

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

$$H_0: \text{no autocorrelation} \quad z = -1.60 \quad \text{Pr} > z = 0.1094$$

One-step system GMM:

Hansen test of overid. restrictions: $\chi^2(53) = 51.36$ Prob > $\chi^2 = 0.538$

Arellano-Bond test for AR(1) in first differences: $z = -0.91$ Pr > $z = 0.361$

Two-step system GMM:

Hansen test of overid. restrictions: $\chi^2(53) = 51.36$ Prob > $\chi^2 = 0.538$

Arellano-Bond test for AR(1) in first differences: $z = -0.73$ Pr > $z = 0.464$

One-step GMM:

Hansen test of overid. restrictions: $\chi^2(44) = 48.51$ Prob > $\chi^2 = 0.296$

Arellano-Bond test for AR(1) in first differences: $z = 1.56$ Pr > $z = 0.120$

Arellano-Bond test for AR(2) in first differences: $z = .$ Pr > $z = .$ (not defined)

Table 12. Size Adjusted Limits GMM estimations.

| | Difference GMM | System GMM (one-step) | System GMM (two-step) | System GMM (one-step) |
|---------------------------|------------------------------------|------------------------------------|--|------------------------------------|
| Ln(Limit/MVE) | Coefficient (Robust Std. Error) | Coefficient (Robust Std. Error) | Coefficient (Corrected Std. Error) | Coefficient (Robust Std. Error) |
| Ln(Limit/MVE) Lagged | .064 (.074) | .269 (.068) | .274 (.062) | |
| Growth | -.234 (.031) | -.245 (.03) | -.246 (.029) | -.189 (.025) |
| Leverage | 1.65 (.622) | .321 (.208) | .180 (.26) | .553 (.258) |
| Risk | -.001 (.000) | -.001 (.001) | -.001 (.001) | -.000 (.001) |
| Raw Returns | -.041 (.027) | -.064 (.036) | -.064 (.035) | -.076 (.028) |
| Members | -.036 (.032) | -.055 (.049) | -.056 (.054) | -.005 (.058) |
| Percent Insiders | .027 (.043) | -.000 (.009) | .000 (.009) | .011 (.009) |
| Percent Outsiders | .024 (.045) | .007 (.005) | .008 (.005) | .006 (.006) |
| CEO=COB | .16 (.130) | -.014 (.138) | .004 (.161) | .007 (.161) |
| D&O Ownership | -.005 (.008) | .002 (.005) | .002 (.006) | .005 (.005) |
| Percent Blockholders | -.01 (.005) | -.004 (.006) | -.003 (.007) | -.003 (.005) |
| Number of Blockholders | .089 (.05) | .069 (.063) | .068 (.072) | .051 (.058) |
| Ln(assets) | -.735 (.151) | -.445 (.104) | -.448 (.115) | -.618 (.100) |
| Acquirer | -.05 (.103) | -.196 (.121) | -.207 (.100) | -.296 (.082) |

| | | | | |
|------------|---------------------|---------------------|---------------------|---------------------|
| Divestor | .146 (.143) | .045 (.129) | .053 (.130) | -.092 (.132) |
| ROA | -.144 (.084) | -.272 (.096) | -.257 (.136) | -.228 (.106) |
| Volatility | .119 (.071) | .023 (.120) | .009 (.136) | .016 (.111) |
| Yr1999 | .073 (.098) | -.157 (.14) | -.155 (.152) | .051 (.087) |
| Yr2000 | .173 (.106) | .023 (.131) | .035 (.137) | .171 (.136) |
| Yr2001 | -.088 (.09) | -.164 (.099) | -.149 (.118) | .004 (.150) |
| Constant | .133 (.046) | 7.23 (1.85) | 7.32 (2.13) | 8.93 (2.08) |

Difference GMM:

Sargan test of over-identifying restrictions (from two step):

chi2(69) = 57.74 Prob > chi2 = 0.8311

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

H0: no autocorrelation z = -0.30 Pr > z = 0.7611

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:

H0: no autocorrelation z = 0.12 Pr > z = 0.9017

Arellano-Bond dynamic panel-data estimation, one-step system GMM results

One-step system GMM:

Hansen test of overid. restrictions: chi2(90) = 77.10 Prob > chi2 = 0.832

Arellano-Bond test for AR(1) in first differences: z = -2.51 Pr > z = 0.012

Arellano-Bond test for AR(2) in first differences: z = 0.62 Pr > z = 0.532

Two-step system GMM:

Hansen test of overid. restrictions: chi2(90) = 77.10 Prob > chi2 = 0.832

Arellano-Bond test for AR(1) in first differences: z = -2.30 Pr > z = 0.022

Arellano-Bond test for AR(2) in first differences: z = 0.59 Pr > z = 0.556

One-step GMM estimation without lagged dependent variable:

Hansen test of overid. restrictions: chi2(87) = 71.69 Prob > chi2 = 0.882

Arellano-Bond test for AR(1) in first differences: z = -2.09 Pr > z = 0.037

Arellano-Bond test for AR(2) in first differences: z = 0.77 Pr > z = 0.443

.Table 13. Size-adjusted limits GMM estimations 1997-2000.

| | Difference GMM | System GMM (one-step) | System GMM (two-step) | System GMM (one-step) |
|-------------------------|------------------------------------|------------------------------------|--|------------------------------------|
| Ln(Limit/MVE) | Coefficient (Robust Std. Error) | Coefficient (Robust Std. Error) | Coefficient (Corrected Std. Error) | Coefficient (Robust Std. Error) |
| Ln(Limit/MVE) Lagged | -.243 (.091) | .078 (.1) | .029 (.108) | |
| Growth | -.172 (.021) | -.287 (.030) | -.279 (.045) | -.179 (.024) |
| Leverage | -.189 (.516) | 1.35 (.813) | 1.38 (1.29) | 1.5 (.911) |
| Risk | -.002 (.000) | -.002 (.001) | -.002 (.001) | -.000 (.001) |
| Raw Returns | -.174 (.027) | -.098 (.040) | -.084 (.077) | -.05 (.044) |
| Members | .098 (.061) | .054 (.102) | .074 (.089) | .052 (.068) |
| Percent Insiders | -.093 (.046) | -.008 (.012) | -.004 (.017) | .012 (.010) |

| | | | | |
|------------------------|----------------------|---------------------|---------------------|---------------------|
| Percent Outsiders | -0.121 (.049) | .007 (.006) | .008 (.006) | .003 (.006) |
| CEO=COB | .125 (.149) | -.237 (.196) | -.293 (.211) | -.243 (.172) |
| D&O Ownership | -0.015 (.006) | .001 (.007) | .005 (.009) | .007 (.005) |
| Percent Blockholders | -.004 (.005) | -.013 (.008) | -.012 (.011) | -.005 (.007) |
| Number of Blockholders | .028 (.046) | .19 (.076) | .174 (.111) | .128 (.081) |
| Ln(assets) | .028 (.046) | -.685 (.136) | -.748 (.157) | -.519 (.097) |
| Acquirer | .243 (.129) | .042 (.132) | .038 (.216) | -.174 (.104) |
| Divestor | .154 (.175) | -.041 (.239) | .141 (.566) | -.076 (.212) |
| ROA | -.118 (.074) | -.168 (.107) | -.144 (.250) | -.356 (.080) |
| Volatility | .179 (.077) | .02 (.156) | .018 (.139) | .029 (.115) |
| Yr1999 | -.047 (.077) | .199 (.172) | .233 (.224) | .037 (.087) |
| Yr2000 | | .303 (.189) | .384 (.211) | .129 (.116) |
| Constant | .305 (.071) | 10.29 (2.42) | 10.91 (2.58) | 6.50 (1.99) |

Difference GMM:

Sargan test of over-identifying restrictions (from two step):

chi2(22) = 21.01 Prob > chi2 = 0.5202

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

H0: no autocorrelation z = -1.08 Pr > z = 0.2801

Arellano-Bond test that average autocovariance in residuals of order 2 is 0 (not defined)

One-step system GMM:

Hansen test of overid. restrictions: chi2(33) = 32.42 Prob > chi2 = 0.496

Arellano-Bond test for AR(1) in first differences: z = -1.51 Pr > z = 0.132

Arellano-Bond test for AR(2) in first differences: z = . Pr > z = . (not defined)

Two-step system GMM:

Hansen test of overid. restrictions: chi2(33) = 32.42 Prob > chi2 = 0.496

Arellano-Bond test for AR(1) in first differences: z = -0.58 Pr > z = 0.560

Arellano-Bond test for AR(2) in first differences: z = . Pr > z = . (not defined)

One-step system GMM:

Hansen test of overid. restrictions: chi2(39) = 41.13 Prob > chi2 = 0.377

Arellano-Bond test for AR(1) in first differences: z = -0.37 Pr > z = 0.709

Arellano-Bond test for AR(2) in first differences: z = 1.27 Pr > z = 0.205

.Table 14. Size-adjusted limits GMM estimations 2000-2002.

| | Difference GMM | System GMM (one-step) | System GMM (two-step) | System GMM (one-step) |
|----------------------|---------------------------------|---------------------------------|------------------------------------|---------------------------------|
| Ln(Limit/MVE) | Coefficient (Robust Std. Error) | Coefficient (Robust Std. Error) | Coefficient (Corrected Std. Error) | Coefficient (Robust Std. Error) |
| Ln(Limit/MVE) Lagged | .100 (.094) | .260 (.101) | .256 (.095) | |

| | | | | |
|------------------------|---------------------|---------------------|---------------------|---------------------|
| Growth | -2.06 (.038) | -2.07 (.046) | -2.14 (.043) | -1.89 (.044) |
| Leverage | 3.88 (1.06) | .412 (.224) | .413 (.422) | .554 (.222) |
| Risk | .031 (.011) | -.003 (.005) | -.003 (.005) | -.001 (.007) |
| Raw Returns | -.016 (.024) | -.02 (.035) | -.015 (.042) | -.055 (.03) |
| Members | .073 (.051) | -.164 (.064) | -.168 (.071) | -.128 (.075) |
| Percent Insiders | .152 (.113) | -.003 (.013) | -.005 (.012) | -.001 (.012) |
| Percent Outsiders | .149 (.112) | .010 (.007) | .009 (.007) | .01 (.008) |
| CEO=COB | -.106 (.263) | .104 (.224) | .098 (.165) | .191 (.24) |
| D&O Ownership | .003 (.008) | .004 (.008) | .005 (.011) | .009 (.010) |
| Percent Blockholders | -.004 (.006) | -.007 (.005) | -.007 (.005) | -.006 (.006) |
| Number of Blockholders | .01 (.061) | -.012 (.088) | -.010 (.099) | -.025 (.089) |
| Ln(assets) | -.593 (.260) | -.490 (.175) | -.479 (.165) | -.668 (.168) |
| Acquirer | -.166 (.122) | -.377 (.161) | -.376 (.212) | -.444 (.149) |
| Divestor | .212 (.201) | .21 (.240) | .182 (.287) | .124 (.226) |
| ROA | -.03 (.129) | .058 (.191) | .028 (.138) | .168 (.182) |
| Volatility | -.230 (.169) | -.055 (.262) | -.032 (.302) | -.209 (.271) |
| Yr2001 | -.203 (.062) | | | |
| Constant | .052 (.063) | 8.83 (3.04) | 8.60 (3.00) | 11.17 (3.35) |

Difference GMM:

Sargan test of over-identifying restrictions:

$$\chi^2(42) = 36.38 \quad \text{Prob} > \chi^2 = 0.7153$$

Arellano-Bond test that average autocovariance in residuals of order 1 is 0:

$$H_0: \text{no autocorrelation} \quad z = -0.72 \quad \text{Pr} > z = 0.4743$$

Arellano-Bond test that average autocovariance in residuals of order 2 is 0:

$$H_0: \text{no autocorrelation} \quad z = . \quad \text{Pr} > z = . (\text{not defined})$$

One-step GMM:

Hansen test of overid. restrictions: $\chi^2(53) = 53.09 \quad \text{Prob} > \chi^2 = 0.471$

Arellano-Bond test for AR(1) in first differences: $z = 0.47 \quad \text{Pr} > z = 0.640$

Arellano-Bond test for AR(2) in first differences: $z = . \quad \text{Pr} > z = . (\text{not defined})$

Two-step GMM:

Hansen test of overid. restrictions: $\chi^2(53) = 53.09 \quad \text{Prob} > \chi^2 = 0.471$

Arellano-Bond test for AR(1) in first differences: $z = 0.58 \quad \text{Pr} > z = 0.563$

Arellano-Bond test for AR(2) in first differences: $z = . \quad \text{Pr} > z = . (\text{not defined})$

One-step GMM estimation:

Hansen test of overid. restrictions: $\chi^2(45) = 47.33 \quad \text{Prob} > \chi^2 = 0.378$

Arellano-Bond test for AR(1) in first differences: $z = 0.68 \quad \text{Pr} > z = 0.497$

Arellano-Bond test for AR(2) in first differences: $z = . \quad \text{Pr} > z = . (\text{not defined})$