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Ownership Concentration and Governance in the U.S. Insurance Industry

James Barrese,* Gene Lai,** and Nicos Scordis***

Abstract: Concentration in the U.S. insurance industry’s market shares and ownership, coupled with a network interlocking ownership relationships by institutional investors, raise social concerns. Studying the relationship between Tobin’s q and corporate governance features of the industry, we fail to find support for the incentive alignment or entrenchment hypotheses, but our findings are consistent with the hypothesis that controlling owners may couple with others to expropriate private value from minority shareholders. An interesting observation from the study is the degree to which family control is prevalent in the industry; combining family control and institutional ownership makes most stock insurers closely held.

INTRODUCTION

The primary purpose of this paper is to perform an investigation and synthesis of the relationships between ownership, governance, and performance in the insurance industry in the United States. The supply of insurance in the United States is controlled by a relatively small number of firms and individuals. The market share of the top 25 property-liability insurers was 63 percent in 2002. This market share and the firms involved are persistent over time.1 The same firms that have the largest market share in a state and line of business have been the market share leaders for decades. Some of the market share leaders are mutual insurers; other firms controlling industry supply are organized in the stock form and are themselves characterized by more concentrated stock ownership or control than

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is true for other industries. This control concentration has both efficiency and social implications, but the focus of this paper is on U.S. stock insurers.

Discussions of corporate ownership structure typically start by observing that the separation of firm ownership and control pits the preferences of owners against those of managers. The utility preferences of the managers may work against the owners’ presumed goal of value maximization, substituting goals such as the maximization of compensation. Such incentive conflicts cause owners to incur expenses, agency costs designed to reduce the conflicts at the expense of corporate performance (Jensen and Meckling, 1976). According to the incentive alignment theory, policies that dilute owners’ shares by granting higher levels of equity ownership to managers may increase corporate performance by aligning the financial incentives of the manager and other equity owners. The entrenchment hypothesis, on the other hand, argues that performance is sacrificed at levels of managerial ownership sufficiently high to render unlikely their replacement by other shareholders. The manager-owners strive to balance the benefits from the maximization of firm value and the maximization of their personal utility (Kamerschen, 1968; Bebchuk, Cohen, and Ferrell, 2004). The level of managerial stock ownership sufficient to guarantee entrenchment differs with the features and interactions of other owners. Similarly, the entrenchment hypothesis has a logical limit at managerial ownership levels so concentrated that all benefits accrue to the owner-managers (Hart, 1995). Merging these hypotheses, we expect that the relation between performance and ownership is U-shaped; the effect of the incentive alignment hypothesis is dominant for low and high levels of managerial ownership, while the entrenchment effect is dominant for intermediate levels, about 5 to 25 percent managerial ownership (Morck, Shleifer, and Vishny, 1989; Stultz, Walkling, and Song, 1990). Finally, working against the “logical limit” argument, reductions in performance may occur even when there is one controlling shareholder, or a small group, if the concentrated ownership conveys private value to the controlling owners (Bennedsen and Wolfenzon, 2000; Grossman and Hart, 1988; Harris and Raviv, 1988; Bebchuk, 1994, 1999). In this situation, the majority owners may willingly bear agency costs rather than cede control. For example, concentrated ownership levels may decrease the marketability of the firm’s shares, as potential purchasers recognize that the share price does not carry with it an equal voice in the firm’s operations. Lower performance would result as the firm’s cost of capital increases in recognition of the decreased market liquidity (Fama and Jensen, 1983). Thus, we consider the possibility that high ownership levels may be associated with an expropriation of private benefits, which offsets, to a degree, the incentive alignment effect.
A separation of ownership and control of the U.S. corporation was documented for the early twentieth century by Adolph Berle and Gardiner Means. Their work spawned modern financial theory. Later investigators felt that Berle and Means’s 1932 treatise, The Modern Corporation and Private Property, described an early snapshot of the evolution of the corporate form (e.g., Larner, 1966). These later researchers continued to find declining managerial ownership by the directors and officers of corporations until an exhaustive survey comparing 1935 and 1995, and using more data than was available to Berle and Means, reached the conclusion that the trend had been reversed (Holderness, Kroszner, and Sheehan, 1999). Following declining estimates of mean managerial ownership from 1935 through the 1960s, the average rose for all industries—from 12.9 percent in 1935 to 21.1 percent in 1995. The mean managerial ownership percentages for the 1935 and 1995 Finance, Insurance, and Real Estate (FIRE) sector, reported in Table 1, show a similar pattern—8.4 and 17.4 percent, respectively (Holderness et al., 1999).

We construct a subset of FIRE, calculating the 2000 ownership patterns for insurance companies using data from the Securities Exchange Commission form 14A for a sample of firms identified as in NAICS code 6331 (Fire, Marine and Casualty Insurance) on the SEC’s Edgar database. The corporate entities in the sample had revenues of $224.6 billion, or 53.2 percent of the $422.1 billion U.S. total industry premium for 2002. Average managerial ownership for the insurance companies in this study is 29 percent, but this measure of the concentration of corporate control in the insurance industry is conservative because, unlike other industries, many large insurance firms are organized as mutual companies, ostensibly owned by their policyholders but controlled by the firm’s managers.

In addition to requiring reports of the holdings of directors and officers, the SEC requires firms to report on other significant beneficial owners. 

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<td>All industries</td>
<td>12.9%</td>
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<td>Finance, Insurance, and Real Estate (FIRE)</td>
<td>8.4%</td>
<td>17.4%</td>
<td>29%</td>
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The values for 1935 and 1995 are from Holderness, Kroszner, and Sheehan (1999). Insurance values for 2000 are the authors’ computations.
When director and officer shareholdings are combined with the holdings of other significant owners, the values for all industries and for the insurance industry are approximately 25 percent and 53 percent, respectively. The effect of these typically institutional or fund investors is not clear. Some argue that the presence of such blockholders may work against the minority shareholders (Zeckhauser and Pound, 1999; LaPorta et al., 1999); others suggest that institutional investors improve corporate governance. This expropriation view relies on a blockholder incentive to partner with those controlling the firm to shift wealth from minority shareholders to themselves. This view is supported by the observed behavior of unaffiliated blockholders who are found to be passive or support managerial growth strategies at the expense of firm residual value (Gibbs, 1993). In addition, the OECD Principles of Corporate Governance (OECD, 1999) suggests reform mechanisms to address potential governance-sourced shareholder abuses. These mechanisms include special procedures for approval of transactions in which large shareholders have a conflict of interest; requirements that a company issue and acquire its own shares only at market value; and redemption and appraisal rights for shareholders who do not approve of a company’s strategic decisions (OECD, 1999). Evidence suggests that controlling shareholders actively lobby against such reforms, causing some to conclude that the probability of abuse of minority shareholders is high (LaPorta et al., 1999). These behaviors negatively affect firm value (Jensen and Meckling, 1976; LaPorta et al., 1998; Wruck, 1989) but the private benefits to the controlling group and affiliated investors or debtors make the loss of firm value acceptable. Others call into question the logical basis for the conclusion that concentrated ownership results in a loss of firm value (Bennedsen and Wolfenzon, 2000). First, concentrated control and external fund concentration are inversely related. As the size of the equity stake of a large-block shareholder increases the marginal net benefit of expropriation declines (LaPorta et al., 2000). Therefore, ownership concentration should be associated with lower expropriation, and large-block ownership may be recognized by minority shareholders as a signal of a better-quality firm (Bennedsen and Wolfenzon, 2000). Thus we consider the combination of a closely held firm coupled with high fund ownership a situation with a higher potential for the expropriation of minority value. In addition, the illiquidity of shares associated with concentrated ownership causes such firms to rely more on retained earnings and bank loans to finance investment projects (Modigliani and Perotti, 1997; Rajan and Zingales, 1995). The providers of debt may require provisions for the supply of regular information and face-to-face meetings, provisions sometimes viewed as an alternative to ownership dispersion in corporate governance debates (Hart, 1995; Jensen, 1986; Booth and Deli, 1999; Myers and
Majluf, 1984). Research, however, has questioned the incentives of debt providers to effectively influence firm-level strategic and operating decisions (Holland, 1994). Debt holders may not be effective monitors when the interest of the debt holder and corporation are aligned. For example, banks have incentives consistent with that of an entrenched ownership concerning a preference for profit retention over distributing dividends; high profit retention reduces debt default probabilities (Baums, 1993).

Studies of the link between ownership, governance, and performance in the insurance industry are rare, though the insurance industry is more concentrated than most other industries. The few available studies of the insurance industry that focus on the performance-ownership link include those of Mayers, Shivdasani, and Smith (1997), Downs and Sommer (1999), and Ke, Petroni, and Safieddine (1999). Ke, Petroni, and Safieddine (1999) use the insurance industry to study the effect of ownership and firm performance on executive compensation by distinguishing between publicly held (less concentrated) and privately held (concentrated) stock firms. Their study is based on a combination of 18 public companies using SEC data (GAAP) and 45 privately held stock insurers using NAIC data (SAP). Regressing CEO compensation on a dummy variable for public versus privately held companies, they find that publicly held companies pay more and reward better for good performance. Their results are consistent with those of Mayers, Shivdasani, and Smith (1997), who look beyond compensation at other perquisite expenditures. Mayers, Shivdasani, and Smith (1997) investigate the relationship between ownership structure in the insurance industry, the composition of the board of directors and officers—specifically, board size and the number of outside directors—and the cost consequences of these relationships. They study the relationship in two ways. First, because the insurance industry has both stock and mutual companies, they compare board structures across these organizational forms. In addition, for stock firms, they draw distinctions between firms that are controlled by corporate managers or outside directors. Their clearest finding is that when stock to mutual (or mutual to stock) conversions occur, the number of outside board members increases (or decreases). They find that CEOs are more highly compensated by stock firms, a finding consistent with governance theories about the benefits of outside board members; in a general setting, Beiner et al. (2004) obtain similar findings regarding board size. Finally, Downs and Sommer (1999) study the impact of guaranty funds on monitoring, ownership, and risk-taking by insurers. They find that risk-taking by insurers increases with the level of insider ownership but, consistent with Hart (1995), they conclude that the relationship is nonlinear—it weakens as insider ownership increases. The nonlinear conclusion is based on a set of variables that
identify firms in different ownership ranges. The ranges are not consistent with those used in the general literature to study the entrenchment and incentive alignment hypotheses, so we retest using more recent data and the approach generally pursued in the ownership-performance literature.

To investigate the hypotheses discussed above we rely on SEC data drawn from forms 10-K and 14-A for a sample of 38 stock corporations operating during the six-year period from 2000 through 2005—ultimately, a sample containing 224 firm-year observations. The remainder of the paper is structured as follows: the next section presents the empirical issues raised in this and prior studies that test for evidence regarding the incentive alignment, entrenchment, and expropriation hypotheses; the third section describes the sample and data issues and presents the empirical results of a regression model with fixed and time-series effects. Section four concludes and presents a discussion of the import of those results. Appendices provide a more detailed descriptive review of ownership concentration and cross-firm linkages.

EMPIRICAL ISSUES

In addition to measures of performance and ownership, tests of the entrenchment and incentive alignment hypotheses involve variables to adjust for differences in the risk of different firms, the size of the firm, and other governance-related factors that are a cause of performance differences. Merging these various studies, we investigate property-liability stock insurer performance as a function of ownership, size, risk, leverage, liquidity, and governance. We integrate and extend the empirical models used by Morck, Shleifer, and Vishny (1988), Agrawal and Knoeber (1996), and Cho (1998). Each uses Tobin's $q$ as a measure of performance, but they approach the estimation of ownership and governance differently. They all control for firm size but differ in their use of other control variables; for example, they differ in the use of variables regarding the influence of leverage, liquidity, and the volatility of historical profit influences on firm performance. We add an adjustment for firm risk (as in Stano, 1976; Bothwell, 1980; Leech and Leahy, 1991, and the insurance work of Downs and Sommer, 1999).

The measure of performance

Studies of the entrenchment and alignment hypotheses use a variety of measures as a proxy for performance, but Tobin's $q$ is the most common. Theoretic Tobin's $q$ is the ratio of the market value of a firm to the replacement cost of its assets (Brainard and Tobin, 1968; Tobin, 1969). In addition
to the difficulty of obtaining the replacement value of assets, theoretic $q$ requires the market value of a firm’s common and preferred stock, and its debt. Because firms generally record book values, a variety of complex procedures have been employed to estimate these values (for recent examples, see Lewellen and Badrinath, 1997; Lee and Tompkins, 1999). Other authors argue that more readily available book values provide sufficiently accurate approximations (Pruitt, 1994; Perfect and Wiles, 1994). For the computation of $q$, we follow Pruitt (1994). He describes a formula for approximating theoretic $q$ that relies on basic financial and accounting information and shows that the approximate $q$ values account for almost 97 percent of the variation of Lindenberg and Ross’s (1981) theoretically correct computation.

Approximate $q$ is \( (V + PS + DEBT)/TA \), where $V$ is the product of a firm’s share price and the number of common stock shares outstanding, $PS$ is the liquidating value of the firm’s outstanding preferred stock, $DEBT$ is the value of the firm’s short-term liabilities net of its short-term assets, plus the book value of the firm’s long-term debt, and $TA$ is the book value of the total assets of the firm. Each of these values is available in the Compustat files.

The logic underlying $q$ is the efficient market hypothesis. If efficient financial markets price stocks to yield an anticipated return that is competitive with comparable alternative investments, firm value is enhanced if the return a firm can earn on retained earnings is higher than the return generally available in the market (Brainard and Tobin, 1968; Tobin, 1969). If the market value of a firm is less than the sale price of its assets ($q < 1$), the firm should sell its assets and distribute the proceeds either through dividends or share repurchases. A low market value relative to replacement cost may also motivate takeover bids, since an outside group may profit by purchasing enough stock to gain control of a company and then liquidating its assets. For the sample in this study, the average $q$ value is 0.40.

**Ownership and governance**

The typical measure of corporate control in empirical research is a set of dummy variables for various ownership percentage ranges. As noted above, tests that consider the possibility that both the entrenchment and incentive alignment hypothesis operate are conducted by identifying low and high levels (typically less than 5 percent and more than 25 percent) to signify incentive alignment with the entrenchment effect dominant at intermediate levels of managerial ownership (Morck, Shleifer, and Vishny, 1989; Stultz, Walkling, and Song, 1990). The relationship between the hypotheses is seen in Figure 1. At lower levels of managerial ownership,
managerial contracts are more likely to be designed to provide an incentive aligning managerial and ownership goals. As managerial ownership percentages rise, it becomes more difficult for stockholders to discipline managers who pursue strategies that reward themselves at the expense of the other owners of the firm; managers become entrenched. In empirical research the use of a 5 percent cutoff provides a dividing line below which the incentive alignment hypothesis rather than the entrenchment hypothesis is believed to be more typical. Managerial entrenchment brings a cost in terms of performance as the goals of management take precedence over those of other shareholders. A limit to this sets in at some higher managerial ownership percentage as the goals of the managers become the goals of the shareholders (e.g., if the managers own almost all of the firm’s shares). In empirical studies, researchers have used 25 percent as a cutoff to distinguish between the likelihood that managerial entrenchment will result in lower performance and the higher performance hypothesized to be likely when managers are the significant shareholders. With no significant difference, Downs and Sommer (1999) use a variety of different cutoff points.

The level of stock ownership required to effectively control varies from firm to firm, but researchers have long used a ten-percent rule to identify dominance (Larner, 1966; Kamerschen, 1968). While there are examples of control with market shares as low as three to four percent, the likelihood of control increases as the ownership percentage of a significant shareholder, or family, increases. Berle and Means (1932, p. 69) described control as “the actual power to select the board of directors (or its majority). Berle and Means considered control with a minority ownership of the

Fig. 1. Summary of governance hypotheses
firm’s stock to occur at ownership rates of between 20 and 50 percent. Thirty-four years later, Larner (1966) felt that larger firms could be controlled with as little as ten percent ownership. He gave a few examples but cited Federated Department Stores as the best illustration. “In 1963, the chairman of its board, its president, and five of its 19 directors were members of the Lazarus family, even though the combined stock interest of the entire family was only 1.32 per cent.” In insurance, similar examples can be given for both stock firms, such as American International Group during the 1990s, and for mutual firms, such as State Farm. In essence, the argument is that the more widely held the shares of a company, the smaller the percentage needed to control. We follow Kamershen (1968) and others in adopting Larner’s ten-percent rule as an indicator of control. We also follow the consistent practice more recently employed by Mayers, Shivdasani, and Smith (1997) to identify the likelihood of control in the insurance industry—we sum the holdings by family members to identify the controlling group. For the U.S. insurance industry, we find control by families or small groups to be the norm. In fact, of the 38 firms identified in the stock sample, 22 are controlled by families and another three are controlled by a mutual. We use a dummy variable to identify as closely held these controlled firms for purposes of testing two possibilities. First, we consider that closely held firms perform better than average because the benefits accrue to the controller. Second, when close control coexists with a high level of institutional investment we consider the possibility that minority value is expropriated. Combining the hypotheses, we expect higher performance for closely held firms but a reduction in performance as the percent of institutional holdings in a closely held firm increases. Working against the notion that high levels of ownership concentration imply better performance is a theory that dominant shareholders may extract a control premium from minority shareholders (LaPorta et al., 1999; Filatotchev and Mickiewicz, 2001). This expropriation occurs when managers and the significant shareholders can coordinate firm activities for their mutual benefit, regardless of the impact on minority shareholders. This possibility exists at virtually all levels of managerial ownership but is more likely as the concentration of ownership increases. Like the entrenchment hypotheses, there is a logical limit to the likelihood of the expropriation motive; as stock concentration in the hands of an individual or family increases, the benefits of the firm are largely internalized and the benefit of expropriation is reduced.

The exploitation of minority shareholders is made possible when governance controls do not adequately protect their rights. Consequently, we also consider related governance variables; we look to the number of board meetings, the percentage of outside board members, whether these
outside members are “busy,” and the percentage of outside board members serving on the nominating and compensation committees.\textsuperscript{21}

Good governance suggestions almost always presume that owners and managers are the primary corporate stakeholders, that the responsibility of board members is to serve the interests of owners, and that outside directors are independent of managers. The identification of a board member as “outside” is an issue that started to receive attention in the past two decades (Weisbach, 1988). Independent or outside directors are better positioned to monitor and control the conflicts of interest affecting executive directors and management. Consequently, among the measures of good governance is the count of outside directors and the quality of their position on the board as measured by whether they are on the compensation, audit, or nomination committees. We consider variables for the number of outside members and the percent representation of outside members on the compensation committee. But the system of determining board membership and the incentive structure embedded in board operations is designed to predispose directors toward managers. Outside directors rarely cause trouble for managers in board meetings. Directors receive perks as long as they are in the good graces of management; these perks may be ego-, reputation-, or financially-enriching (Tirole, 2006). Consistent with the seeming desire of managers for board members who do not impede their actions, “deadwood” directors, who occupy seats on corporate boards but rarely bother to attend meetings or keep abreast of company matters, yet are routinely reappointed.\textsuperscript{22}

Directors are often hand-picked by senior managers from among their socioeconomic network (Belliveau, O’Reilly, and Wade, 1996).\textsuperscript{23} “The Higgs Report … noted a high level of informality surrounding the process of appointing non-executive directors. Almost half of the non-executive directors surveyed for the report were recruited through personal contacts or friendships and only 4 per cent had had a formal interview” (OECD, 2002, p. 70). While the threat of legal action provides an incentive for directors to balance their loyalties toward shareholders, other incentives, such as corporate-funded insurance for directors and officers, add to the likelihood of managerial bias by board members (Barrese and Scordis, 2006). Finally, outside directors are sometimes chosen who are overcommitted, and thus come to board meetings relying on the selective information disclosed to them at the actual meeting. Studies show a positive relationship between CEO pay and the number of outside directors appointed by the CEO and the number of busy directors. The notion of outside board member quality is addressed through the identification of overcommitted or “busy” directors. The effect of busy board members—those who hold multiple directorships—is debated in the literature (Hart,
OWNERSHIP CONCENTRATION AND GOVERNANCE

1995; Ferris, Jagannathan, and Pritchard, 2003). At one level, the argument considers multiple directorships a reward for directors who enhance and oversee firms that perform well; hence a board with members who hold multiple directorships would be associated with positive performance (Ferris, Jagannathan, and Pritchard, 2003).24 Surveys of directors indicate that they themselves believe a director with multiple boards is too busy to give the necessary attention to each. The Council of Institutional Investors (2006) argues that in the absence of unusual and highly specific circumstances, directors with full-time jobs should not serve on more than two other boards. The National Association of Corporate Directors (1996) is more lenient, suggesting that directors with full-time positions should not serve on more than three or four other boards. The argument that some limit to the number of directorships is logical, but the answer to the question of “how many is too many” is not established. Accepting the lenient National Association of Corporate Directors’ suggestion, we identify outside board members as busy if they serve on more than four boards. Unfortunately, data limitations restrict the use of the “busy” variable. Of the 224 firm-year sample, insufficient information exists to obtain a verifiable statistic for 94 observations. That is, limited information or format problems make a careful determination of other directorships difficult. Of the 130 valid observations, over half had boards with a zero “busy” percentage; for 80 percent of the valid observations, fewer than a third of outside members were “busy.”

Arguments about the number of meetings suggest both positive and negative relationships with firm value. Vafeas (1999) explains a negative relationship by suggesting that more meetings are held when the firm’s stock price is falling. Larcker, Richardson, and Tuna (2005) argued that a higher number of meetings suggests a more closely monitored firm; they expect and also find a negative relationship between meetings and performance measures. Consequently, though we identify firms with nominating and compensation committees composed of outside board members, we do not expect a significant relationship because identification as an outside board member is not a perfect proxy for independence.

**Other control variables**

In most ownership-performance studies, researchers include a measure of size for a variety of reasons. Causal arguments exist but empirical results consistently demonstrate a positive relationship between compensation levels and firm size, especially CEO compensation (confirmed for insurers by Mayers and Smith, 1992). Thus, managers may attempt to maximize firms’ size because larger firms provide higher levels of salary, power, and status (Marris, 1963; Belliveau, O’Reilly, and Wade, 1996); or
managers, as potential CEOs, maximize their human capital in hopes of winning the CEO tournament (Main, O’Reilly, and Wade, 1993). Measures of firm size include a variant of assets (Cubbin and Leech, 1983; Agrawal and Mandelker, 1990; Mayers et al., 1997; Ke et al., 1999; Downs and Sommer, 1999), employment (Nickell, Nicolitsas, and Dryden, 1997), and the market value of the firm’s stock (Agrawal and Mandelker, 1990). Other variables considered as measures of size by insurance researchers include the level of premiums, revenue, and loss levels (Joskow, 1973; Grace and Timme, 1992; Cummins and Weiss, 2001). For a measure of size, we consider the sum of assets and revenue. Assets is an appropriate measure of size for firms concentrating in longer-tail, asset-accumulating lines of business, while revenue is appropriate for firms concentrating in shorter-tail lines. The sum of assets and revenue should capture size regardless of the firm’s mix of business lines.

It is a basic tenet of finance that, on average, higher levels of firm risk-taking are associated with higher returns, so empirical work studying firm performance is often adjusted for risk differences among firms. Sometimes the risk adjustment is accomplished by a manipulation of the data, such as a division of firm profit by the risk measure (Bothwell, 1980), but we follow the more usual approach and use beta as an independent variable to adjust for risk differences (Stano, 1976; Cubbin and Leech, 1983; Leech and Leahy, 1991). Because the trading frequency for some insurers is not a daily event, CRSP data were used to develop Scholes-Williams betas as the measure of risk.

A simple definition of liquidity is the ability to change an asset to cash or a cash equivalent. The definition is where the simplicity ends, because the term applies to a broad range of situations. For corporations, liquidity is generally measured by the so-called current ratio: the ratio of current assets to current liabilities. We consider liquidity in a risk context. Liquidity risk refers to the likelihood of unexpected volatility in a firm’s cash flows. The most common liquidity risk for insurance companies is contingent liquidity risk, the risk associated with finding additional funds to replace maturing liabilities under potentially poor future market conditions. In practice, Viswanathan and Cummins (2003) suggest a measure for the insurance industry, the ratio of the sum of NAIC class 1 and 2 bonds, common and preferred stock, and cash and short-term investments to total assets. Because this measure requires an unavailable link between SEC and NAIC data, we approximate the measure using the sum of common and preferred stock plus cash and short-term investments to assets from the firm’s 10-K.

A firm’s return on equity is typically higher (or lower) than its return on assets if the assets are funded by debt. This is the traditional description
of the effect of financial leverage, and it is typical for investigators to consider the effect of liquidity variations on firm performance. For manufacturing industries the ratio of long-term debt to size (either equity or assets) is a measure of leverage (Holderness, Kroszner, and Sheehan, 1999). While insurers sometimes obtain traditional debt, more often their debt is the use of the insured’s premiums until payment of a loss is required, thus we use the measure of leverage used in insurance research to investigate the causes of variation in performance—the ratio of premiums to surplus or equity (Szczepanski 1992).

DATA AND EMPIRICAL RESULTS

Some empirical studies in the literature investigate hypotheses that higher levels of managerial ownership have a positive impact on firm performance, others expect a negative impact, while more recent studies allow for both positive and negative impacts in various ownership ranges. This study relies on a sample containing 224 firm-year observations—38 insurance firms (see Appendix 1) for the years 2000 through 2005 (some data limitations bring the set to 224 observations). The initial screen to identify potential firms for the sample is the existence of the firm in the SEC Edgar database with the SIC code 6331. After dropping insurance agencies or firms providing investment, underwriting, or loss adjusting services to the industry, and setting the additional screen that data for each of these firms self-identified as primarily stock property-liability firms must exist on both the Compustat and CRSP data sets, the 38 firms remained.

The regression estimates are generated using a model with time and fixed effect dummies. A Hausman test confirms that a fixed effect model is preferred to a random effect model given this sample. We do not report the dummies in the tables, but the only significant time effect is for 2002, the only recorded year in which U.S. insurers, in the aggregate, realized losses. The average reduction in $q$ for 2002 was 2 percent. Firm-specific effects, variation in $q$ not accounted for by the set of hypotheses, were found in six of the 38 firms sampled. Negative firm-specific effects were found for CNA Financial, Markel Corp., and Unico American. Positive firm-specific effects were found for Progressive Corp., Mercury General, and Leucadia National. Brusch-Pagan-Godfrey tests failed to reveal evidence of heteroskedasticity. Summary statistics for selected variables are presented in Table 2 (correlations are provided in Appendix 2).

Among the governance variables, the most trustworthy is the count of the number of meetings held: the average is 5.46 per year. The other
governance variables are less reliable for a combination of theoretical and measurement error issues. For example, having a nominating committee of outside board members is considered a good governance condition but it does not guarantee that the nominating committee members will not follow the dictates of a strong board influence. In addition, the existence of a committee at all is dictated more by the desire of corporations to live within the letter rather than the spirit of regulatory dictates. Nominating committees were not common prior to 2003, when the SEC required firms to address their nominating procedures. The number of firms in the sample with a nominating committee increased from 11 to 25 firms from 2001 to 2004. Even the number of meetings held does not provide a consistent sense of the importance of the variable. All meetings are not equally important, and the general notion is that an increase in the number of meetings reflects either greater care (suggesting a positive relationship with firm value) or a need to deal with an emergency situation (suggesting a negative relationship with firm value). In addition, the executive committees of most boards are empowered to act in the absence of a full board meeting. Executive committee action can occur by telephone meetings.

Table 3 reports outcomes of the pooled regression of Tobin’s $q$ on insurance industry variables that describe ownership concentration, firm governance, and the financial characteristics of the firm.
The listed results do not provide the coefficients for the significant firm and year dummies. The only significant year is 2002, reflecting the 2001 effect, the first year of an aggregate industry property-liability loss. Significant and positive dummies are for Luecadia, Mercury, and Progressive. Significant and negative dummies are for CNA, Merchant, and UNAM.

For the variable “Closely held firms owned by institutional funds,” a total of 161 of the firm-year observations are closely held. Sixty-three of these observations occur when D&O ownership levels are in the 5 to 25 percent range. Only one firm, Horace Mann, has a D&O percentage lower than 5 percent and is considered closely held for four years of its operation; the remaining 94 closely held firm-year observations occur when D&O levels measure in the over 25 percent range.

The table shows that the sign and significance of the basic economic variables—size, risk, leverage, and liquidity—are as expected. Perfor-
Performance is shown to increase at a decreasing rate with both size and liquidity; and higher levels of risk and leverage yield higher performance. It is the ownership and governance variables that provide interesting analysis because, to a large degree, the results are not consistent with the entrenchment of incentive alignment hypotheses. The relationship of ownership and performance is positive and significant for closely held firms, negative and significant for closely held firms with higher levels of fund ownership. These ownership results require careful consideration. The results do not support the entrenchment or alignment hypotheses, perhaps because ownership in the insurance industry is so highly concentrated. D&O ownership levels below five percent are found in only 14 percent of the observations; another 40 percent of the observations have D&O ownership in the 5 to 25 percent range; the largest group, 46 percent of the observations, have D&O ownership levels over 25 percent. The measure of how closely held a firm is, however, is positively related to performance. The combination of a positive “closely held” estimate and a negative estimate for the “institutional ownership when closely held” variable suggest support for the expropriation hypothesis. Finally, regarding governance, the average percent (and number) of outside directors, 56 percent (7.27), suggests that shareholder representatives have a majority voice on most insurance company boards. As noted, however, a high percentage of outside members does not guarantee the independence of the board.

A limitation affecting the generalization of this study is its focus on stock firms rather than stock and mutual insurers. Given the different reporting requirements for each, assembling consistent information for the two types of insurer is problematic. We argue that mutual firms behave like closely held stock firms; this result is consistent with the findings that suggest mutual firms perform better than the average stock firm. Mutual policyholders legally own the firm but the directors and officers control the firm because policyholder block voting is almost impossible to coordinate. Recognizing that one of the largest mutual insurers, State Farm, is persistently among the top four market share leaders, it is clear that the exclusion of this group of firms leads to an understated sense of the importance of control of the industry by a small group of individuals.

SUMMARY AND CONCLUSION

This paper describes the results of an investigation and synthesis of the relationships between stock ownership, governance, and performance in the U.S. insurance industry. The supply of insurance is controlled by a relatively small number of firms, and we find that these firms, in turn, are
controlled by a relatively small number of individuals and families. This control concentration has both efficiency and social implications.

Studies of the link between ownership, governance, and performance in the insurance industry are rare. The industry studies find that executive compensation rewards for firm performance are greater when the firm is more concentrated (Ke, Petroni, and Safieddine, 1999); that perquisites, as well as compensation, are higher among better performing and more concentrated insurers (Mayers, Shivdasani, and Smith, 1997); and, consistent with the notion that more concentrated firms do perform better, that such firms engage in higher risk activities, though risk-taking may increase at a decreasing rate with concentration increases (Downs and Sommer, 1999). We add to these findings—after correcting for firm performance (Tobin’s $q$) variations associated with size, leverage, liquidity, and firm risk—by studying governance and ownership conditions in the industry.

Unlike the generally accepted view that there is a trend toward the separation of ownership and managerial control, our finding is that the insurance industry is more like the recent description of industry provided by LaPorta et al., (1999). Most stock insurers are relatively closely held; the managers are the owners. Discussions of value maximization, in this situation, should consider the effect of private value expropriation by manager/owners and the effect on minority shareholders. Following the tradition established in the literature to test for the effect on performance of incentive-alignment practices, at a director and officer ownership concentration range lower than 5 percent, versus the 5 to 25 percent range where managerial entrenchment is presumed to make managers less susceptible to incentive awards, we find evidence of neither effect. While this finding is not without precedent in the literature, in the current study this failure may be due to the relatively small number of insurance firms with managerial ownership in these lower percentile ranges. Fifty-five percent of the insurance firms studied are controlled by a significant shareholder or family.

With a sample containing 224 firm-year observations for insurance firms that account for over half of all 2005 industry premiums, 29 percent of the stock of the average insurer is controlled by the firm’s directors and officers. The firm’s ownership concentration averages 53 percent when the investments by institutional investors are added to this D&O concentration. Investments by institutional investors (holding at least five percent of a firm’s shares) typically reflect support for existing management. The effect of these typically institutional or fund investors is not clear and is a direction for future study. Some argue that the presence of such blockholders may work against the minority shareholders, others suggest that institutional investors improve corporate governance, while more recent
studies consider that the investment activities of institutional investors disproportionately reward large firms (Gompers and Metrick, 2001; Zeckhauser and Pound, 1990; Claessens et al., 1999).

While we follow traditional approaches to estimate the significance of an incentive-alignment or entrenchment effect, like LaPorta et al. (1999) we also consider the possibility that a controlling shareholder or family might affect performance. Our positive finding suggests that the performance of the firm is driven by the controlling owner’s incentive for high performance, but the negative relationship found when such control is coupled with the existence of other significant shareholders suggests the possibility that profit is expropriated from minority shareholders, a finding consistent with LaPorta. Further study in this area is warranted to identify the nature of such expropriation. Finally, we consider the effect of different governance controls on firm performance: the percentage of outside directors, and whether the compensation and nominating committees are independent. Not surprisingly, we do not find the variables to be significant, a result that suggests that rather than exerting independence, outside board members align their allegiance with management.

Among the more interesting issues raised by this study is the fact that so much of the U.S. insurance industry is controlled by a small set of individuals. While we do not investigate the social implications of this phenomenon, we recall the century-old warning of Justice Brandeis that the concentration of ownership is important not only for its implications about the competitiveness of the industry but also for its implications about the distribution of societal wealth, power, and welfare.

NOTES

1 In 2002 the A.M. Best Company listed 1,117 group or unaffiliated property-liability insurers; the top ten and twenty-five groups account for 44 and 63 percent of 2002 industry premiums, respectively. Suspicions of a link between market share concentration and market power have long existed but claims are problematic because of a theoretical disagreement about the causal direction of the link (Bain, 1951; Demsetz, 1973). However, DeVany and Kim (2002) note that high market shares over time, coupled with persistent market share leaders, are atypical in competitive markets. We find that most state personal lines markets are characterized by persistent market share leaders. For example, for private passenger auto, in 18 of 51 states the top four firms in 2002 were also the top four firms in 2000, 1995, 1990, and 1985. In 47 states, the top four 2002 firms occupied at least three of the top positions in the earlier years.

2 For a summary of these arguments and earlier related empirical work, see Morck, Shleifer, and Vishny (1989).

3 Evidence supporting the expected relationship between managerial ownership concentration and managerial compensation is presented by Ruiz-Verdu (2003), who finds a positive relation between increasing managerial ownership and managerial non-stock compensation. However, while the causal direction of their study is reversed, Ofek and Yermack (2000) investigate the impact of stock-based compensation on managerial ownership and find that equity
compensation succeeds in increasing incentives of lower-ownership managers, but higher-
ownership managers negate much of its impact by selling previously owned shares. When
executives exercise options to acquire stock, nearly all of the shares are sold. The authors claim
that the “results illuminate dynamic aspects of managerial ownership arising from divergent
goals of boards of directors, who use equity compensation for incentives, and managers, who
respond by selling shares for diversification.” We believe this pattern is reflected in the
description of a fading incentive-alignment hypothesis.

4 Mathiesen (2002) provides an exhaustive survey of 94 empirical studies produced between
1966 and 2000 that build on Berle and Means (1932) (www.encycogov.com/).

5 For a historical review of the works of Berle and Means, see Nodoushani and Nodoushani
(1999).

6 Holderness et al. (1999) also provide a brief history and critique of the studies performed from
1933 through 1990.

7 The 14A information for 1995 is not available in electronic form on the SEC database. How-
ever, Downs and Sommer (1999) report an average director and officer percentage of 20.6
percent using data for a sample of 55 stock firms operating from 1989 through 1995.

8 A beneficial owner is any person who, directly or indirectly, has or shares: (1) Voting power,
including the power to vote, or to direct the voting of, such security; and/or (2) Investment
power, including the power to dispose, or to direct the disposition of, such security. A signif-
ificant beneficial owner controls at least 5 percent of such shares (Title 17, Chapter II, Part 240:
240.13d-3).

9 The value for all industries is obtained using data from a sample of 2001 blockholders pro-
vided by Andrew Metrick, http://finance.wharton.upenn.edu/~metrick/data.htm (viewed
September 21, 2004). The values for the insurance industry are computed by the authors using
SEC 14A information for 2002.

10 LaPorta, Lopez-de-Silanes, and Shleifer (1999) argue that controlling shareholders typically
have control over firms considerably in excess of their cash flow rights. This is accomplished
through pyramidal structures and, in part, because they manage the firms they control. Ex-
amples of expropriation include obtaining excessive management compensation through the
appointment of friends to the compensation committee of the board or through pyramids—
i.e., an arrangement in which the firm (A) uses a high priced supplier (B) that a manager of (A)
privately owns, where B merely serves as a middleman between the true supplier (C) and (A).

11 A recent Home Depot board meeting demonstrates the passivity of some institutional inves-
directors and officers of the firm control 1.45 percent of the stock, and the only beneficial own-
ers controlling more than five percent are FMR Corp (5.5 percent) and Barclays Global Inves-
tors (5.3 percent). Excepting the chairman, and against all good-governance dictates, no Board
members attended the meeting. All shareholder proposals each a proposal to change gover-
nance rules to increase the protections of shareholder rights—were defeated. The institutional
investors voted with management.

12 LaPorta et al. (1998) provide a description of the various techniques, the mechanics of which
are not relevant to this paper.

13 Larner (1966) and others use ownership of 10 percent of a firm’s stock by an individual or
connected group for purposes of testing the exploitation hypothesis.

14 Debt and the dispersion of equity are complementary in terms of corporate governance func-
tions (Dewatripont and Tirole, 1994).

15 We found no published study discussing the importance of family control in the insurance
industry. The importance of family in the Taiwan insurance industry was discussed in an
unpublished study by Gene Lai, and, more generally, for other industries, by Anderson and
Reeb (2004). We find family relationships to be strong in 20 of the 38 firms in the sample (see
Appendix 1).

16 Their variables for insider ownership are oddly constructed. They report ranges of [0–5%],
[5–45%], and [45–100%] and construct variables measuring the marginal ownership partici-
pation in the range. For example, consider three firms with insider values of 4.5, 9.5, and 49.5 percent, respectively. In one variant of the construction of variables meant to capture increasing ownership levels, the three values for these firms would be:

<table>
<thead>
<tr>
<th>Firm</th>
<th>Insider &lt; 5%</th>
<th>5% &lt; Insider &lt; 45%</th>
<th>Insider &gt; 45%</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>4.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Two</td>
<td>0</td>
<td>4.5</td>
<td>0</td>
</tr>
<tr>
<td>Three</td>
<td>0</td>
<td>0</td>
<td>4.5</td>
</tr>
</tbody>
</table>

Descriptive information for the individual variables is not provided nor is a theoretical argument presented to support the choice of range cutoffs (in fact, multiple cutoffs are tested but not reported). By comparison, other researchers use dummy variables to represent ownership levels of [0–5%], [5–25%], and [25–100%] ranges for purposes of testing the entrenchment and incentive alignment hypotheses (e.g., Morck, Shleifer, and Vishny, 1988).

17 Other measures used vary with the specification of the model. For example, many event studies are performed in which the performance measure is a variant of cumulative abnormal returns (Holderness and Sheehan, 1988; Jarrell and Poulsen, 1987; Song and Walkling, 1993; Yermack, 1997).

18 Without significantly different implications, some studies employ a Herfindahl-type index based on D&O ownership or voting percentages (Demsetz and Lehn, 1985; Agrawal and Mandelker, 1990; Leech and Leahy, 1991).

19 In the insurance industry, AIG provides an example. During the 1990s, the firm was controlled by a shareholder holding between three and four percent of the AIG stock.

20 While we do not focus on mutual control in this paper, a similarity exists. Mutual policyholders, like large stock with broadly distributed shareholders, rarely can assemble a block of votes sufficient to overrule the proposals of the firm’s directors. Succession at State Farm provides a hint of this control. Edward Rust Jr. became the chief executive officer (and later chairman) of State Farm Insurance Companies in 1985 at the age of 35 following the death of his 66-year old father; his father had succeeded his grandfather (see Mike France, “Father Knew Best—and So Did Grandfather,” *Business Week*, November 8, 1999, p. 142).

21 The nominating and compensation committees are particularly important governance committees. The slate of nominated directors is rarely rejected. Thus the nominating committee, by determining who will stand for election, controls the degree to which the firm will be independent of management in the future. Similarly, the compensation committee helps determine the degree to which managers are compensated, and here the concern is a controlling shareholder who sits as a manager or board chairperson. An independent compensation committee will be better positioned to reduce the likelihood of minority expropriation.

22 Siwolop (1999) provides evidence of this phenomenon but suggests a degree of improvement started in the 1990s, during which some companies adopted mandatory retirement ages for board members or imposed term limits.

23 Many other forces work against the maintenance of independence by outside board members. For example, by reducing the financial consequence of violations of fiduciary obligations, D&O insurance better aligns the interests of board members and those who are instrumental in maintaining their board membership (Battiston, Bonabearu, and Weisbuch, 2003). Allegiance by directors to management is logical given that most shareholder resolutions are advisory. Bebcchuk is quoted as reporting that of the 131 good-governance resolutions to abolish staggered boards which passed in 1997 through 2003, less than a third were acted upon by late 2004 (“Battling for Corporate America,” *The Economist*, March 9, 2006).

24 Valued corporate director characteristics include having experience and contacts, having a public image that provides public credibility to the firm, being a trusted friend, and being generous in determining compensation (Shah and Sunder, 1999).
Nine different measures of risk are studied by Downs and Sommer (1999) in their study of the insurance industry. We measure beta, the systematic risk of equity, using daily closing stock return data (in conjunction with a value-weighted market return) as reported in the CRSP database according to the method developed by Scholes and Williams (1977). McInish and Wood (1986), who compare various techniques for mitigating error in estimating betas, attest to the effectiveness of this method.


Because the data for American International Group, AIG, are suspect for part of this period (see B. Mann, Feb. 12, 2002, “How Much Do AIG Execs Make? at www.fool.com/news/foth/2002/foth020212.htm), we also performed the regressions without AIG. The results are not affected (sign and significance are the same) except to the degree that the significance is improved for D&O<5%, 5%<=D&O<25%, nominating and governance but these variables remain insignificant.

In a regression using D&O ownership percentages rather than ranges, the coefficient is positive and significant, but this is a result of the strong positive relationship between performance and ownership among the high ownership group.

The relative importance of non-stock firms in the insurance industry means that any study of the control exerted by a small group of insurance company shareholders must underestimate true industry control levels. Policyholders are allowed minimal participation in electing a mutual insurance company’s board of directors. For example, in New York, mutual life insurance policyholders are allowed one vote regardless of the number or value of their policies. Policyholders have the right to oppose the administrative ticket if they submit a petition signed by at least 500 eligible voters. To obtain a list of eligible voters, the policyholders interested in opposing the administrative ticket must file a petition, signed by twenty-five eligible voters, with New York’s Superintendent of Insurance. After overcoming these two blocks, the insurer’s board of directors can require voting by ballot only rather than by proxy.

REFERENCES


Appendix 1. Sampled firms, ownership range 2000–2004

<table>
<thead>
<tr>
<th>Name</th>
<th>D&amp;O ownership</th>
<th>Institutional ownership</th>
<th>Controlling family</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ace Ltd.</td>
<td>2–4%</td>
<td>22–42%</td>
<td></td>
</tr>
<tr>
<td>Arch Capital Group, Ltd.</td>
<td>7–89%</td>
<td>8–70%</td>
<td></td>
</tr>
<tr>
<td>American Financial Group</td>
<td>50–59%</td>
<td>0–14%</td>
<td>Linder</td>
</tr>
<tr>
<td>Argonaut Group, Inc.</td>
<td>6–9%</td>
<td>26–47%</td>
<td>Singleton</td>
</tr>
<tr>
<td>American International Group</td>
<td>18–25%</td>
<td>0–6%</td>
<td>Greenberg</td>
</tr>
<tr>
<td>Allstate Corp.</td>
<td>&lt;1%</td>
<td>11–19%</td>
<td></td>
</tr>
<tr>
<td>Bancinsurance</td>
<td>60–66%</td>
<td>0–6%</td>
<td>Sokol</td>
</tr>
<tr>
<td>Berkley WR Corp.</td>
<td>14–17%</td>
<td>18–28%</td>
<td>Berkley</td>
</tr>
<tr>
<td>Baldwin &amp; Lyons, Inc.</td>
<td>54–58%</td>
<td>0–23%</td>
<td>Shapiro</td>
</tr>
<tr>
<td>Chubb Corp.</td>
<td>2–3%</td>
<td>6–20%</td>
<td></td>
</tr>
<tr>
<td>Commerce Group</td>
<td>26–27%</td>
<td>9–10%</td>
<td></td>
</tr>
<tr>
<td>Cincinnati Financial Corp.</td>
<td>12–16%</td>
<td>0–9%</td>
<td>Schiff</td>
</tr>
<tr>
<td>CNA Financial</td>
<td>87–90%</td>
<td>0–6%</td>
<td>Loews (Tisch)</td>
</tr>
<tr>
<td>EMC Insurance Group, Inc.</td>
<td>77–84%</td>
<td>0–5%</td>
<td></td>
</tr>
<tr>
<td>HCC Insurance</td>
<td>7–19%</td>
<td>9–22%</td>
<td></td>
</tr>
<tr>
<td>Harleysville Group</td>
<td>59–62%</td>
<td>5–10%</td>
<td></td>
</tr>
<tr>
<td>Horace Mann Educators</td>
<td>2–6%</td>
<td>16–47%</td>
<td></td>
</tr>
<tr>
<td>Leucadia National Corp.</td>
<td>26–38%</td>
<td>0–12%</td>
<td>Cumming &amp; Steinberg</td>
</tr>
<tr>
<td>Mercury General Corp.</td>
<td>51–55%</td>
<td>0–16%</td>
<td>Joseph</td>
</tr>
<tr>
<td>Merchants Group Inc.</td>
<td>15–18%</td>
<td>37–58%</td>
<td>Schwartz &amp; Baird</td>
</tr>
<tr>
<td>Meadowbrook Ins. Group</td>
<td>17–51%</td>
<td>8–29%</td>
<td>Merton</td>
</tr>
<tr>
<td>Markel Corp.</td>
<td>21–32%</td>
<td>0–12%</td>
<td>Markel</td>
</tr>
<tr>
<td>Midland Co.</td>
<td>53–57%</td>
<td>5–8%</td>
<td>Hayden</td>
</tr>
<tr>
<td>Navigators Group</td>
<td>29–43%</td>
<td>10–24%</td>
<td>Deeks</td>
</tr>
<tr>
<td>Ohio Casualty Corp.</td>
<td>8–11%</td>
<td>21–33%</td>
<td></td>
</tr>
<tr>
<td>Paula Financials</td>
<td>15–38%</td>
<td>24–48%</td>
<td>Snider</td>
</tr>
<tr>
<td>Progressive Corp.</td>
<td>10–15%</td>
<td>23–33%</td>
<td>Lewis</td>
</tr>
<tr>
<td>Proassurance Corp.</td>
<td>10–12%</td>
<td>13–21%</td>
<td></td>
</tr>
<tr>
<td>RLI Corp.</td>
<td>11–30%</td>
<td>6–20%</td>
<td>Stephens</td>
</tr>
<tr>
<td>RTW Inc.</td>
<td>30–51%</td>
<td>7–40%</td>
<td>Prosser</td>
</tr>
<tr>
<td>Safeco Corp.</td>
<td>8–9%</td>
<td>5–11%</td>
<td></td>
</tr>
<tr>
<td>Safety Insurance Group Inc.</td>
<td>22–35%</td>
<td>43–49%</td>
<td></td>
</tr>
<tr>
<td>Selective Insurance Group</td>
<td>6–7%</td>
<td>6–19%</td>
<td></td>
</tr>
<tr>
<td>St. Paul Travelers Cos. Inc.</td>
<td>1–2%</td>
<td>9–19%</td>
<td></td>
</tr>
<tr>
<td>State Auto Financial Corp.</td>
<td>70–74%</td>
<td>0–5%</td>
<td></td>
</tr>
<tr>
<td>Unico American Corp.</td>
<td>45–51%</td>
<td>21–39%</td>
<td>Cheldin</td>
</tr>
<tr>
<td>White Mountain</td>
<td>12–26%</td>
<td>20–35%</td>
<td>Byrne</td>
</tr>
<tr>
<td>Zenith National Insurance Co.</td>
<td>6–14%</td>
<td>52–73%</td>
<td></td>
</tr>
</tbody>
</table>

The sample is restricted to those operating from 2000 through 2005 for which data exist in both the Compustat and CRSP databases. The initial screen identified Compustat firms in the property-liability industry code 6331 but this screen includes agencies and firms that provide outsourcing services to the insurance industry.
## Appendix 2: Correlations

<table>
<thead>
<tr>
<th></th>
<th>Tobin’s q</th>
<th>EPS diluted</th>
<th>Log (Size)</th>
<th>(Liquidity +1)^2</th>
<th>Leverage</th>
<th>D&amp;O</th>
<th>D&amp;O-LOW</th>
<th>D&amp;O MID</th>
<th>Funds</th>
<th>Closely held</th>
<th>CH_Funds</th>
<th>Board mting#</th>
<th>Outside Drctrs#</th>
<th>Busy %</th>
<th>Outside %</th>
<th>Nominating committee</th>
<th>Compensation committee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobin’s q</td>
<td>0.131</td>
<td>-0.025</td>
<td>0.149</td>
<td>0.547</td>
<td>0.528</td>
<td>-0.061</td>
<td>0.013</td>
<td>-0.110</td>
<td>-0.021</td>
<td>-0.155</td>
<td>0.113</td>
<td>-0.090</td>
<td>-0.058</td>
<td>0.099</td>
<td>-0.049</td>
<td>0.095</td>
<td>0.228</td>
</tr>
<tr>
<td>EPS diluted</td>
<td>0.088</td>
<td>0.070</td>
<td>0.025</td>
<td>0.014</td>
<td>-0.146</td>
<td>-0.078</td>
<td>0.027</td>
<td>0.110</td>
<td>-0.011</td>
<td>-0.036</td>
<td>-0.113</td>
<td>0.109</td>
<td>-0.026</td>
<td>-0.056</td>
<td>0.024</td>
<td>0.100</td>
<td>0.024</td>
</tr>
<tr>
<td>Log (Size)</td>
<td>-0.040</td>
<td>-0.505</td>
<td>-0.466</td>
<td>-0.114</td>
<td>-0.290</td>
<td>0.392</td>
<td>0.103</td>
<td>-0.183</td>
<td>-0.380</td>
<td>-0.319</td>
<td>-0.106</td>
<td>0.575</td>
<td>0.489</td>
<td>0.149</td>
<td>-0.074</td>
<td>-0.134</td>
<td></td>
</tr>
<tr>
<td>Risk</td>
<td>0.026</td>
<td>0.019</td>
<td>0.033</td>
<td>-0.070</td>
<td>0.083</td>
<td>0.008</td>
<td>-0.013</td>
<td>-0.107</td>
<td>-0.063</td>
<td>-0.035</td>
<td>0.097</td>
<td>-0.039</td>
<td>0.151</td>
<td>0.258</td>
<td>0.565</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquidity</td>
<td>0.992</td>
<td>-0.231</td>
<td>0.161</td>
<td>-0.232</td>
<td>-0.074</td>
<td>0.108</td>
<td>0.255</td>
<td>0.213</td>
<td>-0.001</td>
<td>-0.252</td>
<td>-0.205</td>
<td>0.176</td>
<td>-0.26</td>
<td>0.176</td>
<td>-0.026</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Liquidity +1)^2</td>
<td>-0.229</td>
<td>0.133</td>
<td>-0.208</td>
<td>-0.066</td>
<td>0.109</td>
<td>0.243</td>
<td>0.207</td>
<td>0.034</td>
<td>-0.301</td>
<td>-0.213</td>
<td>-0.193</td>
<td>0.164</td>
<td>-0.003</td>
<td>0.102</td>
<td>0.010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leverage</td>
<td>0.056</td>
<td>-0.082</td>
<td>0.065</td>
<td>0.126</td>
<td>0.037</td>
<td>-0.124</td>
<td>-0.044</td>
<td>-0.167</td>
<td>-0.122</td>
<td>-0.012</td>
<td>-0.003</td>
<td>0.000</td>
<td>-0.21</td>
<td>0.102</td>
<td>0.010</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D&amp;O</td>
<td>-0.441</td>
<td>-0.536</td>
<td>-0.298</td>
<td>0.521</td>
<td>-0.074</td>
<td>-0.169</td>
<td>-0.683</td>
<td>-0.553</td>
<td>-0.448</td>
<td>-0.165</td>
<td>-0.432</td>
<td>0.084</td>
<td>0.086</td>
<td>0.085</td>
<td>0.085</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D&amp;O LOW</td>
<td>-0.344</td>
<td>0.057</td>
<td>-0.511</td>
<td>-0.167</td>
<td>0.069</td>
<td>0.527</td>
<td>0.498</td>
<td>0.374</td>
<td>0.084</td>
<td>0.086</td>
<td>0.085</td>
<td>0.084</td>
<td>0.086</td>
<td>0.085</td>
<td>0.085</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D&amp;O MID</td>
<td>0.260</td>
<td>0.077</td>
<td>-0.217</td>
<td>0.217</td>
<td>0.061</td>
<td>0.231</td>
<td>0.169</td>
<td>0.121</td>
<td>0.028</td>
<td>0.281</td>
<td>0.281</td>
<td>0.281</td>
<td>0.281</td>
<td>0.281</td>
<td>0.281</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Funds</td>
<td>0.51</td>
<td>0.867</td>
<td>0.002</td>
<td>0.217</td>
<td>-0.122</td>
<td>0.127</td>
<td>-0.139</td>
<td>0.074</td>
<td>0.022</td>
<td>0.022</td>
<td>0.281</td>
<td>0.281</td>
<td>0.281</td>
<td>0.281</td>
<td>0.281</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closely held</td>
<td>-0.453</td>
<td>-0.049</td>
<td>-0.475</td>
<td>-0.247</td>
<td>-0.198</td>
<td>-0.068</td>
<td>-0.877</td>
<td>0.030</td>
<td>0.037</td>
<td>0.037</td>
<td>0.037</td>
<td>0.037</td>
<td>0.191</td>
<td>0.191</td>
<td>0.191</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CH_Funds</td>
<td>-0.015</td>
<td>-0.335</td>
<td>0.048</td>
<td>-0.199</td>
<td>-0.199</td>
<td>0.030</td>
<td>0.037</td>
<td>0.037</td>
<td>0.037</td>
<td>0.037</td>
<td>0.037</td>
<td>0.037</td>
<td>0.191</td>
<td>0.191</td>
<td>0.191</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Board mting#</td>
<td>0.249</td>
<td>0.018</td>
<td>0.251</td>
<td>0.071</td>
<td>0.191</td>
<td>0.546</td>
<td>0.648</td>
<td>0.141</td>
<td>0.306</td>
<td>0.306</td>
<td>0.306</td>
<td>0.306</td>
<td>0.306</td>
<td>0.306</td>
<td>0.306</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside Drctrs#</td>
<td>0.567</td>
<td>0.018</td>
<td>0.549</td>
<td>0.306</td>
<td>0.306</td>
<td>0.567</td>
<td>0.185</td>
<td>0.300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Busy %</td>
<td>0.320</td>
<td>0.549</td>
<td>0.306</td>
<td>0.306</td>
<td>0.306</td>
<td>0.306</td>
<td>0.306</td>
<td>0.306</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside %</td>
<td>0.320</td>
<td>0.549</td>
<td>0.306</td>
<td>0.306</td>
<td>0.306</td>
<td>0.306</td>
<td>0.306</td>
<td>0.306</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Bold: significant at 0.05*
*Italic: significant at 0.10*
APPENDIX 3: FUND RELATIONSHIPS

There are many linkages between institutional investors and insurers. An example is provided in Table 4 for two funds and a selected sample of insurers. The table reports ownership percentages by directors and officers, ownership percentages by particular individuals or families (who are not listed in the D&O category), and the percentage owned by two funds—Dimensional Fund Advisors (DIM) and FMR Corp (FMR); the percentage owned by other funds is also provided. The list of other funds holding significant blocks of insurance company stock is large. For the 22 firms listed, 32 funds, including FMR and DIM, are involved as significant owners. Wellington Capital holds significant shares of four of these 22 insurers; Capital Research and Management owns a significant share of 3 of the 22 insurers; four funds own significant shares of two of the 22 firms; and another 24 funds have significant shares of only one of the 22 firms.

Of the firms sampled, DIM owns a large share of at least 13 insurers and FMR owns a large share of at least 11 of the firms; these two mutual funds own two of these 22 firms in common. The connections listed are based on the SEC reporting requirement that firms reveal beneficial owners of 5 percent or more of the firm’s stock. If the fund owns less than 5 percent, SEC rules do not require that the ownership be identified. To understand the possible significance of ownership when less than 5 percent of the firm is owned, the stock holdings of Dimensional and FMR were obtained from the SEC and the insurers in each firm’s portfolio were identified. For 2002, DIM and FMR own shares in 63 additional insurance companies and shares in 51 of these other companies are owned by both DIM and FMR. Linkages also exist through ownership of these firms by other funds. For example, DIM and FMR own 6.6 and 6.7 percent of Ohio Casualty; another 20.1 percent is owned by three other funds: T. Rowe Price (8.8%), First Bancorp (6.2%), and American Financial (5.1%). Each of these other funds owns the stock of more than one insurer. Finally, the stock of some insurers is held in the investment portfolio of other insurers, including mutual insurers. The degree of interrelated ownership of insurance company stocks, coupled with high ownership concentration in the industry, suggests that coordinating behavior for the expropriation of private benefits could be accomplished with relative ease.
Table 4. Significant Ownership Patterns of Selected Insurers from the Sample, 2002\(^1\)

<table>
<thead>
<tr>
<th>Company</th>
<th>Owned by D&amp;O</th>
<th>Owned by family or individuals</th>
<th>Owned by Dimensional Fund Advisors</th>
<th>Owned by FMR Corp.</th>
<th>Owned by other funds</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ace Ltd.</td>
<td>2.0</td>
<td>10.1</td>
<td></td>
<td></td>
<td></td>
<td>39.3</td>
</tr>
<tr>
<td>Argonaut Group, Inc.</td>
<td>7.5</td>
<td>16.5</td>
<td>5.1</td>
<td>25.8</td>
<td></td>
<td>54.9</td>
</tr>
<tr>
<td>American International Group</td>
<td>3.3</td>
<td>16.0</td>
<td></td>
<td>5.2</td>
<td></td>
<td>24.5</td>
</tr>
<tr>
<td>Allstate Corp.</td>
<td>0.8</td>
<td></td>
<td>6.0</td>
<td>12.5</td>
<td></td>
<td>19.3</td>
</tr>
<tr>
<td>Bancinsurance</td>
<td>61.1</td>
<td>5.8</td>
<td></td>
<td></td>
<td></td>
<td>66.9</td>
</tr>
<tr>
<td>EMC Insurance Group, Inc.</td>
<td>3.4</td>
<td>79.8</td>
<td>5.3</td>
<td></td>
<td></td>
<td>88.5</td>
</tr>
<tr>
<td>HCC Insurance</td>
<td>7.3</td>
<td></td>
<td></td>
<td>6.9</td>
<td>11.1</td>
<td>25.3</td>
</tr>
<tr>
<td>Merchants Group Inc.</td>
<td>17.5</td>
<td>35.4</td>
<td>5.7</td>
<td></td>
<td>10.6</td>
<td>69.2</td>
</tr>
<tr>
<td>Ohio Casualty Corp.</td>
<td>7.9</td>
<td>6.6</td>
<td>6.7</td>
<td></td>
<td>20.1</td>
<td>41.3</td>
</tr>
<tr>
<td>Paula Financials</td>
<td>25.3</td>
<td>14.0</td>
<td>5.8</td>
<td></td>
<td>6.8</td>
<td>51.9</td>
</tr>
<tr>
<td>Proassurance Corp.</td>
<td>10.5</td>
<td></td>
<td>5.1</td>
<td></td>
<td>15.4</td>
<td>31.0</td>
</tr>
<tr>
<td>Unico American Corp.</td>
<td>51.1</td>
<td>7.4</td>
<td>8.8</td>
<td>17.1</td>
<td></td>
<td>90.0</td>
</tr>
<tr>
<td>RTW Inc.</td>
<td>30.9</td>
<td>8.0</td>
<td></td>
<td></td>
<td>10.5</td>
<td>49.4</td>
</tr>
</tbody>
</table>

Maurice Greenberg of American International Group, an officer, controls most of the 16% listed as individual/family through a complex arrangement of offshore firms.

\(^1\)All figures are in percentage.
Underwriting Cycles: 
A Synthesis and Further Directions

Mary A. Weiss*

Abstract: Underwriting cycles are associated with a mystique that few topics in the area of risk and insurance share. Many explanations and theories have focused on underwriting cycles, but little research exists to discern the relative importance of these theories in explaining insurance pricing and profitability. This research provides an intuitive review of the existing literature on underwriting cycles in the context of a demand and supply model. Specific, unaddressed issues about underwriting cycles are raised in the literature reviewed.

INTRODUCTION

Underwriting cycles are associated with a mystique that few topics in the area of risk and insurance share. The underwriting cycle is typically defined as repeating, regular periods of soft and hard markets. In a soft market, insurance coverage is readily available at “reasonable” prices, while a hard market is characterized by high prices and unavailability of coverage or limited coverage for potential policyholders. Historically, these cycles have averaged six years in length, although some literature questions whether this period has been lengthening. In tracking underwriting cycles, most of the attention tends to be directed at insurance pricing, or, conversely, insurance underwriting profits, rather than amount of coverage available.

Underwriting cycles have been the topic of considerable economic and financial research, and for good reason. Soft markets are associated with

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higher insolvency rates among insurers, and these are of concern to policyholders and regulators alike. To the extent that insurance is desirable or necessary for businesses to function, hard markets are of concern also because they can affect the price of goods and services in the economy (i.e., businesses must cover all costs, including insurance costs, in the long run). And, at the extreme, underwriting cycles can affect the level of certain economic activities. For example, unavailability of liability insurance for day care centers during the liability crisis in the 1980s resulted in the closing of some of these centers. Many other businesses were affected as well.

But even more than this, underwriting cycles have piqued the interest of both economic and financial researchers because their regularity is unexpected in perfectly competitive, well-functioning capital markets. The regularity of underwriting cycles may call into question the rationality of insurance market operations. For example, naïve, extrapolative forecasting of losses or “out-of-control” cash flow underwriting can be shown to give rise to a cycle in underwriting profit. But explanations such as these are unsatisfactory to researchers who believe in rational markets. Thus a search for market imperfections or some other rational market phenomenon that can explain a cycle characterizes the underwriting cycle literature.

The search has turned up many different factors that help to explain underwriting cycles, and at this stage it appears that underwriting cycles can be at least partially explained by rational responses to several different features of insurance markets and dynamic market developments. These factors encompass institutional and regulatory features of insurance that give rise to an “apparent” cycle as well as the effects of real phenomena such as interest rate and/or loss shocks, asymmetric information in capital markets, and capital surpluses and shortages in insurance.

The purpose of this article is to provide an overview and synthesis of the predominant underwriting cycle theories. Unanswered questions arising from the underwriting cycle literature are highlighted. This overview starts with a basic demand and supply model. Demand and supply are found to be functions of many factors themselves, and displaying these major factors contributes to the understanding of how all of the disparate underwriting cycle theories fit together.

The remainder of this article is organized as follows. In the next section, a stylized demand and supply for insurance model is presented. In the following section, studies that focus on the time series pattern of insurance prices or underwriting profitability are discussed. This section concludes with unanswered questions relating to this stream of literature. Next, the role of insurance crises in explaining underwriting cycles is addressed, and at the end of this section more unanswered questions stemming from this literature are listed. The last section concludes.
PRICE AND QUANTITY OF INSURANCE MODELS

Insurance is unlike other goods in that there is no price at which customers can buy all of the quantity (coverage) that they desire. Instead, the insurance product is a package that consists of price \( p \) and quantity \( q \) (i.e., \( I(p,q) \)). Insurance is purchased in a market that consists of customers (policyholders) and suppliers (insurers). In a perfect, competitive market, this can be represented in a simple way at the micro level as:

\[
\text{Demand: } I(p,q) = f(\mu_L(I), E, A, \sigma_L^2, \sigma_{Ln}, O)
\]

\[
\text{Supply: } I(p,q) = f(\mu_L(I), E, A, \sigma_L^2, n_k \sigma_{jk}, O),
\]

where \( L \) indicates expected losses, \( O \) represents business opportunities,\(^2\) \( I \) is expected inflation, \( n \) is expected income, \( A \) is assets, \( E \) is equity, and \( j \) and \( k \) represent insurance policies \( j \) and \( k \). Arguably, one might add more terms to either the demand or supply specification, but this simple model should suffice for the purpose at hand. The market will clear at the \( I(p,q) \) package where demand meets supply.

Unfortunately, the insurance package \( I(p,q) \) is unobservable, but premiums aggregated by line (at the firm or national level) can be observed, and the premium contains important pricing information. Therefore, premiums play an important role in underwriting cycle research. In theory, premiums can be modeled simply as follows:

\[
\text{Premium} = \frac{\mu_L(I_c, I)}{1 + r} + \text{Expenses}(T_t) + \left( \sigma_L^2 + \sum_{k=1}^{m} \sigma_{jk}E(r),G,D(\mu_L,\sigma^2_L),Q,\text{tax} \right),
\]

where \( I_c \) is claims inflation, \( T \) is state of technology at time \( t \), \( G \) represents agency costs, \( D \) is demand for insurance, \( Q \) is an indicator of financial quality, and \( \text{tax} \) represents insurer income tax. (All other variables are defined as before.) It is assumed in the above that premiums are paid at the beginning of the year and all losses are paid at the end of the year for simplicity's sake. Equation (1) indicates that premiums reflect discounted losses, which are a function of general and claims inflation and the discount
rate \( r \) (Myers and Cohn, 1986; Grace and Hotchkiss, 1995), plus underwriting expenses which are a function of technology at time \( t \) (e.g., Cummins and Outreville, 1987), and profit (or a risk charge).

The risk charge is affected by many factors, including the variance of losses and their covariance with other business written, the amount of the insurer’s equity or surplus (e.g., Winter, 1994, Gron 1994b), agency costs related to information asymmetries between the insurer and capital markets and/or between the insurer and policyholders (Winter, 1994; Cummins and Danzon, 1997), taxes (including taxes on investment income earned on policyholder funds held by the insurer—i.e., reserves) (Myers and Cohn, 1986; Weiss, 1985), financial quality (Cagle and Harrington, 1995; Harrington and Danzon, 1994; Cummins and Danzon, 1997), and demand for insurance in general. Equity is considered a function of the interest rate in equation (1) because insurers’ assets and liabilities may be a function of interest rates (Doherty and Garven, 1995). Equity, then, as a balancing item, must be affected by interest rates as well. The functional items listed here are included because they play a role in underwriting cycle research and will be discussed more fully once specific underwriting cycle theories are considered. Arguably, again, one might include more items in equation (1) above, but equation (1) should be sufficient for the present purposes.

Obviously, when any of the factors that underlie premiums change, premiums will change also. However, the extent to which premiums will change is not always clear. Time series analysis of premiums indicates that expected losses and discount rates are strongly related to premiums in the short run (e.g., Cummins and Tennyson, 1992; Danzon, 1985.

As indicated earlier, price or underwriting profit are specifically considered in underwriting cycle studies. Price is typically measured relative to losses incurred (i.e., \((\text{Premiums}/\text{Losses incurred})\) or \((\text{Premiums}/\text{PV}(\text{Losses incurred}))\). Losses incurred here are not necessarily the same as \(\mu_l\) in equation (1), because the only data usually available are ex-post data, not ex-ante data, and this problem underlies all underwriting cycle research (Harrington and Niehaus, 2000). The underwriting profit \((\pi)\) rate is defined as \((\text{Premiums} – \text{Losses Incurred} – \text{Expenses})/\text{Premiums}.

Now the stage has been set for determining how underwriting cycle theories fit into the general model of insurer pricing, or at least into our measure of insurance price. Our cast of characters (\(E, r, I, G, Q, \text{ etc.}\)) have been assembled, and we will see how each of these factors has been used (sometimes uniquely) to explain insurance pricing and profitability.
TIME SERIES ANALYSIS OF PREMIUMS AND UNDERWRITING PROFIT

The premium model in the preceding section indicates that a number of economic factors potentially play a role in premium determination (e.g., demand, losses, interest rates). Cointegration analysis can be used to determine if premiums or underwriting profits are indeed related to these factors. Conditional on these related factors, one would not expect to see any definite patterns in underwriting profits (or a complementary measure such as the combined ratio) if capital markets are perfect and competitive. Instead they should be random, reflecting the random nature of losses. However, the underwriting profit pattern is not random, but autoregressive.

In this section, cointegration studies are reviewed and theories that explain autoregression in underwriting profits are considered. Finally, some open questions of this research are presented.

Unit Roots and Cointegration

Cointegration analysis can be used to determine whether short-term or long-term relationships exist between premiums or underwriting profits and various economic factors (Engle and Granger, 1987). Cointegration of two variables can exist only if both of the variables are nonstationary (i.e., they do not fluctuate randomly around a mean). Thus before cointegration analysis can be conducted, the stationarity in the mean of the underlying variables must be determined. Frequently, stationarity is assessed from analysis of a unit root. Cointegration analysis is meaningful if a unit root exists.3

A large number of studies in recent years have used cointegration analysis, starting with Haley (1993). In the latter study, a negative, cointegrating relationship is found between interest rates and underwriting profit. This finding is consistent with the model presented in equation (1). This relationship is confirmed in later research by Choi, Hardigree, and Thistle (2002). In further work, Haley (1995) finds that underwriting profits by line are not necessarily cointegrated with interest rates.

However, other research disagrees with the general findings of cointegration between interest rates and underwriting profit. The main bone of contention among these studies concerns the unit root tests. When adding a time series variable to the unit root analysis, Harrington and Yu (2003) reject the unit root hypothesis in their test of underwriting profits. In a series of articles based on varying sample periods, Leng et al. (2002), Leng (2006a, 2006b), and Leng and Meier (2006) also cast doubt on the finding of a unit root in underwriting profits.
In a study in this issue, Haley takes exception to research that casts doubt on cointegration analysis of underwriting profits. Haley argues that limiting the time period of study as in Leng et al. (2002), Leng (2006a, 2006b), and Leng and Meier (2006) because, for example, of a structural break in the data, is not necessary when conducting tests for stationarity. Further, Haley argues, controlling for a time trend when conducting unit root analysis as in Harrington and Yu (2000) may not be appropriate. Instead Haley argues that the finding of a significant time trend in underwriting profits is evidence, itself, of nonstationarity in the data series.

Grace and Hotchkiss (1995) and Choi, Hardigree, and Thistle (2002) also conduct cointegration analysis. Grace and Hotchkiss (1995) find a positive cointegrating relationship between the combined ratio and the following factors: interest rates, GDP, and the consumer price index. In fact, they find that all four series are cointegrated together. Since the combined ratio is inversely related to underwriting profits, Grace and Hotchkiss support Haley (1993). Interpreting GDP as a proxy for demand at the national level, it is not surprising that interest rates, GDP, and the consumer price index are cointegrated. All of these factors appear in the premium model in equation (1). Findings of cointegration with key economic variables are important because they tie the underwriting cycle to other economic cycles such as the business cycle.

Choi, Hardigree, and Thistle (2002) find that underwriting profits are not cointegrated with the ratio of surplus to premiums written, the ratio of surplus to assets, and the ratio of surplus to a lagged moving average of surplus. The ratios of surplus to premiums written and to assets are frequently used as measures of financial quality, and so these results appear to contradict the modeling of long-term profit as a function of financial quality in equation (1). The ratio of surplus to a lagged moving average of surplus is usually used as a measure of the relative supply of capacity or capital, and this finding, too, contradicts the model in equation (1) when it is interpreted as a long-term model. It should be noted, however, that a short-term relationship between insurance prices and surplus is found to exist. Another potentially important consideration in evaluating this work is that the analysis uses data aggregated to the industry level, while some underwriting cycle theories are most applicable at the firm level.

**Apparent Cycles: Autoregression in Underwriting Profits**

Venezian (1985) noted that the pattern displayed by underwriting profits over time (both aggregate and by line) resembles a cosine wave. This discovery sparked research to explain this specific pattern in underwriting profits, and this research is briefly reviewed below.
Venezian (1985) recognized that the cosine wave–like pattern observed in underwriting profits could arise from second-order autoregression in underwriting profits. Evidence of a second-order autoregression process was found by regressing underwriting profits $\pi_t$ on a constant, $\pi_{t-1}$ and $\pi_{t-2}$. The coefficients from this regression model, assuming that they were consistent with the existence of a cycle, can be used to find the period of the cycle. Venezian (1985) found cycles in several lines of insurance and noted that the periods of the cycle among different lines can vary and that the phases of the cycle among lines do not necessarily coincide.

An important question is why second-order autoregression should exist in underwriting profits if insurers price business rationally. Venezian (1985) attributed this second-order autoregression process to naïve forecasting whereby insurers forecast future losses by extrapolating from past trends. Cummins and Outreville (1987) provide a more compelling explanation for the observed autocorrelation in underwriting profits. They posit that the so-called “irrational” pricing behavior is caused by a filtration of rational prices through external events. They develop a model in the context of rational expectations in which external factors can produce second-order correlation among underwriting profits. One such external influence is institutional lags attributed to data collection, regulation, and policy renewal periods. Accounting reporting conventions also contribute to the autoregression. Thus they show that insurers may in fact act rationally, even though the underwriting profit pattern makes it look irrational.

Cummins and Outreville (1987) also hypothesize that if the external factors above are important, they should affect underwriting results not only in the U.S. but internationally. Hence they examine underwriting results for a large sample of countries from 1957 to 1979, and they observe underwriting cycles, as predicted. Lamm-Tennant and Weiss (1997) further the Cummins and Outreville model by more directly linking countries’ institutional features with underwriting cycles. Like Cummins and Outreville, they find evidence of cycles in many countries and among lines of insurance. They link changes in premiums with lagged losses, the presence of regulation, and the policy period among their sample of countries.

Additional studies have been conducted to determine whether underwriting cycles exist in other areas of the world and during more recent time periods (e.g., Chen, Wong, and Lee, 1999; Meier, 2006; and Meier and Outreville, 2006). Simultaneous models are also increasingly used to explain premium changes or premium volatility and other aspects of underwriting cycles (e.g., Fung et al., 1998; Wen and Born, 2005).

Recent research in the U.S. may suggest that the cycle may be lengthening or vanishing. Some explanations for this are that computer technol-
ogy has reduced data lags, price regulation has become less stringent, price changes are more frequent due to intensified competition, and insurers use shorter policy terms in key lines such as auto insurance, allowing them to re-price more often. Whether one finds that the cycle is lengthening or vanishing, however, may depend on the time period chosen for analysis as well as whether a time trend is included in the analysis.

OPEN RESEARCH QUESTIONS REGARDING TIME SERIES PROPERTIES OF UNDERWRITING PROFIT

The following are some questions that have not been satisfactorily answered with respect to the time series properties of underwriting results:

1. How have changes in the regulatory environment and in the types and features of the policies offered affected the time series properties of underwriting profits?
2. How much of the autocorrelation in underwriting profits do accounting issues and regulatory lag explain?
3. How much do changes in expenses contribute to second-order correlation in underwriting profits?
4. Why does regulation and regulatory lag appear to have an impact on some lines such as automobile insurance but not on commercial lines (Stewart, 1987)?
5. If interest rates and interest rate changes are factors associated with cycles, why don’t cycles appear in life insurance products?

REAL CYCLES: SHOCK THEORIES AND EXPLANATIONS FOR CRISES

As compelling as the rational expectations model is for explaining underwriting profit patterns, it cannot explain the market disruptions that are associated with hard and soft markets and with insurance crises (i.e., extreme hard markets such as the liability crisis in the mid-1980s). Several shock theories have been developed to explain this real market phenomenon. The types of shocks discussed can be broadly classified as capital shocks (arising from interest rate shocks or loss shocks) or shocks arising from changes in expectations (probability updating for policies issued in the future).
Capital Shock Theories

The familiar cash flow underwriting hypothesis is a basic supply-side explanation for the underwriting cycle. It posits that when the interest rate margin\(^6\) increases, insurers are willing to cut prices (i.e., use a larger discount rate for losses in the premium) to gain market share and obtain assets to invest. But then an adverse loss shock occurs (reducing underwriting profit) or an adverse interest rate shock occurs (reducing return on assets), causing leverage ratios (e.g., the premium to surplus ratio) to increase. This causes the market to harden. Insurers then reduce supply by reducing premium writings and increase price to reduce leverage to more reasonable levels. Conversely, when favorable loss or interest rate shocks occur, then soft markets arise.

Winter (1994) formalizes this basic supply-side explanation and introduces demand into the analysis. Winter posits that insured losses are correlated so that all insurers are hit similarly by shocks. Also, insurers must hold equity to guarantee that they will be able to pay all claims (i.e., insolvency risk is near zero). External capital is assumed to be more costly than internal capital so that capital does not flow freely into and out of the insurance industry (i.e., equity is “sticky”\(^7\)). These assumptions can be used to show that the market goes through periods of tight capacity following adverse loss shocks when prices go up. That is, losses accumulate, causing the market to tighten temporarily until higher prices allow capital to be built up again from retained earnings. As capital accumulates from retained earnings, firms go through periods of slack capacity when prices fall.

Thus, in Winter’s capacity-constraint hypothesis, the industry’s supply curve is flat over part of the price-quantity range and upward sloping when a capacity constraint becomes binding. The industry operates on the flat part of the supply curve during periods of slack capacity (soft markets). For a hard market, an adverse loss shock shifts the supply curve to the left so that the demand curve now intersects it in the upward sloping portion. Both Winter (1994) and Gron (1994a) test the capacity-constraint model, but the capacity-constraint hypothesis does not fully explain the liability crisis of the mid-1980s.\(^8\) Recall, also, that Choi, Hardigree, and Thistle (2002) do not find relative capacity to be cointegrated with underwriting profit.

Rather than a loss shock, Doherty and Garven (1995) model the effect of interest rate shocks on insurance pricing. Both adverse and favorable shocks are explicitly considered. Their model is a firm-specific model rather than an industry-wide model as discussed above. Doherty and Garven (1995) note that the interest rate level is an important determinant of long-run, equilibrium prices in the insurance industry. Changes in interest rates affect the short-run dynamics of the industry by affecting
insurer assets and liabilities. Thus an insurer’s equity is affected by interest changes as well, and the extent to which an individual insurer is affected by an interest rate change depends on the relative duration of assets and liabilities and the insurer’s ability to raise new external capital. If raising new capital is difficult or costly, then capacity constraints (which vary by firm) would cause insurers to cut back on the amount of coverage provided.

In the capacity-constraint model, demand is assumed to remain constant. In addition, it is assumed that insurers hold sufficient capital to maintain the insolvency risk near zero or insurers hold sufficient capital because of regulatory requirements. In other research, these assumptions are relaxed. Harrington and Danzon (1994) and Cagle and Harrington (1995) develop a model in which capital is endogenous and demand is assumed to depend on financial quality (e.g., insolvency risk). For example, Cagle and Harrington (1995) develop a model in which insurers choose the level of capital to operate at based on the benefits (protecting franchise value) and costs of holding capital.

Like Harrington and Danzon (1994) and Cagle and Harrington (1995), in this issue Ligon and Thistle (pp. 46–61) develop a model in which demand is assumed to be downward sloping, capital is costly, insurer insolvencies are possible, and demand for insurance is sensitive to insolvency risk. Using Bayesian rules, insurers are assumed to overreact to new private information and underreact to public information they receive about losses. That is, their reaction to private information is characterized by a psychological bias of overconfidence. Overconfidence then leads to increased volatility in insurance prices and can lead to soft markets if insurers’ private information indicates that expected losses are falling. The converse occurs when adverse information is received by insurers.

An alternative to the capacity-constraint model is the risky-debt hypothesis (Cummins and Danzon, 1997). In this model, insolvencies are assumed to be possible, and demand for insurance is assumed to be inversely related to expected insolvency costs so that firms have an optimal capital structure. Insurance is assumed to be priced as risky debt (i.e., price equals discounted expected loss minus an insolvency put option). Shocks can occur that drive insurers away from the optimal capital structure. In response to an adverse shock, the insurer’s supply curve shifts inward. However, since policyholders are sensitive to financial quality, the demand curve shifts downward at the same time. Thus it is not possible to predict the immediate effect on price from an adverse loss shock. Insurers initially respond to restoring optimal capital structure through increases in retained earnings from raising prices. Thus this model also assumes that insurers have some market power over prices (e.g., from private information about policyholders). If a price increase is sufficient, insurers will be able to raise
external capital. Cummins and Danzon’s empirical model supports the risky-debt theory, but not the capacity-constraint theory.

The predictions of the capacity-constraint and risky-debt models may seem contradictory. The capacity-constraint theory predicts that price is inversely related to capacity (surplus), while the risky-debt hypothesis predicts that price should be directly related to capacity (i.e., financial quality). However, the two theories are not necessarily contradictory. The capacity-constraint theory could hold for the market as a whole (as a time series relationship), while the risky-debt model could explain cross-sectional price differences among insurers at a given time (Weiss and Chung, 2004). Research on reinsurance prices by Weiss and Chung (2004) provides support for both the capacity-constraint and risky-debt hypotheses. This might also explain why Choi, Hardigree, and Thistle (2002) did not find financial quality to be cointegrated with underwriting profit.

Finally, a demand and supply model developed by Lai et al. (2000) emphasizes the role of changing expectations concerning \( \mu_L \) and \( \sigma^2_L \) in explaining insurance crises. They derive a theoretical model with risk-averse policyholders and insurers in a market with perfect competition. Policyholders and insurers are interested in maximizing utility and are assumed to have constant absolute risk aversion. Exposures are assumed to be IID, and in some examples normally distributed. In their model, an adverse change in expectations would reduce supply and make the supply curve more inelastic. At the same time, since demand is assumed to be sensitive to \( \mu_L \) and \( \sigma^2_L \) also, the demand curve shifts outward and becomes more inelastic. This exacerbates the effect of reduced supply on quantity and price of insurance, and the end result is an increase in premiums and a reduction in coverage. The opposite occurs when expected losses fall or there is a decline in risk: Demand contracts and supply expands, resulting in lower prices. Their model is robust enough to include the effects of adverse loss or interest rate shocks on capital structure.

Open Questions Regarding Capital Shock Theories and Real Crises

The following are some questions that have not been satisfactorily answered with respect to the time series properties of underwriting results:

1. What is the actual mechanism for jointly determining the premium and quantity of coverage?
2. What is the shape of the demand curve for insurance (e.g., its elasticity), and how has this changed over time with the development of the alternative market in some commercial lines?
3. How can second order autocorrelation in underwriting profits be consistent with capital shock theories, especially the capacity-constraint theory (Winter, 1994)?
4. For the capital shock theories, why do soft markets always appear to exist prior to a shock that depletes capital (e.g., Winter, 1994)?
5. Do regulatory requirements such as minimum premiums to surplus ratios or RBC requirements affect the amount or quantity of insurance written and hence its price?
6. To what degree can costly external capital explain the effect of shocks on insurer pricing?
7. If one traced the history of large loss events (i.e., events producing a loss shock), do all of them result in a hard market?
8. Is it changing expectations that cause premiums to change and supply to constrict or actual loss shocks that deplete industry surplus? (The former does not involve any liability on the part of insurers.)
9. If a loss shock occurred during the general liability crisis, why doesn’t Winter’s capacity-constraint theory help to explain the general liability crisis?

CONCLUSION

The disparate underwriting cycle theories reviewed here may leave one with the same feeling obtained by looking at a tangled ball of twine. How can these theories be disentangled to determine how much each of them contributes to underwriting cycles, if they contribute at all? For example, how significant is it that underwriting profits are cointegrated with GDP (and hence a business cycle) and that they may be affected by capacity? How much of the change in prices or underwriting profit can be explained by each of these factors? Exactly how much of the underwriting cycle is an artifact of institutional features of the insurance market versus real shocks? If the shock theories are relevant, how much of each hard market can be explained by an interest rate shock versus a loss shock? There are many more questions such as these that deserve attention, both theoretically and empirically. And what about the missing link—the quantity of coverage associated with premium levels? If we had knowledge of this, how would tests of the underwriting cycle theories be affected? Undoubtedly, questions such as these are the next frontier in underwriting cycle research.
NOTES

1 For a more in-depth discussion of the theories discussed here, see Harrington and Niehaus (2000).

2 That is, when demand for the policyholder’s products is high, then more insurance may be demanded. For example, liability insurance purchases should be related to products produced, and workers’ compensation insurance purchases should be related to number of workers, etc. This means that when overall activity is high in the economy, then demand for insurance should be affected.

3 In a study by Haley in this issue, it is pointed out that finding a unit root is a sufficient but not necessary condition for conducting cointegration analysis.

4 It is true that insurers do use naïve time trending in rate filings with the state, but these rates might never be used, because they might never be approved or because insurers are still able to engage in individual risk rating and other forms of price cutting.

5 Changes in premiums are targeted since factors hypothesized to drive apparent underwriting cycles affect premiums directly, and the authors find that changes in premiums are significantly related to lagged losses (for at least some countries) and that changes in premiums are significantly related to regulation. They also develop an empirical model to predict the presence of a cycle in a country.

6 The net interest margin is defined as the difference between the rate insurers can earn on invested assets and the rate they implicitly pay on debt (the discount rate for losses).

7 For example, insurers do not pay out excess capital to stockholders during soft markets because of a “trapped equity effect.” Informational asymmetries between investors and management of insurers could make it expensive for insurers to raise capital after it has been depleted.

8 Some of the capacity constraint models concentrate on the effect of adverse loss shocks (hard markets). Other explanations might exist for underpricing in soft markets. Underpricing might occur due to limited liability or due to guaranty fund payments that do not reflect the insolvency risk of the insurer. A “winner’s curse” could account for soft markets also if insurers that underprice business because of inaccurate loss forecasts are more likely to be awarded business (Harrington and Danzon, 1994).

9 Insurers’ assets consist largely of investments that by their nature are sensitive to interest rates, especially investments such as bonds, and Doherty and Garven (1995) show that liabilities are sensitive to interest rates as well.

10 The argument for raising new capital from retained earnings is different from the capacity-constraint hypothesis (i.e., it is not because of market imperfections). Rather, it is because insurers are assumed not to impose a capital loss on new equity (raising new capital would add value to existing policies with no compensation from existing policyholders).

REFERENCES


A Behavioral Model of Insurance Pricing

James A. Ligon* and Paul D. Thistle**

Abstract: We develop a model of price competition between insurers where insurers maximize expected profit subject to a solvency constraint. Insurers base prices in part on expected losses, the estimates of which are updated in a Bayesian fashion. We assume that insurers are overconfident—they overestimate the precision of their private signal about expected losses. This leads insurers to overreact to their private signal on expected losses. The consequence is that prices may cycle and that the distribution of price changes may be positively skewed because of the role played by the solvency constraint. [Key words: cycles, overconfidence, overreaction].

INTRODUCTION

The recurrence of hard or tight markets in property liability insurance is a well-known characteristic of the industry. In soft markets, underwriting standards are relaxed and prices and underwriting profits are low. In hard markets, underwriting standards become restrictive and prices and underwriting profits increase. Following a hard market, prices and profits remain high, then gradually erode as the market softens. Over the last 20

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years, a substantial research effort has been undertaken to understand the causes of these cycles. There are three basic theoretical models that have been employed to analyze the insurance cycle—the financial pricing/rational expectations model (e.g., Cummins and Outreville, 1987), the capacity constraint model (e.g., Winter; 1988, Gron, 1994), and the financial quality model (e.g., Cagle and Harrington, 1995; Cummins and Danzon, 1997). These models are based on the standard economic model of a competitive market; in particular, these models are based on the assumption that agents on both sides of the market are well informed.

Recent research suggests that these models do not account for the time series properties of property/liability underwriting profits. Choi, Hardigree, and Thistle (2002) compare six alternative models of insurance pricing as explanations of underwriting cycles. They are particularly careful to distinguish between the short-run and long-run implications of the models. They find that the economic loss ratio (Winter, 1988) is stationary, while surplus is not. This implies that (1) there is a long-run equilibrium relationship between prices and discounted losses and (2) there cannot be a long-run equilibrium relationship between the economic loss ratio and surplus. Higgins and Thistle (2000), using data for 1934-1993, find that surplus is a determinant of whether underwriting profits are in a cyclical or non-cyclical regime, but that long-run expected profits do not depend on surplus. Perhaps more importantly, Higgins and Thistle find that the variation in surplus does not account for the short-run variation in profits over the 1972–1988 period—that is, changes in surplus do not account for the hard markets of the 1970s and 1980s. There is also evidence that the length and timing of insurance cycles vary by line of insurance (Venezian 1985; Fields and Venezian, 1989; Lamm-Tennant and Weiss, 1997). There is also some evidence of a structural break in the time series of underwriting profits around 1980 (Leng, Powers, and Venezian 2006; Leng, 2006a, 2006b). Taken together, these factors lead us to consider alternative approaches as possible explanations for the underwriting cycle.

Insurance markets are characterized by substantial incomplete information. For example, insurers generally have imprecise estimates of the expected losses on any pool of policies. Policyholders may be concerned with an insurer’s ability to pay claims, but again have only imprecise estimates of the probability of default. In both cases, estimates must be revised as new information becomes available. How new information is processed in updating these estimates has important implications for the functioning of markets.

The purpose of this paper is to examine the impact of incomplete information on pricing and profits in the property-liability insurance industry. We focus on the processing of new information about insurers
expected losses as a potential source of insurance underwriting cycles. The model developed is behavioral in the sense that it is based on the psychological bias of overconfidence. While insurers are assumed to be rational in the sense of revising beliefs according to Bayes rule, they are overconfident in the sense that they overestimate the precision of the signals they receive regarding expected losses. This leads to an overweighting of the data in the signal relative to the prior. One of the strongest arguments against abandoning the assumption of full rationality in economic and financial modeling is that by assuming a particular form of irrationality any empirical phenomenon can be explained. However, our “irrationality” is quite limited. We assume that firms misestimate one parameter necessary to the application of Bayes rule in a particular way. Further, the way in which we assume that they misestimate this parameter has a firm foundation in human psychology. The psychological bias of overconfidence is one of the most robust empirical regularities in the psychology of judgment.

We assume that insurers are risk-neutral expected-profit-maximizers who compete in prices. We assume that losses are correlated, and capital is costly so that there is some risk of insolvency. We assume that individual insurers face downward-sloping demands for coverage and that demands depend on the probability of solvency. Insurers have prior estimates of expected losses per policy. They receive private and public information about losses per policy and, based on these signals, revise their beliefs according to Bayes rule. Insurers are overconfident in the sense that they overestimate the precision of their private signal. In the short run, this leads insurers to overreact to new private information about expected losses and to underreact to new public information.

In the insurance literature, our analysis is most closely related to the work by Venezian (1985) and Harrington and Danzon (1994). As in Venezian, the emphasis here is on the problem of predicting expected losses per policy. Venezian’s point is essentially statistical, that the OLS forecast errors are serially correlated. In contrast, our analysis is behavioral. Harrington and Danzon (1994) assume that firms have heterogeneous information for forecasting expected losses. We also assume firms have heterogeneous information (i.e., private signals); in contrast to Harrington and Danzon, we explicitly model how the information is processed. As in Harrington and Danzon, our model provides an explanation of underpricing in soft markets. Harrington and Danzon focus on two explanations. First, there may be a “winner’s curse” in that firms with the most optimistic forecasts of losses (due to heterogeneous information and/or naïve forecasting) will tend to underprice. Second, moral hazard (due to limited liability and/or insurance guarantee funds) creates incentives for firms to price below
expected costs. In our analysis, overconfidence can lead insurers to underprice in response to "good news."


Our model has a number of empirical implications for the time series of insurance prices. An important implication of the analysis is that prices will be cyclical; insurers' overreactions lead to short-term momentum in prices followed by reversals over the long term. Our model also implies that prices will exhibit excess volatility relative to what should be expected based on economic fundamentals. Finally, our model implies that price changes will be asymmetric, since price decreases are bounded below by the solvency constraint. Our model also has implications for cross-sectional analysis. The model implies that insurers' prices should tend to move together. Also, to the extent that larger insurers have more precise estimates of future losses, their prices should be more responsive to private signals and less responsive to public signals than those of smaller firms.

The next section of the paper sets out the basic framework for the analysis. The third section develops the implications of overconfidence for insurance prices. The final section contains concluding remarks.
THE BASIC FRAMEWORK

The basic framework for the analysis is a model of price competition among firms that produce differentiated products. The primary differences from the standard model, which are required to apply the model to the insurance industry, are that costs (losses per policy) are uncertain and that firms are subject to a constraint on the probability of insolvency.

We assume there are $n$ risk-neutral expected-profit-maximizing insurance firms. Policyholders are concerned with the price of insurance and with the probability that claims will be paid. We assume that policyholders are concerned with the insurer’s risk of insolvency, but are heterogeneous in the sense that they have different willingness to trade off the price of an insurance policy against its “quality” or the probability of the insurer’s solvency. Informational asymmetries (by firms about policyholders and by policyholders about firms) and other differences among firms give rise to switching costs. This implies that the demand for coverage facing a particular firm, given the firm’s probability of solvency, is downward sloping. The demand for insurance for firm $i$ is $q_i(p, \alpha)$ where $p$ is the $n$-vector of prices and $\alpha$ is the $n$-vector of solvency probabilities. We assume that demand is a decreasing function of $i$’s price and an increasing function of the prices of other firms; we also assume the elasticity of demand is a decreasing function of rivals’ prices. We assume that demand is an increasing function of firm $i$’s solvency probability, and a decreasing function of other firms’ solvency probabilities. We let $p_{-i}$ and $\alpha_{-i}$ denote the vectors of prices and solvency probabilities of firm $i$’s rivals.

Firms invest financial capital $K_i$ to support the sale of insurance policies. The flow cost per unit of capital is $r$. The expected present value of losses per policy is denoted $x_i$. The insurer’s prior distribution on per policy loss is $N(\mu_{0i}, h_{0i}^{-1})$, where $h_{0i}$ is the precision of the prior (the variance is $1/h_{0i}$). For simplicity, we assume that all insurers face the same loss distribution.8 We also assume that the prior does not depend on the number of policies sold; this implies that variation in the loss per policy is due to correlation in losses across policies. The firm is solvent if

$$p_iq_i - x_iq_i + K_i \geq 0,$$

or if

$$p_i + K_i / q_i \geq x_i.$$

Then the solvency constraint is
\[ N_0(p_i + K_i / q_i) \geq \alpha_i, \]  

where \( N_0 \) is the (prior) cumulative normal distribution. The solvency constraint is not necessarily due to insurance regulations. The constraint could be the solvency probability needed to maintain a certain financial strength rating.

Prior to receiving information regarding losses per policy, the firm’s expected profit is

\[ \pi_i(p, \alpha) = p_i\theta_i - \mu_0q_i - rK_i, \]  

which the firm maximizes with respect to price, subject to the constraint that the probability of solvency is at least \( \alpha_i \). We assume that expected profit is strictly concave in price. The unrestricted profit maximizing price solves

\[ \frac{\partial \pi_i}{\partial p_i} = (q_i + p_i\frac{\partial q_i}{\partial p_i}) - \mu_0\frac{\partial q_i}{\partial p_i} = 0. \]  

Let \( p_i^* \) denote unrestricted profit maximizing price; \( p_i^* \) is free of the solvency probability and precision and is increasing in rivals’ prices. Also, \( p_i^* \) is increasing in the expected loss per policy.\(^9\)

The solvency constraint can be rewritten as

\[ p_i \geq \mu_0 + \frac{z_{a_i}}{(h_0)^{1/2}} - K_i / q_i, \]  

where \( z_{a_i} \) is the 100\( \alpha_i \) percentile point of the standard normal distribution. The first term on the right-hand side of (4) is the pure premium, the second term is the safety loading, and the third term is the available capital per policy. Letting \( \hat{p}_i \) be the lowest price that satisfies the solvency constraint, the solvency constraint becomes \( p_i \geq \hat{p}_i \). The minimum price \( p_i \) is decreasing in the precision of the loss distribution and increasing in the probability of solvency and in rivals’ prices.

The insurer sets price at the unrestricted price, \( p_i^* \), if the solvency constraint is not binding and at the minimum price, \( \hat{p}_i \), if the constraint is binding. That is, the actual price set by the insurer is \( p_{0i} = \max\{p_i^*, \hat{p}_i\} \). This is the insurer’s best response function. Since both \( p_i^* \) and \( \hat{p}_i \) are increasing in \( p_{0i} \), so is \( p_{0i} \). A Nash equilibrium exists, and, under reasonable restrictions, is unique (Vives, 1990; Milgrom and Roberts, 1990).\(^{10}\)

One implication of this model is that, since best response functions are upward sloping, the prices of firms will tend to move together. That is, let \( \theta \) be any parameter that increases the firm’s marginal profitability (\( \partial^2 \pi_i / \partial \theta \partial p_i \geq 0 \) for all \( i \)). Then in equilibrium, \( \partial p_{0i} / \partial \theta \geq 0 \), the prices of all firms
increase. Thus, for example, an increase in the expected loss per policy increases the prices of all firms. Similarly, $\partial p_{ij} / \partial \alpha_i \geq 0$ and $\partial p_{ij} / \partial K_i \leq 0$ for all $i$ and $j$—that is, equilibrium prices are nondecreasing in the solvency probability and nonincreasing in the capitalization of any individual firm.$^{11}$

**OVERCONFIDENCE AND BAYES RULE**

To examine the effect of overconfidence on insurance prices, we extend the model to three periods. In period 0, the firm has only its prior information. We assume that each firm receives both private and public signals regarding the loss per policy. The private signal is received in period 1 and the public signal in period 2; losses are realized at the end of period 2. The prior estimate of losses is then updated each period according to Bayes rule. We assume that insurers are overconfident in that they overvalue the private signal they receive about estimated losses per policy.

The loss per policy, $x$, is drawn from a normal distribution with mean $\mu_0$ and precision $h_0^{-1}$—that is, $x \sim N(\mu_0, h_0^{-1})$. The private information signal received by insurer $i$ at date 1 is

$$s_{1i} = x + \varepsilon_{1i},$$

where $\varepsilon_{1i} \sim N(0, h_1^{-1})$ and $h_1$ is the true precision of the private signal. The insurer is overconfident and overestimates the precision of the private signal, treating the precision as if it is $\beta h_1$, where $\beta > 1$; we say the insurer is “properly calibrated” if $\beta = 1$. One interpretation of this assumption is that the insurer has more confidence in its own estimates of expected losses than in estimates from service agencies such as the Insurance Services Office.

The public information signal received by all insurers is

$$s_2 = x + \varepsilon_2,$$

where $\varepsilon_2 \sim N(0, h_2^{-1})$ and $h_2$ is the precision. Both private and public signals are unbiased estimates of per policy losses. While the errors $\varepsilon_{1i}$ are independent across firms and independent of $\varepsilon_2$, insurers’ private signals are correlated with each other and with the public signal.

**Private Signals**

Applying Bayes rule, the insurer’s revised estimate of the loss per policy in response to the private signal is
\( \mu_1 = E(x \mid s_1) = (h_0 \mu_0 + \beta h_1 s_1) / (h_0 + \beta h_1), \) \hspace{1cm} (7)

which is the average of the prior and the signal, weighted by their relative precisions, where the firm-specific subscript is suppressed. The posterior estimate of the precision is \( h_0 + \beta h_1 \), which is greater than the true precision. The posterior mean may also be written

\[ \mu_1 = \mu_0 + \beta h_1 (s_1 - \mu_0) / (h_0 + \beta h_1) = \mu_0 + w_1 (s_1 - \mu_0), \]

where the second term is the revision due to the signal. Compared to an insurer who is properly calibrated (\( \beta = 1 \)), overconfidence increases the magnitude of the revision in beliefs. In this sense, overconfidence leads to an overreaction to the private signal. Despite this, if the underlying distribution of \( x \) is stationary, the insurer will eventually learn the correct loss per policy. After \( T \) private signals the posterior mean is \( E(x \mid \cdot) = (h_0 \mu_0 + T \beta h_1 \bar{s}_1) / (h_0 + T \beta h_1) \), where \( \bar{s}_1 \) is the mean signal, and, as \( T \to \infty \), this converges to \( x \) by the strong law of large numbers.

Now consider the effect of the private signal on the insurer’s best response. We say a private signal is “good news” if it is below the prior mean, \( s_1 < \mu_0 \), and “bad news” if it is above, \( s_1 > \mu_0 \). The effect of the signal on the unrestricted profit maximizing price, denoted \( p_1^* \), is straightforward. Good news leads to a downward revision in average loss per policy and a decrease in price. Bad news has the opposite effect.

The private signal also affects the minimum price implied by the solvency constraint. We let \( \hat{p}_{1i} \) denote this minimum price based on the private signal. The solvency constraint in (3) becomes

\[ p_{1i} \geq \mu_1 + z_{a_i} / (h_0 + \beta h_1)^{1/2} - K_i / q_i. \] \hspace{1cm} (8)

We want to determine whether \( \hat{p}_{1i} \) is larger or smaller than \( \hat{p}_{0i} \). The question is whether the right-hand side of (8) is larger or smaller than the right-hand side of (4). The pure premium increases or decreases as there is bad news or good news. The safety loading decreases whether the news is good or bad. Thus, good news shifts the right-hand side of (8) downward, which reduces the minimum price, \( \hat{p}_1 \). If the news is bad, but “not too bad,” the effect on the safety loading dominates and \( \hat{p}_1 \) decreases. If the news is sufficiently bad, then the effect on the pure premium dominates and \( \hat{p}_1 \) increases. This is true whether the insurer is properly calibrated or overconfident. Overconfidence increases the magnitude of the downward revision in \( \hat{p}_1 \) in response to good news. If the news is bad, then the effect of overconfidence is to decrease the smallest value of the signal for which \( \hat{p}_1 \).
increases.\footnote{12} That is, overconfidence tends to increase the magnitude of the change in $\hat{p}_1$, especially in response to good news.

As before, the best response is $p_1 = \max\{p_1^*, \hat{p}_1, \}$. Good news decreases both $p_1^*$ and $\hat{p}_1$, so $p_1$ decreases in response to good news. Overconfidence leads insurers to underestimate average losses per policy and consequently set prices lower than they otherwise would. This suggests that realized underwriting profit margins are likely to be below expectations. This is especially problematic for firms that are on or close to their solvency constraint since overconfident firms underestimate the price needed to maintain their solvency probability. This suggests that, over time, such firms will find that their capital is eroded and their actual default probabilities are increasing. Eventually, such firms will need to obtain an infusion of capital or increase prices; such price increases may need to be substantial.

If the news is “not too bad,” then $p_1^*$ increases and $\hat{p}_1$ decreases. If the solvency constraint is not binding then $p_1$ increases, and if the constraint is binding then $p_1$ decreases. Again, this situation is likely to create problems for firms that are on their solvency constraint. However, overconfidence makes it more likely that $\hat{p}_1$, hence, $p_1$, will increase in response to bad news. If news is sufficiently bad, then both $p_1^*$ and $\hat{p}_1$ increase, so $p_1$ increases; again, overconfidence magnifies the response.

The responses to good news and bad news may be asymmetric. This asymmetry arises for firms that are on or close to the solvency constraint. There is no upper bound on price increases in response to signals that losses will increase. However, price decreases in response to signals that losses will decrease are limited by the solvency constraint. This is true even if overconfident firms underestimate the price needed to maintain a given probability of solvency.

It seems reasonable to expect the precision of the private signal to depend on the size of the insurer, with larger insurers having more precise private signals. The weight, $w_1$, is increasing in the precision $h_1$. This implies that larger insurers will react more strongly than smaller insurers to the same signal, whether it is good news or bad news.

**Public Signals**

At time 2, insurers also receive public signals of average losses per policy. The insurer’s revised estimate of the loss per policy in response to the public signal is

$$\mu_2 = E(x \mid s_1, s_2) = (h_0 h_0 + \beta h_1 s_1 + h_2 s_2) / (h_0 + \beta h_1 + h_2), \quad (9)$$
which is the average of the prior and both signals, weighted by their relative precisions. The posterior precision is \( h_0 + \beta h_1 + h_2 \), which is greater than the true precision. The posterior mean may also be written

\[
\mu_2 = \mu_1 + w_2(s_2 - \mu_1) = \mu_0 + w_1(s_1 - \mu_0) + w_2(s_2 - \mu_1),
\]

where \( w_1 = \beta h_1 / (h_0 + \beta h_1) \) and \( w_2 = h_2 / (h_0 + \beta h_1 + h_2) \). The last term is the revision due to the public signal. Since \( w_2 \) is decreasing in \( \beta \), overconfidence decreases the magnitude of the revision in beliefs compared to a properly calibrated insurer. Again, if the underlying distribution of \( x \) is stationary, \( \mu_2 \) will converge to \( x \), and as the number of signals approaches infinity the insurer will eventually learn the correct loss per policy.

We say a public signal is good news if it is below the prior mean, \( s_2 < \mu_1 \), and bad news if it is above, \( s_2 > \mu_1 \). The effect of the public signal on the profit maximizing price, \( \hat{p}_2 \), is essentially the same as the effect of the private signal. Good news leads to a downward revision in average loss per policy and a decrease in price. Bad news that is not too bad increases \( \hat{p}_2^* \) and decreases \( \hat{p}_2 \), while news that is sufficiently bad increases price unambiguously.

While overconfidence reduces the reaction to the public signal, the net effect of the public and private signals is an overreaction. That is, let \( \mu_2' \) denote the properly calibrated posterior mean and assume \( |s_1 - \mu_0| = |s_2 - \mu_1| \) so that both signals contain the “same amount of news.” Then, so long as the prior is not too diffuse, if \( s_1 - \mu_0 > 0 \), then \( \mu_2 - \mu_2' > 0 \), and if \( s_1 - \mu_0 < 0 \), then \( \mu_2 - \mu_2' < 0 \), regardless of whether the public signal is good news or bad news. That is, the effect of the private signal dominates.

The precision of the public signal may be independent of the size of the insurer, but is likely to depend on the size and homogeneity of the statistical reporting agency with which the insurer is affiliated. The weight on the public signal, \( w_2 \), is increasing the precision of the public signal, \( h_2 \), but decreasing in the precision of the private signal, \( h_1 \), and in \( \beta \), the degree of overconfidence. If larger insurers have more precise private signals than smaller insurers then they will revise prices less than smaller insurers in response to the same public signal.

**CONCLUDING REMARKS**

Existing models of underwriting cycles, based on the economic model of a competitive market, assume that agents on both sides of the insurance market are well informed. Insurance markets are characterized by substantial incomplete information. We examine insurers’ processing of informa-
tion regarding expected losses as a potential source of underwriting cycles. The model developed is behavioral in that we assume insurers are overconfident, an assumption that has a strong foundation in psychology. Overconfidence is modeled as an overestimate of the precision of the insurers’ private information. Overconfidence leads insurers to overreact to their private information. Thus, overconfidence increases the volatility of insurance prices. Increased volatility of insurance prices due to overconfidence may be a contributing factor in insurance cycles.

Overconfidence may be a contributing factor in soft markets. If firms receive private signals that losses are decreasing, then overconfidence increases the downward revision in prices. In particular, overconfidence leads them to underestimate the minimum price necessary to maintain a given level of default risk. If the private signal indicates losses have fallen and the public signal indicates losses have risen, for overconfident firms the net effect of the private and public signals will be to underprice. The underestimates of expected losses and minimum prices can be expected to lead to the erosion of capital over time. As capital erodes, the number of firms that are on or near their solvency constraints increases. Such firms are more vulnerable to shocks to capital and to bad news about expected losses.

One implication of the model is that the changes in prices in response to information may be asymmetric. This is more likely if signals indicate that large changes in losses are occurring so that the resulting price changes will be large. Upward revisions in prices occur in response to bad news that expected losses per policy are increasing. Downward revisions in prices in response to good news that losses are decreasing are limited by the solvency constraint.

The formal analysis is based on a model of a monoline insurer. However, it seems reasonable to believe that the precision of both private and public signals varies by line of insurance. It also seems reasonable to believe that insurers’ overconfidence varies by line of insurance. If insurers have more precise data or are more overconfident about certain lines of insurance, then the pattern of cycles will differ by line of insurance. Our formal model also assumes that the underlying economic structure is stable. Thus, our model does not account for structural breaks per se. Any structural break must necessarily be the result of a change in some underlying parameter or functional relationship. For example, the central problem analyzed here is that of forecasting expected discounted future losses. Then, as suggested by Leng, Powers, and Venezian (2002), a structural change in interest rate policy could lead to a shift in the distribution of the discounted losses and therefore a structural change in the time series of underwriting profits.
Our model also has implications for cross-sectional analyses of insurance prices. We assume that insurers produce differentiated (by their risk of insolvency) policies and compete in prices. As a consequence, the model predicts that insurers’ prices should tend to move together. It seems reasonable to think that larger insurers have more precise private estimates of losses per policy than smaller insurers. If so, then larger insurers should have a greater reaction to any given private signal than smaller insurers. Larger insurers should also have a smaller reaction to any given public signal than smaller insurers. Finally, we should point out that we assume that coverage is optional and that there is no price regulation. Thus, the model applies more directly to commercial lines than to, say, homeowners insurance.

For such a behavioral model to have long-run explanatory power there must be some mechanism that allows overconfidence to persist in the marketplace. It is frequently argued that rational economic agents (investors, firms) will drive irrational agents out of the market; see Sandroni (2000, 2005a, 2005b) for one such argument. DeLong, Shleifer, Summers, and Waldmann (1990), Daniel, Hirshleifer, and Subramanyam (1998), Benos (1998), Hirshleifer and Luo (2001), and Wang (2001) all argue that overconfident investors can survive and even dominate the market in the long run. More generally, Slezak (2003) shows that inter-temporal predictability (i.e., cycles) of asset prices “is robust to the inclusion of dynamic rational agents under very weak conditions” (p. 525) and that irrational agents will typically survive. We should also point out that overconfidence is one of a number of behavioral biases that are known to affect decision making. For example, it is known that individuals systematically misperceive the laws of probability and that individuals tend to overweight small probabilities and underweight large probabilities.

Finally, the behavioral model described here cannot be the entire story of cycles. Even an overconfident insurer ultimately discovers the true value of expected losses if the distribution is stationary. Thus, cycles would eventually become muted. For a long-run cyclical pattern to exist, there must be shocks to the expected loss distribution. What our modest efforts here suggest is one possibility of why the pattern of premium and profitability cycles may not be perfectly correlated with observable loss or surplus shocks.

NOTES

the U.S. insurance industry; see Cummins and Outreville (1987), Lamm-Tennant and Weiss (1997), and Chen, Wong, and Lee (1999) on international comparisons.

More precisely, Higgins and Thistle find that when the premium-surplus ratio is low, underwriting profits follow an AR(1) process, and when the premium-surplus ratio is sufficiently high, underwriting profits follow a cyclical AR(2) process. Underwriting profits follow a cyclical AR(2) in 1948–1954 and 1968–1993.

A review of other recent empirical literature on cycles suggests that the current evidence can only be characterized as inconclusive. Harrington and Niehaus (2000) survey the literature on insurance cycles, as does Harrington (2004). Other recent evidence includes Gron and Winton (2001), Harrington and Yu (2003), and Weiss and Chung (2004).

We should point out that insurers in our model are not fully rational Bayesians in that they do not update their estimate of the precision over time. If they did so, we would expect overconfidence to disappear over time.

See Lichtenstein, Fischhoff, and Phillips (1982) for an excellent summary of early work in the area and the March 1996 special issue of Organizational Behavior and Human Decision Processes and the September 1997 issue of the Journal of Behavioral Decision Making for a sampling of more recent research on overconfidence. Some evidence suggests that experts tend to be more overconfident than novices (Griffin and Tversky, 1992). Evidence also suggests that overconfidence is greater for difficult tasks that require judgment and for tasks where feedback is noisy and delayed (Einhorn, 1980).

This problem is compounded if non-stationary data are regressed on a linear time trend, since this introduces spurious cycles into the residuals (Granger and Newbold, 1974).


Loss distributions may differ across insurers due to differences in, e.g., underwriting standards. Relaxing the assumption of a common loss distribution complicates the model, but has no qualitative effect on the results.

Since we are taking the firm’s capital as fixed, this is a model of short-run price determination. The best available empirical evidence suggests that insurer capital has only a short-run effect on prices.

The firm will operate only if \( p_{0i} \geq \mu_{0i} \). We assume there is a maximum price, \( p_{i}^{\text{max}} \), above which quantity demanded is zero. Then the firm’s strategy space can be taken to be \([\mu_{0i}, p_{i}^{\text{max}}]\). Under the assumptions on demands, \( \frac{\partial^2 \pi_i}{\partial p_j \partial p_i} \geq 0 \). Then the game is supermodular (e.g., Milgrom and Roberts, 1990, p. 1264) and a pure strategy Nash equilibrium exists. If own effects dominate cross effects, so that a “dominant diagonal” condition also holds (e.g., Milgrom and Roberts, 1990, p.1271), the equilibrium is unique. Note also that, since the firm can earn a strictly positive expected contribution margin by charging a price slightly above \( \mu_{0i} \), the solution to the unrestricted profit maximization problem must be in the interior of the strategy space, consequently, \( p_{0i} > \mu_{0i} \) hence, the equilibrium is interior.

The inequalities are strict if the solvency constraint is binding for firm \( i \).

Letting \( f_0 \) denote the right-hand side of (4) and \( f_1(s_i) \) denote the right-hand side of (8), \( \hat{p}_1 \) decreases if \( f_1(s_i) - f_0 \) is negative and increases if it is positive (\( f_1 - f_0 \) is increasing in \( s_i \)). The effect of a change in \( \beta \) on the root of \( f_1(s_i) - f_0 = 0 \) is in general ambiguous, but should be negative for most parameter values. Then overconfidence decreases the value of the smallest signal for which \( f_1(s_i) - f_0 \geq 0 \) and increases the smallest value if the signal for which \( \hat{p}_1 \) increases.
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Further Considerations of Underwriting Margins, Interest Rates, Stability, Stationarity, Cointegration, and Time Trends

Joseph D. Haley*

Abstract: This article provides a philosophical discussion detailing the limitations of univariate analysis in the pre-testing step of data analysis. The case in point is the relationship between the property-liability aggregate underwriting margin and interest rates. Haley (1993) and Choi, Hardigree, and Thistle (2002) both found strong evidence indicating such a relationship exists. Since then assorted authors, relying extensively on univariate analysis, have questioned the cointegration conclusion. The paper uses a cointegration analysis of the property-liability aggregate underwriting margin and interest rates (1930–2000) to illustrate the discussion. [Key words: cycles, cointegration, underwriting margins.]

The importance of interest rates is well established in insurance pricing theory.¹ Since insurance premium inflows and claim cost outflows occur at different points in time, interest rates and insurance prices have a (theoretically) negative relationship. Haley (1993) and Choi, Hardigree, and Thistle (2002) both conclude that a negative cointegrating relationship does indeed exist between the underwriting margin and the risk-free rate.² Some researchers, however (Leng et al., 2002; Harrington and Yu, 2003; Leng, 2006a, 2006b; Leng and Meier, 2006), have questioned these cointegration conclusions, mostly basing their contrary arguments on the results of univariate analysis. Leng and Meier (2006) comment, at the end of their article, that the theoretical relationship between the loss ratio and interest rates (in the U.S.) is “not well supported empirically.”

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CONSIDERING THE COINTEGRATION METHODOLOGY

The purpose of this article is to present a philosophical perspective on the limitations of using univariate analysis as a pre-test while evaluating the relationship between underwriting margins and interest rates. My perspective is concerned with careful interpretation and extraction of the information contained in the underwriting margin and interest rate time series. My arguments consider what a priori restrictions should be placed on the data and what the assorted univariate statistical methods are capable of describing. The context of this article includes a thoughtful and back-to-the-basics consideration of equilibrium conditions and stationarity. A cointegration analysis of the property-liability aggregate underwriting margin and the 90-day Treasury bill rate is presented, in part, to illustrate the discussion. The analysis also provides evidence in support of insurance pricing theory.

Equilibrium

Economic equilibrium can be broadly defined as a set of circumstances that possesses a tendency for no change. Equilibrium conditions are considered stable if, when a deviation occurs, there is a tendency to return to them. Since many economic systems (or subsystems) are subject to frequent shocks from a wide variety of sources, the actual (exact) attainment of equilibrium is probably quite rare. What is more generally the case in a stable equilibrium system is a continuous effort to move towards a target, yet rarely settling on the target. A stationary time series (fixed mean and variance) can, for instance, be indicative of equilibrium conditions. A multivariate set of circumstances that is indicative of equilibrium conditions occurs when two or more variables have the collective tendency to move towards an attracting space. In the two-variable case this attractor is a line.

Two major variables of interest in an equilibrium analysis of the property-liability underwriting cycle are the underwriting margin and the risk-free interest rate. As already mentioned, the theoretical insurance pricing models promote the expectation of a negative relationship between these two variables with variations in the risk-free interest rate being an explanatory factor for variations in the underwriting margin. Figure 1 displays the 90-day Treasury bill rate for new issues and the aggregate underwriting margin for stock property-liability companies, 1930–2000. Visually, both variables appear to be nonstationary since they do not fluctuate around a fixed mean (for the entire period). The interest rate variable trends upward until 1981, after which it begins to decline, while the underwriting margin trends downward until approximately 1984, after which it begins a slight upward trend.
Cointegration Analysis

The cointegration technique for analyzing long-run equilibrium relationships in time series data was first developed by Engle and Granger (1987). According to this technique, two nonstationary variables are cointegrated if (1) they can be linearly combined \((x_t - \beta y_t)\) to create a third variable that is stationary and (2) this resulting new variable has a statistically significant relationship with the first differences of at least one of the original variables.

Cointegrated variables are interpreted as having a long-run equilibrium relationship. The \((x_t - \beta y_t)\) relationship defines the long-run attractor line for the variables, while the stationarity of the deviations from this line displays the short-run dynamics and indicates a tendency for the relationship to return to the line. Rewriting the expression for this relationship gives\(^5\)

\[
x_t = \beta y_t + \epsilon_t
\]

where \(\epsilon \sim N(0,\sigma^2)\). \(E(\epsilon) = 0\) is an important property indicating that the two-variable system is attempting to achieve equilibrium.

A prerequisite to any conclusion of cointegration is, of course, that the underwriting margin and the interest rate variables both be nonstationary. It is this “pre-test” analysis that is the main source of differing opinions and conclusions by other researchers.

Pre-Testing and Stationarity

A stationary time series, \(x_t\) variable has three conditions (Vandaele, 1983):

\[
E(x_t) = \mu \text{ (fixed mean)}
\]

\[
E[(x_t - \mu)^2] = \sigma^2 \text{ (fixed variance)}
\]

\[
(E[(x_t - \mu)(x_s - \mu)])/\sigma^2 = \rho_{t-s} \text{ (fixed autocorrelation coefficients).}
\]

Each condition refers to a particular feature of the variable remaining constant through time. Of greatest significance to a cointegration study is a fixed mean. The fixed variance is important, but can be relaxed under certain conditions.\(^6\) Neither variable presented in Figure 1 appears to fluctuate around a fixed mean over the entire time period.
CONSIDERING THE COINTEGRATION METHODOLOGY

The source of mean nonstationarity in the underwriting margin is the essential issue in Harrington and Yu (2003). Their results clearly show mean nonstationarity (1953–1998) and they attribute the nonstationarity to a deterministic time trend, thereby asserting (univariately) a process onto the time series. It is important to mention, however, that nonstationarity is a much more open-ended property than stationarity. Nonstationarity, as the word implies, is simply the absence of stationarity. The sources of nonstationarity in a time series variable may be few or myriad. A cointegration analysis is concerned with mean stationarity and, in this case, the possible long-run relationship between the risk-free interest rate and the underwriting margin. I am not concerned with a full (univariate) determination of these variables’ data generating processes (DGP). The Newbold, Leybourne, and Wohar (2001) analysis of U.S. real GNP concludes that a single notion of stationarity (trend- or difference-stationary) does not apply during 1875–1993. They are not surprised by this conclusion (neither am I) and continue on to state that “stationarity of any sort” is “a priori implausible” for the entire 119 years.

The fact that nonstationarity has a wide variety of forms is reflected by the considerable amount of literature that has been devoted to developing tests for it. According to Robinson (1994), the literature’s emphasis on unit roots may have obscured the fact that a unit root is “an extremely specialized form of nonstationarity.”

Fig. 1. Ninety-day Treasury bill and property-liability underwriting margin for stock companies, 1930–2000.
Instead of being enamored with the specificity of unit root tests, Granger (1995, 1997) describes time series variables as possessing the property of “persistence” or “extended-memory.” A time series process is said to have extended memory if the conditional (univariate) expected mean over a large time horizon does not tend to be constant—i.e., has no fixed mean.

Pre-Testing and Structural Stability

Several articles (Leng et al., 2002; Leng and Meier, 2006; Leng, 2006a, 2006b) follow a structural stability line of thought in evaluating insurers’ aggregate underwriting results. While this type of analysis can provide important insights into certain aspects of a time series, it is not needed as a cointegration pre-test (nor does it affect the cointegration test). For example, through a series of hypotheses, Leng and Meier (2006) conclude that the U.S. property-liability loss ratio (1955–1997) is nonstationary. They then proceed to determine that a structural break occurred around 1986 and divide the time series into pre-break and post-break subperiods. Subsequently, they conclude that the interest rate and loss ratio are not cointegrated in the post-break period. However, dividing the data (univariately) into pre-break and post-break subperiods interferes with a multivariate long-run analysis. In a similar fashion, Leng (2006a, 2006b) eliminates data prior to 1952 with the reasoning that World War II events and price controls and the passage of the McCarran-Ferguson Act may have created abnormal behavior. In the cointegrating equilibrium analysis that follows, unusual fluctuations during the mid-1940s are easily identified, but the industry’s effort to maintain equilibrium is clear. Eliminating data, a priori, eliminates potential information.

Leng et al. (2002) states that “cointegration tests are valid for only stable nonstationary processes.” This assertion places an unnecessary pre-test restriction on time series data. A long-run equilibrium relationship may be subject to many, many influences that cause the relationship to take different forms. Cointegration simply attempts to determine whether a set of variables exhibit the tendency, over the long run, to return to an attracting space. For instance, Leng (2006b) concludes that a structural break in the combined ratio occurred (approximately) in 1981. She further concludes that the combined ratio followed an AR(2) process only during the pre-break period. This indicates a change in dynamics—but the change could easily be limited to short-term dynamics. This result does not eliminate the possibility of the underwriting margin and interest rates having a long-run relationship.

The objective of the univariate pre-testing portion of a cointegration analysis is only to discuss the significance of finding whether the respective variables are stationary in mean, or, to use Granger’s term, persistent.
While I refer to unit root tests, I am not testing for a specific form of nonstationarity.\textsuperscript{11}

**Pre-Testing and Time Trends**

It is my opinion that the inclusion of a time trend factor in a unit root test needs to be given very careful consideration. Harrington and Yu (2003) emphasize the comments of Dejong et al. (1992), who state that the trend “need not literally be part of the data generation process, but may be viewed as a substitute for a complicated and unknown function of population, capital accumulation, technical progress, etc.” There are pitfalls, though, in using a generic trend factor as a substitute for a “complicated and unknown” functional influence. The foremost problem is the removal of information that can be measured and assessed to a known and very legitimate influential factor. In the case of the property-liability underwriting margin, the interest rate is widely accepted as a factor in insurance pricing.

Harrington and Yu (2003) identify other factors affecting underwriting margins over the time period of their study—breakdown of bureau rating systems and growth of direct writers—but the lumping together of these factors (with the possible effects of the interest rate) into a trend removes the ability of a researcher to analyze the particular component effects. A major motivation, in my view, of the development of cointegration analysis was to give researchers the ability to distinguish between generic trend movements (“everything is going up”) and specific estimators regarding the long-run and the short-run relationship between variables. If factors such as the breakdown of bureau rating systems and the growth of direct writers could feasibly and reliably be measured in a time series data set, then these variables would possibly be the subject of a cointegration analysis involving the underwriting margin.

Few economic processes can be directly attributed to the mere passing of time. Dejong et al. (1992) repeatedly refer to the plausibility of using a trend factor when analyzing a time series. To this end, I think it is important for trend factors to be subject to some of the same scrutiny as any other “explanatory” variable.\textsuperscript{12} For instance, a positive time trend factor for underwriting margins makes little sense in the very long run because underwriting margins cannot increase forever. A quadratic time trend may fit a particular time period (as Harrington and Yu show), but a quadratic trend allows for only one bend-point in the trend (see Figure 1). In the limit, neither of these underwriting margin specifications can exist, so any use of these types of trend factors should be regarded as temporary. It can certainly be argued that the mere finding of a statistically significant trend factor is an indicator of the presence of nonstationarity in mean.\textsuperscript{13} The very
long run notwithstanding, it should be acknowledged that all estimates are most applicable to the data and time period being evaluated.

**Estimating Cointegration Models**

The cointegration technique comprises two sets of estimators—the cointegrating equation and the error-correction model. The cointegrating equation measures the long-run equilibrium relationship between two (or more) nonstationary variables, while the residuals of this equation, if stationary, contain information about the variables’ short-run dynamics. A complete equilibrium relationship exists only if these (stationary) error terms possess a statistically significant relationship with the (stationary) first differences of at least one of the cointegrating variables. Finding this result is necessary because the residuals of the cointegrating equation represent temporal deviations from the long-run equilibrium attractor, and it is expected that at least one of the cointegrating variables will consistently adjust towards the attractor. Haley (1993) showed that the underwriting margin (insurance prices) makes such an adjustment. If a statistically significant error-correction is not found in the second step of the estimation, spurious correlation is a likely conclusion.

**Cointegration Testing Results**

A two-step cointegration analysis was performed on the 90-day Treasury bill rate for new issues and the aggregate underwriting margin for stock property-liability companies, 1930–2000. The estimated cointegrating equation is

$$ r_u = 3.055 - 1.197 r_f $$

where $r_u$ = underwriting margin and $r_f$ = 90-day T-bill rate. Both estimated parameters are significant at the 1% level, the adjusted r-square is .376, and the F-ratio is 43.16. These results compare quite favorably to Haley (1993), whose time period was 1930–1989. This equation is representative of the long-run equilibrium relationship between the underwriting margin and the risk free interest rate. The deviations from this equation (potentially) represent the short-run dynamic activity surrounding the equilibrium relationship between the aggregate underwriting and the 90-day T-bill rate.

The second step of the two-step analysis is concerned with verifying the short-run equilibrium adjustments using two error-correction models (ECM). These models take the form
CONSIDERING THE COINTEGRATION METHODOLOGY

where \( g = 3 \) and was chosen by minimizing the AIC. The estimated results of the ECM are reported in Table 1. The ECM results show a strong negative relationship (–0.464) between the short-run deviations from the cointegrating line and changes in the underwriting margin. The negative sign on this ECM coefficient conforms to theory by showing that prices tend to increase when the actual underwriting margin is less than the value predicted by the equilibrium cointegrating equation.

The estimated error terms from equation (3) are presented in Figure 2. The error terms appear to be stationary, as they make a consistent effort to return to equilibrium. Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests of these error terms reject the null hypothesis of a unit root, also indicating stationarity.\(^\text{16}\)

### Table 1. Estimated Parameters of Error-Correction Models

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>( \Delta r_u )</th>
<th>( t )-value</th>
<th>( \Delta r_f )</th>
<th>( t )-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>–0.164</td>
<td>–0.43</td>
<td>0.093</td>
<td>0.71</td>
</tr>
<tr>
<td>( z_{t-1} )</td>
<td>–0.464</td>
<td>–3.63*</td>
<td>0.049</td>
<td>1.11</td>
</tr>
<tr>
<td>( \Delta r_{f_{t-1}} )</td>
<td>0.281</td>
<td>0.66</td>
<td>0.0800</td>
<td>0.54</td>
</tr>
<tr>
<td>( \Delta r_{f_{t-2}} )</td>
<td>0.900</td>
<td>2.38</td>
<td>–0.346</td>
<td>–2.65</td>
</tr>
<tr>
<td>( \Delta r_{f_{t-3}} )</td>
<td>–0.080</td>
<td>–0.19</td>
<td>–0.088</td>
<td>–0.62</td>
</tr>
<tr>
<td>( \Delta r_{u_{t-1}} )</td>
<td>0.254</td>
<td>2.08</td>
<td>0.026</td>
<td>0.62</td>
</tr>
<tr>
<td>( \Delta r_{u_{t-2}} )</td>
<td>0.024</td>
<td>0.20</td>
<td>0.036</td>
<td>0.86</td>
</tr>
<tr>
<td>( \Delta r_{u_{t-3}} )</td>
<td>–0.260</td>
<td>–2.28</td>
<td>0.065</td>
<td>1.65</td>
</tr>
</tbody>
</table>

\[ z = \text{cointegrating equation error terms}, \Delta r_f = \text{changes in the risk-free rate}, \Delta r_u = \text{changes in underwriting margin} \]

* significant at the 1% level. The 1% standard \( t \)-distribution critical value for \( N = 60 \) is \( \pm 2.66 \).

\[ \Delta r_{u_t} = \alpha_1 + \rho_1 z_{t-1} + \sum_{i=1}^{g} \Delta r_{f_{i-1}} + \sum_{i=1}^{g} \Delta r_{u_{i-1}} + \varepsilon_1 \]  

\[ \Delta r_{f_t} = \alpha_2 + \rho_2 z_{t-1} + \sum_{i=1}^{g} \Delta r_{f_{i-1}} + \sum_{i=1}^{g} \Delta r_{u_{i-1}} + \varepsilon_2 \]  

(4)
A few features in Figure 2 are worth noting. The mid-1940s show some abnormal fluctuation, and the mid-1980s severe underwriting cycle is evident, as is 1992’s Hurricane Andrew. It also appears that, starting sometime in the mid-1980s, the behavior of the error term series may have changed somewhat. This could indicate some sort of structural change, but it does not take away from the cointegrating conclusion a long-run attractor.  

The possibility that the series of estimated error terms contains a structural break is a topic for further investigation. The series of error terms in Figure 2 represent short-term dynamics and possess many of the same characteristics as the aggregate underwriting margin series in Figure 1. The main difference is that the estimated error terms series has been “flattened” by the removal of equilibrium forces provided by the interest rate.

Figure 3 is a phase space plot of the error terms. A very reasonable interpretation of the diagram is that a stable attractor exists and the aggregate property-liability underwriting margin has a long-term equilibrium relationship with the risk-free interest rate.

The exact attainment of equilibrium is represented by the origin on the graph. It is clear the \((e_t, e_{t+1})\) pairs have a tendency to move towards the area of the origin. The large deviations from exact equilibrium (mostly in the negative quadrant) are associated with the well-known outlying
market events or situations already mentioned—mid-1940s regulatory uncertainty, the mid-1980 liability crisis, and 1992’s Hurricane Andrew.

**Concluding Comments**

It is best if important conclusions are made with minimal assumptions and conditions. Nonstationarity can take a variety of forms (as evidenced by the variety of tests available). Mean nonstationarity of interest rates and the property-liability underwriting margin is a sound conclusion, and the detailed consideration of a single DGP existing for the entire 1930–2000 period is unnecessary (for present purposes). The cointegration analysis presents strong evidence of a long-run equilibrium relationship between the 90-day T-bill rate and the underwriting margin. This conclusion agrees with the theoretical models of insurance pricing and affirms the results of Haley (1993) and Choi, Hardigree, and Thistle (2002).

A cointegration analysis, however, cannot be all-encompassing. The variations in the 90-day T-bill rate do not explain all of the variations in underwriting margin. There are clearly other factors that influence the time series behavior of underwriting margins. Regulatory changes, the evolution of rating bureaus into advisory organizations, and changes in taxation all have affected the insurance industry. Yet the aggregate underwriting margin and the 90-day T-bill rate have maintained a long-run relationship through these changes. The error terms generated by removing the long-run equilibrium influence of interest rates form a new time series and still

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*Fig. 3. Phase space of estimated error terms from cointegrating equation.*
contain information regarding the (aggregate) short-term dynamics of the property-liability insurance market.

The cointegration methodology differs philosophically from Leng et al. (2002), Harrington and Yu (2003), Leng (2006a, 2006b), and Leng and Meier (2006). The data contain information that needs to be carefully extracted. By taking the incremental approach of determining nonstationarity in mean of the underwriting margin and the interest rate, I acknowledge a feature of the data without asserting a specific DGP, removing information, or eliminating possible models.

It is not my intention, though, to endorse a wide-open approach to data collection. The intent here is to emphasize that researchers need to be careful when extracting information from data. Too heavy a reliance on univariate analysis ignores the complexities and influences of other variables. Placing too many *a priori* requirements on a data set eliminates information, and a sort of “paralysis-by-analysis” can occur. The main requirement of time series is continuity of objective—i.e., the same variable being measured in each observation. I believe this to be true for both the 90-day T-bill rate series and the aggregate underwriting margin for stock property-liability insurers.

In regards to time trends, finding a significant time trend actually supports the conclusion of nonstationarity in mean. But to assert that the time series is trend stationary *instead* of difference stationary is a much stronger statement resulting in greater limitations. The assertion of a time trend (leaving only the stationary deviations from the time trend) removes information from the data without assigning much meaning to it. Comparatively, the cointegrating regression inserts the interest rate as a regressor in place of the generic time trend factor and achieves essentially the same result—stationary residuals. Only these residuals have a statistically significant relationship with the first differences of the interest rate and allow for a much more meaningful interpretation that conforms to the widely accepted insurance pricing models.

The research process shouldn’t be unidirectional. Feedback and reconsideration need to be done from time to time in an attempt to reconcile differing approaches and opinions.

NOTES


2 Haley (1993) reports only on the cointegration of the 90-day T-bill rate and underwriting margins. The cointegration conclusion of Choi, Hardigree, and Thistle (2002) is just part of a much broader analysis.
CONSIDERING THE COINTEGRATION METHODOLOGY

3 The equilibrium notion used here is somewhat different from that of a market clearing equilibrium. For a discussion see Chapter 1, Sections 1.1 and 1.2, of Banerjee et al. (1993) and pages 179–182 of Milgate (1987).

4 The notion of a non-fixed mean holding throughout the entire analyzed time frame is one that’s repeated several times in this article. However, at no point am I asserting a univariate model or character form on the time series.

5 If a constant term is added to equation (1) the linear relationship is referred to as an “affine” relationship. This does not affect the cointegration analysis.


7 Leng and Meier (2006) do acknowledge that the post-break sample is small.

8 Hakkio and Rush (1991) conclude that the length of a data set in a cointegration study is of greater importance than the number of observations.

9 I am not attempting to invalidate, or even disagree with, the competitiveness conclusions of Leng et al. (2002). I’m only disagreeing with their comment that cointegration is not appropriate because of pre-testing conditions.

10 The time period analyzed was 1952–1997.

11 Granger (1997) actually describes determining whether a time series process has a unit root or is stationary with a broken straight line trend as “uninteresting.” Because there are so many other possible models, Granger writes that the question of interest is simply whether a series is persistent—as evidenced by the failure to reject a unit root hypothesis test.

12 The quotes are used to indicate the dubious nature of a trend factor’s ability to provide explanatory power.

13 Banerjee et al. (1993) make this very point (page 6).

14 The Engle and Granger (1987) technique has two explicit estimation steps.

15 Ceteris paribus, when insurance prices increase, underwriting margins increase.

16 The data set contained 71 observations before differencing and lag computation. The DF test was significant at the 10% level, whereas the ADF tests with 1 lag and 2 lags were both significant at the 1% level. The N = 50 critical values of Engle and Yoo (1987) were used for the tests. No intercept term was used in the estimations.

17 This result roughly coincides with the Leng and Meier (2006) finding of a 1986 structural break in the loss ratio for the U.S. and with the Leng et al. (2002) result of the relationship between underwriting margins and interest rates changing during the early 1980s.

18 The diagram has $\varepsilon_t$ on the horizontal axis and $\varepsilon_{t+1}$ on the vertical axis.

REFERENCES


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