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# Evidence on the Time Series Properties of Insurance Premiums and Causes of the Underwriting Cycle: New Support for the Capital Market Imperfection Hypothesis

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## ABSTRACT

Time series causality tests are used to examine hypotheses about the determinants of insurance premiums and causes of the underwriting cycle. The evidence supports the hypothesis that underwriting cycles are partially due to costly external capital as predicted by Winter (1989), Cummins and Danzon (1992), and Gron (1992).

## Introduction

Numerous studies document that underwriting profit rates and insurance prices in the property-liability insurance industry have been cyclical in the postwar period (for example, see Cummins and Outreville, 1987; Doherty and Kang, 1988; and Venezian, 1985). A "hard market," where prices and profits are high and coverage is restricted tends to be followed by a "soft market," where prices and profits are low and coverage is expanded. The cycle in property-liability underwriting profits has a period of about six years.[1]

The cause of this underwriting cycle has been the subject of much debate. In a perfect market, a price cycle would occur only if insurers' expected costs—the present value of expected losses—were cyclical. Most explanations, however, attribute the cycle to imperfections on the supply side of the

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[1] Fields and Venezian (1989) report that individual lines within the property-liability industry have different cycles. Butler and Worrall (1990) show cycles for workers' compensation insurance vary by state. Moreover, Butler and Worrall find that after controlling for economic factors, cycles in premiums and losses still remain. Grace and Hotchkiss (1992) examine the relation between gross national product and underwriting profits.

property-liability insurance market.[2] Cummins and Outreville (1987) present a model in which insurers set prices rationally, but in which almost all relevant information in forming expectations of future losses is contained in past loss reports. These assumptions, along with regulatory and accounting lags, induce a cycle in reported profits and prices. Venezian (1985) attributes the cycle to the extrapolative methods used in the rate setting process. Several recent articles show that capital market imperfections can generate a cycle. For example, Winter (1989) assumes that the quantity of insurance is constrained by an insurer's equity and that internal equity is a cheaper source of capital than external equity (Myers, 1984). Consequently, a reduction in capital (e.g., due to unexpected losses) causes industry supply to contract and insurance prices to increase.[3]

These hypotheses have different implications for the determinants of premiums, which are tested using time series regressions similar to the causality tests proposed by Granger (1969) and Sims (1972). In a perfect market with rational expectations, insurers set premiums equal to the present value of expected future losses, where expectations are formed using all relevant information. Premiums are therefore the best predictors of future losses in the sense that premiums aggregate all information about future losses.[4] In the terminology of Sim's causality tests, premiums "cause" losses; that is, current premiums can be explained by future loss payments. After controlling for expected future loss payments, other information such as past losses and past surplus will not help explain premiums. In contrast, the capital market imperfection hypothesis (Winter, 1989; also see Gron, 1992, and Cummins and Danzon, 1992) implies that premiums are not the best predictors of actual losses because past surplus affects premiums. Venezian's (1985) model implies that premiums are not the best predictors of actual losses, because premiums are mechanically set based on the realizations of past losses. Accordingly, past loss experience affects premiums.

Although data problems limit the strength of the conclusions, our results suggest that market imperfections play an important role in insurance pricing. Consistent with the capital market imperfection hypothesis, the evidence suggests that past values of surplus affect premiums. Weaker evidence is presented that past values of losses affect premiums, which is consistent with Venezian's hypothesis.

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[2] Doherty and Kang (1988) provide a model that is perhaps closest to a perfect markets explanation. They model both supply and demand and attribute cycles to movements in capital market rates (interest rates) and aggregate income. However, Doherty and Kang introduce an imperfection in their model by assuming that supply only partially adjusts to changes in rates of return. Also see Doherty and Garven (1991).

[3] Costly external equity is also a key element in the underwriting cycle models of Gron (1992) and Cummins and Danzon (1992). Unlike most analyses of the underwriting cycle, which focus on explaining "hard" markets, Harrington and Danzon (1991) focus on "soft" markets.

[4] An analogy in the finance literature is Fama (1975), where he argues that nominal interest rates are the best predictor of future inflation.

The article proceeds as follows. In the next section, the hypotheses are described in more detail. In the third section, the methodology and data are presented along with potential econometric problems. The results are then summarized. The article concludes with a short summary and some caveats.

## Hypotheses

*Perfect Markets/Rational Expectations Hypothesis*

In a perfect market, the price of insurance would be determined by discounting expected cash flows by the appropriate discount rates. To be more specific, consider a competitive insurance market with no transaction costs and no information costs.[5] The distribution of losses is known and independent of the actions of the consumer. Assume all losses are paid one period after premiums are received.[6] Then, premiums at time t, $P_t$, equal the present value of expected loss payments:

$$P_t = \delta_t \, E(L_{t,t+1}), \tag{1}$$

where $E(L_{t,t+1})$ is the expected loss payment at time t+1 on policies written at time t, and $\delta_t$ is the discount factor for policies written at time t (see Cummins, 1990, for a detailed description of the discounted cash flow approach; also see Fairley, 1979, and Kraus and Ross, 1982, for further discussion of the proper discount rate).

The major difficulty in testing the perfect markets framework is measuring expected losses. Rational expectations implies that all available information is taken into account when forming expectations about future losses. In other words, actuaries use sophisticated models and they incorporate all relevant information when setting rates (see Kahane, 1990, for example). Relevant information would include past losses, expected inflation, and trends in tort liability. Thus, rational expectations implies that the premium set at time t incorporates all prior information.

Mathematically, rational expectations implies that the difference between actual losses and expected losses (the forecasting error) is unbiased and uncorrelated with any information known at time t (Cummins and Outreville, 1987). That is,

$$u_{t,t+1} = L_{t,t+1} - E(L_{t,t+1}) \;, \quad E(u_{t,t+1}) = 0, \quad E(u_{t,t+1}\, Z_t) = 0, \tag{2}$$

where $u_{t,t+1}$ is the forecasting error at time t+1 on policies written at time t, and $Z_t$ represents any information known at time t. Substituting equation (2) into equation (1) yields the following relation:

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[5] There is some inconsistency here, because if transaction and information costs were truly zero, then individuals would sell claims against these assets and there would not be an insurance market (see Mayers and Smith, 1982).

[6] For ease of presentation, the analysis focuses on the insurer's claim costs. That is, administrative costs associated with insurance are not explicitly incorporated in the analysis. This simplification reflects a belief that administrative costs are a relatively constant proportion of premiums over time.

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$$P_t = \delta_t\, L_{t,t+1} + \delta_t\, u_{t,t+1}\ . \tag{3}$$

Equation (3) implies that future loss payments and current interest rates should explain premiums at time t and that other information known at time t should not help explain premiums. In essence, rational expectations implies that actual losses measure expected losses with error, but this error is uncorrelated with any other information known when premiums are set.

*Capital Market Imperfection Hypothesis*

Winter (1989) presents a model in which premiums are not the best predictors of future losses (also see Gron, 1992, and Cummins and Danzon, 1992). In Winter's model, losses are interdependent, and, consequently, the amount of insurance that can be credibly supplied depends on insurers' equity. In addition, Winter assumes that internal equity (i.e., retained earnings) is a cheaper source of funds than external equity (see Myers, 1984). The assumption of costly external capital implies that an insurer will not instantaneously raise new capital after an unexpected reduction in capital. Winter states that "the most important implication of this model is the failure of the present value relationship. Premiums are not informationally efficient predictors of future claims even with rational expectations." When surplus is low, premiums are greater than the present value of expected losses, and when surplus is high, premiums are lower than the present value of expected losses. According to the capital market imperfection hypothesis, lagged values of surplus are negatively related to current premiums. Thus, premiums not only depend on expected future loss payments but also on past values of surplus.

*Institutional Rigidities Hypothesis*

Venezian (1985) provides an alternative hypothesis for why insurance premiums are backward looking. Venezian hypothesizes that the extrapolative rate setting methods used by rating agencies and insurers cause the underwriting cycle. That is, insurers use mechanical methods to analyze past loss data in setting premiums, so past losses influences premiums. Because the failure to adopt improved forecasting methods reflects a type of industry-wide inertia, Venezian's explanation is sometimes called the institutional rigidities hypothesis. Under this hypothesis, premiums may be biased predictors of future losses, because unexpected past losses influence premiums even if these unexpected losses carry no information about future loss payments. Thus, unexpected past loss data would help explain current premiums even after controlling for expected future loss payments. A direct test of this implication, however, is not possible, because unexpected losses are not measurable.[7]

[7] If such expectations were observable, many of the issues addressed is this paper would be simplified. For example, premiums could simply be compared to expected losses to test the perfect markets hypothesis.

The spirit of Venezian's model is that premiums are retrospective; that is, past loss experience helps to explain premiums. This idea can be examined by testing whether premiums are related to actual past losses, after controlling for actual future losses. The use of actual past losses, however, gives rise to the possibility that past losses will be significantly associated with premiums, not because of mechanical rate setting methods, but because past losses provide information about expected future losses. For example, if the loss distribution is constant over time, then the actual values of past and future losses are realizations from the same distribution. Consequently, both past and future losses would be informative with respect to estimating the mean of the distribution (expected losses). On the other hand, if the mean of the loss distribution is changing over time, then past realizations of losses are less likely to be informative about expected future losses. As a result, past losses would not help explain premiums unless, as Venezian suggests, extrapolative rate setting methods were being employed. Thus, finding that past losses are significant in explaining premiums is consistent with Venezian's hypothesis, but also consistent with past losses being informative about expected future losses.

*Rational Expectations and Past Losses*

A similar issue arises with respect to Cummins and Outreville's (1987) hypothesis, which suggests that premiums are set using rational expectations but that almost all information relevant in forming expectations of future losses is contained in past losses. Past losses therefore would not affect premiums if one could effectively control for expected future losses. However, if expected future losses are measured with error and if this error is correlated with past losses, one may find that past losses help explain premiums even though premiums are set using rational expectations. Thus, if the measurement error in expected future losses is correlated with past losses, it will be difficult empirically to distinguish Venezian's extrapolative rate setting hypothesis from Cummins and Outreville's hypothesis that premiums are set using rational expectations and that losses are an important information source.

*Summary*

These hypotheses are not mutually exclusive. The perfect markets/rational expectations hypothesis implies that premiums are forward looking and that premiums are the best predictors of future losses. Consequently, current premiums should be explained by future losses, and past information should not help explain premiums. Market imperfections, however, imply that premiums are influenced by factors other than the present value of expected future losses. The capital market imperfection hypothesis implies that premiums are negatively related to past surplus. Venezian's (1985) model suggests that premiums may be related to past losses even after controlling for future losses. See Table 1 for a summary of these hypotheses.

**Table 1**
Summary of Hypotheses

| *Hypothesis* | *Implications* |
|---|---|
| Perfect Markets/Rational Expectations (Cummins, 1990) | Current premiums are explained by future losses. Past information does not help explain current premiums. |
| Capital Market Imperfection (Winter, 1989; Gron, 1992; Cummins and Danzon, 1992) | Current premiums are explained by past surplus after controlling for future losses. |
| Institutional Rigidities (Venezian, 1985) | Current premiums are explained by past losses after controlling for future losses. |

## Empirical Analysis

### *Basic Idea and Potential Problems*

Consider a time series regression where the dependent variable is premiums written in year t, and the independent variables are current and future loss payments on policies written in year t, past loss payments, past values of surplus, and other control variables:

$$\begin{aligned} \textit{Premiums}_t = f\,(&\textit{loss payments on policies written in year } t, \\ &\textit{past losses, past surplus, control variables}) + \varepsilon_t. \end{aligned} \tag{4}$$

According to the perfect markets/rational expectations hypothesis, premiums on a pool of policies should be explained by the loss payments on those policies, but not by past losses or past surplus. The capital market imperfection hypothesis implies that past values of surplus help explain premiums,[8] and Venezian's hypothesis suggests that past values of losses may help explain premiums.

Unfortunately, data limitations prevent the implementation of the tests as outlined above. To measure loss payments on policies written in year t (see equation [4]), we need a loss variable that associates losses paid to the year in which the policy was written. Such loss data are not publicly available. Therefore, the losses paid by insurers in a calendar year ("calendar year losses paid") is used as a proxy. The losses paid in a calendar year are not all from policies written in the same year. For lines with a short claim tail, the losses paid in a calendar year are likely to be from policies written in the reporting year or the year before. For lines with a long claim tail, losses paid could reflect losses on policies written many years earlier. Thus, the losses paid

[8] The empirical specification assumes a symmetric relation between premiums and past values of surplus. See Gron (1992) for a discussion and tests of an asymmetric relation.

variable includes measurement error, especially in lines with a long claim tail.[9] Although the errors in variables problem causes the coefficient estimates to be inconsistent, it cannot be avoided given the available data.

*Data and Stationarity Tests*

The data are annual aggregates for property-liability stock insurers from 1946 through 1988 obtained from *Best's Aggregates and Averages* (A. M. Best Company, various years). Premiums (P) are measured using premiums written in a calendar year. Premiums written have an advantage over premiums earned in that the latter averages premiums over a two-year period, whereas premiums written are for policies issued during the reporting year (Cummins and Outreville, 1987). Surplus (S) is equal to the aggregate policyholder surplus for property-liability stock insurers. Policyholder surplus is the difference between assets and liabilities using Statutory Accounting Practices. Losses paid (L) is obtained by subtracting the change in the loss reserve from losses incurred.[10] Because the perfect markets hypothesis implies that, *ceteris paribus*, premiums decrease with the level of interest rates, we include as a control variable the annual return on treasury bills (R) taken from Ibbotson Associates (1990).

Although most studies use aggregate data, Venezian (1985) and Fields and Venezian (1989) argue that individual lines should be examined separately. Two problems prevent examination of individual lines here. First, losses paid can be calculated only for the aggregate series because the change in the loss reserve is not reported by line. Second, surplus (S), which is central to the capital market imperfection hypothesis, is not allocated by line. Consequently, aggregate data are examined which tend to reflect the experience of the largest lines: auto and workers' compensation.

Panel A of Table 2 contains the time series characteristics of the levels of premiums written, losses paid, surplus, and of the natural logarithms of these variables. The failure of the autocorrelations of all three variables to die out quickly suggests that the distributions are nonstationary. This is true when the variables are measured in levels and in the natural logarithm of levels. Dickey-Fuller tests (not reported) also suggest that the variables are nonstationary (see Dickey, Bell, and Miller, 1986, for an overview of tests for nonstationarity [unit roots]).

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[9] Accident year losses incurred—losses paid plus the loss reserve for losses that occurred during a given year—would be a better measure of losses for these tests (see Cummins and Danzon, 1992). This measure includes insurer's expectations of losses occurring in a given year but that are not paid until future years. Even for lines with a long claim tail, accident year losses incurred is more likely to reflect losses on policies written in the current year and the year before. Accident year losses incurred, however, are publicly available in *Best's Aggregates and Averages* only since 1980, which yields too few observations to reliably estimate the model. Use of incurred losses would also raise the concern that reserves may be manipulated.

[10] Losses incurred is calculated by multiplying the ratio of losses incurred to premiums earned by the difference between premiums written and the change in the unearned premium reserve (see Harrington, 1988, for further details about insurance accounting).

**Table 2**
Time Series Characteristics of Annual Calendar Year Losses Paid (L), Premiums Written (P), and Surplus (S) for the Property-Liability Stock Insurers from 1946 through 1988

| | *Mean* | *Standard Deviation* | *Autocorrelations* $\rho 1$ | $\rho 2$ | $\rho 3$ | $\rho 4$ | *Partial Autocorrelations* $\gamma 1$ | $\gamma 2$ |
|---|---|---|---|---|---|---|---|---|
| | | | Panel A: Levels | | | | | |
| P | 34.55 | 37.03 | 0.88* | 0.76* | 0.64* | 0.55 | 0.88* | -0.11 |
| L | 20.81 | 22.89 | 0.89* | 0.79* | 0.69* | 0.60 | 0.89* | 0.02 |
| S | 23.91 | 24.61 | 0.85* | 0.73* | 0.61* | 0.53 | 0.85* | -0.02 |
| Log(P) | 16.81 | 1.07 | 0.92* | 0.84* | 0.77* | 0.70* | 0.92* | -0.02 |
| Log(L) | 16.23 | 1.15 | 0.92* | 0.85* | 0.77* | 0.70* | 0.92* | -0.01 |
| Log(S) | 16.52 | 0.97 | 0.91* | 0.82* | 0.73* | 0.65* | 0.91* | -0.02 |
| | | | Panel B: First Differences | | | | | |
| ΔP | 3.28 | 4.86 | 0.76* | 0.38 | 0.17 | 0.10 | 0.76* | -0.45* |
| ΔL | 2.02 | 2.43 | 0.63* | 0.60* | 0.55* | 0.64* | 0.63* | 0.33* |
| ΔS | 2.36 | 4.21 | 0.46* | 0.23 | 0.26 | 0.06 | 0.46* | 0.03 |
| ΔLog(P) | 0.09 | 0.05 | 0.46* | -0.02 | -0.16 | -0.09 | 0.46* | -0.29* |
| ΔLog(L) | 0.10 | 0.04 | 0.24 | -0.22 | 0.08 | 0.25* | 0.24 | -0.29* |
| ΔLog(S) | 0.09 | 0.12 | 0.04 | -0.34 | -0.04 | 0.09 | 0.04 | -0.34* |

Note: All variables are measured in billions of dollars. $\rho i$ = autocorrelation at lag i. $\gamma i$ = partial autocorrelation at lag i.
* Coefficient is two standard deviations from zero.

Because regression analysis using nonstationary series can result in spurious correlation (see Granger and Newbold, 1986), first differences are taken.[11] Panel B of Table 2 contains the time series characteristics of the first differenced data. The autocorrelations for the first differences in the levels of premiums and surplus die off quickly, but the autocorrelations for the first differences in the level of losses do not die off. Consistent with the autocorrelation pattern, Dickey-Fuller tests reject the existence of a unit root for the first difference in premiums and surplus but not for the first difference of losses. Because of the nonstationarity in the first difference of losses, the regressions using this series should be interpreted cautiously.

The autocorrelations of the first differences of the logarithmic transformed data (i.e., the percentage changes) die off quickly for all three variables. In addition, the Dickey-Fuller tests reject the presence of a unit root for these series. Since the evidence indicates that the first differences of each of the logarithmic transformed series (percentage changes) are stationary, the regressions using these series should be given the greatest weight.

Panel B of Table 2 also presents evidence on the time series of premiums. Both measures of the first difference in premiums have a significant first-order

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[11] Differencing the data is not necessary if the series are cointegrated (see, e.g., Granger, 1986). Simple tests fail to reject the null hypothesis that premiums and losses are not cointegrated.

autocorrelation coefficient and significant first- and second-order partial autocorrelation coefficients. This pattern suggests that lagged premiums can be used to explain current premiums.

*Equation Specification*

Linear equations of the following form are estimated.[12]

$$P_t = \alpha + \sum_{s=0}^{M} \lambda_s L_{t+s} + \sum_{s=1}^{M} \pi_s L_{t-s} + \sum_{s=1}^{M} \gamma_s S_{t-s} + \sum_{s=1}^{M} \theta_s P_{t-s} + \beta R_t + \varepsilon_t. \qquad (5)$$

This specification is consistent with the models proposed by Granger (1969) and Sims (1972) to test for "causality," although these tests really refer to the concept of predictability. Intuitively, premiums "cause" losses in the Sims sense if, *ceteris paribus,* future values of losses help predict premiums. Thus, the statistical significance of the coefficients on the contemporaneous and the lead values of losses ($L_t$, $L_{t+1}$, $L_{t+2}$) test whether premiums "cause" losses (Geweke, Meese, and Dent, 1983).[13]

Losses or surplus will "cause" premiums in the Granger sense if, *ceteris paribus,* past values of losses or surplus help explain premiums. Thus, the statistical significance of the coefficients on lagged values of losses test whether losses "cause" premiums. Similarly, the statistical significance of the coefficients on the lagged surplus variables test whether surplus "causes" premiums.

Consistent with time series evidence presented above, lagged values of premiums are included in the model as control variables. Including lagged values of the dependent variable on the right-hand side of the equation is also consistent with the usual implementation of causality tests. Causality studies do not provide guidance as to the appropriate lag structure. To conserve degrees of freedom, a lead and lag structure of two years is assumed for all variables; that is, M = 2 in equation (5).

Pearson correlation coefficients for the percentage changes in the value of premiums, losses, surplus, and interest rates are presented in Table 3. Losses are negatively correlated with contemporaneous surplus and positively correlated with surplus lagged two years. However, the small correlation coefficients suggest that pairwise collinearity is not likely to be a problem. Nevertheless, alternative specifications of the model are estimated to determine whether the findings are sensitive to the inclusion of different sets of variables.

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[12] Theoretically, interest rates would enter the model in a nonlinear fashion. For simplicity and ease of estimation, a linear specification is used.

[13] An issue in implementing causality tests is whether the contemporaneous variable (in this case $L_t$) should be treated as a lead or a lag variable or alternatively treated as neither. In the absence of measurement error in the losses, the conceptual framework implies that the contemporaneous value should be treated similarly to the lead values of losses. This is the approach adopted here.

**Table 3**

Correlation Matrix for Annual Percentage Changes in Aggregate Premiums Written (P), Losses Paid (L), and Surplus (S) for Property-Liability Stock Insurers and for Annual Returns on Treasury Bills (R) from 1946 through 1988

| | *Pearson Correlation Coefficients* | | | | |
|---|---|---|---|---|---|
| | $P_t$ | $S_{t-1}$ | $S_{t-2}$ | $L_t$ | $L_{t-1}$ |
| $S_{t-1}$ | 0.10 | | | | |
| | (0.53) | | | | |
| $S_{t-2}$ | -0.35 | 0.04 | | | |
| | (0.05) | (0.80) | | | |
| $L_t$ | 0.16 | -0.09 | 0.46 | | |
| | (0.29) | (0.58) | (0.01) | | |
| $L_{t-1}$ | 0.26 | -0.34 | -0.09 | 0.25 | |
| | (0.10) | (0.03) | (0.57) | (0.11) | |
| $R_t$ | 0.07 | 0.40 | 0.25 | 0.37 | -0.06 |
| | (0.67) | (0.01) | (0.12) | (0.02) | (0.71) |

Note: P values are in parentheses.

## *Results: Support for Imperfections Hypothesis*

Equation (5) is estimated using both first differences and percentage changes. The results of several specifications are reported in Table 4. The above discussion of the time series properties of the variables suggests that the greatest weight should be placed on the first specification in Panel B, in which percentage changes are used and all of the right-hand side variables are included.

Under the perfect markets/rational expectations hypothesis, premiums would be positively related to current and future loss payments. The first equation in Panel A and in Panel B of Table 4 provides little support for this prediction. The coefficients on future losses are insignificantly different from zero, and the coefficient on contemporaneous losses ($L_t$) is significant at the ten percent level only when percentage changes are used. In these equations, the coefficients on lagged premiums are highly significant and have opposite signs, suggesting cyclical behavior.

The remaining equations reported in Table 4 omit a set of variables. When lagged premiums are not included in the equations, the statistical significance of future losses increases. In addition, the coefficients on the future loss variables alternate in sign, suggesting that the future loss variables in these equations are capturing the cyclical effect that the lagged premium variables capture in the first equations. The negative coefficient on the one year lead loss variable ($L_{t+1}$), however, is inconsistent with the perfect markets/rational expectations hypothesis. The lack of support for the perfect markets/rational expectations hypothesis may be due to the measurement error in losses.

The perfect markets/rational expectations hypothesis also predicts that past information, such as past loss payments and past surplus, would not help predict premiums, but evidence to the contrary is presented in Table 4. The

**Table 4**
Regression Analysis of Aggregate Premiums Written (P) on Future and Past Loss Payments (L), Past Surplus (S), and Interest Rates (R) for Property-Liability Stock Insurers
(Annual Data 1946 through 1988)

Regression Equation: $P_t = \alpha_0 + \lambda_2 L_{t+2} + \lambda_1 L_{t+1} + \lambda_0 L_t + \pi_1 L_{t-1} + \pi_2 L_{t-2} + \gamma_1 S_{t-1} + \gamma_2 S_{t-2} + \Theta_1 P_{t-1} + \Theta_2 P_{t-2} + \beta_1 R_t + e_t$

| *Intercept* | $L_{t+2}$ | $L_{t+1}$ | $L_t$ | $L_{t-1}$ | $L_{t-2}$ | $S_{t-1}$ | $S_{t-2}$ | $P_{t-1}$ | $P_{t-2}$ | $R_t$ | $adjR^2$ | *DW* | $\rho$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel A: Coefficient Estimates Using First Differences | | | | | | | | | | | | | |
| 23.74 | -0.10 | 0.19 | 0.22 | 0.86 | -0.11 | -0.28 | -0.16 | 1.53 | -0.96 | 15.47 | 0.93 | 2.31 | 0.16 |
| (0.08) | (-0.22) | (0.66) | (0.76) | (2.47) | (-0.23) | (-1.92) | (-1.19) | (8.99) | (-3.96) | (0.51) | | | |
| 128.90 | -0.53 | 0.42 | 0.73 | | | -0.23 | -0.12 | 1.72 | -0.85 | -29.52 | 0.93 | 2.54 | 0.28 |
| (0.38) | (-1.52) | (1.52) | (2.83) | | | (-1.48) | (-0.85) | (9.69) | (-3.24) | (-0.91) | | | |
| -212.01 | 1.85 | -1.23 | 0.57 | 1.91 | -0.78 | -0.23 | -0.87 | | | 86.93 | 0.75 | 1.48 | 0.24 |
| (-0.36) | (3.35) | (-2.69) | (1.02) | (3.45) | (-0.94) | (-0.82) | (-4.07) | | | (1.76) | | | |
| Panel B: Coefficient Estimates Using Percentage Changes | | | | | | | | | | | | | |
| 0.02 | -0.06 | 0.04 | 0.28 | 0.13 | 0.04 | -0.03 | -0.20 | 0.93 | -0.40 | 0.03 | 0.68 | 2.39 | 0.20 |
| (0.75) | (-0.32) | (-0.20) | (1.67) | (0.88) | (0.29) | (0.64) | (-3.89) | (5.92) | (-2.17) | (1.31) | | | |
| 0.03 | -0.09 | -0.08 | 0.33 | | | 0.03 | -0.21 | 0.95 | -0.34 | 0.03 | 0.67 | 2.36 | 0.18 |
| (1.63) | (-0.50) | (-0.45) | (2.06) | | | (0.53) | (-4.32) | (6.11) | (-1.98) | (1.20) | | | |
| 0.04 | 0.22 | -0.34 | 0.35 | 0.18 | 0.08 | 0.10 | -0.16 | | | 0.01 | 0.27 | 0.98 | 0.45 |
| (1.20) | (1.00) | (-1.44) | (1.43) | (0.85) | (0.41) | (1.32) | (-2.10) | | | (0.28) | | | |

Source: A. M. Best Company (various years).
Note: T statistics are in parentheses.

coefficient on lagged losses is positive and statistically significant using first differences, suggesting that high losses are followed by higher premiums. This finding is consistent with imperfections in the rate setting process (Venezian, 1985). It is also consistent with the hypothesis that the future loss variables measure expected future losses with error and that this error is correlated with past losses. When percentage changes are used, however, lagged losses are not statistically significant.

The lagged surplus variables consistently exhibit explanatory power across the different specifications. The negative coefficients on lagged surplus suggests that low surplus is followed by high prices.[14] This result is inconsistent with the perfect markets/rational expectations hypothesis but is consistent with the capital market imperfection hypothesis put forth by Winter (1989), Cummins and Danzon (1992), and Gron (1992).

## Summary

This article provides new evidence on the determinants of insurance prices. In a perfect market, premiums equal the present value of expected future losses; consequently, premiums should be the best predictors of future losses. The data, however, suggest that market imperfections prevent premiums from being informationally efficient predictors of losses. In particular, there is some evidence that past losses affect premiums and stronger evidence that past surplus affects premiums. The evidence therefore corroborates the findings of Winter (1989), Cummins and Danzon (1992), and Gron (1992).

An important caveat must be emphasized. Ideally, it would be best to conduct the tests presented in this article using data that allows losses paid to be attributed to the year in which the underlying policy was written. That is, accident year or policy year loss data are better suited for these tests. Unfortunately, these data are not publicly available, and so calendar year loss data are used instead. This creates an errors in variables problem, which probably creates a bias against finding that premiums predict losses. The implementation of these tests with accident or policy year data would yield additional insights about pricing in the property-liability insurance industry.

[14] In the last equation reported in Panel B, the Durbin-Watson statistic rejects the absence of first-order serial correlation in the residuals at the ten percent level. After correcting for first-order serial correlation, the coefficient estimates on the one- and two-year lagged surplus variables are not significantly different from zero.

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