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External Impacts on the Property-Liability Insurance Cycle

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External Impacts on the Property-Liability Insurance Cycle

Abstract

Traditionally, underwriting performance is considered to be a function of industry specific institutions. Using quarterly data from 1974 to 1990, we provide evidence of a long-run linkage between general economic conditions reflected in the gross domestic product, the short-term interest rate, and the level of inflation and underwriting performance. Although we find that general economic fluctuations and the fluctuations in property-liability industry underwriting results are tied together in the long-run, the impact of the general economic fluctuations seem to have little impact on short-run fluctuations in the industry.

External Impacts on the Property-Liability Insurance Cycle

Introduction

The traditional reason given for the existence of property-liability cycles supposes an equilibrium position which changes because of a lack of restraint. Why this lack of restraint occurs is debatable, but could simply be the consequence of an exogenous shock. This shock causes an increase in profits, which in turn, increases the firm's capacity to write insurance. An increase in capacity then causes the firm to desire to sell more insurance which allows the firm to lower prices in order to employ its capacity. This price cutting behavior then causes a decrease in profitability which, in turn, results in a decreasing surplus. The firm then starts pricing its product in a manner supposedly reflecting its true costs which eventually leads to higher prices and an increase in surplus (see Stewart, 1987). The traditional reasoning, however, does not suggest anything about the shocks that start the cycle, the cycle's equilibrium path, or the pre-shock equilibrium.

This paper uses time series methods to examine the property-liability industry to determine effects of shocks to real income, inflation, and the short-term interest rate on the insurance cycle. Time series techniques allow us to explore both the short-term relationship between the cycle and these external factors while controlling for the underlying long-term relationships among these series; something cross-sectional studies have been unable to do. Previous work has examined institutionally related changes in the market and their relationship to the property-liability cycle. However, with some exceptions little credit is given to the general economic conditions of the economy for movements in the industry's underwriting performance. This paper examines these external shocks.

This paper is organized as follows. First, a brief description of the literature in insurance cycles and general business cycles is presented which is followed by the empirical analysis where we estimate the linkage between the insurance industry performance and general economic conditions. We then conclude by finding that, although there is a link between the insurance industry and the general economy, external economic shocks seem to have little effect on industry underwriting performance.

Background and Literature Review

The fact that cycles exist, in theory or in fact, is disturbing given some belief in efficient and competitive markets. Most would agree that the U.S. property-liability industry exhibits competitive characteristics, yet it shows a cyclical underwriting pattern. In perfectly competitive markets there should be no predictable cycles. This is due to the fact that everyone has perfect information about all relevant variables and is able to make an unbiased forecast of the future. In fact, under a rational expectations framework where the firm can make its best guess about the future, there should be no cyclical behavior of prices or profits. (Cummins and Outreville, 1987). However, the presence of cycles in the property-liability insurance industry is well documented and much of the literature is devoted to explaining why these cycles exist. Most explanations to date are rooted solely within the industrial and regulatory institutions of the insurance industry. This paper focuses on external economic effects rather than institutions to examine the sensitivity of the industry to external macroeconomic effects.

Industry folklore states the reason cycles exist is because there is no market restraint. The proponents of the "lack-of-restraint" theory believe the cycle is cause by the lack of ability to control price (Stewart, 1987). Other reasons offered for the existence of cycles in the insurance industry include the possibility that current underwriting policy is based upon the previous period's experience and surplus (Berger, 1988); that regulatory and accounting systems are imperfect and these imperfections allow errors to creep into the firm's decision making process (Venezian, 1985); that firms may differ as the their future expectations concerning losses (McGee, 1986); that regulation may cause the cycles (Cummins and Outreville, 1987); and that one or more of the above are taking place (Harrington, 1984).

Regarding empirical evidence of internal or institutional based cycle theories, Outreville (1989) found a significant relationship between the existence of an empirically observable cycle and insurance regulatory policy in the United States while Grace (1990) found international differences in regulatory policy lead to different cycle lengths across countries. Tennyson (1991) finds mixed evidence of a regulatory effect on the cycle. Although regulation may increase the inter-temporal variance of some line's loss ratios, it does not affect the magnitude of the peaks nor the valleys of the cycle.

Several authors have examined the relationship between interest rates, an exogenous variable, and various aspects of underwriting performance. Fields and Venezian (1989) find that there is a strong relationship between unanticipated interest rates and profitability. Doherty and Kang (1988) suggest that cycles are related to interest rate cycles. Smith (1989) shows that there is a strong relationship between insurance prices as measured by the loss ratio and bond yields. Further, Grøn (1989) examines the effect of capacity constraints on insurance pricing and finds that underwriting profits are consistent with a capacity constraint model. Doherty and Garven (1991), also using a capacity constraint model, examine the effect of changing interest rates on the level of underwriting profits while controlling for the simultaneous effect of changing capital market rates in underwriting profits and the value of the insurers equity operating through the respective duration of the firm's assets and liabilities. They find that interest rates are related to underwriting performance, but that cycles are dampened from the equilibrium path which suggests the existence of capacity restrictions which are due to due to readjustments of the firm's capital structure.

Others, however, more explicitly discuss the effect of a exogenous shock on the general underwriting results, such as that resulting from a natural disaster (Grøn [1989], Winter [1988], Cagle and Harrington [1992]). These models, however, while focusing on external shocks do not follow the long term performance of the industry. They show that surplus might adjust to shocks but do not predict a time path or provide a relationship to the underlying cycle. This paper examines the shocks to exogenous economic variables such as real GDP, interest rates, and inflation to see how these external shocks affect the future performance of the industry.

Empirical Analysis

The empirical analysis of the relationship between the property-liability industry cycle and the general business cycle is split into three sections. First, visual evidence of the relationship is explored. Second, cointegration techniques are used to explore the long-run contemporaneous relationship. And, third, the short-run dynamics are examined through vector autoregression analysis; this tells us something about the adjustments to the long-run relationship that are made in the short-run.

Visual Evidence

Figure 1 shows the first-differenced (detrended) real GNP and the combined ratio over time. As can be seen in the figure, a graphical description shows little, if any, relationship between the two series. This may be why much traditional research has focused on institutional or other endogenous reasons for the cycle's existence.

[Figures 1 and 2 about here]

Figure 2, however, shows something very different than figure 1.[1] In addition, evidence shows that use of this more-recent time series is preferred to one starting before and continuing through 1970 as changes in regulations and institutions potentially alter the industry's behavior. By examining the more recent series, this potential instability is minimized.[2]

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[1]Please note that figures 1 and 2 have different national income series. Both real GDP and real GNP have nearly identical cyclical properties. The reason we examine real GDP for the quarterly set is because the government does not provide a consistent quarterly series prior to 1957 that is complete to 1990. Also, figure 2 starts in 1974 because quarterly insurance data is only available since 1974.

[2]Because of the numerous changes in the regulatory environment of the states, (see Harrington 1984) it is hypothesized that there may be different time series regimes over the period 1940-1990. For example, in the late 1960s and early 1970s states enacted pro-competitive rating laws and introduced no-fault insurance. This could potentially affect the dynamic equilibrium process. To provide evidence consistent with the hypothesis that there are at least two regimes present during the time period 1940-1990, the time period was broken into two sub-periods. The first from 1940-1969 to reflect the old regulatory environment and the second,

Figure 3 makes use of an additional visual diagnostic to illustrate the substantial similarity between the combined ratio and the real GDP through the graphing of the series' spectral densities. A spectral density function is estimated to examine the data for cycles or periodicities (Jenkins and Watts, 1968).[3] The use of spectral density analysis supposes that any time series can be thought of as the sum of a non countably infinite number of uncorrelated components, each with a particular frequency, and the importance of any group of components with frequencies falling into some narrow band is measure by their composite variance (Granger and Newbold, 1986). It is interesting to note that the area underneath the spectral density function is equal to the total variance for the process. Therefore, peaks in the density signify important contributions to the variance in that range (Chatfield, 1984).

The output shown in figure 3 represents the result of applying a finite Fourier transform which is a decomposition of a sum of sine and cosine waves of different amplitudes and wavelengths. The result can then be used to infer periodicity of cycles. For example, in figure 3 there is a peak at about 1.6. This corresponds to a cycle of period length of $2\pi/\omega$, where ω is the frequency. When ω=1.6, $2\pi/\omega$ = 3.93 quarters or approximately 1 year. Similarly there is another peak at 0.19. This corresponds to a cycle of approximately 8.4 years.[4] Note that both

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1970-1990, to reflect the new regulatory environment. The following regression was estimated for both time periods:

$$CR_{tk} = \alpha + \beta_1 CR_{t-1,k} + \beta_2 CR_{t-2,k} + \varepsilon_k, \text{ for } k = \begin{cases} 1 \text{ when } 1940 < t \leq 1969 \\ 2 \text{ when } 1970 \leq t \leq 1990 \end{cases}.$$

The null hypothesis that the parameter coefficients are the same across time periods (constant dynamics across time periods) was rejected at the 10% level. Although it may be preferred to use data corresponding to longer time periods to examine long-run relationships (Maddala, 1992), we concentrate on the period only since 1970 as this period represents a series where the regulatory environment is relatively more stable. We employ quarterly data over this period in order to obtain as many observations as possible.

[3]The treatment of spectral density functions and their analysis is "very technical." For a simple introduction see Kennedy (1992), or see Granger and Engle (1984) for a more advanced treatment. See also, for uses in the insurance cycle literature, Venezian (1985) and Doherty and Kang (1988).

[4]Venezian (1985) finds that the cycle's length is approximately 6 years. Using Venezian's methodology on the combined ratio (rather than the loss ratio) we obtained a cycle period of 7.6 years for the period 1940-1990. For the period of Venezian's study (1965-1980) we

the real GDP and the combined ratio have cycles of about 1 year (a yearly cycle) and an 8.4 year cycle. In addition, the short-term interest rate and the CPI exhibit cyclical behavior similar to that illustrated in figure 3 for GDP and the CR. Traditionally, research has not included the extra-industry economic fluctuations, other than interest rates, as potential causes of insurance industry performance fluctuations. However, the spectral densities suggest that the economic fluctuations of the economy are closely related to those experienced by the industry.

[Figure 3 about here]

Long-Run Relationship between the Combined Ratio and the National Business Cycle

Spectral densities show that the series have similar behavior, but do not provide information concerning the relationship between the series. To test the theory that the combined ratio of losses (payouts and changes in loss reserves) and expenses to premiums written (combined ratio, or CR) is tied to the general business cycle in the long-run we test whether the CR and real gross domestic product (RGDP) are cointegrated. The null hypothesis of cointegration is that there is no long-run relationship among the variables. If cointegration is not rejected, then we conclude that although seasonal or random events may cause the series to drift apart in the short-run, underlying economic forces will eventually bring their paths in-line with one another again in the long-run. Finding that RGDP and the CR are cointegrated would suggest that (economic) factors are at work tying the movement of the CR cycle with that of a more wide-ranging national business cycle. Cointegration between the two series alone is tested first, then the short-term interest rate and the consumer price index are included in the analysis since these series are expected to influence the underwriting capacity of insurance companies,

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obtained a cycle period of 5.8 years, and for the period covered by this study we obtained a cycle period of 7.43 years. The discrepancy can be partially accounted for by the different sample periods and the use of quarterly over yearly data. Visual inspection also implies that recent cycles seem to be longer than older cycles.

thus profits (measured inversely by the CR). The analysis is performed using quarterly data available from 1974.I to 1990.IV.

The short-term interest rate (SINT) and the consumer price index (CPI) are also included as controlling factors in the analysis. The SINT is expected to control for the cost of obtaining capital to the firm. The CPI is expected to control for the income effects resulting from price changes. All series are treated endogenously.

Quarterly RGDP is constructed by deflating nominal GDP, obtained from the *Survey of Current Business*, with the producer price index, obtained from CITIBASE.[5] The quarterly CR series was obtained from *Best's Review*. The quarterly short-term treasury bill interest rates (90 day) was obtained from *International Financial Statistics* compiled by the International Monetary Fund, and the quarterly consumer price index was obtained from CITIBASE.

Cointegration as an indicator of long-run relationships was introduced by Granger and Weiss (1983) and has been used extensively to examine a variety of relationships.[6] While the concept of cointegration provides information about how two (or more) series move together in the face of un-specified external forces, it provides nothing specific about the explanatory power one of the series might have on the other.[7] The impulse response functions generated via a vector autoregression (VAR) will be examined later for this purpose.

Two time series, X_t and Y_t, are said to be cointegrated if they are each integrated of order one (stationary in their first difference, or difference-stationary), and if there exists a constant α, such that

$$\mu_t = X_t - \alpha Y_t \tag{1}$$

is integrated of order zero (stationary). Stationarity means that the mean and the variance of the series are finite and constant, insuring the series is non-explosive. The implication is that both X_t

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[5]The PPI is used since the only GDP price deflator available is seasonally adjusted and implicit in nature, making direct unadjusted calculations impossible.

[6]See, for example, Hall (1986), Goldin and Margo (1989), and Boucher (1991).

[7]See Granger and Newbold (1986, p.226).

and Y_t have long-run components that, when combined linearly through α, cancel each other out, resulting in μ_t, which has no long-run component. Long-run in this context takes on a meaning of permanence. Thorough expositions of the theory underlying the concept of cointegration can be found in Engle and Granger (1991), Granger (1986), Engle and Granger (1987), and Granger and Newbold (1986, pp. 224-6). The cointegrating regression can be extended to include more than two time series. MacKinnon (1990) has computed critical values for regressions including up to six series.[8]

A series Z_t is said to be integrated of order one, I(1), if it is stationary in its first-difference. In other words, if the coefficient ρ in

$$Z_t = \rho Z_{t-1} + \varepsilon_t \tag{2}$$

is less than one in absolute value, then Z_t is stationary. If $|\rho|=1$ the series is not stationary and is said to have a unit root with a variance equal to $t\sigma^2$ (Dickey and Fuller, 1979). When $|\rho|= 1$ the series is said to be difference-stationary, or I(1). Table 1 contains the unit root tests for RGDP, the CR, the short-term interest rate (SINT), and the consumer price index (CPI).

[Table 1 about here]

The null hypothesis of a unit root (non-stationarity) is not rejected for any of the series tested. In addition, non-stationarity is rejected for all of the series after first differencing, implying that the series are stationary in their first differences, and thus are integrated of order one. This determination of difference-stationarity of the series paves the way for the following test for cointegration.

Equation (1) is referred to as the cointegrating regression. The Augmented Dickey-Fuller (ADF) test will be used to determine whether the series are cointegrated.[9] The ADF test

[8]The cointegrating vector, however, need not be unique when more than two series are analyzed (see Engle and Granger, 1987).

[9]See Engle and Granger (1987) for an exposition of the ADF test.

involves testing the stationarity of the residuals that result from regressing X_t on Y_t; stationarity of the residuals implies that X_t and Y_t are cointegrated. The tests for cointegration can be generalized to more than two series so that cointegration between the CR, RGDP, the SINT, and CPI can be determined.

Results from cointegrating regressions between the CR and each of the other three series, as well as the cointegrating regression which includes all four series are reported in table 2. The ADF test statistic reported for each regression rejects non-stationarity of the residuals, indicating that the CR is cointegrated with each of the other series as well as all four series being cointegrated. Consequently, in the long-run we expect that RGDP, the CR, the SINT and the CPI to be tied together; there exist forces that tie the movement of the CR with the movement of the national business cycle, the movement of short-term interest rates, and the movement of prices. This determination of cointegration tells us there exists an equilibrium relationship between the four series and that more structured modelling should take the form of an error-correction model (ECM) to account for this equilibrium relationship.[10]

[Table 2 about here]

The Short-Run Relationship Between the Combined Ratio and the National Business Cycle

In this section, we establish a more concrete relationship between RGDP, the CR, the SINT, and the CPI. Since there is no theory that would dictate how to specify an empirical short-run relationship between the CR and the national business cycle, we make use of Vector Autoregression (VAR) to allow the data to determine the dynamic structure of the relationship.[11]

The Vector Autoregression/ECM Estimation. A VAR with two (or more) time series of interest that takes the form

$$Y_t = \mathbf{F}Y_{t-1} + \mathbf{G}\xi_t, \tag{3}$$

[10]See Kennedy (1992).
[11]See Pindyck and Rubinfeld (1991).

where Y_t is the vector of stationary (first differenced) series of interest, ξ_t is a sequence of independent innovations (no assumptions regarding its distribution are made), and **F** and **G** are matrices of parameters to be estimated. The number of lags included in the state-space model is dictated by the maximum order of the series' AR component identified for the series.[12]

Since the series of interest were determined to be cointegrated, the VAR as describe above (estimated with the series differenced) will be mis-specified. In addition, specification of the VAR with the non-differenced series will omit important constraints. The mis-specification can be corrected by including the lagged residual that results from the cointegrating regression estimation.[13] The resulting VAR specification takes the form of an error-correction model (ECM):

$$Y_t = \mathbf{F}Y_{t-1} + \mathbf{\Theta} m_{t-1} + \mathbf{G}\xi_t, \tag{4}$$

where m_t is the cointegrating regression residual (from the fourth regression in table 2), which controls for the pertinent information regarding the ability of the series to achieve long-run equilibrium. Table 3 contains the VAR-ECM parameter estimates.

The estimated VAR-ECM parameters reported in table 3 show a number of important relationships. First, most of the regression parameters are not significant as most of the behavior seems to be explained by past behavior, as indicated by the coefficient on the lagged terms. Real GDP, however, is not related to its past, although it shows a highly seasonal nature as all of the quarterly dummies are significant. The combined ratio is basically white noise as it is not related

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[12]A standard Box-Jenkins (1976) IEV procedure suggests inclusion of two AR components is sufficient. The IEV procedure is used to identify the process a series follows, not the length of its cycles. Therefore, it is not unusual that the same AR process was identified in the existing literature (see Venezian, 1985) using annual data as was found here. In addition, the quarterly series does exhibit cyclical behavior comparable to earlier results using annual data, including the identification of a fairly long cycle. We identify an eight-year cycle using quarterly data, however, compared to the six-year cycle identified by Venezian (1985) using annual data and a different time period (see figure 3 and Venezian, 1985, and Doherty and Kang, 1988).

[13]See Engle and Granger (1987).

to its past or any other autoregressive terms. Changes in the CPI are related to past changes in the CR and past changes in the SINT.

Second, the coefficient of the error correction term (m_{t-1}) represents the short-run dynamic behavior of the dependent variable. Taken together the error correction term's coefficients imply that the CR, SINT, and the CPI all respond in the short-run to changes in the long-run relationship described in the cointegration regression, while real GDP does not. A positive coefficient, like that found in the CR autoregression, implies that, when in disequilibrium, the industry is operating below the long-run equilibrium relationship described by the cointegrating regression and thus, will increase in order to to return to the long-run equilibrium. In contrast, SINT and CPI have significantly negative coefficients on the error correction term and thus will experience decreases to return to the long-run equilibrium. These VAR estimates are often difficult to interpret, thus we turn to impulse response functions (IRFs) to describe the behavior of the system.

[Table 3 about here]

The Impulse Response Functions. The impulse response function (IRF) allows us to simulate the impact of a shock to one of the series on the outcome of the other series included in the VAR.

Letting L denote the lag operator, from equation (4) above we have

$$(1-\mathbf{F}L)Y_t = (\mathbf{\Theta} m_{t-1} + \mathbf{G}\xi_t); \qquad (5)$$

multiplying both sides by $(1-\mathbf{F}L)^{-1}$, we have $Y_t = (1-\mathbf{F}L)^{-1}(\mathbf{\Theta} m_{t-1} + \mathbf{G}\xi_t)$, which is easily recognized as the infinite sum

$$Y_t = \sum_{i=0}^{\infty} \mathbf{F}^i(\mathbf{\Theta} m_{t-1-i} + \mathbf{G}\xi_{t-i}) \; . \qquad (6)$$

Choosing an appropriate number as an upper limit of the sum (i.e., 20), we can simulate the effect of a shock to ξ_t on the series Y at simulated times t+1, t+2, ... ,t+20.

Figure 4 illustrates the simulated response of the combined ratio that results from isolated shocks to each of the other three series. The response is measured in terms of CR standard deviations. A shock to RGDP of one standard deviation initially causes the CR to decline (probably by an amount insignificantly different from zero), and then to increase before eventually dying out. Shocks to the SINT and the CPI increase the CR, whose response remains positive before dying out.

These responses of the CR to shocks in the external factors is intuitive. First, we observe a pure income effect when GDP experiences a shock. A positive shock to GDP is interpreted as an increase in total income, leading to increased demand for all normal goods, thus increasing the revenue and profits in the property-liability industry. Second, a positive shock to the short-term interest rate means the price of borrowing capital (cost of doing business) goes up, decreasing profits. And, third, the response of the CR to a shock in the CPI illustrates the net effect of an increase in price on goods competing with insurance for expenditures. The negative impact of a positive shock implies that the income effect dominates the substitution effect when the price of other goods increases.

One thing to note, however, is the relative size of the effects of these shocks on the CR; the response of the CR to each of the shocks is less than one of its standard deviations. The standard deviation of the quarterly combined ratio over the whole time period is 5.92 and the mean is 106.65. According to figure 4, a one standard deviation shock to RGDP causes its largest response in the CR of 0.04 standard deviations three quarters from when the shock took place. This translates to an absolute increase in the CR of 0.23 (0.04 x 5.92), which is less than 0.1% of the average CR for the whole period. The largest response the CR has is to a shock in figure 5 results from a shock to the SINT. A one standard deviation shock to the SINT causes CR to increase by 0.20 standard deviations during the next quarter, which is an absolute increase in the CR of 1.18 (1% of the period's average). Thus, the effects of the external influences of the general business cycle on the insurance industry seem relatively small.

[Figure 4 about here]

Decomposing the Impact of a Shock. An additional diagnostic tool that will tell us something about the dynamic short-run relationship between the CR and the general business cycle is variance decomposition. A variance decomposition breaks down the variance of the forecast error for the CR into components that can be attributed to each of the other variables in the VAR. In other words, this decomposition tells us how much of the uncertainty surrounding predictions of the CR can be attributed to the uncertainty regarding the other three variables. Table 4 breaks down the forecast error for the CR into components attributable to RGDP, the SINT, and the CPI.[14]

The results in table 4 confirm the conclusions drawn from reviewing the impulse response functions above: there does not exist a strong direct relationship between the CR and the rest of the series which represent the general business cycle. The decomposition of the forecast variance reported in table 4 results from shocking the CR in period 1, with the other variables in the model responding in the following periods. Column 3 in table 4 shows the percentage of the CR forecast variances that can be attributed to shocks in the combined ratio alone. The fourth column shows the percentage of the CR forecast errors that can be attributed to shocks in real GDP, the fifth column shows the percentage attributable to short-term interest rates, and the sixth column shows the percentage attributable to the consumer price index. For example, if the model is used to make an 8 quarter forecast of the CR, 88.77% of the forecast variance will be attributable to CR shocks, .28% to real GDP shocks, 7.81% to interest rate shocks, and 3.15% to CPI shocks. In other words, even if we had no idea what to expect for the level of RGDP, the SINT, or the CPI to be in the future, it would be of little concern regarding forecasts of the CR. Although this may be good news for the internal stability of profits in the industry, it also means that adjusting these external factors will have little effect on profits. This

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[14]There is no appreciable change in the decomposition beyond the thirteenth time period from the shock.

also implies that the industry's profitability is insensitive to changes in macroeconomic policy, such as changes in political administrations.

[Table 4 about here]

Summary and Conclusion

This paper examined the long-run relationship between fluctuations in the national business cycle and fluctuations in the the property and liability underwriting cycle. Using cointegration techniques we tested for a long-run relationship between real GDP, inflation, and the short-term interest rate on the insurance underwriting cycle, as measured by the combined ratio. We find that there is a long-run relationship between general economic changes and underwriting performance as evidenced by the cointegrating regression. In addition, we estimated an error correcting vector autoregressive model to ascertain the short-run dynamics of the long-run equilibrium relationship. From this we found that, although spectral analysis suggested that the fluctuations of the property-liability underwriting cycle seem to fit exactly with general economic fluctuations, the effects of shocks to these general economic variables had little effect on the performance of the property-liability industry.

A conclusion that could be drawn from this analysis is that changes in demand have no effect on insurer underwriting performance. This could be a simplification because of the fact the IRFs do not include an industry supply response. One could hypothesize that the reason that shocks to GDP seem to have little effect on the combined ratio is because the industry is able to increase supply quickly without a significant effect on underwriting performance. Shocks to supply related economic variables, such as the short-term interest rate and the rate of inflation, have a larger impact on the combined ratio, potentially because the industry can not respond to shocks to supply as well as it can to shocks in demand. Thus, the conclusion that should be made is that the industry can "absorb" demand shocks easier than supply shocks.

Figure 4 provides evidence that shocks to the short-term interest rate do have an immediate and relatively large effect on the industry's combined ratio. One could conjecture that the combined ratio is increasing (premiums are being decreased) as a result of a supply shock to interest rates in order to attract business by so-called "cash flow underwriting." By underpricing insurance, the firm can obtain greater premium income which can be invested at a higher return in the market. Even though the size of the change of the combined ratio due to shock in the short-term rates is relatively large, it should be noted that the change in the combined ratio amounts to only 1 percent of the mean level combined ratio for the period. This implies that the "evil" of cash flow underwriting is not a significant industry problem.

Shocks to inflation, too, are relatively more difficult for the industry to absorb. However, one would expect inflation to influence expenses and losses more, in the short-run, than premiums. Premiums are generally fixed by contract for some period of time (say, six months), so the industry must absorb increases in losses and expenses in the short-run. Note that the impulse response peaks at 6 months (2 quarters) and has another major peak at 12 months (4 quarters) after the initial shock, so it seems the industry can adjust to changes in inflation in about 1 year. Again, it should be noted that the effect of a shock to inflation on the combined ratio is relatively small.

These results imply that the even though the general economic fluctuations track the fluctuations in the insurance cycle very well, unanticipated changes do not cause large changes in the industry's performance. This does not imply, however, that institutional details are more important than the general economic condition as the spectral analysis showed an almost identical picture of the economic and insurance industry behavior. For example, the cobweb cycle models of the industry (Stewart, 1987) are institutional models claiming that prices fail to converge smoothly to an equilibrium (Doherty and Garven, 1991). The impulse response functions show that the equilibrium path for the combined ratio and it is relatively smooth. Focus should thus be placed on the industry's responses to supply shocks.

In addition, this research finds little or no evidence of a "lack of restraint theory" operating to increase cyclicality. Shocks to GDP or the interest rate had little short-term and no long-term effect on the combined ratio. Even if the property-liability insurance industry exhibited a lack of restraint, the market returned to an equilibrium position in about 4 to 6 quarters -- considerably less than one-half of the underwriting cycle's length. Even though external factors are not important in determining the CR, they move together in the LR, therefore the use of solely institutional stories to explain the insurance industry's performance is questionable.

Table 1

Results for Testing Whether RGDP, the CR, the SINT, and the CPI Are Each I(1)

Series	$\hat{\rho}$ (std. error)	Dickey-Fuller (1979) Test Statistic $n(\hat{\rho}-1)$
RGDP	1.0164 (0.0093)	1.0824
CR	0.9105 (0.0523)	-5.9070
SINT	0.9129 (0.0514)	-5.7486
CPI	0.9999 (0.0033)	-0.0066
ΔRGDP	-0.4531 (0.1141)	-95.9047
ΔCR	-0.1680 (0.1207)	-77.0880
ΔSINT	0.2023.(0.1222)	-52.6482
ΔCPI	0.6326.(0.0989)	-24.2484

Notes: Δ is the difference operator. The 10% critical value of -10.7 is obtained from Fuller (1976), table 8.5.1.

Table 2
Cointegrating Regressions (standard errors in parenthesis)

Cointegrating Regression	ADF Test Statistic	R^2
CR = 101.438 + 0.0065*RGDP (1.2994) (0.0014)	-5.4588	0.24
CR = 103.445 + 0.3996*SINT (2.4251) (0.2886)	-5.5230	0.19
CR = 95.750 + 0.1207*CPI (2.2558) (0.0240)	-5.4745	0.27
CR = 87.678 - 0.0098*RGDP + 0.1144*SINT + 0.2869*CPI (6.4624) (0.0091) (0.2861) (0.1595)	-5.4778	0.30

Notes: Critical values obtained from MacKinnon (1990). The 1% critical value is -4.1035.

Table 3

Vector Autoregression-Error Correction Model Parameter Estimates; RGDP, the CR, the SINT, and the CPI (standard errors in parentheses)

Dep Var =	ΔCR_t	$\Delta RGDP_t$	$\Delta SINT_t$	ΔCPI_t
ΔCR_{t-1}	-0.1734	1.6735	0.0232	0.0685**
	(0.1444)	(1.2190)	(0.0696)	(0.0312)
ΔCR_{t-2}	0.0490	-1.2207	-0.0023	0.0614**
	(0.1407)	(1.1882)	(0.0678)	(0.0304)
$\Delta RGDP_{t-1}$	-0.0115	-0.1085	0.0048	-0.0031
	(0.0176)	(0.1483)	(0.0085)	(0.0037)
$\Delta RGDP_{t-2}$	-0.0157	0.4376**	0.0107	-0.0032
	(0.0168)	(0.1416)	(0.0081)	(0.0036)
$\Delta SINT_{t-1}$	0.4337	1.3684	0.2648*	0.2337***
	(0.2788)	(2.3541)	(0.1344)	(0.0602)
$\Delta SINT_{t-2}$	0.3154	-3.3428	-0.3458**	-0.0327
	(0.2880)	(2.4315)	(0.1388)	(0.0622)
ΔCPI_{t-1}	0.3450	9.8643*	-0.3672	0.3672**
	(0.6435)	(5.4336)	(0.3102)	(0.1389)
ΔCPI_{t-2}	0.9459	-5.4732	0.2805	0.2105*
	(0.5826)	(4.9195)	(0.2809)	(0.1258)
m_{t-1}	0.1293**	-0.0327	-0.0599**	-0.0288**
	(0.0608)	(0.5131)	(0.0293)	(0.0131)
Intercept	-1.5555	-34.1125***	-0.1433	0.5617**
	(1.0575)	(8.9288)	(0.5098)	(0.2283)
Q2 dummy	-0.3677	53.7776***	-0.4970	0.1183
	(1.4718)	(12.4269)	(0.7095)	(0.3178)
Q3 dummy	-0.1407	64.6033***	0.4850	0.2932
	(1.1388)	(9.6158)	(0.5490)	(0.2459)
Q4 dummy	2.9522***	60.2049***	-0.4203	0.0636
	(0.9947)	(8.3983)	(0.4795)	(0.2148)
Adj. R^2	0.3663	0.7317	0.1523	0.5580
Std.Err.	2.0401	17.2257	0.9835	0.4405

Note: Q2 - Q4 are quarterly dummies used to account for seasonality within the year. ***, **, * represent significance at the 0.01, 0.05, and 0.10 levels respectively.

Table 4

Variance Decomposition of the Combined Ratio

Period from Shock	Standard Error	Combined Ratio	Real GDP	Short-Term Interest Rate	Consumer Price Index
1	1.8247	100.00	0.00	0.00	0.00
2	1.8954	95.72	0.00	3.88	0.41
3	1.9576	90.60	0.10	7.18	2.12
4	1.9662	90.20	0.20	7.44	2.15
5	1.9753	89.65	0.20	7.37	2.78
6	1.9801	89.28	0.26	7.50	2.96
7	1.9862	88.90	0.26	7.72	3.11
8	1.9882	88.77	0.28	7.81	3.15
9	1.9899	88.66	0.28	7.83	3.23
10	1.9908	88.61	0.28	7.85	3.26
11	1.9916	88.55	0.28	7.87	3.29
12	1.9920	88.53	0.28	7.89	3.30
13	1.9924	88.50	0.28	7.89	3.32

Figure 1
Annual Real GNP and the CR Series in Their First Differences From 1940 to 1990

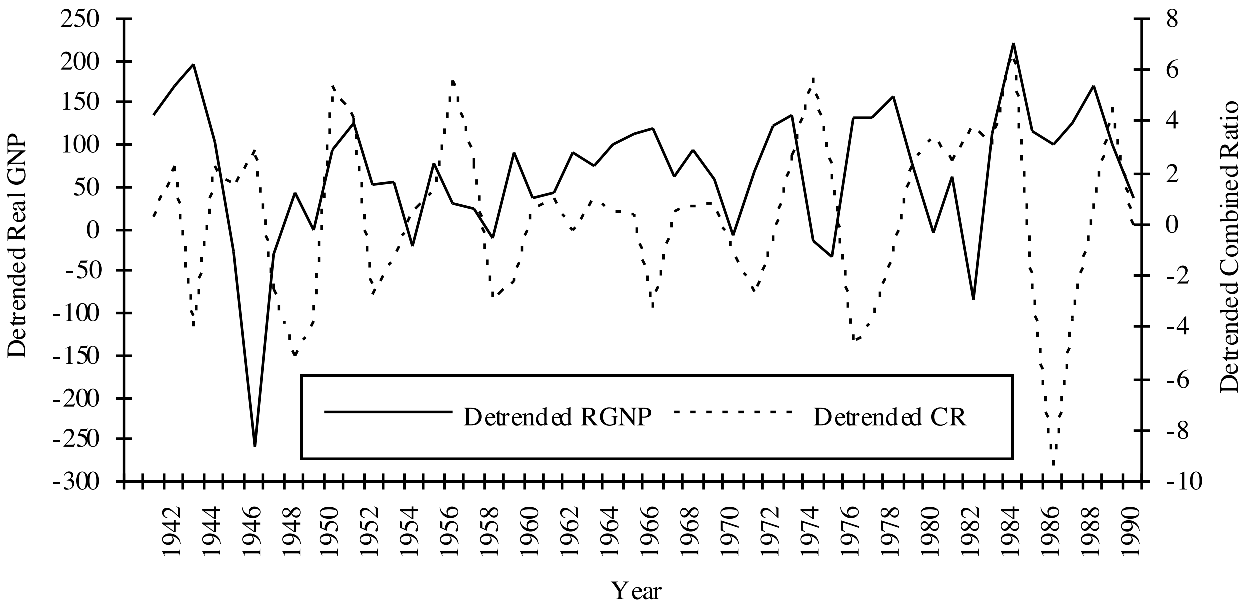


Figure 2

Quarterly Real GNP and the CR Series in Their First Differenced From 1974 to 1990

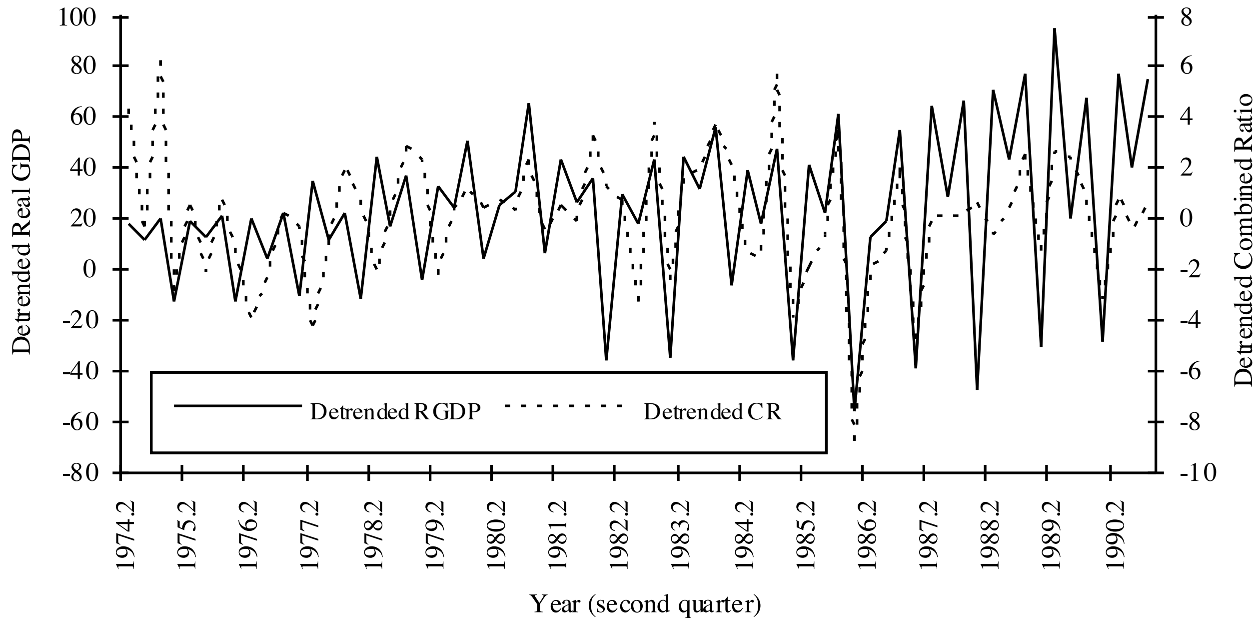


Figure 3

Spectral densities for the First-Differenced Series of Real GDP, and the Combined Ratio, quarterly 1974.1-1990.4

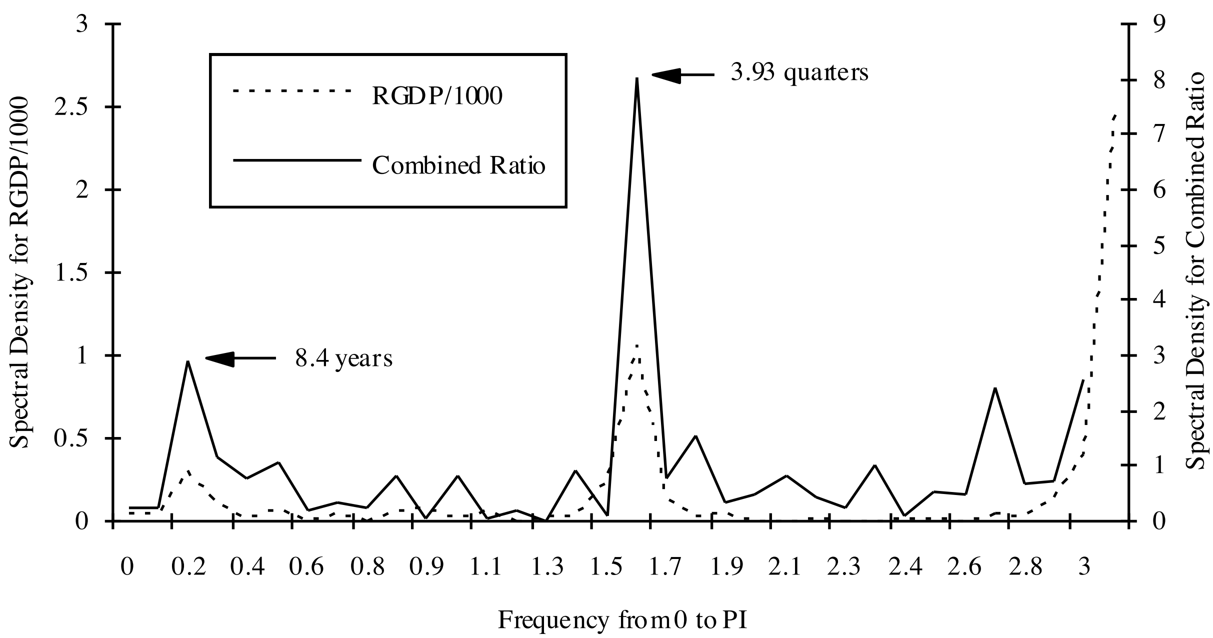
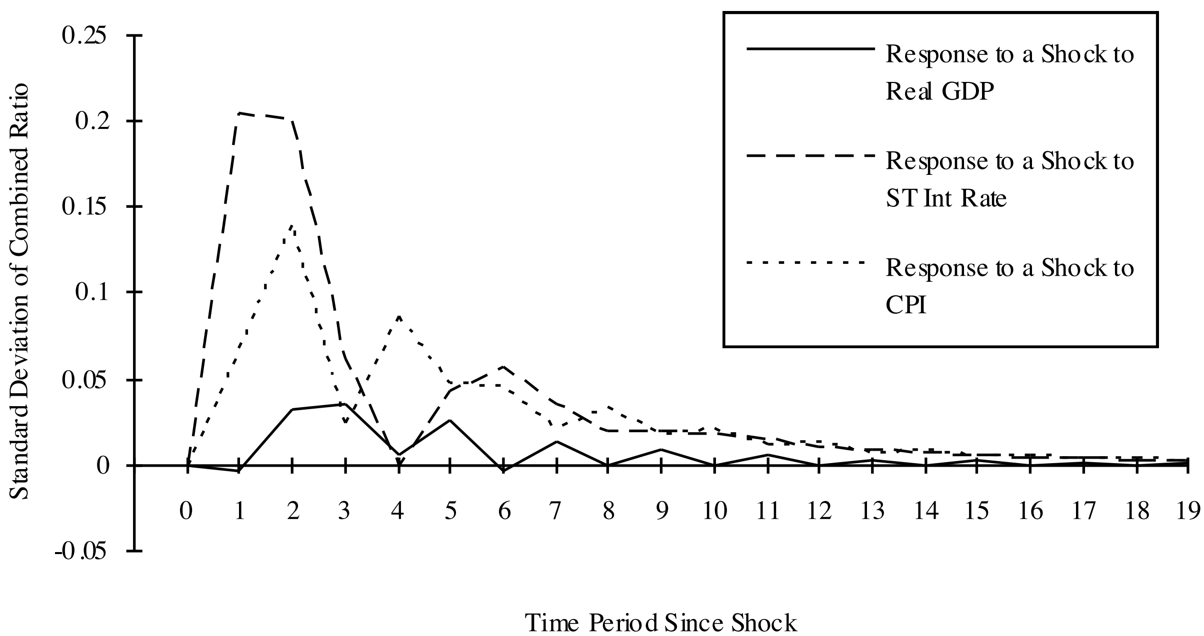


Figure 4
Impulse Response (measured in terms of CR standard deviations) of CR to a One Standard Deviation Shock to RGDP, the SINT Rate, and the CPI.



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