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External Impacts on the Property-Liability Insurance Cycle

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ABSTRACT

Traditionally, underwriting performance is considered to be a function of industry-specific institutions. Using quarterly data from 1974 through 1990, we provide evidence of a long-run link between the general economy and the underwriting performance as measured by the combined ratio. Using cointegration techniques, we estimate the long-run relationship between the general economy as measured by real gross domestic product, the short-term interest rate, and inflation. We then estimate the short-run link between the industry and the general economy using vector autoregression techniques and find that, although the property-liability insurance industry is linked to the long-run performance of the national economy, short-run shocks in economic variables have little effect on the combined ratio.

Introduction

Time series methods can be employed to examine the property-liability insurance industry to determine effects on the insurance cycle of external factors such as shocks to real income, inflation, and the short-term interest rate. These methods allow exploration of the short-term relationship between the cycle and these external factors while controlling the underlying long-term relationships among these series. Previous work examined institutionally related changes in the market or specific economic variables such as the interest rate and their relationships to the property-liability cycle. However, with some exceptions, little credit is given to the general conditions of the economy for

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fluctuations in the industry's underwriting performance. We examine these external links.

This article first describes the literature in insurance cycles and then presents an empirical analysis of the link between insurance industry performance and general economic conditions. We conclude that, although there is a link between the insurance industry and the general economy, external unanticipated economic shocks seem to have little effect on industry underwriting performance, but under the assumptions of the fair rate of return literature, the effects on profits may be more important.

Background and Literature Review

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.

Industry folklore states the reason cycles exist is because there is no market restraint. Proponents of the "lack-of-restraint" theory believe the cycle is caused by an inability to control price (Stewart, 1987).[1] 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 in their future expectations concerning losses (McGee, 1986); that regulation, policy renewal lags, and accounting practices may cause the appearance of cycles even when prices are set under a rational expectation framework (Cummins and Outreville, 1987); and that one or more of the above are taking place (Harrington, 1988).

Several authors have examined the relationship between interest rates, an exogenous variable, and various aspects of underwriting performance. Fields and Venezian (1989) find a strong relationship between unanticipated interest rates and profitability. Doherty and Kang (1988) suggest that insurance 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, and Haley (1993) finds a long-term relationship between short-term interest rates and the underwriting margin. Further, Grøn (1990; 1994) finds that underwriting profits are consistent with a capacity constraint model. Doherty and Garven (1991), also using a capacity constraint model, examine

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[1] Harrington and Danzon (1994) test for the winner's curse effects in general liability insurance pricing and find little evidence that insurers experience the winner's curse. The winners curse is likened to the lack-of-restraint hypothesis: firms cut prices to obtain market share and then must pay the expected loss. A proxy for the winner's curse was linked to low prices in the early 1980s for some insurers. However, they find the evidence for underpricing is consistent with moral hazard induced by excessive risk taking resulting from the insurer's limited liability.

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 due to readjustments of the firm's capital structure.[2] Taken together these results imply some capital market imperfections that may lead to cyclical behavior. Further, there is some empirical evidence consistent with this view (Niehaus and Terry, 1993). In fact, Cummins and Danzon's (1994a) comparison of the capacity constraint model finds that the behavior of the liability industry during the 1980s cannot be explained by the perfect market pricing model alone.

Empirical Analysis

The empirical analysis is divided into three sections. First, visual evidence of the relationship is explored. Second, cointegration techniques are used to explore the long-run contemporaneous relationship. Finally, the short-run dynamics are examined through vector autoregression analysis, which provides information concerning adjustments to the long-run relationship that are made in the short run.

Although one could examine annual or quarterly data, we examine the quarterly combined ratio from 1974 through 1990 for a number of reasons. Primarily, quarterly data are available from the A. M. Best Company since 1974 and are consistent with the real gross domestic product series we employ in our analysis. Further, we question the validity of time series analysis under potentially differing regulatory regimes implied by a long annual time series.[3]

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[2] Others, however, more explicitly discuss the effect of an exogenous shock on the general underwriting results, such as that resulting from a natural disaster (Grøn, 1990, 1994; 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.

[3] Because of the numerous changes in states' regulatory environments (see Harrington, 1984), it is hypothesized that there may be different time series regimes over the period from 1940 through 1990. For example, in the late 1960s and early 1970s, states enacted procompetitive rating laws and introduced no-fault insurance, which 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 from 1940 through 1990, the time period was broken into two subperiods. The first subperiod—from 1940 through 1969—reflects the old regulatory environment, and the second subperiod—from 1970 through 1990—reflects the new regulatory environment. The null hypothesis that the parameter coefficients are the same across time periods (constant dynamics across time periods) was rejected at the 10 percent level. This result may call into question Haley's (1993) results since he employed yearly data from 1930 through 1989 and did not account for differing regulatory regimes in the data. Although it may be preferable to use data corresponding to longer time periods to examine long-run relationships (Maddala, 1992), we concentrate only on the period since 1970 because this period represents a series where the regulatory environment is relatively more stable. We employ quarterly data in this research over this period to increase the number of observations.

Using the quarterly data, the bivariate correlation between the combined ratio and the real gross domestic product was 0.49, while the correlation for the same variables in their first differences was 0.48 for the years 1974 through 1990. Thus, we see potential for examining the link between the two series.

Figure 1 illustrates the substantial similarity between the combined ratio and the real gross domestic product by graphing the series' spectral densities. A spectral density function is estimated to examine the data for cycles or periodicities (Jenkins and Watts, 1968).[4] The use of spectral density analysis supposes that any time series can be thought of as the sum of a noncountable 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 measured by their composite variance (Granger and Newbold, 1986). It is interesting to note that the area underneath the spectral density function in Figure 1 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 1 results from applying a finite Fourier transform, which is a decomposition of a sum of sine and cosine waves of different amplitudes and wavelengths. The result then can be used to infer periodicity of cycles. For example, the peak at about 1.6 in Figure 1 corresponds to a cycle of period length $2\pi/\omega$, where ω is the frequency. When $\omega = 1.6$, $2\pi/\omega =$ 3.93 quarters or approximately one year. Similarly, there is another peak at 0.19, which corresponds to a cycle of approximately 8.4 years.[5] The peaks in Figure 1 to the left of $\omega = 1.6$ imply some seasonality in the combined ratio. Both the real gross domestic product and the combined ratio have cycles of about one year and 8.4 years. In addition, the short-term interest rate and the consumer price index exhibit cyclical behavior similar to that illustrated in Figure 1 for gross domestic product and the combined ratio. Traditionally, research has not included extraindustry 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 fluctuations experienced by the industry.

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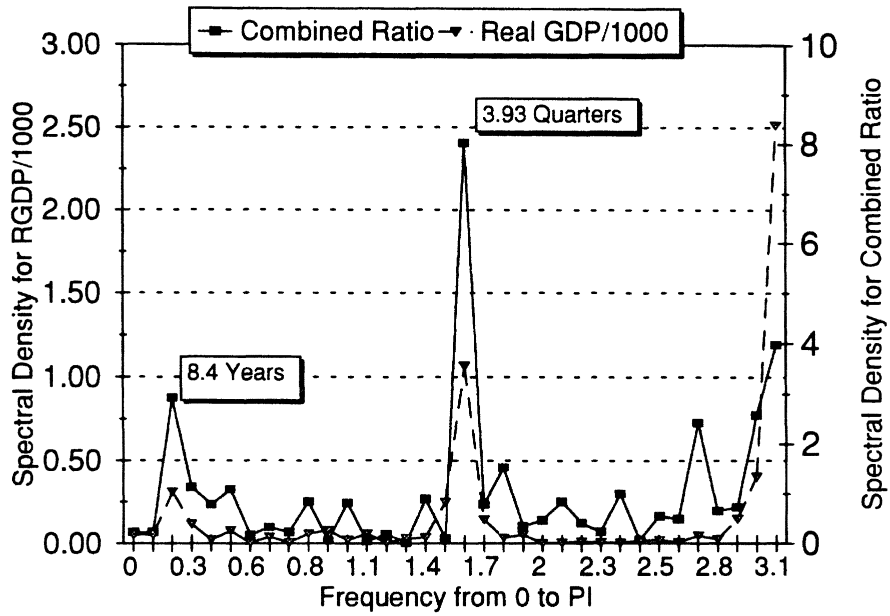
[4] The treatment of spectral density functions and their analysis is technical. For a simple introduction, see Kennedy (1992), or see Granger and Engle (1984) for a more advanced treatment. For uses of spectral density functions in the insurance cycle literature, see also Venezian (1985) and Doherty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

[5] Venezian (1985) finds that the cycle's length is approximately six years. Using Venezian's methodology on the combined ratio (rather than the loss ratio) we obtain a cycle period of 7.6 years for the period 1940 through 1990. For the period of Venezian's study (1965 through 1980) we obtain a cycle period of 5.8 years, and for the period covered by this study we obtain 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 indicates that recent cycles are longer than older cycles.

Figure 1
Spectral Density of Quarterly Real Gross Domestic Product
and the Quarterly Combined Ratio, 1974 Through 1991



Long-Run Relationship Between Combined Ratio and 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 (the sum of the ratio of expenses before taxes to premiums written and the ratio of losses and loss adjustment expenses to premiums earned) is tied to the general business cycle in the long run, we test whether the combined ratio and real gross domestic product are cointegrated.[6] The null hypothesis of cointegration is that there is no long-run relationship among the variables. If the null hypothesis is rejected (i.e., the series are cointegrated), 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 the real gross domestic product and the combined ratio are cointegrated would suggest that (economic) factors are at work tying the move-

[6] Potential problems arise when premiums earned is used to determine the loss ratio component of the combined ratio. Premiums written reflects pricing on policies issued during a given time period rather than the average price over a two-period interval. Thus, premiums written reflects the same information set as the measure of losses in the numerator of the combined ratio. Cummins and Danzon (1994b) report qualitatively similar results for premiums written and premiums earned when the loss ratio was used to develop a measure of price.

ment of the combined ratio cycle to a more wide-ranging national business cycle.

Cointegration between the two series 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 insurers and thus profits (measured inversely by the combined ratio). The analysis is performed using quarterly data available from 1974 through 1990.

The short-term interest rate and the consumer price index are also included as controlling factors in the analysis. Under the Myers-Cohn (1987) fair rate of return premium model, there is a relationship between the combined ratio and the interest rate as increases in interest rates reduce the premiums needed to cover expected future loss costs. The consumer price index is expected to control for the income effects resulting from price changes. All series are treated endogenously.

The quarterly real gross domestic product is constructed by deflating nominal gross domestic product, obtained from the *Survey of Current Business* with the producer price index obtained from CITIBASE.[7] The quarterly combined ratio series was obtained from *Best's Review.* The quarterly short-term 90-day Treasury bill interest rate 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 (Hall, 1986; Goldin and Margo, 1989; and Boucher, 1991). Although the concept of cointegration provides information about how two (or more) series move together in the face of unspecified external forces, it provides no specific information about the explanatory power one of the series might have on the other (Granger and Newbold, 1986, p. 226). The impulse response functions generated via a vector autoregression will be examined later for this purpose.

In order to determine whether economic series are cointegrated, each series must be stationary. 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

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

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 the real gross domestic product, the combined ratio, the short-term interest rate, and the consumer price index.

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[7] The producer price index is used since the only gross domestic product price deflator available is seasonally adjusted and implicit in nature, making direct unadjusted calculations impossible. CITIBASE is a data base containing approximately 7,000 macroeconomic time series and is maintained by Fame Software, a subsidiary of Citibank, N.A.

Table 1
Unit Root Tests for the Real Gross Domestic Product, Combined Ratio, Short-Term Interest Rate, and Consumer Price Index When $|\rho| = 1$ and the Series is Difference-Stationary I(1)

Series	$\hat{\rho}$	*Standard Error*	*Dickey-Fuller (1979) Test Statistic* $n(\hat{\rho}-1)$
Real Gross Domestic Product	1.0164	(0.0093)	1.0827
Combined Ratio	0.9105	(0.0523)	-5.9070
Short-Term Interest Rate	0.9129	(0.0514)	-5.7486
Consumer Price Index	0.9999	(0.0033)	-0.0066
Δ Real Gross Domestic Product	-0.4531	(0.1141)	-95.9047
Δ Combined Ratio	0.1680	(0.1207)	-77.0880
Δ Short-Term Interest Rate	0.2023	(0.1222)	-52.6482
Δ Consumer Price Index	0.6326	(0.0989)	-24.2484

Note: Δ is the difference operator. The 10 percent critical value of -10.7 is obtained from Fuller (1976, Table 8.5.1).

The null hypothesis of a unit root (nonstationarity) is not rejected for any of the series tested. In addition, nonstationarity 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.[8] 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 combined ratio, real gross domestic product, the short-term interest rate, and the consumer price index can be determined.

Results from cointegrating regressions between the combined ratio and each of the other three series, as well as the cointegrating regression that includes all four series, are reported in Table 2. The ADF test statistic reported for each regression rejects nonstationarity of the residuals, indicating that the combined ratio is cointegrated with each of the other series as well as all four series being cointegrated.[9] Consequently, in the long run, we expect the real gross domestic product, the combined ratio, the short-term interest rate, and the consumer price index to be tied together as there exist forces that tie the movement of the combined ratio with the movement of the national business cycle,

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[8] See Engle and Granger (1987) for an exposition of the Augmented Dickey-Fuller test.

[9] The standard errors in the regressions shown in Table 2 may be biased toward being smaller than the true standard errors. The coefficients, however, are not biased. In addition, there may be multicollinearity in the fourth regression as the short-term interest rate and consumer price index may be correlated. These problems are not important here because the focus of the regressions is to determine whether the variables are cointegrated.

the movement of short-term interest rates, and the movement of prices. This determination of cointegration tells us that an equilibrium relationship exists between the four series and that a more structured model should take the form of an error-correction model to account for this equilibrium relationship (see Kennedy, 1992).

Table 2
Cointegrating Regressions Between the Combined Ratio (CR) and the Real Gross Domestic Product (RGDP), Short-Term Interest Rate (SINT), and Consumer Price Index (CPI) and for All Four Series

Cointegrating Regression	*Augmented Dickey-Fuller 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 + 0.114 · SINT + 0.2869 · CPI		
(6.462) (0.009) (0.286) (0.159)	-5.4778	0.30

Note: Standard errors are in parentheses. Critical values are obtained from MacKinnon (1990). The one percent critical value is -4.1035.

Short-Run Relationship Between Combined Ratio and National Business Cycle

This section establishes a more concrete relationship between the real gross domestic product, the combined ratio, the short-term interest rate, and the consumer price index. Since theory does not dictate the specification of an empirical short-run relationship between the combined ratio and the national business cycle, we use vector autoregression to allow the data to determine the dynamic structure of the relationship (see Pindyck and Rubinfeld, 1991).

The vector autoregression/error-correction model estimation. The resulting vector autoregression specification takes the form of an error-correction model:

$$Y_t = FY_{t-1} + \Theta m_{t-1} + G\xi_t, \quad (2)$$

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 (see Engle and Granger, 1987). The number of lags included in the state-space model is dictated by the maximum order of the autoregression component identified for the series.[10] Table 3 contains the vector autoregression–error-correction model parameter estimates.

The estimated vector autoregression–error-correction model parameters show a number of important relationships (see Table 3). First, most of the nonlagged regression parameters are not significant; most of the behavior seems to be explained by past behavior, as indicated by the coefficient on the lagged terms. However, due to the possible existence of multicollinearity, especially between the short-term interest rates and the consumer price index, the standard errors may be inflated. Real gross domestic product, however, is not related to its past, although it shows a highly seasonal nature as all of the quarterly dummy variables are significant. The combined ratio is basically white noise as it is not related to its past or any other autoregressive terms. Changes in the consumer price index are related to past changes in the combined ratio and past changes in the short-term interest rate.

Second, the coefficient of the error-correction term (m_{t-1}) represents the short-run dynamic behavior of the dependant variable. Taken together, the error-correction term's coefficients imply that the combined ratio, the short-term interest rate, and the consumer price index all respond in the short run to changes in the long-run relationship described in the cointegration regression, while real gross domestic product does not. A positive coefficient, like that found in the combined ratio 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 return to the long-run equilibrium. In contrast, the short-term interest rate and consumer price index have significantly negative coefficients on the error-correction term and thus will experience decreases to return to the long-run equilibrium. These vector autoregression estimates are often difficult to interpret; thus, we turn to impulse response functions to describe the behavior of the system.

The impulse response functions. The impulse response function allows us to simulate the impact of a shock to one of the series on the outcome of the other series included in the vector autoregression. Letting L denote the lag operator, from equation (2) above we have

$$(1\text{-}FL)Y_t = (\Theta m_{t-1} + G\xi_t); \qquad (3)$$

multiplying both sides by $(1\text{-}FL)^{-1}$, we have $Y_t = (1\text{-}FL)^{-1}(\Theta m_{t-1}+G\xi_t)$, which equals the infinite sum

[10] A standard Box-Jenkins (1976) identify-estimate-verify (IEV) procedure suggests inclusion of two autoregression 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 autoregression 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 1 and Venezian, 1985, and Doherty and Kang, 1988).

Table 3
Vector Autoregression–Error-Correction Model Parameter Estimates for the Real Gross Domestic Product (RGDP), Combined Ratio (CR), Short-Term Interest Rate (SINT), and Consumer Price Index (CPI)

	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 Variable	-0.3677	53.7776*	-0.4970	0.1183
	(1.4718)	(12.4269)	(0.7095)	(0.3178)
Q3 Dummy Variable	-0.1407	64.6033*	0.4850	0.2932
	(1.1388)	(9.6158)	(0.5490)	(0.2459)
Q4 Dummy Variable	2.9522*	60.2049*	-0.4203	0.0636
	(0.9947)	(8.3983)	(0.4795)	(0.2148)
Adjusted R^2	0.3663	0.7317	0.1523	0.5580
Standard Error	2.0401	17.2257	0.9835	0.4405

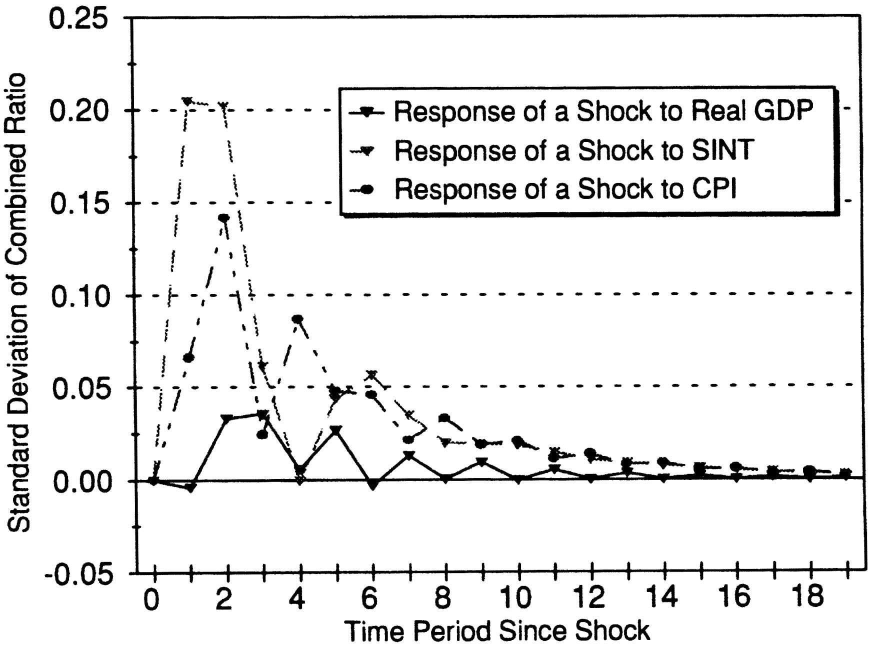
Note: Standard errors are in parentheses. Q2, Q3, and Q4 are quarterly dummy variables used to account for seasonality within the year.
* Significant at 0.01. ** Significant at 0.05. *** Significant at 0.10.

$$Y_t = \sum_{i=0}^{\infty} F^i (\Theta m_{t-1-i} + G\xi_{t-i}). \tag{4}$$

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

Figure 2 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 combined ratio standard deviations. A shock to the real gross domestic product of one standard deviation initially causes the combined ratio to decline (probably by an amount not significantly different from zero), and then to increase before eventually dying out. Shocks to the short-term interest rate and the consumer price index increase the combined ratio, whose response remains positive before dying out.

Figure 2
Impulse Response Function: Changes Due to a One Standard Deviation Shock



These responses of the combined ratio to shocks in external factors have an intuitive interpretation. First, we observe a pure income effect when real gross domestic product experiences a shock. A positive shock to real gross domestic product 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, since in a competitive market insurance premiums will reflect discounted expected losses, there is a direct and positive relationship between the competitively determined combined ratio and the interest rate. This is consistent with theory (Cummins, 1991) and empiricism (Cummins and Harrington, 1985).

Finally, the response of the combined ratio to a shock in the consumer price index illustrates a number of possible effects. First, there is the direct effect of an increase on claims costs once policies are sold. Second, an increase in prices of other goods competes with insurance for expenditures. It is likely that the inflationary impact on claims expenses dominates the effect of increasing prices of other goods as the short-run demand for insurance is relatively price inelastic.[11] The negative impact of a positive shock implies that the income effect dominates the substitution effect when the price of other goods increases.

A variance decomposition analysis confirms the conclusions drawn from reviewing the impulse response functions above: there is not a strong direct relationship between the combined ratio and shocks to the series representing the general business cycle.[12] The decomposition explains how much of the uncertainty surrounding the prediction of the combined ratio can be attributed to uncertainty surrounding the other variables. If the model is used to make an eight-quarter forecast of the combined ratio, 88.77 percent of the forecast variance will be attributable to combined ratio shocks, 0.28 percent to real gross domestic product shocks, 7.81 percent to interest rate shocks, and 3.15 percent to consumer price index shocks (Pindyck and Rubinfeld, 1991, p. 390). In other words, even if we had no idea what to expect for future levels of real gross domestic product, short-term interest rate, or consumer price index, it would be of little concern regarding forecasts of the combined ratio. However, as shown below, it is the sensitivity to profits and not the combined ratio that is truly important.

Shocks to the short-term interest rate do have an immediate and relatively large effect on the industry's combined ratio relative to a shock to real gross domestic product or the consumer price index (see Figure 2). It is important to note that, under the Myers-Cohn (1987) model, interest rate changes can affect premiums because, as interest rates increase, the equilibrium level of premiums needed to cover the expected loss costs decreases. Even though the size of the change of the combined ratio due to a shock in the short-term rates is relatively large, the change in the combined ratio amounts to only one percent of the mean level combined ratio for the period.

Shocks to inflation, too, are relatively more difficult for the industry to absorb. However, one would expect inflation in the short-run to influence expenses and losses more 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 six months (two quarters) and has another major peak at twelve months (four quarters) after the initial shock, so it seems the industry can adjust to changes in inflation in about one year. Again, the effect of a shock to inflation on the combined ratio is relatively small.

As mentioned above, the relative size of the effects of these shocks on the combined ratio (the response of the combined ratio 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. As shown in Figure 2, a one standard deviation shock to the real gross domestic

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[11] Our thanks to an anonymous referee for making this point.

[12] This analysis is available from the authors upon request.

product causes its largest response in the combined ratio of 0.04 standard deviations three quarters from when the shock took place. This translates to an absolute increase in the combined ratio of 0.23 (0.04 x 5.92), which is less than 0.1 percent of the average combined ratio for the whole period. A shock to the short-term interest rate results in the combined ratio's largest response. A one standard deviation shock to the short-term interest rate causes the combined ratio to increase by 0.20 standard deviations during the next quarter, which is an absolute increase in the combined ratio of 1.18 (one percent of the period's average). Thus, the effects of the external influences of the general business cycle on the insurance industry seem relatively small.

However, important changes can be obscured by looking at the combined ratio rather than the profit level. Using some stylized facts, it is possible to obtain some indication of the effect on profits of the one-period response to a shock. For example, a change in the short-term interest rate of one percent of its mean level causes a loss of 3.4 percent in terms of profits. An increase of one percent from the mean level of real gross domestic product causes a decrease of 0.70 percent in profits, while an increase in the consumer price index of one percent of its mean causes a decrease of 10.04 percent in profits.[13] It is important to note, too, that the reaction with respect to interest rates is consistent with the Myers-Cohn (1987) model and modifications (Harrington, 1988; Cummins and Danzon, 1994a) as well as with empirical results (Haley, 1993).

These results imply that, even though the general economic fluctuations track fluctuations in the insurance cycle very well, unanticipated changes do not cause large changes in the industry's performance as measured by the combined ratio. Profitability, based on stylized assumptions, seems more responsive to changes in exogenous variables. Exogenous economic factors that have often been dismissed are shown to be important. This does not necessarily imply that external economic factors are more important than institutional factors, but, as the spectral density analysis (Figure 1) showed an almost identical picture of the behavior of the economy and the insurance industry, it is hard to say that the insurance industry cycles are mere institutional artifacts.

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[13] These calculations are based on an assumed level of losses and under the assumptions of the Myers-Cohn (1987) model that the break-even premium equals the present value of expected future losses discounted at the risk-adjusted rate plus the present value of income taxes discounted at the risk-free rate. Because the quarterly data are of the combined ratio rather than the premiums and losses and loss adjustment expenses, we assume a given level of losses and expenses (say 100). We then solve for the premium (P) that is consistent with the combined ratio and the assumed losses also assuming that premiums are the present value of future losses. Solving for P and then calculating a profit rate (P-L)/L, we can obtain the profit rate for assumed losses and loss adjustment expenses of 100. We then assume that the short-term interest rate, real gross domestic product, and consumer price index increase one percent of their mean levels. Using the impulse response function, we then calculate the one-period change in the combined ratio due to a one percent change in the explanatory variable. We then calculate a premium consistent with the new combined ratio and assumed losses and then calculate the new profit rate. Finally, we calculate the percentage change between the profit rates to obtain the results described above. Richard Phillips helped us with this calculation.

Conclusion

This article examines the long-run relationship between fluctuations in the national business cycle and fluctuations in the property-liability underwriting cycle. Using cointegration techniques, we tested for a long-run relationship between real gross domestic product, inflation, and the short-term interest rate on the insurance underwriting cycle as measured by the combined ratio. We find a long-run relationship between general economic changes and underwriting performance. In addition, we estimated an error-correcting vector autoregressive model to ascertain the short-run dynamics of the long-run equilibrium relationship. Although spectral density 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 as measured by the combined ratio, but the effects on profitability were greater.

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