

External Impacts on the Property-Liability Insurance Cycle*

by

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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 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 linkage between the industry and the general economy using vector autoregression techniques and find that, although the property-liability 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 in the short run.

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Introduction

The traditional reason given for the existence of property-liability cycles supposes an equilibrium position which changes because of a lack of industry restraint. Why this lack of restraint occurs is debatable, but it 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. 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 on the insurance cycle of external factors such as shocks to real income, inflation, and the short-term interest rate. These methods allow one to explore 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 movements in the industry's underwriting performance. This paper examines these external linkages.

This paper is organized as follows. First, a brief description of the literature in insurance cycles is presented. This is followed by an 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 unanticipated economic shocks seem to have little effect on industry underwriting performance.

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. The proponents of the "lack-of-restraint" theory believe the cycle is caused by the lack of an 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 in 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, 1988).

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 and Haley (1993) finds a long term relationship between short-term interest rates and the underwriting margin. Further, Grøn (1989) examines the effect of capacity constraints on insurance pricing and finds that underwriting profits are consistent with a capacity constraint mode. 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 readjustments of the firm's capital structure.* 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 (Neihaus and Terry, 1993).

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. We find, in contrast, to the above theories the underwriting cycle tends to follow the patterns of the general economy. We can not reject outright the institutional theories or the capital market imperfection theories of underwriting behavior, but suggest that the simpler explanation of a link between the underwriting performance and the national economy is the more probable explanation.

Empirical Analysis

The empirical analysis 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. 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.

One could examine annual or quarterly data. We examine the quarterly combined from 1974 to 1990 ratio for a number of reasons. Primarily, quarterly data are available from A.M. Best since 1974 consistent with the real GDP 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.**

*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[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 for provide a relationship to the underlying cycle.

**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.

Using the quarterly data we note the bivariate correlation between the combined ratio and the real GDP was 0.49 while the correlation for the same variables in their first differences was 0.48 for the years 1974-1990. Thus, we see potential for examining the linkage between the two series.

Figure 1 makes use of a 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).*** The use of spectral density analysis supposes that any time series can be thought of as the sum of a non-countable 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 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 can then be used to infer

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, reflects the old regulatory environment and the second, 1970-1990, 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% 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 to obtain as many observations as possible. This result may call into question Haley's (1993) results since he employed yearly data from 1930 to 1989 and did not account for differing regulatory regimes in the data.

***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).

periodicity of cycles. For example, in figure 1 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 $\omega = 1.6$, $2\pi/\omega=3.93$ quarters or approximately 1 year. Similarly there is another peak at 0.19. This corresponds to a cycle of approximately 8.4 years.^{****} The peaks to the left of $\omega = 1.6$ imply some seasonality in the combined ratio. Note that both 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 1 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 fluctuations experienced by the industry.

[Figure 1 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 incurred losses and expenses to premiums earned (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 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 RGDP and the CR are cointegrated would suggest that (economic)

^{****}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 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.

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, 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.**** The quarterly CR series was obtained from *Best's Review*. The quarterly short-term treasury bill interest rate (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.***** While the concept of cointegration provides information about how two (or more) series move together in the face of unspecified external forces, it provides nothing specific about the explanatory power one of the series might have on the other.***** The impulse response functions generated via a vector autoregression (VAR) will be examined later for this purpose.

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

***** See, for example, Hall (1986), Goldin and Margo (1989), and Boucher (1991).

***** See Granger and Newbold (1986, p. 226).

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

$$Z_t = \rho Z_{t-1} + \xi_t \quad (1)$$

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 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.***** 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 the

***** See Engle and Granger (1987) for an exposition of the ADF test.

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 modeling should take the form of an error-correction model (ECM) to account for this equilibrium relationship. *****

[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 theory does not dictate the specification of 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. *****

The Vector Autoregression/ECM Estimation. The resulting VAR specification takes the form of an error-correction model (ECM):

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

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. ***** The number of lags included in the state-space model is dictated by the maximum order of the AR component identified for the series. ***** Table 3 contains the VAR-ECM parameter estimates.

***** See Kennedy (1992).

***** See Pindyck and Rubinfeld (1991).

***** See Engle and Granger (1987).

***** 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

The estimated VAR-ECM parameters reported in table 3 show a number of important relationships. First, most of the non-lagged 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 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. Both of these results are to be expected as, according to the Fisher equation nominal interest rates are related to inflation, and to the extent that insurance premiums increase due to increases in the general price level, the changes in the combined ratio will be linked to changes in the CPI.

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 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 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]

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).

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 (3) above we have

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

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

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

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 $t + 1, t + 2, \dots, t + 20$.

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 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 have an intuitive interpretation. 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, 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 empirics (Cummins and Harrington, 1985). Finally, the response of the CR to a shock in the CPI can illustrate either the (more likely) net effect of an increase in price on goods competing with insurance for

expenditures, or perhaps the effect of inflation on losses and expenses. 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 2, a one standard deviation shock to RDGP 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 (0.04×5.92), which is less than 0.1% of the average CR for the whole period. The largest response the CR has to a shock in figure 2 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 2 about here]

A variance decomposition analysis confirms the conclusions drawn from reviewing the impulse response functions above: there does not exist a strong direct relationship between the CR and shocks to the series representing the general business cycle.***** The decomposition explains how much of the uncertainty surrounding the prediction of the CR can be attributed to uncertainty surrounding the other variables. 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 GDP, 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 adjustments of

***** Available from the authors.

***** See Pindyk and Rubinfeld (1991, p. 390).

these external factors will have little effect on profits. This also implies that the industry's profitability is insensitive to changes in macroeconomic policy, such as those often seen resulting from changes in political administrations.

Figure 2 provides evidence that 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 GDP or the CPI). 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 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 necessarily imply that institutional factors are more important than general economic factors, however, as the spectral analysis (Figure 1) showed an almost identical picture of the behavior of the economy

and the insurance industry. Thus, if the economy and the industry move together over the long run, institutional factors are not likely to be the underlying cause of the insurance cycles.

Summary and Conclusion

This paper examined the long-run relationship between fluctuations in the national business cycle and fluctuations in 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 there is 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. 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 that impulse response factors 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 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 absorb shocks in demand. Thus, while the results do seem to provide support for the capital market imperfection theory of underwriting behavior, one must not overlook the fact that the underwriting margin and the national economy are closely linked and that shocks to major economic variables, including interest rates, have little long run effect on the combined ratio.

Table 1

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

Series	$\hat{\rho}$ (std. error)		Dickey-Fuller (1979) Test Statistic
			$n(\hat{\rho} - 1)$
RGDP	1.0164	(0.0093)	1.0827
CR	0.9105	(0.0523)	-5.9070
SINT	0.9129	(0.0514)	-5.7486
CPI	0.9999	(0.0033)	-0.0066
Δ RGDP	-0.4531	(0.1141)	-95.9047
Δ CR	0.1680	(0.1207)	-77.0880
Δ SINT	0.2023	(0.1222)	-52.6482
Δ CPI	0.6326	(0.0989)	-24.2484

Note: 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 + 0.114*SINT + 0.2869*CPI (6.462) (0.009) (0.286) (0.159)	-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 (0.1444)	1.6735 (1.2190)	0.0232 (0.0696)	0.0685** (0.0312)
ΔCR_{t-2}	0.0490 (0.1407)	-1.2207 (1.1882)	-0.0023 (0.0678)	0.0614** (0.0304)
$\Delta RGDP_{t-1}$	-0.0115 (0.0176)	-0.1085 (0.1483)	0.0048 (0.0085)	-0.0031 (0.0037)
$\Delta RGDP_{t-2}$	-0.0157 (0.0168)	0.4376** (0.1416)	0.0107 (0.0081)	-0.0032 (0.0036)
$\Delta SINT_{t-1}$	0.4337 (0.2788)	1.3684 (2.3541)	0.2648* (0.1344)	0.2337*** (0.0602)
$\Delta SINT_{t-2}$	0.3154 (0.2880)	-3.3428 (2.4315)	-0.3458** (0.1388)	-0.0327 (0.0622)
ΔCPI_{t-1}	0.3450 (0.6435)	9.8643* (5.4336)	-0.3672 (0.3102)	0.3672** (0.1389)
ΔCPI_{t-2}	0.9459 (0.5826)	-5.4732 (4.9195)	0.2805 (0.2809)	0.2105* (0.1258)
m_{t-1}	0.1293** (0.0608)	-0.0327 (0.5131)	-0.0599** (0.0293)	-0.0288** (0.0131)
Intercept	-1.5555 (1.0575)	-34.1125*** (8.9288)	-0.1433 (0.5098)	0.5617** (0.2283)
Q2 dummy	-0.3677 (1.4718)	53.7776*** (12.4269)	-0.4970 (0.7095)	0.1183 (0.3178)
Q3 dummy	-0.1407 (1.1388)	64.6033*** (9.6158)	0.4850 (0.5490)	0.2932 (0.2459)
Q4 dummy	2.9522*** (0.9947)	60.2049*** (8.3983)	-0.4203 (0.4795)	0.0636 (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 level respectively.

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Response to Reviewer A

Thank you for your thoughtful review of our paper. We appreciate the time you spent reading our work.

Major Criticisms

- 1) We attempted to reduce the length of the paper, but were unable to cut the paper to 12 pages. The text was cut by approximately 25% (in words). We were afraid that more cutting would interfere with the readers ability to understand and follow our methodology.
- 2) The reviewer's point is noted and remedied on bot p. 10 - p. 11.
- 3) The reviewer is correct and we have modified the definition of the combined ratio in the text.
- 4) The overall effect of each shock to GDP, SINT, and CPI is relatively small as a percentage of the combined ratio. However, the effect of a shock to SINT has the largest effect on the CR. Thus, the overall size of the shocks is small, but SINT is most important. This is made clear on page 12. (2d para 4th sentence)
- 5) The reviewer's comments were taken to heart. The discussion and elaboration of the results was moved to the preceding section and reduced. The concluding section was also made shorter and more to the point.

A second point regarding institutional factors and supply shocks was removed as it was confusing and it was not clear to us as what we originally intended by the statement.

Minor Criticisms

- 1) Fixed
- 2) Fixed
- 3) Figures 1 and 2 omitted and bivariate correlations are on p. 4.
- 4) Fixed
- 5) Fixed
- 6) Fixed
- 7) The term regression parameters refer to the lagged dependant variables' regression parameter estimates and is now noted as such on p. 9. We were referring (in the original version) to the non-lagged regression parameters.
- 8) Fixed

Reviewer A's Comments (cont.)

9) Fixed

10) Fixed

11) a) Fixed

b) "Also it was not clear to me whether the effects of the other variables only reflected feedback effects from the shock to the combined ratio."

We could not figure out what the reviewer meant by this statement. The variance decomposition shows the percent of the forecast error attributable to each of the endogenous variables. There are feedback effects in the VAR, but the shock enters into the analysis through the error terms. To the extent the error terms are correlated, there is an effect there too. Please see Pindyck and Rubinfeld, pp. 387-390.

Responses to Reviewer B.

Thank you for your thoughtful review of our paper. We appreciate the time you spent reading our work.

We have responded to each point as listed on the reviewers comment sheet.

1. Typos and other grammatical errors have been fixed.
2. The clause on previous page six (currently on the bottom of page 5) referring to "rejecting cointegration" has been reworded to be more explicit.
3. A sentence was added on new page 9 to discuss the relationships between ΔCR , $\Delta SINT$, and ΔCPI which provides some intuition behind the possible relationships. I believe the relationships are derived from macro economic theory and the relationship between price changes and inflation.
4. The section surrounding the variance decomposition has been rewritten. However, the variance decomposition was designed to show the sources of the uncertainty surrounding the forecast.