Dynamics of Underwriting Profits: A by-line Analysis

JIANG Shi-jie, PENG Bin-win
(Hsuan Chuang University)

Abstract: Property-liability insurance markets have displayed underwriting cycles, with their large swings in underwriting margins, for more than a century. Various models have been developed to explain these fluctuations. Without examining whether variables possess unit roots, bounds test on underwriting profits from 1956 to 2009 can demonstrate which hypothesis or models may be the most suitable model for explaining insurance pricing. A long-term equilibrium between underwriting profit, interest rate and surplus may be found. An evident cyclical pattern in underwriting margins can be explained as dynamic feed back to the long-term equilibrium. Considerable evidence may suggest that whether insurance companies are risk averse or not. The error correction component may be constructed as a leading indicator to predict turning points of underwriting cycles. In practice, my findings may help insurance companies to smooth their profit fluctuations and enhance their financial operations.
Keywords: Underwriting Cycle; Underwriting Margins; Conditional ECM; Bounds Test.

INTRODUCTION

Underwriting margins is the most critical component of the structure of insurance price. The dynamics of underwriting margins in property-liability insurance markets exhibit a clear pattern of recurrence and have traditionally been viewed as dynamically shifting back forth between hard markets and soft markets (see Harrington and Niehaus, 2000 for a review). This phenomenon helps maintain long-term margins/losses, could not easily be eliminated (Feldblum, 1992), and is crucial for insurance operations. Modeling and predicting such fluctuations, which can help insurance companies to control their operating volatility, could be the greatest challenge for practitioners. In fact, there are many more questions about cycles deserve attention, both theoretically and empirically (Weiss, 2007).

Many theories have demonstrated the cyclical nature of historical underwriting margins in the property-liability insurance industry. According to Choi et al. (2002), both short-term and long- term analyses are required to differentiate various theories or hypotheses. The well-known financial pricing model (i.e. rational expectation model) indicates that insurance price only reflects the discounted value of costs associated with losses. Such hypothesis, only temporary deviation from long-term equilibrium can be explained by random changes in demand and supply, therefore, are inadequate for explaining large and visible cycles. Cummins and Outreville (1987) built on the financial pricing hypothesis by attributing such cyclical pattern to a second-order process, created by the unique characteristics of the insurance industry, including regulatory and reporting lags. Subsequent studies (e.g., Doherty and Kang, 1988 and Lamm-Tennant and Weiss, 1997) also provided consistent results. These models implicitly assume insurers are risk neutral and insurance markets are perfect. Insurers can adjust their capital sufficiently to reduce insolvency risk to a negligible level. Accordingly, underwriting profit is a decreasing function that depends only on interest rate in both the short and long term.

Focused on temporary market imperfections, surplus constraint hypothesis (Winter, 1988, 1994; Gron, 1994a, b; Doherty and Garven, 1995) provides an alternative explanation of underwriting cycle. Because of the imperfections of capital markets, raising insurance prices became a common way of capital adjustment after insurers experienced unexpected shocks or crises. The analytical results imply that underwriting margins are inversely dependent on surplus in the short term and do not depend on surplus in the long term. Winter (1994) and Gron (1994a, b) argue that asymmetric information availability in the insurance market prevents insurers from quickly adjusting their surplus to maintain a long-term equilibrium. The existence of this relationship can be tested by examining whether surplus is negatively related to underwriting margins. Furthermore, if insurers are assumed to be risk averse, it implies that they must be compensated for bearing insurance risk due to the unpredictable nature of policyholder claims. This constraint also holds in a long-term equilibrium and can be interpreted as implicitly defining normal expected margins. Therefore, the risk premium is positive, and increases with decreasing surplus both in the long-run and short-run. It refers as the economic model (Choi et al. (2002)).

For the last two decades, empirical analyses of insurance industry volatility focused on whether insurer surplus determines underwriting margins. As Harrington and Yu (2003) note, earlier studies extensively utilized conventional regressions and ignored the question of whether underwriting margins are stationary. Most of earlier empirical analyses employed regressions that extensively used changes in interest rate and surplus proxies to examine how different levels of underwriting margins were related. However, such models could lead to spurious regression because of misspecification. Previous studies appear to leave both the nature of underwriting margins and the surplus proxy ambiguous. To solve the above weaknesses, this study proposes a more flexible and robust empirical methodology and seeks to provide further insight into this context by simultaneously assessing the long term and short term effects.

CONDITIONAL ERROR CORRECTION APPROACH

Let yt represents the proxy of underwriting profit of industry (i.e. loss ratio, economic loss ratio and combined ratio) at current time t. rt and st denote the interest rate and the surplus respectively and define is a vector of variables. Consider that the data-generating process for underwriting profit, the interest rate, and the surplus is an unrestricted VECM as followed:

$$\Delta \mathbf{z}_t = \mu_0 + \mu_1 t + \mathbf{A}\mathbf{z}_{t-1} + \sum_{i=1}^{n} \Phi_i \Delta \mathbf{z}_{t-i} + \mathbf{v}_t$$

(1)

where the partition $\mathbf{z}_t = (y_t, \mathbf{x}_t')'$ is 3×1 vector of variables. Similarly, deterministic term $\mu_j = (\mu_{jy}, \mu_{jx}')'$ and error term $\mathbf{v}_t = (v_{yt}, \boldsymbol{v}_{xt}')'$ are 3×1 vectors. The long-term multiplier, $\mathbf{A} = \begin{bmatrix} A_{yy} & \mathbf{A}_{yx} \\ \mathbf{A}_{xy} & \mathbf{A}_{xx} \end{bmatrix}$, is a matrix of order 3×3, and $\Phi_i = \begin{bmatrix} \Phi_{yy,i} & \Phi_{yx,i} \\ \Phi_{xy,i} & \Phi_{xx,i} \end{bmatrix}$ is the short-term dynamic coefficient matrices. A critical assumption is that if vector $\mathbf{A}_{xy} = 0$, it ensures that there is at most one long-term relationship between underwriting margins and their determinants, irrespective of the order of integration. There is no feedback from the level of y_t and the interest rate and the surplus could be regarded as long-term forcing variables (see Granger and Lin (1995)). Such assumption is intuitively reasonable because the underwriting activity of insurance industry has seldom impacts on the macroeconomic system (e.g. movement of interest rate). Also, the current surplus, which is calculated at the end of last period, is not to be explained by the current underwriting profit. Equation 1 can then be written in terms of the dependent variable y_t and the forcing variables $\mathbf{x}_t$ as:

$$\Delta y_t = \mu_{0y} + \mu_{1y} t + A_{yy} y_{t-1} + \mathbf{A}_{yx}\mathbf{x}_{t-1} + \sum_{i=1}^{n} \Phi_{yy,i} \Delta y_{t-i} + \sum_{i=1}^{n} \Phi_{yx,i} \Delta \mathbf{x}_{t-i} + v_{yt}$$

(2)

$$\Delta \mathbf{x}_t = \mu_{0x} + \mu_{1x} t + \mathbf{A}_{xx}\mathbf{x}_{t-1} + \sum_{i=1}^{n} \Phi_{xy,i} \Delta y_{t-i} + \sum_{i=1}^{n} \Phi_{xx,i} \Delta \mathbf{x}_{t-i} + \boldsymbol{v}_{xt}$$

(3)

Also, define the variance matrix of error term as:

$$\Omega = \begin{bmatrix} w_{yy} & \mathbf{w}_{yx} \\ \mathbf{w}_{xy} & \mathbf{w}_{xx} \end{bmatrix}$$

(4)

v_{yt} can be expressed conditionally in terms of $\boldsymbol{v}_{xt}$ as:

$$v_{yt} = w' \boldsymbol{v}_{xt} + \varepsilon_t$$

(5)

where $w = \mathbf{w}_{xx}^{-1} \mathbf{w}_{xy}$, ε_t is normal distributed with zero mean and is independent of v_{yt}. A conditional modeling of the underwriting profit, the scalar variable y_t, can be constructed by substituting equation (3) and (5) into (2), yields a conditional error correction model as:

$$\Delta y_t = a_0 + a_1 t + A_{yy} y_{t-1} + \mathbf{A}_{yx,x}\mathbf{x}_{t-1} + \sum_{i=1}^{n} \psi_i \Delta y_{t-i} + \sum_{i=1}^{n} \varphi_i \Delta \mathbf{x}_{t-i} + w' \Delta \mathbf{x}_t + \varepsilon_t$$

(6)

where $a_0 = \mu_{0y} - w'\mu_{0x}$, $\mathbf{A}_{yx,x} = \mathbf{A}_{yx} - w'\mathbf{A}_{xx}$ $a_1 = \mu_{1y} - w'\mu_{1x}$, $\psi_i = \mathbf{\Phi}_{yy,i} - w'\mathbf{\Phi}_{xy,i}$,

$\varphi_i = \mathbf{\Phi}_{yx,i} - w'\mathbf{\Phi}_{xx,i}$

It follows from Equation 6 that, if $A_{yy} \neq 0$ and $\mathbf{A}_{yx,x} \neq 0$, then there exists a long-run relationship between underwriting margins and their determinants, given by:

$$y_t = \theta_0 + \theta_1 t + \theta \mathbf{x}_{t-1} + u_t$$

(7)

where $\theta = -\mathbf{A}_{yx,x} / \mathrm{A}_{yy}$ is the long-run response parameters and u_t is a zero mean stationary process. A conditional ECM can be represented as:

$$\Delta y_t = a_0 + a_1 t + A_{yy}(y_{t-1} - \theta \mathbf{x}_{t-1}) + \sum_{i=1}^{n} \psi_i \Delta y_{t-i} + \sum_{i=1}^{n} \varphi_i \Delta \mathbf{x}_{t-i} + w'\Delta \mathbf{x}_t + \varepsilon_t$$

(8)

where the error correction component, $A_{yy}(y_{t-1} - \theta \mathbf{x}_{t-1})$, is the current adjustment due to the deviation from equilibrium at last period. The absolute value of A_{yy} can be viewed as the speed back to equilibrium and if $\mathrm{A}_{yy} < 0$, then this long run relationship is stable. The existence of a unique valid long term relationship among variables, and hence a sole error-correction term, is the basis for estimation and inference. Short term relationship cannot be supported unless a unique and stable equilibrium relationship holds in significant statistical sense.

According to Pesaran et al. (2001), the conditional ECM represented as Equation (6) is used as the basis of long-run relationship testing procedure. This approach, which separates the long-term (level) relationship and short-term dynamics, could be applied to test the long-term relationship between the variables, irrespective of the order of the underlying variables (I(0) or I(1)), even fractionally integrated (Cavanaugh et al., 1995; Persaran et al., 2001). Such outstanding characteristic is suitable for studying the underwriting activity in insurance industry because the underwriting profit is usually assumed to be stationary, thus, could not be utilized by traditional cointegration analysis. Unlike other cointegration techniques (e.g., Johansen's procedure) which require certain pre-testing for unit roots as well as underlying variables to be integrated of order one, this conditional ECM provides an alternative test for examining long-term relationship. The unit root testing of variables (e.g. Haley, 1993, 1995) is no longer necessary. Notice that Equation (6) can be differentiated between five cases of interest delineated according to how the deterministic components are specified. This paper will test all three cases to fit the most suitable case into various insurance lines separately.

Once the long-term relationship is determined by bounds testing procedure, Pesaran et al.

1 Linear trend is not considered in this paper because the linear trend is usually not considered in this context according to prior researches. Three cases in this paper is no constant, restricted constant and unrestricted constant

(2001) suggest that the augmented autoregressive distributed lag model can be estimated. The autoregressive distributed lag model can be rearranged as a conditional ECM and is allowable to differentiate lag lengths on the lagged variables in Equation 6 without affecting the asymptotic results of bounds test. Many previous studies suggest underwriting profit follow AR(2) process, thus, We chose n=2 in Equation 6 and search across $(n+1)^3$ autoregressive distributed lag models via Schwartz Bayesian Criterion (SBC). Allowing for differential lag lengths on the lagged variables is more general than the cointegration analysis of partial systems carried out by Boswijk (1994, 1995).

EMPIRICAL RESULTS

For the purposes of this paper, we firstly examine the long run relationship between underwriting profit, interest rate and the surplus proxy. When long run relationship has been verified, conditional ECM will be utilized for further analysis. Underwriting margins usually refer to insurers' underwriting returns which are the margins without including investment returns. We use loss ratio which is traditionally employed for evaluating in insurance industry. We apply annual U.S. insurance industry-wide data for all lines combined and various lines during the period 1956-2009 from Best's Aggregates and Averages published by A.M. Best Company. Various insurance lines contain homeowners, commercial multi-peril and other liability (sometimes called general liability). On the other hand, surplus proxy is defined as the ratio of lagged aggregate policyholders' surplus to lagged net written premiums. Such a ratio is the inverse version of the well-known Kenney ratio which is traditionally used for evaluation purpose and regulation concerns. The policyholders' lagged surplus, which reflects insurers' surplus at the beginning of a new period, are reported at the end of previous year from Best's Aggregates and Averages. Finally, we employ the three-month Treasury bill rates, which are collected from the Federal Reserve Bulletin, as the interest rate proxy in our study.

In testing the null hypothesis of no cointegration in equation (7), the critical issue is to choose the maximum lag (n).Because of smaller samples in this study, we carefully impose our order of lag from 1 to 2 on the first difference of each variable and compute the F-statistic, generated from of a non-standard F distribution (Pesaran et al., 2001). The results of three cases of restricted and unrestricted constant are reported in Table 1.

As shown in Table1, the null hypothesis of the nonexistence of the long-run relationship is rejected for whole industry underwriting margins when order of lag equal to one. The results provide evidence for the existence of a long-run underwriting margins equation, irrespective of whether underlying variables are I(0) or I(1), and overcome the hurdles of earlier studies(e.g. Choi, et. al., 2002; Harrington and Yu, 2003). Therefore, merely considering short-term determination is not enough to explain the dynamics of underwriting margins. Moreover, one lag is large enough to find out the long-run relationship which demonstrate that the previous AR(2) modeling might be inappropriate.

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2 The definition of general liability insurance line has been changed twice during the sample period. Best's Aggregates and Averages began separate reporting for medical malpractice line in 1975 and for products liability line in 1991. For the reason of data consistency, we combined medical malpractice line and general liability after 1975 weighted by earned premium, as well as products liability line after 1991.

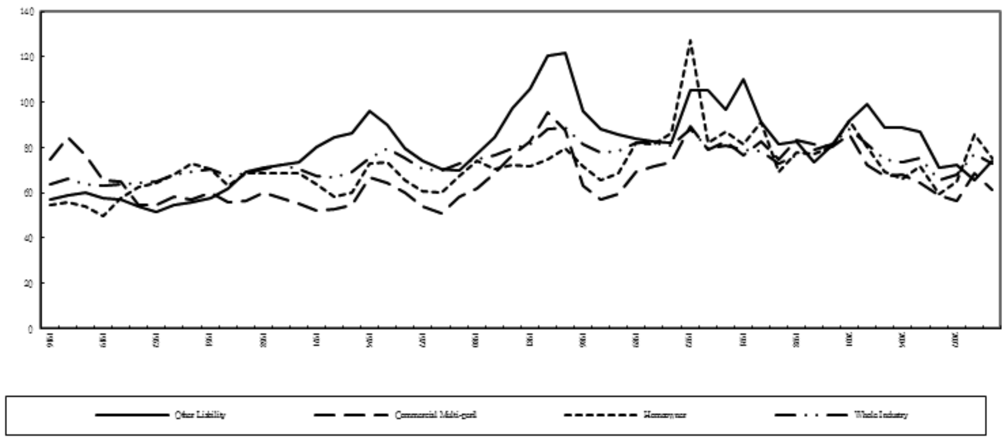

Fig 1. Loss ratio of various insurance lines

Table 1. Results of bounds teats of whole industry

n	t_I	F_I	F_{II}	t_{III}	F_{III}
1	-3.7444***	5.4821***	6.2480***	-4.1549***	8.3194***
2	-2.6789	2.6877[	3.3767	-3.3290*	4.5015*

Note: *,**,and***indicate significance at 10%,5%,1%,repectively.

In the second stage, the maximum order of lag (=1) is selected in this study, thus, one of 8 (=) ADL models has to be chosen via Schwartz Bayesian Criterion (SBC). The estimates are reported in Table 2.

As expected, such modeling framework provides efficient estimates of parameters. The adjusted are 0.74 and the computed F-statistics clearly reject the null hypothesis that all regressors have zero coefficients, suggesting that such a model fits the data reasonably well. The diagnostic testing are statistically insignificant for the proxy, , suggesting no evidence of misspecification.

Estimating of dynamic relationships between underwriting margins and other variables requires an estimation method designed to deal with the particular problems raised by the inclusion of lagged dependent variables. After controlling the variables of interest rate and surplus proxy, the underwriting margins for whole industry follows AR(1) process at 95% significant level. This result demonstrate that the first lagged underwriting profit has crucial explanatory power on the current period underwriting profit while the coefficient on the second lagged underwriting profit is negligible. According to Cummins and Outreville (1987), the effect of information lags can produce an AR(1) model and the combined effects of reporting lags and information lags can generate an insurance cycles, thus AR(2) process yields a good data generating process. Many following research (Niehaus and Terry, 1993; Lamm- Tennant and Weiss, 1997; Fung et al., 1998; Harrington and Yu, 2003) adopted the same assumption of DGP. In contrast, our results with carefully data assessing provides a more reliable explanation with statistically recognizing and prove that AR(1) process would be sufficient to modeling the dynamics of underwriting margins in industry level.

A visible cyclical pattern of underwriting margins might be explained as dynamics feed back to the equilibrium, rather than modeling as a predetermined AR(2) process. Following ECM reference which reinforces our findings of insurance cycle dynamics, could integrate the long run and short run implication altogether within CECM modeling. It needs to further explore the specification of underwriting margins for long term equilibrium and short term dynamics separately. The static long-run model and the error correction representation of the corresponding model are reported in Table.3 and Table.4.

Table2. Estimates of autoregressive distributed lag model (Dependent Variable: loss ratio of the whole industry)

	ADL(1,0,0)
constant	9.7401 [5.5650]*
y_{t-1}	0.7652 [0.0726]***
r_t	0.7208 [0.2094]***
s_t	4.7639[2.0311]**
Adj. R^2	0.7339
F-stat.	47.8991 ***
DW-statistic	2.1086
LM Serial correlation	0.2973
Heteroscedasticity	1.7439

Note:*,**,and***indicate significance at 10%,5%,1%,repectively.
(.)indicate standard error.

Table3. Estimated Long Run effects (Dependent Variable: loss ratio of industry)

	ADL(1,0,0)
constant	41.4942 [13.5441]***
r_t	3.0710 [1.1723]***
s_t	20.2950 [9.9548]**

Note:*,**,and***indicate significance at 10%,5%,1%,repectively.
(.)indicate standard error.

Table4. Conditional Error Correction Model (Dependent Variable: First Difference of Loss ratio of industry)

	ADL(1,0,0)
constant	9.7401 [5.5650]*
ECM_{t-1}	-.23473 [0.0726]***
Δr_t	.72086 [0.2094]***
Δs_t	4.7639[2.0311]**
Adj. R^2	0.2843
F-stat.	6.3563***
DWstatistic	2.1086

Note:*,**,and***indicate significance at 10%,5%,1%,repectively.
(.)indicate standard error.

Respectively, the error correction coefficient reveals a highly significant negative sign for all three models which prove that the existence of long run level relationship between underwriting margins and surplus. Earlier studies were restricted from analyzing long run relationship just because the stationary characteristic of underwriting margins. The interest rate reveals a positive direction to combined ratio in both long run and short run as we expected. In the short run, models indicate that is consistent with the prediction of surplus constraint model as earlier studies' findings. Interestingly, for surplus proxy, models show apparent positive long run relationship between combined ratio and all three surplus proxies which denied the surplus constraint hypothesis due to its short term determinant nature. By contrast, the findings of our study are consistent with economic pricing hypothesis which implies a strictly negative relationship between underwriting margins and surplus proxy in both short run and long run. Such results provide solid evidence that supply effect tends to dominate the U.S. insurance market under whole industry level.

Then this paper extends the work by determining whether the cointegrating relationship that was found at the aggregate level also exists at the micro level, that is, for individual lines of insurance coverage. Using a regression analysis, Gron (1994a) provided findings supported the surplus constraint hypothesis for short-tail lines of insurance including auto liability, auto physical damage, and homeowners' coverage, however, not for general liability insurance which is the long-tail coverages most affected by macroeconomic effects. Utilizing Johansen's analysis procedure, Haley (1995) reported a more detail analysis that eight of 17 property-liability lines are non-stationary and only three of them (i.e. general liability, auto liability, and group accident and health) were proved that are negatively cointegrated with interest rate. The cointegrated results are not significant for workers compensation and homeowners multiple peril is not testable because it reveals the characteristic of I(2). Most major insurance lines were also not testable because their characteristic of I(0) such as auto physical damage, fire, ocean marine, inland marine and commercial multiple peril. Harrington and Yu (2003) proved that the null hypothesis that loss ratios have a unit root is rejected for most limes including whole industry, auto liability, auto physical damage, and commercial multiple peril, using both traditional ADF tests and GLS-ADP tests when mean and trend are included in the model. They suggested that cointegration analysis is neither relevant nor necessary, and the inclusion of any non-stationary regressors would make both least squares regressions and cointegration analysis inappropriate. Employing ECEM framework, this study could solve these kinds of problems and could gain access to explore the long run relationship we are interested in.

Table 5. Results of bounds teats for individual lines

	n	t_I	F_I	F_{II}	t_{III}	F_{III}
Other liability	1	-3.292***	4.3034**	3.2561	-2.948	4.2803
Homeowners peril	1	-3.848***	5.2146**	5.9287***	-4.712***	7.9031***
Commercial multi-peril	1	-3.668***	5.7950**	4.3739**	-3.126*	5.7412**

Note:*,**,and***indicate significance at 10%,5%,1%,repectively.(.)indicate standard error.

Interestingly, one lag order of variables is enough for verifying the existence of cointegration relationship for all insurance lines. In the second stage, the maximum order of lag=2 is selected for insurance lines in this study. Retaining the maximum lag, meanwhile, Schwartz Bayesian Criterion (SBC) is used to estimate ADL models. Notice that there are special treatments for homeowners multiple perils, and general liability insurance lines by adding a dummy variable which represents the catastrophe impact of hurricane Andrew in 1992.

Hurricane Andrew damaged and destroyed thousands of buildings and caused an estimated $16 billion in insured losses, which is the greatest loss that ever happened in the history of insurance. There are about 50%, 30% increases in the combined ratios for homeowners multiple perils, general liability respectively. All underwriting margins are formulating an ADL model respectively and the estimates are reported in Table 6.

The long-run and short-run estimation are determined by rearranging associated ADL models. The results of long-run and short-run estimation are presented in Table7-8.

As presented in Table 7-8, loss ratio of all insurance lines reveal significant positive long run level relationship with interest rate and surplus, which conform to the implication of economic pricing hypothesis. Due to the characteristic of long claims tail for general liability insurance that increases the risk of large errors in forecasting claim costs, adding more risk margin to the pricing structure would be a suitable way when the supply effects dominate the markets. The" tail" means the time between the accident event and actual compensation payoff. After controlling the variables of interest rate and surplus proxy, the risk margins are bigger for other liability and commercial multi-peril. Such a "long tail" insurance business traditionally been viewed as risky lines. Our results show that the risk-averse characteristic of insurance company when they process their pricing strategies and provide solid evidences that the greater the uncertainty, the larger the risk margin, when the equilibrium has achieved.

Table 6. Estimates of ADL model for various insurance lines
(Dependent Variable: Loss ratio various insurance lines)

	Other liability	Home-owners	Commercial multi-peril
constant		24.8810 [7.006]***	
Andrew Dummy	26.0122 [7.5304]***	51.5793 [7.086]***	
y_{t-1}	0.85573 [0.04841]***	0.41406 [0.0819]***	0.7462 [0.0561]***
r_t	1.2509 [0.39816]***	1.0509 [0.4010]***	1.3699 [0.30548]***
s_t	5.4797 [3.1671]*	12.7939 [4.0122]***	10.9238 [3.3659]**
Adj. R^2	0.80382	0.67640	0.7035
F-stat.	70.6567***	27.6502***	61.5045 ***
DW-statistic	1.7430	2.0518	2.0074
LM Serial correlation	0.7656	0.0907	0.0101
Heteroscedasticity	12.173***	0.4809	2.7439

Note:*,**,and***indicate significance at 10%,5%,1%,repectively.(.)indicate standard error.

Table 7 Estimated Long Run effects
(Dependent Variable: loss ratio of various insurance lines)

	Other liability	Home-owners	Commercial multi-peril
constant		42.4634 [8.7518] ***	
r_t	8.6708 [2.1286]***	1.7936 [0.7225]**	5.3989 [0.9978]***
s_t	37.9835 [13.5225]***	21.8348 [6.8326]***	43.0515 [6.3245]***

Note:*,**,and***indicate significance at 10%,5%,1%,repectively.(.)indicate standard error.

Table 8 Error Correction Representation of ADL Model
(Dependent Variable: First Difference of Loss ratio of industry)

	Other liability	Home-owners	Commercial ulti-peril
Constant		24.8810 [7.0064]***	
Andrew Dummy	26.0122 [7.5304] ***	51.5793 [7.0864]***	
ECM_{t-1}	-.14427 [.04841]***	-0.58594 [0.0819]***	-0.2537 [.0561]***
Δr_t	1.2509 [0.39816]***	1.0509 [0.4010]***	1.3699 [0.3054]***
Ds_t	5.4797 [3.1671]*	12.7939 [4.0122]***	10.9238 [3.3659] ***
Adj.R^2	0.30217	0.6349	0.33246
F-stat.	6.9284***	23.1139***	12.2019***
DW-statistic	1.7430	2.0518	2.0074

Note:*,**,and***indicate significance at 10%,5%,1%,repectively.(.)indicates standard error.

CONCLUSION

The main contribution of our study is exploring the long-term relationships related to underwriting margins, an area that was previously not possible to examine owing to inconsistent integration order. This study presents a more flexible means of portraying the pattern of underwriting margins, and provides an econometric base for describing insurance cycle dynamics. Another contribution is finding significantly negative long-term relationship between underwriting margins and surplus proxy, which suggests that insurance suppliers dominate the U.S. insurance market. The price elasticity of insurance demand must be sufficiently low that consumer demand will not drop substantially when insurance suppliers raise their prices due to their lower capacity. Overall, the empirical evidence strongly suggests that the supply effect, which can be reflected by the pricing strategies of risk-averse insurance companies, has dominated the U.S. insurance market for the last half century.

There might be two possible reasons why insurance price adjusts gradually to the equilibrium. Actuaries have to get balance between responsive and stability when they design pricing strategies. The price be not shift too quickly when the macroeconomic environment changes. Another explanation is, in practice, incurred loss at a given year includes paid loss and unpaid loss. Underwriting margins are realized in part at current year because of parts of current loss been paid, thus, is related to current interest rates and current capacity. Unpaid loss, on the other hand, relies on estimation from previous year's loss ratio because of information lag. Therefore, current underwriting margins are also related to lagged underwriting margins and the effects of past impact of interest rates and surplus will persist at a declined rate based on the autoregressive effect of lagged underwriting margins.

Considering the uncertainty regarding the time series properties of the variables in question, this study proposes ECEM modeling as an appropriate approach for examining the existence and causes of U.S. insurance cycles. Rather than being structured by the predetermined second-order process (i.e. AR(2)), the tendency to return to the long-term equilibrium explains the cyclical pattern of underwriting margins reasonably well. The predetermined second-order process DGPs has been replaced by more flexible models. The results of this study provide clear and reliable answers that are statistically significant to capture the equilibrium of insurance markets and represent their short-term dynamics via error correction.

ARDL modeling has implications for forecasting. In the short term, underwriting margins can be essentially viewed as a risk premium plus a disequilibrium component which is represented as a conditional error correction term. One step ahead forecasting can be generated using the error correction model to predict underwriting margins in the coming year. Such dynamic forecasting can also help actuaries to determine an appropriate underwriting profit loading.

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