External Impacts on Insurance Price: Evidence from the Chinese Insurance Market

Ling Tian
Department of Insurance and Actuarial Science
Wuhan University, Wuhan, CHINA 430072
ltan@whu.edu.cn
Tel: +86 27 68753035

Shi-jie Jiang
Department of Insurance and Actuarial Science
Wuhan University, Wuhan, CHINA 430072
Department of Insurance,
Hunan University, Changsha, CHINA 410082
actjiang@gmail.com
Tel: +86 27 68753035

Guochen Pan
（corresponding author）
Department of Insurance and Actuarial Science
Wuhan University, Wuhan, CHINA 430072
gcpan@whu.edu.cn
Tel: +86 27 68753204

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Abstract: Nonlife insurance prices may fluctuate due to economic and/or institutional factors; occasionally, the changes are cyclical; this is known as the underwriting cycle. While the majority of previous studies relating to insurance price dynamics adopt data from developed economies, this paper uses data from China to provide new evidence. Employing an autoregressive distributed lag model (ARDL) cointegration framework, this study tests the long-term and short-term effects of real GDP, interest rate and rate of stock market return on the prices of different lines of nonlife insurance, i.e., property-liability insurance and personal accident insurance. The results indicate that the price dynamics of property-liability insurance are generally similar to those of developed countries except for the effect of GDP, while price determination of personal accident insurance seems to be affected by a wider range of economic and institutional variables and has its own features. The price dynamics of nonlife insurance in China have been identified as being connected to the country-specific economic and institutional environments.

Key words: insurance cycle; price dynamics; external impacts; nonlife insurance

JEL Classification: G17; C32

1. Introduction

The dynamics of insurance price (measured as underwriting profits or loss ratio; see Harrington and Niehaus (2000) for a review.) in property-liability insurance markets are traditionally observed as the dynamic shifting back and forth of insurance price between 'hard' and 'soft' markets. The soft market is characterized by readily available insurance coverage and lower insurance prices, while hard markets are characterized by difficulty in obtaining restrictive insurance coverage and higher insurance prices. In practice, the most obvious form of such a phenomenon is known as the *underwriting cycle*. Underwriting cycles are widely observed in the nonlife insurance industry and are not easy to eliminate from insurance operations. By modeling and predicting such fluctuations, insurance companies might control their operating volatility and thus lower their capital costs.

Many theories try to explain the dynamics of insurance price, but no single theory seems capable of explaining all of its aspects. There are at least three schools of thought in this context. Note that these schools of thought are not necessarily mutually exclusive because the insurance price might be affected by many factors simultaneously. The first is a rational expectation framework, whereby the insurance price is assumed to only reflect the discounted cash flow of future costs, and expectations are made using all relevant information; thus, insurance prices are the best predictors of future losses and expenses. Accordingly, insurance price is a decreasing function that depends only on the interest rate in both the short and long term. Many empirical studies indicate the short-run relationship between insurance price and interest rate (e.g., Chen, 1999), and fewer studies focus on long-term determination (e.g., Grace and Hotchkiss, 1995). According to this theory, a price cycle occurs only if insurance companies' expected costs are cyclical in a perfect insurance market. Cummins and Outreville (1987) provide a more compelling explanation, the rational expectations/institutional intervention hypothesis, for this theory. Based on the U.S. insurance market, they attribute a cyclical pattern to a second-order autoregressive process, which is caused by a filtration of the rational insurance price through institutional lags of the insurance industry; thus, rational acts of insurance companies may appear irrational. They also suggest that the cycle, as observed in the U.S. market, may also be present in other countries through the proliferation of international reinsurance services. Their insurance price dynamics model, which is based on a second-order autoregressive process, has been the standard form for the past two decades.

Another famous school of thought is based on the irrational behavior of insurance companies. Winter (1994) proposes a well-known capacity constraint hypothesis, which documents that the imperfect insurance market prevents insurance companies from quickly adjusting their capacity to maintain a long-term equilibrium. Because the cost of external equity is more than internal equity, insurance companies are willing to drive up the insurance price rather than issue external capital to increase capacity when they experience unexpected negative capital shock, such as an unexpected catastrophe claim. Therefore, insurance prices not only depend on interest rates but also on present and past values of capacity. Doherty and Garven (1995) also note that not only a loss shock but also an interest rate shock would affect the assets and liabilities of insurance companies, as well as their capital. The capacity constraint hypothesis can be tested by examining whether capacity is negatively related to insurance price.

The third school of thought is devoted to the correlation between the insurance price and the broad condition of the economy. They attempt to explain cyclical behavior through its relationship with cyclical economic variables. Cyclicality is not unique to the insurance industry. Many industries have had upturns and downturns in prices and profits accompanied by variations in commodity quality and supply. Economists have referred to the fluctuations in the overall business activity as the 'business cycle' for more than a century. In addition to being a financial asset, an insurance policy may be viewed as a commodity that is related to its insured property. Overall demand for insurance is also expected to vary with economy growth, with expansion and contraction periods corresponding to demand for insurance. Moreover, profitability for insurance companies, which is also a factor in insurance price making, is linked to investment income as well as the cost of capital, which must be linked to the wider economy. Within this school, several studies use cointegration analysis to attempt to discover the long-term determination (e.g., Grace and Hotchkiss, 1995; Lazar and Denuit, 2011), while many studies focus on the short-term relationship between insurance price and relevant macroeconomic variables (e.g., Chen, 1999; Lamm-Tennant and Weiss (1997)) or introduce macroeconomic variables into a second-order autoregressive process (e.g., Meier, 2006).

Over the past two decades, a considerable number of empirical studies have been performed regarding the dynamics of insurance price based on the above theories. However, many researchers find that the long-run level of the relationship is relatively difficult to observe when addressing insurance price or profit primarily because the insurance price might be demonstrated to be a stationary process, while the relevant regressors, such as interest rate, are treated as nonstationary processes. Cointegration is constrained under Johansen's VECM framework, which requires that the underlying variables be integrated of order one. For example, Choi, *et al*. (2002) report that the ratio of discounted losses to premiums net of expenses (ELRs) was I(0), but the interest rate and capacity proxy series were I(1). They conclude that underwriting profits are cointegrated with the interest rate simply because the ELR series reveals I(0); however, the long-run relationship between underwriting profits and capacity proxy is not testable in such circumstances. Harrington and Yu (2003) pay more attention to the time series characteristics of insurance price by using a battery of tests for unit roots under the assumption of a deterministic trend. They indicate that insurance prices are stationary both at the entire industry level and within individual insurance lines. They argue that inclusion of any nonstationary regressors will make both least squares regressions and cointegration analysis inappropriate. Therefore, cointegration analysis is neither relevant nor necessary after controlling for deterministic influences. By contrast, Haley (2007) notes that finding a unit root is a sufficient although unnecessary condition. He also argues that controlling for a time trend when addressing insurance price may not be appropriate. Without the necessity for testing unit roots, Jiang and Nieh (2012) propose a more robust empirical methodology and provide further insight into this context by simultaneously assessing the long-term and short-term effects. They provide evidence of the long-term relationship between interest rate, capacity and underwriting profits in the U.S. market during the last half century. Furthermore, Boyer *et al*. (2012) utilize the time series technique of the business cycles and indicate that any evidence of underwriting cycles could simply be spurious. Regardless of whether the cycles exist, there is no way to predict this cycle to obtain profits. In fact, as Weiss (2007) indicated, there are many more mysteries about underwriting cycles that deserve attention, both theoretically and empirically.

Pioneering studies on underwriting cycles have been widely performed with data from developed economies, focusing in particular on the U.S. and some European countries. To the best of our knowledge, similar studies have rarely been conducted for Asian insurance markets, let alone China. China is well known as a mixed economy in which the state-owned sector used to dominate the private sector and remains influential in the whole economy, which is very different from the typical market economies. The proportion of the state-owned sector has been observed to decline over time, but the transition of the economic and political institutions may take an even longer time. The Chinese insurance industry has been dominated by state-owned enterprises since the first state-owned insurance companies, which were the only insurance companies at that time; the People's Insurance Company of China (PICC), set up in 1979, is just a miniature of the whole economy of China. The Chinese insurance industry has gone through major changes along with the economic variables during the past three decades. In Chinese insurance markets, the private sector, including foreign insurance companies, has been gradually encouraged to compete with the state-owned firms and has been observed gaining a larger market share. In addition, the regulations have also been reformed in accordance with this trend, for instance, the rates for the majority of insurance products are determined by the market rather than being strictly regulated as in the past. Given this unique background, the relationship between macroeconomic variables and the insurance price may assume a different form compared to the cases of mature market economies appearing in the literature. This article explores external impacts on insurance price determination in the Chinese nonlife insurance market and attempts to bridge the gap in understanding the relationship between insurance price and external economic factors.

The importance of this research is also derived from the fact that the Chinese insurance industry has begun to play an important role in the global insurance market. The Chinese insurance industry has grown rapidly in the past three decades and has become one of the largest markets in the world. In 2012, the Chinese insurance market had total gross written premiums of $245.5 billion, ranking 4th in the world insurance market and representing a compound annual growth rate (CAGR) of 18.0% between 2003 and 2012. However, the insurance density and penetration rates are USD 178.9 and 2.96%, respectively, which is much lower than the developed countries, indicating that the Chinese insurance market is still growing. Our study contributes to the literature by providing more evidence on the dynamics of insurance price and helping to deepen the understanding of the Chinese nonlife insurance market, thus providing insights for both researchers and insurance firms.

Compared to the existing literature, the present work is also innovative because the external impacts on insurance price are studied in an ARDL cointegration framework. The advantages of utilizing such a methodology in this context are fourfold. First, the arguments about stationary features of insurance price (e.g., Haley, 2007; Harrington and Yu, 2003) are avoided as there is no need to examine whether variables possess unit roots in an ARDL cointegration framework. Second, the data generating process (DGP) of this methodology is based on an autoregressive process, which is typically constructed to portray the dynamics of insurance price (Cummins and Outreville, 1987; Higgins and Thistle, 2000; Winter, 1994) and thus is appropriate in this context. Third, the ARDL cointegration framework is valid for using small samples to test and estimate the cointegration relationship (30-35 observations are still valid. See Jalil *et al*., 2010). The small sample properties of the ARDL approach are superior to those of Johansen's technique (Pesaran and Shin, 1999) and are more favorable in our case because the number of observations in our study is rather small (approximately 50). Finally, for the error-correction representation of the corresponding ARDL model, uneven lag orders and contemporaneous innovations are permitted, and only a unique error-correction term will be present, which avoids confusion from having multiple cointegration vectors. Findings under this framework indicate that the price dynamics of property-liability insurance in China are generally similar to those of developed economies, while the price of personal accident insurance is significantly affected by some country-specific economic and institutional factors, thus providing new evidence to the existing literature.

This paper is organized as follows: Section 2 explains the external variables that could have an effect on insurance price; Section 3 describes the data and methodology employed; Section 4 gives the empirical results; Section 5 presents conclusion.

2. External effects on the insurance price

As discussed above, the theories of the insurance cycle are not inclusive, and the external factors that affect the insurance price are not clearly known. According to previous studies related to insurance price dynamics, several economic variables may have an impact on insurance price in the short or long term.

Gross domestic product (GDP). Nonlife insurance activities may be linked to the general economic performance of the national economy and may be related to changes in real gross domestic product (GDP). The reason to include income variables is not only because of the wealth and income effect on attitudes toward risk but also the economic growth effect, which creates more insurable risk as a result of the increase in goods such as houses and automobiles and affects the demand for insurance. Price is determined by demand and supply; thus, factors affecting the demand side or supply side can have impacts on price determination. Doherty and Kang (1988) develop a structure model including both the demand side and supply side and describe underwriting cycles as a market clearing process with partial adjustment. The supply function is specified with expected excess underwriting profits, and the competitive underwriting profits are modeled by the insurance CAPM (Doherty and Garven, 1986; Fairley, 1979), which depends on the risk-free interest rate and capital market return. The demand function is mainly conditioned by aggregate income measured by GDP. Meier (2006) extends Cummins/Outreville's second-order autoregressive process by inclusion of the general economic variables and reformulates a cointegration analysis by re-parameter procedures. Three developed countries are examined. GDP serves as an indicator for potential losses and mainly influences the demand side of the model. The results indicate that compared with the U.S. and Switzerland, the Japanese insurance market reveals quite different features for both GDP and interest rate implications. Lamm-Tennant and Weiss (1997) use a generalized least square regression model to analyze the changes in premiums with respect to the changes in lagged losses, interest rates, average stock prices and real gross domestic products of nine developed countries. Many countries follow the theoretical prediction that the changes in interest rates and changes in average stock prices have a negative impact on insurance premiums; however, some countries reveal neutral, even positive, impacts on insurance premiums, including Germany, Japan, Spain, Austria and Switzerland, which is not consistent with the results for the U.S. market. The changes in GDP have neutral or even negative impacts on insurance premiums, as in the cases of Italy, Japan and Switzerland. Chen *et al*. (1999) focus on Asian countries for the first time and report that the changes in GDP have no impact on insurance price in Japan and Taiwan. Because a significant relationship between the premium and real gross domestic product is identified after accounting for the claim paid in Lamm-Tennant and Weiss (1997) and Chen *et al*. (1999), it is reasonable to assume that GDP is related to insurance price according to our definition of insurance price.

Interest rate. According to the rational expectation theory, insurance price reflects the discounted cash flow of future costs; thus, insurance price is a decreasing function that depends only on the discount rate in both the short and long term. Practically, the interest rate is usually referred to as the discount rate. As mentioned above, interest rate is found to have significant effects on insurance price in some countries in Meier (2006). Similar results are indicated in Lamm-Tennant and Weiss (1997) and Chen *et al*. (1999) when the dependent variable is insurance premium. Grace and Hotchkiss (1995) applied a cointegration technique to examine the relationship between the insurance price and the general condition of the economy; a bundle of economic variables, including interest rate, GDP and CPI, are included. They find that the nonlife insurance industry is generally linked to the long-term performance of the national economy but not linked to short-term shocks in economic variables.

Rate of market return. Rate of market return reflects how much return can be paid for unit capital invested in the market. Insurance activities are involved with investment in approximately two ways. First, underwriting capacity comes from the investment of equity holders who will ask for a return that is no less than the general market return elsewhere. So, when the outside market return rises, insurance price might also go up to meet the requirement of equity holders. Second, insurance companies usually invest the reserves of the premiums in the markets to earn profit, especially in the case of life insurance. When the rate of market return rises, insurance companies will benefit from the investment, and the pressure to increase the price to make more money will be eased, thus helping to lower the price. So, how the rate of market return will affect insurance price when adding these two impacts up is uncertain. Average stock prices are included in Lamm-Tennant and Weiss (1997) and Chen *et al*. (1999). Jawadi *et al*. (2009) reports the cointegration relationship between the nominal insurance premium received and financial markets (i.e., interest rates and stock market returns) for five developed countries. They conclude that the adjustment of the insurance premium toward equilibrium in France, Japan and the U.S. is rather discontinuous, asymmetrical and nonlinear.

There are still some other variables, such as CPI, surplus of insurance companies, and market concentration ratio, that could have a short- or long-term relationship with insurance price; even the cost of distribution channels can have a significant impact on insurance price (Banyár and Regős, 2012), but currently, we focus on real GDP, interest rate and rate of market return in this study due to constraints in data availability. The relationship between insurance price and interest rate(r), real GDP, and rate of market return(Rm) is examined in an ARDL cointegration framework.

3. Data and methodology

3.1. Data

This article uses quarterly data for the period 2001Q1-2013Q2 to study the dynamics of insurance price under the influence of external effects of economic variables. The definition of unit insurance price by Cummins and Outreville (1987), the ratio of premiums to loss (or inverse of loss ratio), is used to indicate the insurance price. This measure reflects the loading or transaction costs of insurance, which measures the aggregate economic value of insurance. Much of the underwriting cycle literature adopts the same definition of unit price. To reach a deeper understanding of the different lines of nonlife insurance industry, two lines, i.e., property-liability insurance and personal accident insurance, are examined together. The data for written premiums and claims paid for property-liability insurance and personal accident insurance are taken from the website of the China Insurance Regulatory Committee (CIRC); we transform the written premiums into premiums earned to compute the loss ratio. The rate of the three-month Treasury bill is used to represent the level of the interest rate (r) in China; the data for the interest rate are adopted from the database of CSMAR Solution. The data for gross domestic product (GDP) are obtained from the China Economic Information Network (CEIN) and are adjusted with CPI based on 2000Q1 to obtain real monthly GDP. Stock market returns are indicated with the rate of return of the Shanghai Composite Index; the data are also taken from the database of CSMAR Solution.

Table 1 presents relevant descriptive statistics. As indicated in Table 1, the inconsistency in the integration order of variables in this study encourages the use of the ARDL bounds approach rather than one of the alternative cointegration tests.

Table 1. Descriptive statistics

	Underwriting loss ratio (%)		Interest Rate (r)	Real GDP	Stock Market Return (Rm)
	Property-liability Insurance	Personal Accident Insurance			
Mean	0.5640	0.3301	0.0123	7149861	2.2622
Median	0.5591	0.3130	-0.0153	6677223	2.3318
Maximum	1.0061	2.2352	0.5267	15003307	3.9000
Minimum	0.3900	0.0412	-0.3400	2404192	1.0850
Standard Deviation	0.0967	0.2888	0.1691	3158321	0.6702
Skewness	1.7890	5.8429	0.7879	0.4645	0.3699
Kurtosis	10.1119	39.5068	4.0370	2.4199	2.8607

Jarque-Bera Statistic	132.0453**	3061.039**	7.4135*	2.4199	1.1806
ADF Test (Levels)	-6.4725**	-7.1451**	-5.1172**	3.4824*	-0.7216
ADF Test (First difference)	-13.0101**	-11.5706**	-8.3863**	3.0254*	-5.5621**
DFGLS Test (Levels)	-2.2592*	-7.2191**	-5.1708**	0.1104	-1.1020
DFGLS Test (First difference)	-11.5710**	-11.6730**	-8.4624**	-1.4443	-5.3808**
PP Test (Levels)	-6.4725**	-7.3100**	-5.1642**	2.2854	-2.4611
PP Test (First difference)	-31.3563**	-48.4029**	-10.9215**	-35.1760**	-5.2556**
KPSS Test (Levels)	0.1393**	0.2200**	0.0903**	0.9236	0.1465**
KPSS Test (First difference)	0.2787**	0.5000*	0.0465**	0.0928**	0.0584**
ERS Test (Levels)	2.6438*	0.9812**	1.1138**	4122.767	10.5173
ERS Test (First difference)	1.6879**	1.2893**	0.5227**	92.5749	244.2973

Note: * and ** indicate significance at the 5% and 1% level, respectively.

3.2. Methodology

To examine the relationship between unit price of insurance and macroeconomic determinants, we employ the ARDL cointegration model (Pesaran *et al.*, 2001) as a framework. Let y_t represent the proxy of unit insurance price of the industry at current time *t*. r_t, Rm_t, and GDP_t denote the interest rate, the market return and real gross domestic products, respectively, and define $\mathbf{x}_t = (r_t, Rm_t, GDP_t)'$ as a 3×1 vector of variables. Consider that the data-generating process for unit insurance price, the interest rate, the market return and real gross domestic products is an unrestricted VECM as follows:

$$\Delta \mathbf{z}_t = \boldsymbol{\mu}_0 + \boldsymbol{\mu}_1 t + \mathbf{A}\mathbf{z}_{t-1} + \sum_{i=1}^{n} \boldsymbol{\Phi}_i \Delta \mathbf{z}_{t-i} + \mathbf{v}_t \qquad (1)$$

where the partition $\mathbf{z}_t = (y_t, \mathbf{x}_t')'$ is a 4×1 vector of variables. Similarly, deterministic term $\boldsymbol{\mu}_j = (\mu_{jy}, \boldsymbol{\mu}_{jx}')'$ and error term $\mathbf{v}_t = (v_{yt}, \boldsymbol{v}_{xt}')'$ are 4×1 vectors. The long-term multiplier, $\mathbf{A} = \begin{bmatrix} \mathrm{A}_{yy} & \mathbf{A}_{yx} \\ \mathbf{A}_{xy} & \mathbf{A}_{xx} \end{bmatrix}$, is a matrix of order 4×4, and $\boldsymbol{\Phi}_i = \begin{bmatrix} \Phi_{yy,i} & \boldsymbol{\Phi}_{yx,i} \\ \boldsymbol{\Phi}_{xy,i} & \boldsymbol{\Phi}_{xx,i} \end{bmatrix}$ is the short-run 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 the unit insurance price and the determinants, irrespective of the order of integration. There is no feedback from the level of y_t and the interest rate, and the market return and real gross domestic products could be regarded as long-term forcing variables (see Granger and Lin (1995)). Such an assumption is intuitively reasonable because the underwriting activity of the insurance industry has only a modest impact on the macroeconomic system. Equation 1 can then be written in terms of the dependent variable y_t and the forcing variables $\mathbf{x}_t$ as (Mills and Markellos, 2008):

$$\Delta y_t = \mu_{0y} + \mu_{1y} t + A_{yy} y_{t-1} + \mathbf{A}_{yx} \mathbf{x}_{t-1} + \sum_{i=1}^{n} \Phi_{yy,i} \Delta y_{t-i} + \sum_{i=1}^{n} \boldsymbol{\Phi}_{yx,i} \Delta \mathbf{x}_{t-i} + v_{yt} \tag{2}$$

$$\Delta \mathbf{x}_t = \boldsymbol{\mu}_{0x} + \boldsymbol{\mu}_{1x} t + \mathbf{A}_{xx} \mathbf{x}_{t-1} + \sum_{i=1}^{n} \boldsymbol{\Phi}_{xy,i} \Delta y_{t-i} + \sum_{i=1}^{n} \boldsymbol{\Phi}_{xx,i} \Delta \mathbf{x}_{t-i} + \boldsymbol{v}_{xt} \tag{3}$$

Additionally, define the variance matrix of error term as:

$$\Omega = \begin{bmatrix} \mathrm{w}_{yy} & \mathbf{w}_{yx} \\ \mathbf{w}_{xy} & \mathbf{w}_{xx} \end{bmatrix} \tag{4}$$

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

$$v_{yt} = w' \boldsymbol{v}_{xt} + \varepsilon_t \tag{5}$$

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

$$\Delta y_t = a_0 + a_1 t + A_{yy} y_{t-1} + \mathbf{A}_{yx,x} \mathbf{x}_{t-1} + \sum_{i=1}^{n} \psi_i \Delta y_{t-i} + \sum_{i=1}^{n} \boldsymbol{\varphi}_i \Delta \mathbf{x}_{t-i} + w' \Delta \mathbf{x}_t + \varepsilon_t \tag{6}$$

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

$$\boldsymbol{\varphi}_i = \boldsymbol{\Phi}_{yx,i} - w'\boldsymbol{\Phi}_{xx,i}$$

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

$$y_t = \theta_0 + \theta_1 t + \boldsymbol{\theta}\mathbf{x}_{t-1} + u_t \tag{7}$$

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

$$\Delta y_t = a_0 + a_1 t + A_{yy}(y_{t-1} - \boldsymbol{\theta}\mathbf{x}_{t-1}) + \sum_{i=1}^{n} \psi_i \Delta y_{t-i} + \sum_{i=1}^{n} \boldsymbol{\varphi}_i \Delta \mathbf{x}_{t-i} + w'\Delta \mathbf{x}_t + \varepsilon_t \tag{8}$$

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

According to Pesaran *et al*. (2001), the conditional ECM represented as Equation (6) is used as the basis of the 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 (Cavanagh *et al.*, 1995; Persaran *et al.*, 2001). Such an outstanding characteristic is suitable for studying the underwriting activity in the insurance industry because the insurance price is usually assumed to be stationary and thus not 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 relationships. The unit root testing of variables (e.g., Grace and Hotchkiss, 1995) is no longer necessary. Such an important feature of this test reduces the degree of uncertainty arising from the pre-testing stage of each series in the analysis of level relations, which is an important issue in our case. 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 five cases, i.e., no constant, restricted constant, unrestricted constant, restricted constant and trend, and unrestricted constant and trend, to fit the most suitable case into various insurance lines separately.

Once the long-term relationship is determined by the bounds testing procedure, Pesaran *et al*. (2001) suggest that the augmented autoregressive distributed lag model (ARDL) can be estimated. The autoregressive distributed lag model can be rearranged as a conditional ECM and is capable of differentiating lag lengths on the lagged variables in Equation 6 without affecting the asymptotic results of bounds test. We chose n=4 in Equation 6 and search across $(n+1)^4$ autoregressive distributed lag models via Akaike Information Criterion (AIC). Allowing for differential lag lengths on the lagged variables is more general than other types of CECM of partial systems carried out by Boswijk (1994, 1995).

4. Empirical results

4.1 Bounds testing

As mentioned in the previous section, a critical assumption that has to be tested is whether there is at most one long-term relationship among variables. Irrespective of whether variables are $I(0)$ or $I(1)$, a bounds testing procedure is provided to test null hypotheses of long-term relationships. This study imposes the order of lag length (n) from 1 and calculates the F-statistic and t-statistic. Note that the asymptotic distributions of the F-statistic and t-statistic are nonstandard irrespective of whether the variables are I(0) or I(1). Because the asymptotic distributions of these two statistics are nonstandard, Pesaran *et al.* (2001) provide a bounds testing procedure that has two sets of asymptotic critical values. One set assumes all variables are I(0), and the other assumes that all variables are I(1). If the computed F-statistic and t-statistic falls above the upper limit of the bound critical value, the null hypothesis is rejected, which means the variables are cointegrated. Conversely, if the computed F-statistic and t-statistic falls below the lower bound critical value, the variables are concluded to be not cointegrated, and the null hypothesis cannot be rejected. Finally, the case within the band would be inconclusive.

Table 2 indicates that the null hypothesis maintaining nonexistence of the long-term relationship is rejected for models with intercept and no trend and with unrestricted intercept and trend for the property-liability insurance. The null hypothesis is rejected for models with no intercept and no trend for the personal accident insurance. Under the parsimony principle, we choose models with no intercept and no trend for the personal accident insurance and models with intercept and no trend for the property-liability insurance. The reason for which the trends are not included in this study is not exactly known; one possible explanation is that our sample period is rather short to reflect the trend. The results for all five cases are listed in Table 2.

Table 2. Bounds testing statistics

A	Models with no intercept and no trend		
	Orders of lag n	F_I	t_I
Property-liability Insurance	1	1.5218	-1.9128
	2	1.6015	-1.4255
	3	0.7620	-0.5962
	4	1.0016	-0.8577
Personal Accident Insurance	1	3.9682*	-3.2143
	2	7.0097*	-3.6468*
	3	3.2445	-3.1055
	4	5.2203*	-3.4123*

B	Models with intercept and no trend			
	Orders	Restricted intercept	Unrestricted intercept	
	of lag n	F_{II}	F_{III}	t_{III}
Property-liability Insurance	1	6.8738*	8.5538*	-5.4908*
	2	4.3420*	5.4211*	-3.9868*
	3	3.1442	3.9264	-3.4472
	4	1.6361	2.0448	-2.1176
Personal Accident Insurance	1	3.1007	3.8757	-2.8526
	2	5.5159*	6.8867*	-3.2717
	3	2.8031	3.4930	-3.1256
	4	4.0449*	5.0560*	-2.7847

C	Models with unrestricted intercept and trend			
	Orders	Restricted trend	Unrestricted trend	
	of lag n	F_{IV}	F_V	t_V
Property-liability Insurance	1	5.6048*	7.7530*	-5.1887*
	2	3.5185	5.1336*	-3.9311
	3	2.7398	3.8993	-3.4542
	4	1.3194	1.9690	-1.9025
Personal Accident Insurance	1	2.5397	3.8053	-2.7808

	2	4.5774*	6.8523*	-3.2430
	3	2.3257	3.4709	-3.0551
	4	3.2526	4.7622	-2.4168

Note: 1.*indicates significance at the 5% level.

2. For no intercept and no trend case, critical value bounds of F statistics is (2.45, 3.63) at the 5% level. Critical value bounds of t statistics is (-1.95, -3.33) at the 5% level.

3. For restricted intercept case, critical value bounds of F statistics is (2.79, 3.67) at the 5% level

4. For unrestricted intercept case, critical value bounds of F statistics is (3.23, 4.35) at the 5% level. Critical value bounds of t statistics is (-2.86, -3.78) at the 5% level.

5. For unrestricted intercept and restricted trend case, critical value bounds of F statistics is (3.38, 4.23) at the 5% level.

6. For unrestricted intercept and unrestricted trend case, critical value bounds of F statistics is (4.01, 5.07) at the 5% level. Critical value bounds of t statistics is (-3.41, -4.16) at the 5% level.

4.2 Estimation

Given the maximum order of lag (n = 4) by the bounds test, one of 125 (=$(1+4)^3$) ARDL models must be selected using the Akaike Information Criterion (AIC) during the second stage. Table 3 then lists the diagnostic statistics used in ARDL estimation. The adjusted $R^2{}_s$ for two models are 0.59 and 0.66, respectively. The computed F-statistics clearly reject the null hypothesis that all regressors have zero coefficients, suggesting that the ARDL model fits the data reasonably well. Diagnostic testing is statistically insignificant for all ARDL models, suggesting no misspecification.

Table 3 Diagnostic statistics of ARDL estimations

Insurance line	Property-liability Insurance	Personal Accident Insurance
ARDL (m, n, p, q)	ARDL (1,1,0,1)	ARDL (4,0,4,0)
$\overline{R^2}$	.5877	.66497
F- statistic	5.7016*	7.8706*
DW-statistic	1.9122	2.0767
Durbin's h-statistic	1.1073	
LM Serial correlation F test	.31100	2.4298
Heteroscedasticity F test	1.1378	2.9221

Note: * indicate significance at the 5%.

Table 4 Estimated long term effects of ARDL model

Insurance line	Property-liability Insurance	Personal Accident Insurance
ARDL (m, n, p, q)	ARDL (1,1,0,1)	ARDL (4,0,4,0)

constant	2.0956**(.23350)	
r_t	-.31497**(.15016)	3.4138**(1.1005)
Rm_t	-.58667*(.32820)	29.0952**(9.9099)
GDP_t	.05569**(.02651)	.4454(.3092)

Notes: 1.* and ** indicate significance at the 10% and 5% level, respectively.

2. Numbers in parentheses are standard errors.

Long-term effects estimation in Table 4 indicates that the price of property-liability insurance has a constant of 2.0956, but the price of personal accident insurance does not have one. This might indicate that the price of property-liability insurance is at some certain level in general, while the price of personal accident insurance is quite flexible. In China, automobile insurance accounts for more than two-thirds of insurance premiums in the nonlife insurance industry, the price of automobile insurance has been nearly the same across different insurance firms in the past years, and this phenomenon may help to explain the existence of the price constant. In contrast to property-liability insurance, personal accident insurance has undergone a large price adjustment in the past decade. Aviation personal accident insurance, for instance, was sold for RMB 20 for an insurance amount of RMB 200,000 before January 2003, but after that, the insurance amount increased to RMB 400,000 with the price of the policy unchanged. Moreover, when insurance firms discovered that the real cost of personal accident insurance is very low, an increasing number of new personal accident insurance products were designed with a lower price and/or wider coverage. Thus, during the sample period, it is not surprising to see no price constant.

It is illustrated in Table 4 that real GDP has a significant positive long-term relationship with the price of property-liability insurance, which means that the demand side of the insurance market has a positive effect on insurance price in the long run. Real GDP also exhibits a positive long-term relationship with the price of personal accident insurance, but the result is not significant. Our findings for property-liability insurance are different from Lamm-Tennant and Weiss (1997), which did not find a significant relationship between real GDP and premiums, but similar to Chen et al (1999), in which a significant relationship between the changes in the real GDP and changes in the premiums of all five sample Asian countries (i.e., Japan, Malaysia, Singapore, South Korea and Taiwan) was identified. The positive effect of GDP growth on insurance price can be attributed to the enlarging demand and capacity constraint on the supply of insurance in developing countries such as China. During the growth process in developing countries, the development of the service industry always lags behind the manufacturing industry, as most capital is allocated to the manufacturing sector as a priority, and a scarcity of underwriting capital in the insurance industry is more often the case than not; thus, the capacity constraint increases the price and hard market forms as indicated by Winter (1994). Personal accident insurance follows a special growth path as discussed above, but we speculate that the intense competition among the insurers eases the effect of the demand side, resulting in an insignificant positive effect.

As can be seen from Table 4, the price of property-liability insurance is negatively correlated with interest rate and rate of market return at the 5% and 10% significance level, respectively. Generally speaking, profit from nonlife insurance operation is mainly from two channels: One is underwriting profit, which is the surplus left in premiums after paying for the claim and the cost of operation, and the other is investment profit, which is earned by investing the reserve and surplus. When the revenue from investment is considerable, insurance firms may lower the expectation on underwriting profit, which means that insurance firms can underwrite some relatively bad risk that they would not accept otherwise or underwrite standard risk with a lower price. According to our definition of insurance price, insurance price reflects the margin that insurance firms can obtain from selling the policies. Thus, insurance price has a negative relation with investment profitability, a proxy for rate of market return. Premiums are usually thought to be the discounted present value of future costs; thus, it is not surprising to see that the discount rate, a proxy for interest rate, is negatively related with insurance price. Our findings for the property-liability line are consistent with many previous studies (Doherty and Garven, 1995; Doherty and Kang, 1988; Fields and Venezian, 1989; Haley, 1993; Lamm-Tennant and Weiss, 1997; and Smith, 1989). In contrast to property-liability insurance, the price of personal accident insurance is identified as being positively correlated with rate of market return and interest rate in Table 4. This finding is contrary to normal expectations but not rare in the previous literature. Stock index is found to be positively correlated with premiums among 4 out of 5 sample Asian countries, and interest rate has a positive effect on premium among 3 out of 5 sample Asian countries in Chen *et al.* (1999). Lamm-Tennant and Weiss (1997) also identified similar results for Japan indicating that stock index has a positive relationship with premiums, but an adequate explanation for this result was not given. For the case of China, because the price of personal accident insurance has experienced radical changes during the past decade and the trend in price has been downward, we believe this change is not the result of any single factor but due to the whole economic environment during the process of marketization. Under such conditions, the price of personal accident insurance decreases along with less price regulation and intense competition among insurance firms. At the same time, interest rate levels have been descending since financial market reform. Rate of market return shares the same feature as interest rate and correlates with personal accident insurance price positively.

Table 5 Error correction representation of ARDL model

Insurance line	Property-liability Insurance	Personal Accident Insurance
ARDL(m, n, p, q)	ARDL (1,1,0,1)	ARDL (4,0,4,0)
Constant	1.2240**(.30114)	
ECM_{t-1}	-.58407**(.14202)	-.76251**(.2023)
Δy_{t-1}		.39139(.18578)
Δy_{t-2}		.10757(.15398)
Δy_{t-3}		-.19179(.15168)
Δr_t	.01858(.13262)	2.6031**(1.2148)
ΔRm_t	-.34265*(.1914)	4.1981(3.3189)
ΔRm_{t-1}		-19.7556**(4.9319)
ΔRm_{t-2}		-6.0989(3.9343)
ΔRm_{t-3}		-10.5161(3.1627)
ΔGDP_t	.0003288(.04423)	-0.3397(0.2692)
Q1 dummy variable	.25693*(.12802)	-.73195(.80792)
Q2 dummy variable	-.086987(.062413)	.75390(.75076)
Q3 dummy variable	.017830(.050504)	-.75073(.79402)
$\overline{R^2}$	.68994	.64207
F- statistic	15.5906**	4.7835**
DW-statistic	1.9122	2.0767

Notes: 1.* and ** indicate significance at the 10% and 5% level, respectively.

2. Numbers in parentheses are standard errors.

In our short-term analysis framework, the coefficient of ECM can be viewed as the price adjustment speed of different lines of insurance. The results from Table 5 indicate that personal accident insurance has a higher price adjustment speed than property-liability insurance. This means that when a price shock is sustained by both lines of insurance, causing prices to deviate from the equilibrium level, it will take less time for personal accident insurance than property-liability insurance to return to the former price trend, indicating a shorter cycle. Actually, such results can be well justified with the practice of insurance. Although the duration of many property insurance policies is one year, some forms of property insurance, such as construction project insurance, have a more than one-year term, and it is hard to change the price once those contracts are signed. Moreover, even for a one-year policy, such as environmental pollution liability insurance and medical liability insurance, the settlement of claim may last for several years. The long-tail property of claim settlement may also have a sticky effect on the insurance price. For instance, when insurance companies detect higher risk on pollution liability insurance, they may raise the premiums, and for the sake of safety, the premiums will not go down until the claim settlement provides evidence that the risk is lowered; this may take quite some time. In contrast to property-liability insurance, the duration of personal accident insurance policies is generally short, and moreover, the settlement of claim will generally not last for more than one year. Thus, our test in the ARDL cointegration framework provides substantial evidence for the difference in price dynamics for different lines of nonlife insurance.

The error correction model also provides some evidence on the short-term effect of external factors on different lines of insurance (as indicated in Table 5). Changes in the rate of market return are identified as being negatively correlated with changes in property-liability insurance price and personal accident insurance price (with one period lag) in the short term. This might indicate that although many lines of nonlife insurance have short-duration policies, the investment of insurance funds still matters for insurance price setting in the short run. Changes in interest rate are found to positively affect the changes in price of personal accident insurance. This finding is not in accordance with rational expectation theory, and we speculate that the interest rate is not just a discount operator as in the rational expectations framework but is an indicator of the cost of acquiring capital from outside. When the interest rate rises, insurers intend to raise the price of personal accident insurance, for which the price adjustment is much easier, to accumulate capital.

Our by-line analysis finds that the price dynamics of property-liability insurance, which represents a more than 95% share of the nonlife insurance industry in China, has a great deal in common with counterparts in developed countries except for the long-term effect of GDP. On the other hand, the findings about the price dynamics of personal accident insurance are quite inconsistent with the existing literature. As Cummins *et al.* (1992) suggests, the impacts of some economic and institutional variables on insurance are line-specific. We believe that the economic and institutional environment of China shaped the special price dynamics for the two nonlife insurance lines under study.

Specifically, several important factors are thought to have significant impacts on the dynamics of the nonlife insurance price in China according to the empirical results. First, strong demand for insurance as a result of continuous economic development is not only a powerful engine for the development of the insurance industry, which is unlikely in developed economies, but also helps to raise the price of insurance.

Second, with an increasingly competitive insurance market – one that is characterized by more competitors and less market share for state-owned companies, the gradual abolishment of monopolies and strict regulation of insurance price setting, and decreasing prices for some lines of nonlife insurance – different lines of nonlife insurance seem to be affected by this process in varying degrees. Third, the interest rate not only serves as an operator when computing the rate of insurance but also as an indicator of the reform of the financial system for a country transitioning from a planned to a market-oriented economy, which means its relation with insurance price might be complicated compared with developed economies. Finally, the rate of market return does not contain consistent effects on personal accident insurance price; the reasons for this could be the irrationality of the capital market, the insurance firms, or both.

5. Conclusion

This article uses the ARDL method to study both the long-term and short-term relationship between external factors and nonlife insurance price by employing for the first time data from China, the largest developing country with mixed economic structure and the fourth biggest insurance market in the world. Findings for the long-term effects indicate that the price dynamics for various lines of nonlife insurance are different. Specifically, GDP is found to have a significant positive effect on the price of property-liability insurance. Interest rate and rate of market return have a negative effect on property-liability insurance price, which is consistent with the evidence provided in much of the previous literature, while a positive effect is found for personal accident insurance price, which indicates that the price determination for personal accident insurance might be affected by some special factors, such as deregulation and intense competition among insurance firms in China. Empirical results for short-term effects indicate that property-liability insurance contains a longer cycle than personal accident insurance. Moreover, rate of market return negatively correlates with the price of both property-liability insurance and personal accident insurance (with a one-period lead); Interest rate is found to have a positive effect on personal accident insurance price. Test results indicate that the price dynamics of different lines of nonlife insurance in China are identified as varying according to the specific feature of the line and the related background of economic and institutional reform. Our findings not only add new evidence on insurance price determination in Asian developing countries by employing data from China for the first time but also have important practical significance. According to our research, insurance companies in the Chinese nonlife insurance market should widely consider economic factors in insurance rate determination rather than solely relying on actuarial methods when competing with counterparts. Regulatory authorities should pay attention to the specific economic and institutional environments in China and adopt flexible regulatory measures when supervising the insurance markets; for specific lines, such as personal accident insurance under discussion here, in which the price dynamics significantly deviate from the traditional mode, special attention should be given to prevent irrational operations within the insurance companies and to protect the consumers.

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