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An Empirical Research on the Relationship between Property Insurance Premiums and Macroeconomic Variables Based on ARDL Model*

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Abstract

Given that most of property insurance policies are one-year contracts and have a high renewal, this paper establishes Auto-regressive Distributed Lag Model (ARDL) which considers adding lags of the dependent variable and/or lags of some independent variables. Based on the data of Insurance Premiums in China, Gross Domestic Product (GDP), Consumer Price Index (CPI) and Fixed-asset Investment during the period from 1980 to 2012, this paper analyzes the long-term and short-term relationships between them with method of the ARDL bounds testing approach. The results indicate that GDP is the major factor driving the growth of property insurance premiums in China; fixed-asset investment has significant impact on Chinese property insurance premiums, and they show the conspicuous negative correlation; Moreover, CPI has little effect on the premium income.

Keywords: Insurance Premiums, Macroeconomic Variables, ARDL model

1. Introduction

In this paper, data of insurance premiums in China, Gross Domestic Product (GDP), Consumer Price Index (CPI) and fixed-asset investment during the period from 1980 to 2012 are utilized in order to establish ARDL to analyze the long-term and short-term relationships between them. The outcome indicates that GDP is the factor which influences property insurance mostly.

Numerous scholars consider that economic growth is the main factor affecting premiums. Macroeconomic variables, which include GDP, CPI as well as fixed-asset investment, may reflect the economic development to some extent. Moreover, several foreign scholars studied the relationships between premiums and some macroeconomic variables. Specifically, Outreville (1990) [1] analyzed the panel data from 55 developing countries. The result indicated that the economic growth had a positive impact on property insurance premiums.

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Ward and Zurbruegg (2000) [2] studied insurance market of 9 Member States in the Organization for Economic Cooperation and Development. However, the results of their research were slightly different from Outreville's(1990). In their view, the relationship between economic growth and the development of insurance industry varied among countries. In details, they believed that the improvement of insurance industry could promote the economic growth in some countries; however, the opposite happens in others. Besides, the research by .Kugler and Ofoghi's (2005) [3] was different from Outreville's(1990) as well as Ward and Zurbruegg's (2000). In their research, aggregate data was replaced by component metrics data to study the relationship between insurance industry and economic growth in UK. Arena (2008) [4] also differed from the previous scholars in method of research. He analyzed the data of 56 countries from 1976 to 2004 with the method of GMM estimation model of dynamic Panel, and then he concluded that there existed two-way causality relationship between premium and GDP. Differing from the scholars mentioned above, after reviewing 85 papers related to the relationship between development of insurance industry and economic growth, Outreville (2011) [5]pointed out that the insurance demand was affected by exogenous variables. As can be seen from the above-mentioned foreign scholars' researches, the regression analysis was widely adopted and GDP was the only economic variable selected which affects the insurance industry.

Chinese scholars also carried out some researches on the relationship between premiums and macro-economy. Specially, linear regression was utilized by some researchers. For example, Lin Baoqing, Hong Xixi and Wu Jiangming (2004)[6] thought that economic growth may has diverse effects on premium income in different insurance market structure. They selected two-stage inter-provincial panel data to study the development of insurance industry in China during the two-stage period which were oligopoly highly monopolistic stage from 1988 to 1992 and monopolistic competition stage from 1997 to 2002 respectively. The results showed that there existed highly stable positive relationship between variables no matter which stage we were in. However, to some extent, the coefficients may be different. The former study mainly analyzed the relationship between economic development and insurance industry in different time periods. While Wu Xiangyou (2009) [7] established a multiple linear regression model using the data of 30 provinces in China from the period of 1997 to 2007. He found that the economic development was the fundamental driving force of the advance of insurance industry. Moreover, the distinctions in the level of economic growth had led to deviations in the level of advance in insurance industry. Be similar to Lin Baoqing (2004) and Wu Xiangyou (2009), Zhao Hongmei and Su Huijuan (2013)[8] also used inter-provincial panel data. Nevertheless, their study was based on the developing individual (time) fixed effect model. The different intercept terms of the model were used as the base of calculating the weights. As a result, the panel data was adjusted according to the regional weight as well as time weight. After that, they used the adjusted panel data to finish the stepwise regression, and then they analyzed the influencing factors for the demand of property insurance in China. The results showed that the influencing factors for the demand of property insurance contained disposable income per person, fixed-asset investment and population considering the regional differences. However, the influencing factors became fixed-asset investment in consideration of the time differences.

Some scholars, including Qian Zhen (2008)[9] and Zhang Chunhai (2010)[10], used vector auto-regression (VAR) model. Qian added impulse response function to VAR model, and she selected more indexes, which included GDP, urban and rural resident savings as well as disposable income per person, to explore the relationships among economic growth, savings, consumption and insurance development. Eventually she found that there existed dynamic co-integrated relationship. Besides, Zhang selected time series data of GDP and premiums which covered the period from 1985 to 2009 to analyze the correlative mechanism of economic growth and premium with VAR model. They believed that GDP growth played an important role on the increase of premium.

Other scholars established a combinational model. For example, Rao Weinan (2011)[11] analyzed the relationship between premium and economic development of China in terms of the insurance penetration. Moreover, he constructed a portfolio mode on the base of quarterly data, and ultimately he achieved that the elastic coefficient of the national premium income gross to GDP was 1.102[11].

Without considering the autocorrelation or hysteresis quality of dependent variables, linear regression and VAR were used as the main research methods in the previous studies. In this paper, considering the characteristics of the property insurance that the policies are one-year period and high renewal, the model of ARDL, which adds lags of the dependent variable and/or lags of some independent variables, is constructed. Additionally, this paper carries out the Bound Test in co-integration test when time series data are not more than integrated of 1. Index selection also differs from the previous studies. Previous researches usually just took GDP as an indicator of economic growth. However, in order to comprehensively reflect macroeconomic conditions, this paper also adds CPI and fixed-asset investment for empirical analysis.

2. Model and Methods

ARDL is a relatively innovative dynamic co-integration test model, which was first used by Charemza and Deadman (1992) [12]. Besides, this model was gradually improved by Pesaran and Smith (1998), Pesaran and Shin (1999) [13], Pesaran (2001) [14] and so on.

Form of the model is

$$y_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} y_{t-i} + \sum_{j=0}^{n} \beta_{2j} x_{t-j} + \varepsilon_t \qquad (1)$$

When using dynamic test model to determine the long-term or short-term coefficients between the variables, the premise is the existence of co-integration relationship between variables. Therefore, at first this paper applies bound test method to determine whether there is a co-integration relationship between the variables. There are two steps as followed:

Firstly, unconstrained error correction model (UECM) is constructed:

$$\begin{aligned} \Delta \mathbf{y_t} &= \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta y_{t-i} + \sum_{j=0}^{n} \alpha_{2j} \Delta x_{t-j} \\ &\quad + \lambda_1 y_{t-1} + \lambda_2 E_{t-1} + \varepsilon_t \end{aligned} \qquad (2)$$

Among them, α_0 is constant, α_{1i} and α_{2j} are short-term dynamic coefficients, λ_1 and λ_2 are long-term dynamic coefficients, ε_t is white-noise process.

Afterwards, the optimal lag order of each differential item in formula (2) is determined respectively by the AIC or SBC information criterion. And then its F statistics as well as joint significant test are carried out based on the following assumptions.

$$\begin{cases} \textbf{Null Hypothesis } H_0 : \lambda_1 = \lambda_2 = 0 \\ \textbf{Alternative Hypothesis } H_1 : \lambda_1 \neq 0 \textbf{ or } \lambda_2 \neq 0 \end{cases}$$

Since the asymptotic distribution of F statistic is nonstandard, Pesaran (2001) has calculated the two different thresholds of F statistic corresponding different number regression item. If the calculated F statistic is larger than the upper bound of the threshold, the null hypothesis will be rejected. Namely, there exist long-term relationships between variables. In additional, if the calculated F statistic is less than the lower bound of the threshold, the null hypothesis will be accepted. Namely, there do not exist long-term relationships between variables. Moreover, if the F statistic falls between two thresholds, the relationship between time series without unit root test cannot be judged. If all variables are integrated of 1, the null hypothesis will also be rejected. Namely, there exist long-term relationships between variables. However, if all variables are integrated of 0, the null hypothesis will be accepted. Namely, there is not exist long-term relationships between variables.

Secondly, on the premise of the existence of a long-term relationship, this paper applies ARDL model to estimate the long-term relationship between coefficients of variables.

Compared with traditional EG two-step method and Johansen method, ARDL Bounds Testing method has the following advantages: Firstly, regardless of the time series are $I(1)$ or $I(0)$ at the same time, this method can be used to test the long-term relationships between the variables. Secondly, this method is the most efficient co-integration technique when it comes to smaller sample data. Further, this approach corrects for possible endogeneity of explanatory variables effectively.

3. Empirical Study

3.1. *Data*

Considering data availability, the paper sets sample from the data of property insurance premiums, GDP, CPI and fixed-asset investment during the period from 1980 to 2012 to study the relationships between property insurance premiums and macroeconomic variables.

The data of property insurance premiums from 1980 to 1998 originates from *property insurance* [15], while others come from *Insurance Association of China*.

Besides, units are one hundred million Yuan. The data of GDP, fixed-asset investment, consumer price index comes from the National Bureau of Statistics. The units of two former are one hundred million Yuan, the latter chooses 1978 as the base period. In order to eliminate the effects of heteroskedasticity, the paper takes the natural logarithm on property insurance premiums, GDP, and fixed asset investment. The actual value of property insurance premiums income, GDP, and fixed assets investments are replaced by P, GDP, and FAI respectively. And their logarithm value is replaced by LP, LGDP, and LFAI respectively. In additional, CPI is also represented by CPI.

3.2. *Unit root test*

ARDL Bounds Testing has certain prerequisites that each sequence is less than integrated of 1. As a result, stationary of each sequence is needed to be tested to determine the order of integration before co-integration test. This article uses Eviews6.0 for unit root test and results are shown in Table 1.

As can be seen, the original sequence of LP, LGDP, and CPI are non-stationary at 10% significance level. Via differencing, the differential results of variable LP (DLP) is stationary at the 1% significance level. Therefore, LP is *I*(1).The differential results of variable LGDP (DLGDP) is stationary at the 5% significance level according to ADF test, while it is stationary at 10% significance level according to PP test. Consequently, LGDP is *I*(1). The differential results of variable CPI (DCPI) is stationary at the 5% significance level according to ADF test, while it is stationary at 10% significance level according to PP test, so LGDP is *I*(1). The variable LFAI is stationary at the 5% significance level according to ADF test, while it is non-stationary according to PP test, and its differential results (DLFAI) is stationary at the 5% significance level according to ADF test or PP test, so DLFAI is *I*(0)or *I*(1).Subsequently, model variables are *I*(0) or *I*(1), which qualify prerequisite of ARDL Bounds Testing, so that the ARDL model can be established for co-integration test.

3.3. *ARDL bound testing*

In order to test the long-term relationships among property insurance premiums, GDP, CPI and fixed-asset investment variables, the optimal lag order of each differential item in formula (2) should be determine by the AIC or SBC information criterion firstly. Taking the sample size and the lag phase into account, it is better to choose the maximum lag order of the differential variable which is no more than 4. Besides, this paper uses Microfit4.0 to test two cases whether or not to consider trend. The results are presented in Table 2.

As shown from Table 2, whether containing trend term or not, when n equal to 2, AIC and SBC are the most significant. Therefore, the best lag order is 2.

Next, this paper carries out bound margin co-integration test on models with trend or not. When trend

Table 1 ADF and PP unit root test results for each time series.

Variables	ADF test form	ADF test results	PP test form	PP test results	Integration
LP	c,t,0	-2.7878	c,t,4	-2.7156	I(1)
DLP	c,0,0	-4.9753***	c,0,4	-5.0102***	
LGDP	c,t,4	-1.1978	c,t,2	-1.6037	I(1)
DLGDP	c,0,3	-3.5658**	c,0,0	-2.7221*	
LFAI	c,t,1	-3.8050**	c,t,1	-2.2631	I(0) or I(1)
DLFAI	c,0,0	-3.4948**	c,0,3	-3.5564**	
CPI	c,t,1	-2.7889	c,t,3	-1.8746	I(1)
DCPI	c,0,1	-3.3889**	c,0,3	-2.6417*	

Note: D represents the first difference; (c, t, n) denotes the unit root test model intercept, time trend and lag order.
***, **, * represent significance at 1%, 5% and 10% levels, respectively; determine lag order by the SIC criteria.

Table 2.AIC and SBC information criterion of ARDL-ECM model.

Lag length	Without trend		With trend	
	AIC	SBC	AIC	SBC
1	18.8805	15.2955	20.1213	15.8194
2	16.0898	9.7844	16.4845	9.4785
3	25.6562	16.7688	24.7097	15.1386
4	26.0334	14.7097	28.4330	16.4432

term is excluded, F (LP | LGDP, LFAI, CPI) = 10.8455, corresponding P is 0.000, the null hypothesis is rejected. Namely, LP and LGDP, LFAI, CPI have long-term stable relationships. When trend item is contained, F (LP | LGDP, LFAI, CPI) = 8.9462, corresponding P is 0.001, the null hypothesis is also rejected. Namely, LP and LGDP, LFAI, and CPI have long-term stable relationships. Therefore, whether containing trend item or not, there exist long-run equilibrium relationships among the four variables.

3.4. *ARDL model estimating*

This paper estimates two cases of ARDL model form that considering trend or not. Estimation results are shown in Table 3.

The results can be seen from the table above. Whether containing trend item or not, model form is ARDL (2,2,2,0) by AIC criteria, while it is ARDL (2,0, 1,0) by SBC criteria. The above table shows that model error is small by AIC criteria, so the model form is ARDL (2,2,2,0). Table 4 shows estimated coefficients of the model.

As can be seen from Table 4, when trend term is contained, the trend term in ARDL (2,2,2,0) model is not significant. However, when trend term is excluded, the coefficients of model are more significant. Therefore, ARDL (2,2,2,0) model excluding trend term has priority to estimate the long-term coefficients between the variables and the corresponding error correction model.

The Table 5 illustrates the long-term relationships, and the equation is:

$$LP = -16.6573 + 3.0067LGDP - 0.00628CPI - 0.84109LFAI \quad (3)$$

Table 5 ARDL (2,2,2,0) model estimation results of long-term relationships.

Variables	Coefficients	Standard Error	T statistic	P
LGDP	3.0067	0.70094	4.2896	0.000
CPI	-0.00628	0.002215	-2.8336	0.008
LFAI	-0.84109	0.42668	-1.9712	0.058
C	-16.6573	2.9942	-5.5632	0.000

Table 4 ARDL (2,2,2,0) estimated coefficients.

With trend				Without trend			
Variables	Coefficients	T statistic	P	Variables	Coefficients	T statistic	P
LP(-1)	0.40599	2.1121	0.047	LP(-1)	0.44059	2.2595	0.035
LP(-2)	0.25235	1.6529	0.114	LP(-2)	0.32683	2.2318	0.037
LGDP	1.7066	2.6191	0.016	LGDP	1.2535	2.1648	0.042
LGDP(-1)	-2.0858	-2.4478	0.024	LGDP(-1)	-2.2064	-2.5444	0.019
LGDP(-2)	1.5268	2.6809	0.014	LGDP(-2)	1.1997	2.2568	0.035
CPI	-0.00111	-0.43971	0.665	CPI	0.000826	0.38220	0.206
CPI(-1)	0.000517	0.15920	0.875	CPI(-1)	0.000345	0.10371	0.918
CPI(-2)	0.00335	-1.9174	0.070	CPI(-2)	-0.0029	-1.6507	0.114
LFAI	0.97840	0.55813	0.583	LFAI	0.16181	0.93453	0.361
C	-8.7392	-1.7372	0.098	C	-2.1842	-1.1391	0.267
T	-0.06818	-1.4042	0.176				
R-Squared	0.9991			R-Squared	0.9990		
DW-statistic	2.5191			DW-statistic	2.5772		

In the long run, there is a balanced relationship between property insurance premiums as well as GDP, CPI, and fixed asset investment. The elasticity of GDP, CPI, and fixed-asset investment are 3.0067, -0.00628, -0.84109 respectively. Specifically, when GDP, CPI and fixed asset investment change by 1%, the property insurance premiums will change by 3.0067%, -0.00628%, -0.84109% correspondingly. This result shows that GDP is the major factor driving the growth of property insurance premium income in China. Moreover, fixed-asset investment has a significant impact on Chinese property insurance premium income, and they show the negative correlation. Lastly, CPI almost has no effect on the premium income.

Table 6 shows the error correction model is

$$\begin{aligned}\Delta LP = -2.1842 - 0.32683\Delta LP_{t-1} + 1.2535\Delta LGDP \\ -1.1997\Delta LGDP_{t-1} + 0.000825\Delta CPI \\ +0.002903\Delta CPI_{t-1} + 0.16181\Delta LFAI \\ -0.23258 emc(-1)\end{aligned} \tag{4}$$

Table 6 ECM model estimation results of ARDL (2,2,2,0).

Variables	Coefficients	Standard Error	T statistic	P
dLP1	-0.32683	0.14644	-2.2318	0.036
dLGDP	1.2535	0.57905	2.1648	0.041
dLGDP1	-1.1997	0.53159	-2.2568	0.034
dCPI	0.000825	0.0021607	0.38220	0.706
dCPI1	0.002903	0.0017588	1.6507	0.112
dLFAI	0.16181	0.17315	0.93453	0.360
dC	-2.1842	1.9174	-1.1391	0.266
ecm(-1)	-0.23258	0.10190	-2.2824	0.032

Equation (4) gives the short-term dynamic relationships among property insurance premiums as well as GDP, CPI, and fixed-asset investment. The coefficient of *emc* (-1) is negative and significant at the 5% level, indicating that when the short-term fluctuations deviate from the long-term equilibrium, the adjustment intensity of model modifying from non-equilibrium to equilibrium is -0.23258.

4. Conclusions

In this paper, with the related data from 1980 to 2012, ARDL Bound Testing method is established to study the long-term relationship between property insurance premiums as well as GDP, CPI, and fixed-asset investment. Besides, this paper uses error correction model to analyze long-term impact of above factors. As a consequence, several conclusions can be carried out through the research. Firstly, GDP has a positive and marked impact on property insurance premiums. Therefore, GDP is the most important factor which affects premiums. In details, when GDP grows by 1%, property insurance premiums will be increased by 3.0067%. Secondly, CPI and fixed-asset investment have negative impacts on property insurance premiums in China, and the impact of CPI on property insurance premiums is much less than the influence of fixed-asset investment. Economically, GDP growth reflects the improvement of living standards which means that people have the ability to buy more insurance products, promoting the growth of premiums. However, CPI growth means serious inflation and rising prices, which induces the falling purchasing power of buying insurance products. Moreover, fixed-asset investment and insurance products are both an investment option for residents when income is certain, the growth of fixed asset investment will have a negative impact on premiums.

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