The Empirical Study on Factors Influencing Investment Efficiency of Insurance Funds Based on Panel Data Model

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Abstract. Investment efficiency of insurance funds reflects ability of capital operation of insurance companies, which is crucial of great importance to the continuous stable operation and long-term development of insurance companies. By using panel data of 23 insurance companies of China in 2007-2014 on an empirical study on relationship between investment efficiency of insurance funds and factors influencing investment efficiency, result shows that asset size is negatively correlated with using efficiency of insurance funds; fixed term deposit-rate has significantly negative effects on investment efficiency of insurance funds, long-term securities investment-rate does prominently positively; market share significantly improves investment efficiency; comprehensive operating fee-rate has a negative effect on investment efficiency, The quality of investment department staffs plays a positive role on investment efficiency, but results are not significant.

Introduction

In 2014, "A number of opinions about the State Council accelerating development of modern insurance services" explicitly pointed out that we should give full play to the unique advantages of long-term investment of insurance funds; and that we should innovate application of insurance funds and improve allocation efficiency of insurance funds under the premise of ensuring safety and profitability.

At present, there are few researches on investment efficiency of insurance funds both at home and abroad. Foreign countries mainly focus on insurance industry efficiency. Diacon (1996) analysed efficiency differences of insurance industry between six countries in Europe. Cummins et al. (1999) studied relationship between merger and reorganization, scale economy and efficiency of American life insurance industry, and estimated efficiency of American life insurance companies. Andrew et al. (2002) calculated pure technical efficiency, scale efficiency, allocation efficiency and cost efficiency of Australian non-life insurance companies. Yang (2006) used DEA method to estimate technical efficiency, production efficiency and investment efficiency of Canadian life insurance companies. Some domestic scholars such as Jin Hou (2004), Xin-min Tian (2013), Ke Han (2014), used DEA model to focus on operation efficiency of insurance companies. Wei Huang (2013) studied influence of foreign capital entry on China's insurance industry efficiency. Guo-an Li (2001) considered that insurance funds has the characteristics of scale, and long-term stability by studying, and according to objective environment faced by investment of insurance funds in our country, put forward some suggestions to improve investment level of insurance funds in China. Xiao-qing Liu and Wei Liu (2013) obtained investment efficiency of life insurance companies through DEA model, and then used regression model to find out factors influencing investment efficiency. Based on DEA model and panel fixed effect model, Xin-yu Li and Jing-tao Zhao (2014) studied utilization efficiency of insurance funds and factors influencing operation efficiency.

In summary, domestic and foreign scholars pay more attention to insurance industry efficiency research, but less involve operation efficiency of insurance funds, and researches on factors affecting investment efficiency by using panel data model are much less. For this reason, this article uses panel data model to study factors affecting investment efficiency of insurance funds, and analyze its internal mechanism. Therefore, it puts forward corresponding policy suggestion for insurance companies to improve their capital use efficiency and enhance their competitiveness.
Panel Data Econometric Model

Panel Data Model Overview

Supposing there is a dependent variable \( y_{it} \) and \( k \times 1 \) explanatory variables vector \( x_{it} = (x_{1,it}, x_{2,it}, \ldots, x_{k,it})' \) to meet the linear relationship:

\[
y_{it} = \alpha_{it} + x_{it}'\beta_{it} + \mu_{it} \quad i = 1,2,\ldots, N, \quad t = 1,2,\ldots, T \tag{1}
\]

Type (1) considers changes of \( k \) economic indicators in \( N \) members of cross section and \( T \) time points, where parameter \( \alpha_{it} \) indicates the constant term in this mode, parameter \( \beta_{it} \) indicates \( k \times 1 \) explanation variables vector, and \( k \) indicates number of explanation variables vector. The random error term \( \mu_{it} \) are independent of each other, and \( E(\mu_{it}) = 0, \) \( \text{Var}(\mu_{it}) = \sigma^2_{\mu}. \) The model (1) can be simplified as follows:

\[
y_{i} = \alpha_{i}e + x_{i}'\beta_{i} + \mu_{i}, \quad e = (1,1,\ldots,1)', \quad i = 1,2,\ldots, N \tag{2}
\]

Among \( y_{i} = [y_{i1}, y_{i2}, \ldots, y_{iT}]' \), \( x_{i} = [x_{1,i1}, x_{2,i1}, \ldots, x_{k,i1}; x_{1,i2}, x_{2,i2}, \ldots, x_{k,i2}; \ldots; x_{1,iT}, x_{2,iT}, \ldots, x_{k,iT}]' \), \( \mu_{i} = [\mu_{i1}; \mu_{i2}; \ldots; \mu_{iT}]' \).

The model (2) can be further simplified as follows: according to different set of coefficients, this model can be divided into three situations:

(i) Variable coefficient model: the intercepts are different, and the regression coefficients are different too: \( y_{i} = \alpha_{i}e + x_{i}'\beta_{i} + \mu_{i} \), \( i = 1,2,\ldots, N, \)

(ii) Variable intercept model: the intercepts are different, and the regression coefficient is the same: \( y_{i} = \alpha_{i}e + x_{i}'\beta + \mu_{i} \), \( i = 1,2,\ldots, N, \)

(iii) Hybrid model: the intercepts are the same, and the regression coefficients are the same too: \( y_{i} = \alpha e + x_{i}'\beta + \mu_{i} \), \( i = 1,2,\ldots, \)

Studying panel data, the first step is to test which of the three models can describe this problem. F test is generally used to determine the model form, and the F-statistic test determines whether a hybrid regression model or an individual fixed effect regression model should be established.

\[
H_{1}: \beta_{1} = \beta_{2} = \cdots = \beta_{N}, \quad \alpha_{1} \neq \alpha_{2} = \cdots = \alpha_{N} (\text{individual fixed effect regression model})
\]

\[
H_{2}: \beta_{1} = \beta_{2} = \cdots = \beta_{N}, \quad \alpha_{1} = \alpha_{2} = \cdots = \alpha_{N} (\text{hybrid regression model})
\]

Let \( S_{1}, S_{2}, S_{3} \) respectively indicate the residuals sum of squares of the variable-coefficient model (i), the variable intercept model (ii) and the hybrid model (iii), then statistic \( F_{2} \) obeys F distribution of statistics under conditions of the hypothesis \( H_{2} \), namely,

\[
F_{2} = \frac{(S_{3} - S_{1})/[(N - 1)(k + 1)]}{S_{1}/[NT - N(k + 1)]} \sim F[(N - 1)(k + 1), N(T - k - 1)]
\]

Then statistic \( F_{1} \) obeys F distribution of statistics under conditions of the hypothesis \( H_{1} \), namely

\[
F_{1} = \frac{(S_{2} - S_{1})/[(N - 1)(k + 1)]}{S_{1}/[NT - N(k + 1)]} \sim F[(N - 1)k, N(T - k - 1)]
\]

The calculated statistic \( F_{2} \) is compared with the critical value of F distribution table. If it is less than the critical value, then accept \( H_{2} \) and the mixed model is adopted to fit the sample. Conversely, if the value of statistics \( F_{1} \) is less than the critical value, then accept \( H_{1} \) and use the variable intercept model to fit the sample; Instead, the variable coefficient model is used to fit the sample.

When modeling with panel data, should individual effects model or fixed random effects model be established? How to test model individual effects correlated or not with explanatory variables, Hausman (1978) and other scholars put forward a rigorous statistical test method-Hausman test. The original hypothesis of test is: that individual effect in the random effects model is not associated with explanatory variables. If the original hypothesis is true, this mode will be identified the model.
as form of random effects, otherwise, as form of fixed effects. The form of test statistics \( W \) is as follows: 
\[
W = [b - \hat{\beta}]'\varnothing^{-1}[b - \hat{\beta}]
\]

Among \( b \) indicates estimation results of regression coefficients in fixed effects model, \( \hat{\beta} \) indicates estimation results of regression coefficients in random effects model, and \( \varnothing \) indicates the variance of difference between estimation results of regression coefficients in two models, namely: 
\[
\varnothing = \text{var}[b - \hat{\beta}].
\]

Hausman proves that under the original hypothesis, the statistics \( W \) obeys \( \chi^2 \) distribution of \( k \) degrees of freedom, where \( k \) indicates number of variables explained in this model. At a given level of significance, if the value of statistics \( W \) is not greater than the critical value, then random effects model is selected, otherwise individual effects model is adopted.

**Variable Selection**

On the basis of related research at home and abroad for reference, combined with reality of Chinese insurance industry funds applications for the outstanding Return on investment, this paper chooses the most representative index: insurance company investment yield (Return on investment: ROV) as explained variable, and selects relevant factors affecting investment efficiency of insurance funds, mainly including company assets, investment varieties, market share, comprehensive operating fee-rate and quality of investment department staffs as explanatory variable.

(1) Asset size (AST). Economies of scale refer to decline in long-term average management costs and improvement of economic benefits due to scale expansion. Insurance companies with a certain size have more advantages in terms of capital utilization and resource allocation, so investment efficiency is correspondingly higher. In this paper the natural logarithm of company total assets represents company asset size.

(2) Investment varieties. The investments of insurance companies mainly include fixed term deposit and long-term securities investment. Therefore, when examining influence of investment varieties, this paper focuses on the impact of fixed term deposits-rate and long-term securities investment-rate on use efficiency of insurance funds, where fixed term deposits-rate (DPS) is the ratio of fixed term deposit to total assets, Long-term securities investment-rate (LTS) refers to the ratio of assets that are available for sale of financial assets, holdings to maturity and long-term equity investment to total assets.

(3) Market share (MKS). Because insurance reserve is main source of insurance investment funds, therefore, underwriting business will affect use of insurance funds from both investment size and amount of compensation. In this paper, the proportion of premium market share represents underwriting business scale, and the ratio of premium income of an insurance company to total premium of insurance industry represents market share of this company. Considering that market share is all smaller than 1, all data points are too concentrated, so logarithm of market share replaces market share.

(4) Fee-rate (FER). The comprehensive operating fee-rate is an important index to reflect comprehensive management level of company. The higher operating fee rate indicates the lower comprehensive management level of company, contrarily, the higher overall management level of company. In this paper the ratio of operating expenses to premium income is used to describe overall operating fee-rate of enterprises.

(5) Quality of investment department staffs (QUY). The quality of investment department staffs of insurance enterprise has a significant impact on investment efficiency, but application of insurance funds has characteristics of high investment technology and difficulty of risk control, and high demand for talents. In recent years, more and more insurance companies' investment departments are more likely to recruit graduates with advanced degrees, and the proportion of graduate students in insurance investment institutions is expanding year by year. In this paper, the quality of investment department staffs will be illustrated by proportion of graduates or above.
Data Source and Modeling

The data of this paper is based on statistics of China insurance yearbook from 2008 to 2015, China Insurance Regulatory Commission website and personnel structure statistics of companies. The sample period is data from 23 insurance companies in China from 2007 to 2014.

This paper selects return on investment (ROV) as explained variable, with assets scale of company (\(\text{InAST}\)), fixed term deposit rate (DPS), long-term securities investment-rate (LTS), market share (\(\text{InMKS}\)), comprehensive operating fee-rate (FER) and quality of investment department staffs (QUY) as explanatory variable. Panel data model is set up.

Empirical Analysis

This paper makes an in-depth analysis on factors that affect investment efficiency of insurance funds by establishing panel data model.

Unit Root Test and Co-integration Test

Firstly, for explanatory variables and explained variables, descriptive statistical analysis of data is performed by using EViews9.0 software, and the data features are generally acquired, and unit root test is carried out on this basis. The time sequence diagram of each variable is made, test mode of unit root is determined.

According to trend of the sequence diagram, and then unit root test is carried out. Test results are as follows:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Levin-Lin-Chu</th>
<th>Im-Pesaran-Skin</th>
<th>Fisher-ADF</th>
<th>Fisher-PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROV</td>
<td>-33.6849(0.0000)</td>
<td>-7.06094(0.0000)</td>
<td>176.975(0.0000)</td>
<td>261.766(0.0000)</td>
</tr>
<tr>
<td>InAST</td>
<td>-6.27162(0.0000)</td>
<td>0.43866(0.6695)</td>
<td>0.43545(0.6682)</td>
<td>64.5651(0.0367)</td>
</tr>
<tr>
<td>DPS</td>
<td>-20.9576(0.0000)</td>
<td>-1.74489(0.0405)</td>
<td>88.6608(0.0002)</td>
<td>132.420(0.0000)</td>
</tr>
<tr>
<td>LTS</td>
<td>-10.4209(0.0000)</td>
<td>-0.29794(0.3829)</td>
<td>59.8857(0.0821)</td>
<td>98.8456(0.0000)</td>
</tr>
<tr>
<td>InMKS</td>
<td>-96.0280(0.0000)</td>
<td>-22.8736(0.0000)</td>
<td>340.924(0.0000)</td>
<td>389.621(0.0000)</td>
</tr>
<tr>
<td>FER</td>
<td>-32.5965(0.0000)</td>
<td>2.73726(0.0031)</td>
<td>88.6544(0.0002)</td>
<td>144.089(0.0000)</td>
</tr>
<tr>
<td>QUY</td>
<td>-668.557(0.0000)</td>
<td>-57.3199(0.0000)</td>
<td>163.658(0.0000)</td>
<td>180.250(0.0000)</td>
</tr>
</tbody>
</table>

From above test results, it is found that InAST and LTS have the unit root. Therefore, the first difference of two indicators is performed, and unit root test is carried out again. Results are as follows:

<table>
<thead>
<tr>
<th>Test methods</th>
<th>Levin-Lin-Chu</th>
<th>Im-Pesaran-Skin</th>
<th>Fisher-ADF</th>
<th>Fisher-PP</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\Delta\text{InAST})</td>
<td>21.0268(0.0000)</td>
<td>1.80661(0.0354)</td>
<td>92.2322(0.0001)</td>
<td>174.481(0.0000)</td>
</tr>
<tr>
<td>(\Delta\text{LTS})</td>
<td>22.8736(0.0000)</td>
<td>2.91195(0.0063)</td>
<td>71.6041(0.0092)</td>
<td>119.665(0.0000)</td>
</tr>
</tbody>
</table>

For above indexes after first order difference, we again carry on unit root test. Test results in table 2 above show that there is no unit root, therefore, the above indicators can be tested by co-integration. Co-integration relationship between InAST and LTS is found by co-integration, and the regression analysis can be carried out.

Regression Analysis

Firstly, regression of three types of panel data is carried out, and results of \(S_1, S_2, S_3\) are shown as follows:
Let’s calculate the statistics $F_1$ and $F_2$:

$$F_1 = \frac{(0.627870 - 0.23664) / [(23-1) \times 6]}{0.023664 / [23 \times (8-6-1)]} = 4.44888$$

$$F_2 = \frac{(0.787119 - 0.23664) / [(23-1) \times (6+1)]}{0.023664 / [23 \times (8-6-1)]} = 4.81840$$

$F_2$ is significantly greater than the critical value $F_2(154,23)= 2.26$ under significance level of 1%, so original hypothesis $H_2$ should be rejected, and it can only be selected between variable intercept model and variable coefficient model. $F_1$ is significantly greater than the critical value $F_1(154,23)= 2.26$ under significance level of 1% too, so original hypothesis $H_1$ should be rejected, therefore, this regression model of variable coefficient is determined.

The Hausman statistical test should be used to establish the regression model of individual stochastic effects or individual fixed effects regression model, and results are as follows:

### Table 4. Hausman test results.

<table>
<thead>
<tr>
<th>Original hypothesis</th>
<th>Hausman test</th>
<th>degree of freedom</th>
<th>probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual influences are not related to explanatory variables</td>
<td>8.610016</td>
<td>6</td>
<td>0.1967</td>
</tr>
<tr>
<td>critical value W(12.59)</td>
<td></td>
<td>6</td>
<td>0.05</td>
</tr>
</tbody>
</table>

According to test output, the value of Hausman statistic is 8.610016, and the corresponding probability is 0.1967. Under 5% of the significance level, the original hypothesis should be accepted and model of individual random influence should be established. Based on above analysis, the final regression model is estimated, as shown in table 5:

### Table 5. Regression analysis results.

<table>
<thead>
<tr>
<th>Constant and explanatory variables</th>
<th>Regression coefficient</th>
<th>T statistic</th>
<th>Probability: P</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.304135***</td>
<td>-6.140906</td>
<td>0</td>
</tr>
<tr>
<td>InAST</td>
<td>-0.009794***</td>
<td>-2.611547</td>
<td>0.0098</td>
</tr>
<tr>
<td>DPS</td>
<td>-0.098259**</td>
<td>-2.085502</td>
<td>0.0385</td>
</tr>
<tr>
<td>LTS</td>
<td>0.087004**</td>
<td>-2.850040</td>
<td>0.0049</td>
</tr>
<tr>
<td>InMKS</td>
<td>0.016254***</td>
<td>-5.564703</td>
<td>0</td>
</tr>
<tr>
<td>FER</td>
<td>-0.023118</td>
<td>-0.900856</td>
<td>0.3689</td>
</tr>
<tr>
<td>QUY</td>
<td>0.025426</td>
<td>-0.629205</td>
<td>0.5341</td>
</tr>
</tbody>
</table>

Note: * indicates that test result is significant at the 10% level, ** is significant at 5% level and *** is significant at 1% level. The third column are the value of T statistic.

Therefore, the regression model of factors influencing investment efficiency of insurance funds is as follows:

$$ROV = 0.304135 - 0.009794InAST - 0.098259DPS + 0.087004LTS + 0.016254InMKS - 0.023118FER + 0.025426QUY$$
Conclusion and Suggestions

1. The asset size of insurance company is negatively correlated with investment efficiency. As the asset size increases, investment efficiency decreases, and the T value is significant, indicating that the impact is significant.

   Insurance enterprises have scale economy, and the larger scale means lower average cost and improve operating efficiency, thus improving investment efficiency of capital. However, empirical results show negative correlation, indicating that scale efficiency of funds application of insurance enterprises is in a decline stage. Why is it that the bigger the asset size, the lower investment efficiency of insurance funds? Since development of insurance industry in China is still in its primary stage now, and a process is still needed to convert the extensive growth of scale speed to the intensive growth of quality. Therefore, it is necessary for insurance companies and the supervision department to innovate and guide insurance business philosophy, and enhance investment efficiency of insurance funds while improving scale efficiency of insurance companies.

2. The impact of fixed term deposits-rate and long-term securities investment-rate on investment efficiency of insurance funds is significant, but results are quite opposite. There is a negative correlation between fixed term deposits-rate and investment efficiency of insurance funds. The long-term securities investment-rate is positively correlated with investment efficiency of insurance funds. This suggests that for insurance companies, large holdings deposit is not a good choice, and appropriate increase in long-term securities investment-rate is an effective way for insurance enterprise to improve use efficiency of funds.

3. Market share is positively significantly correlated with investment efficiency of insurance funds, which is consistent with actual hypothesis. The amount of premium income directly decides the amount of funds invested by insurance companies, which indirectly determines investment efficiency of insurance funds.

   With expansion of market share of insurance companies, scale efficiency of insurance capital utilization increases. As the underwriting business and investment business complement each other, increase in market share expands source of funds, thus improving investment efficiency of insurance funds as a whole.

4. The overall operating fee-rate has a negative impact on investment efficiency of insurance funds. The quality of investment department staffs has a positive impact on investment efficiency, which is consistent with the hypothesis, but the results are not significant.

   This indicates that operating expenses are embodiment of operation ability of insurance companies, but not enough to reflect investment efficiency of company. Reducing operating expenses can bring more capital into investment channels, which is conducive to improving investment efficiency. Insurance companies should try to lower operating expenses.

   The positive influence of quality of investment department employees shows that the higher level of their education, the higher investment efficiency of insurance funds. Vice versa. Therefore, it is suggested that insurance companies should pay more attention to cultivation of professional investment talents and effectively improve investment personnel's ability to use insurance funds.

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References


