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The appropriate forecasting models and dependence measurement: Real estate sector stock and Shenzhen index in People's Republic of China

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ABSTRACT

This paper mainly has two purposes. On the one hand, it aims to find the appropriate models for forecasting the Real Estate Sector Stock and Shenzhen Index in People's Republic of China, respectively. On the other hand, this paper will analyze the dependence measures between these two kinds of stock indexes in China. The linear method and nonlinear method was introduced for seeking the appropriate models for each stock index. And the empirical copula method was implied to examine the dependence measures between these two indexes. The results are: Firstly, the Autoregressive-linear model (AR-linear Model) fits for forecasting the Real Estate Sector Stock and Shenzhen Index over the period of 2006 to 2012. Secondly, based on the empirical copula approach, the dependence measures between returns in percentage of Real Estate Sector Stock and Shenzhen Index is very strong.

Keywords: Linear; Nonlinear; Copulas; Exchange Rate; Forecasting; Dependence

1. Introduction

With the development of the stock market and real estate market, both of them have become two essential component of Chinese economy. Through the past 20 years develop, China's stock market already improved and become the barometer of economic development. Similarly, real estate is one of the pillar industries of national economic, the change of real estate prices pay a lot of attentions from public.Under the globalization and financial integration, researchers try to find how to let the capital market keep sustainable development, recently more and more scholars pay the attentions on the relationship between real estate market and stock market.

From the point of the stock market, due to the real estate price reactions also lag behind the stock index, the prosperity and recession of real estate market will accurately showed by real estate sector stock. Therefore research of the dependence measures of real estate sector stock and Shenzhen Index has the very vital practical meaning. From the micro perspective, the study of interaction mechanism between them can help investors to understand the current capital market; from the macro perspective, it will help government to put forward effective policy suggestion in capital market and promote a sustainable and stable development of the real estate market and stock market

Thus , this paper mainly has two purposes. First , it will find the appropriate models for forecasting the real estate sector stock and Shenzhen Index. Because we want to use the appropriate model know how the stock indexes run in stock market and forecast the stock indexes in the future. Second , it will analyze the dependence measures between returns in percentage of these two kinds of stock indexes in China. Because it will not only help investors to understand current capital market, but also help China's government to put forward effective policy suggestion for real estate market.

The rest of the paper is organized as follows. Section 2 provides the literature review and highlights the contributions of this study. Section 3 introduces the econometric methodology. Section 4 describes the data. Section 5 shows empirical result is presented. Section 6 presents conclusions and discussions.

2. Literature review

No matter foreign literature review or Chinese literature review , most of former studied had always focus on the relationship between real estate market and stock market. There are different empirical evidences in the literature review the relationship between them. Most related researchers found that there was a relationship between real estate market and stock market. For example, Awartani and Corradi (2005) used GARCH model to examine the relationship between the real estate market and the stock market. The results showed that there was the relationship between these two markets.

Zhang, Lii and Huang (2007) used co-integration models to examine the relationship between the stock market and real estate market. They found that those markets were related in Taiwan from 1986 to 2001.

Arnaud Costinot and Thierry Roncalli（2000） shows that the coefficient does not give accurate information on the dependence structure. Instead, they propose a conceptual framework based on copulas.

Liu Qiongfang and Zhang Zongyi (2011) apply the Copulas theory to investigate the dependence structure between real estate and finance industries. Based on AIC and BIC minimum theories，the Gumbel Copula function shows that a correlation between these two markets exists in only upper tail for single parameter Copulas.

On the other hand, some researchers found that there was no relationship between real estate market and stock market. For example, Okunev and Wilson (1999) used nonlinear methods to detect the relationship between the real estate market and the stock market in Australia，U.S. and UK. The results showed that there was no correlation in U.S. and UK, while there was a correlation in Australian.

Li and Jia（2010）used the Unit Root Test，Co-integration Test and Granger Test to test the relationships between Shanghai composite index and real estate index. The finally research shows no existence of Co-integration and Granger causality relationship.

3. Methodology

The methodology employed in this study has two steps：First, use linear method and nonlinear method find the appropriate models for forecasting the Real Estate Sector Stock and Shenzhen Index respectively. Second, analysis the dependence relationship between returns in percentage of Real Estate Sector Stock and Shenzhen Index based on empirical copula approach.

3.1 Linear and Nonlinear Theory

In the time-series literature reviews, despite linear methods often work well. It also provides a useful standard as a basis for analyses. However, there is no promising why real observations should all be linear. Moreover, stock market is a kind of complex nonlinear dynamic system, linear model could not accurate show stock index fluctuation. So using nonlinear models seems to be reasonable choice. And we know linear model is one of the special nonlinear models.

(1) Autoregressive-linear model (AR-linear Model)

The basic linear model is AR model can be written in equation:

$$y_{rt+s} = \phi + \phi_0 y_{rt} + \phi_1 y_{1-d} + \dots + \phi_m y_{rt-(m-1)d} + \varepsilon_{rt+s} \quad (1)$$

$$y_{st+s} = \phi + \phi_0 y_{st} + \phi_1 y_{1-d} + \dots + \phi_m y_{st-(m-1)d} + \varepsilon_{st+s} \quad (2)$$

Where y_{rt} is real estate sector stock data at time t, ϕ is parameter and coefficient of y_{rt} in the model. In addition, ε is error term of this equation.

Where y_{st} is Shenzhen index data at time t, ϕ is parameter and coefficient of y_{st} in the model. In addition, ε is error term of this equation.

(2) Self-Exciting Threshold Autoregressive Model (SETAR Model)

The general Self-Exciting Threshold Autoregressive Model can be written in equation:

$$y_{rt+s} = \begin{cases} \phi_1 + \phi_{10} y_{rt} + \phi_{11} y_{rt-d} + ... + \phi_{1L} y_{rt-(L-1)d} + \varepsilon_{rt+s} & Z_{rt} \le th \\ \phi_2 + \phi_{20} y_{rt} + \phi_{21} y_{rt-d} + ... + \phi_{2H} y_{rt-(H-1)d} + \varepsilon_{rt+s} & Z_{rt} > th \end{cases} \quad (3)$$

$$y_{st+s} = \begin{cases} \phi_1 + \phi_{10} y_{st} + \phi_{11} y_{st-d} + ... + \phi_{1L} y_{st-(L-1)d} + \varepsilon_{st+s} & Z_{st} \le th \\ \phi_2 + \phi_{20} y_{st} + \phi_{21} y_{st-d} + ... + \phi_{2H} y_{st-(H-1)d} + \varepsilon_{st+s} & Z_{st} > th \end{cases} \quad (4)$$

Where y_{rt} is real estate sector stock data at time t, ϕ is the parameter and coefficient of equation. In addition, ε is error term of this equation and Z_{rt} is a threshold variable in the model. The "L" is represented lower regime of model and "H" is represented the higher regime of the model.

Where y_{st} is Shenzhen index data at time t, ϕ is the parameter and coefficient of equation. In addition, ε is error term of this equation and Z_{st} is a threshold variable in the model. The "L" is represented lower regime of model and "H" is represented the higher regime of the model.

(3) Logistic Smooth Transition Autoregressive Model (LSTAR model)

The general Logistic Smooth Transition Autoregressive Model model can be written in equation:

$$\begin{aligned} y_{rt+s} &= (\phi_1 + \phi_{10} y_{rt} + \phi_{11} y_{rt-d} + \ldots + \phi_{1L} y_{rt-(L-1)d})(1 - G(z_{rt}, \gamma, th)) + \\ &(\phi_2 + \phi_{20} y_{rt} + \phi_{21} y_{rt-d} + \ldots + \phi_{2H} y_{rt-(H-1)d}) G(z_{rt}, \gamma, th) + \varepsilon_{rt+s} \end{aligned} \quad (5)$$

$$\begin{aligned} y_{st+s} &= (\phi_1 + \phi_{10} y_{st} + \phi_{11} y_{t-sd} + \ldots + \phi_{1L} y_{st-(L-1)d})(1 - G(z_{st}, \gamma, th)) + \\ &(\phi_2 + \phi_{20} y_{st} + \phi_{21} y_{st-d} + \ldots + \phi_{2H} y_{st-(H-1)d}) G(z_{st}, \gamma, th) + \varepsilon_{st+s} \end{aligned} \quad (6)$$

Where y_{rt} is the real estate sector stock data at time t, ϕ is the parameter and coefficient of equation. In addition, ε is error term of this equation and Z_{rt} is a threshold variable in the model. The "L" is represented lower regime of model and "H" is represented the higher regime of the model. Moreover, "G" is the logistic function and ϕ, γ, th are the parameters to be computed.

Where y_{st} is the Shenzhen index data at time t, ϕ is the parameter and coefficient of equation. In addition, ε is error term of this equation and Z_{st} is a threshold variable in the model. The "L" is represented lower regime of model and "H" is represented the higher regime of the model. Moreover, "G" is the logistic function and ϕ, γ, th are the parameters to be computed.

(4) Neural Network Models (NNT Model)

From the Neural Network Model can be written in equation:

$$y_{rt+s} = \beta_0 + \sum_{j=1}^{D} \beta_j g(\gamma_{0j} + \sum_{i=1}^{m} \gamma_{ij} y_{rt-(i-1)d}) \quad (7)$$

$$y_{st+s} = \beta_0 + \sum_{j=1}^{D} \beta_j g(\gamma_{0j} + \sum_{i=1}^{m} \gamma_{ij} y_{st-(i-1)d}) \quad (8)$$

Where y_{rt} is real estate sector stock data at time t, the β_0 is parameter of equation. In a hidden units and activation function g.

Where y_{st} is Shenzhen index data at time t, the β_0 is parameter of equation. In a hidden units and activation function g .

(5) Additive Autoregressive Model (AAR Model)

The generalized non-parametric additive model (Generalized Additive Model) can be written in equation:

$$y_{rt+s} = \mu + \sum_{i=1}^{m} s_i(y_{rt-(i-1)d}) \quad (9)$$

$$y_{st+s} = \mu + \sum_{i=1}^{m} s_i(y_{st-(i-1)d}) \quad (10)$$

Where y_{rt} is real estate sector stock data at time t. S_i are smooth functions represented by penalized cubic regression.

Where y_{st} is Shenzhen index data at time t. S_i are smooth functions represented by penalized cubic regression.

3.2 Copulas Theory

Copula is a function which connects multi-dimensional distribution function with one-dimensional marginal distribution function. Simplicity we focus on the bivariate case in my paper. At the same time, it can describe the multi-variable distribution correlation accurately.

3.2.1 The Sklar's theorem

Sklar's theorem shows that a joint distribution can be put into two marginal distributions of the components by a copula connection which describes the dependence between the components.

Suppose the marginal distribution function of a multi-dimensional distribution function H is that $F_1(u_1),..., F_n(u_n)$, there is a Copula function satisfies:

$$H(u_1,...u_n) = C(F_1(u_1),...F_n(u_n)) \quad (11)$$

If $F_1(u_1),..., F_n(u_n)$ is continuously time series observation, the Copula function is uniquely determined.

3.2.2 Rank correlation

Rank correlation reflects the monotonic dependence between variables, it should be better than traditional linear correlation. The classical rank correlation coefficients are Kendall.tau and Spearman.rho.

(i) Kendall.tau

Suppose $(x_1, y_1), (x_2, y_2)$ are i.i.d vector, $x_1, x_2 \in x$, $y_1, y_2 \in y$, let

The τ is between [-1, 1], suppose the copula function of (x_1,y_1) is C (u, v). Schwettzer and Wolff (1998) gave the definition of τ as following:

$$\tau = 4\iint_0^1 C(u,v)dC(u,v) - 1 \qquad (12)$$

(ii) Spearmam.rho

Let (x, y) have the joint distribution H(x, y).

When the Copula function C (u, v) is given, where u=F(x), v=G (y). Schwettzer and Wolff (1998) gave the definition of ρ as following:

$$\rho = 12\iint_0^1 C(u,v)dC(u,v) - 3 \qquad (13)$$

3.2.3 Pearson's correlation coefficient

Two variables Pearson's linear correlation can be written in equation：

$$\rho_{u,v} = \frac{E(UV) - E(U)E(V)}{\sqrt{E(U^2) - (E(U))^2}\sqrt{E(V^2) - (E(V)^2}} \qquad (14)$$

The sample Pearson correlation coefficient can be written in equation：

$$\gamma_{uv} = \frac{\sum u_i v_i - \bar{u}\bar{v}}{(n-1)s_x s} = \frac{n\sum u_i v_i - \sum u_i \sum v_i}{\sqrt{n\sum u_i^2 - (\sum u_i)^2}\sqrt{n\sum v_i^2 - (\sum v_i)^2}} \qquad (15)$$

Depending on the numbers observations involved in, sometimes the correlation will be unstable.

3.2.4 Dependence Measures

There are 4 properties explain the dependence measures shown below (Embrechts, Lindskog and McNeil (2003)):

1. $\delta(U,V) = \delta(U,V)$
2. $-1 \leq \delta(U,V) \leq 1$
3. $\delta(U,V) = 1$If X and Y are comonotonic; as well as $\delta(U,V) = -1$if U and V are comontonic.
4. If T is exactly monotonic, then $\delta(T(U),V) = \{\delta(U,V), T = increa\sin g$ or $-\delta(U,V), T = decrea\sin g\}$

Normally, the Pearson linear correlation only satisfied the first two properties but the rank correlation measures Spearman's rho and Kendall's tau which are nonlinear correlation fit all of the properties we showed. Therefore, the copulas use the Spearman's rho and Kendall's tau calculating the dependence measures between U and V which are random variables.

4. Data

4.1 Sources of data

This study is mainly based on Real Estate Stock Index data and Shenzhen Index data, covered 6 years' daily data, from 2006 to 2012, and the total numbers of data are 1407. The data are secondary data, which are derived from the official website, namely Real Estate Sector Stock (RESS) and Shenzhen Index (SZ Index).

The data have been collected from People's Republic of China Statistics Bureau website. All of the following results (tables and figures) are calculated by R and S-PLUS.

4.2 Data description

The data are presented in table 1 to table 4 and in figure 1 to figure 4 as follows:

TABLE 1: The descriptive statistics of People's Republic of China's Real Estate Sector Stock return in percentage from the period of 2006 to 2012.

Item	People's Republic of China's Real Estate Sector Stock return in percentage
Observation	1404
Mean	0.000757
Median	0.001901
Maximum	0.093974
Minimum	-0.096031
Std.Dev	0.025990
Skewness	-0.360211
Kurtosis	4.317917
JB	131.9709
Probability	0.000000

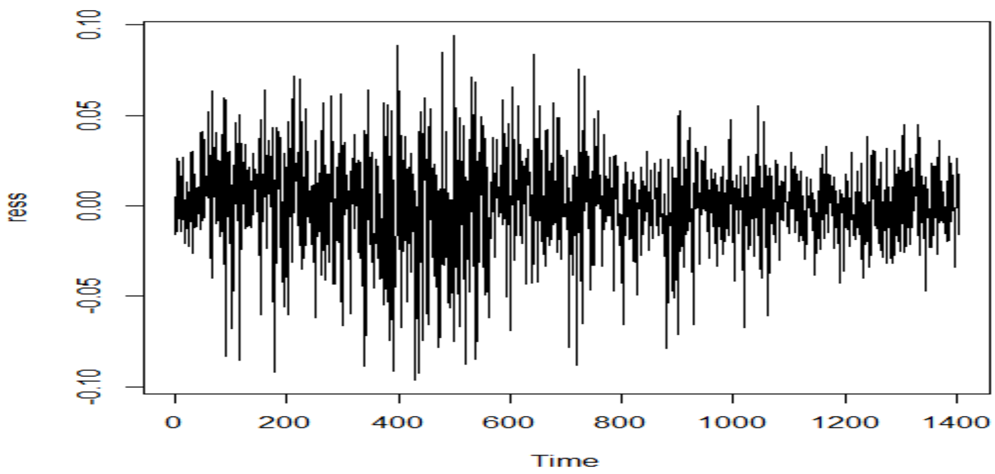


Figure 1: The historical daily data of People's Republic of China's Real Estate Sector Stock return in percentage during the periods of 2006 to 2012.

Source: Computation

TABLE 2: Results of People's Republic of China's Real Estate Sector Stock rate of return in percentage Unit Root tests

Item	ADF Tset	Item	PP Test
Data	ress	Data	ress
Dickey-Fuller	-10.4306	Dickey Fuller Z(alpha)	-1381.947
Lag order	11	Truncation lag Parameter	7
p-value	0.01	p-value	0.01
Alternative hypothesis	Stationary	Alternative hypothesis	Stationary
Result	Stationary	Result	Stationary

Note: Significant at 1% level
Source: From computed

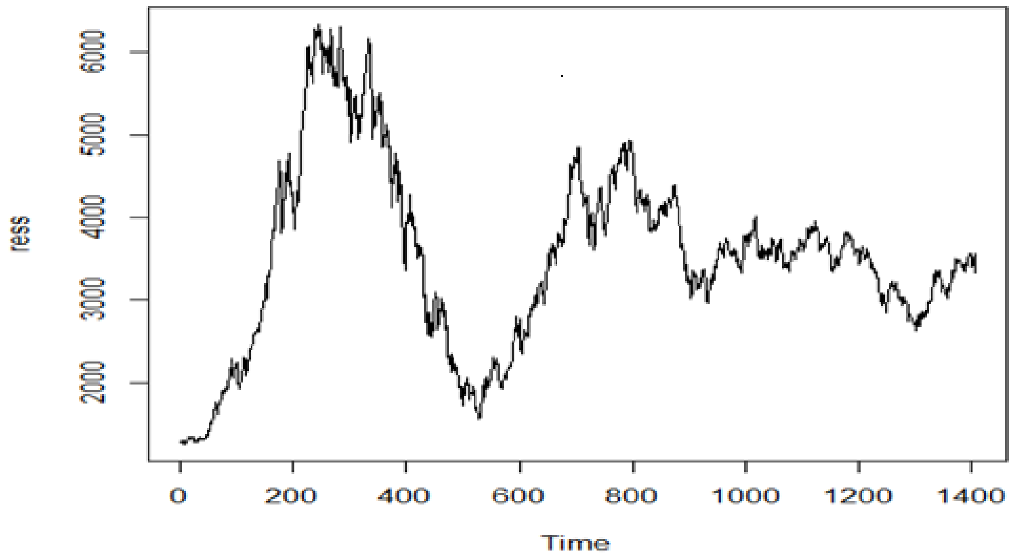


Figure 2. The People's Republic of China's nominal Real Estate Sector Stock from 2006 to 2012.

Source: Computation

TABLE 3. The descriptive statistics of People's Republic of China's Shenzhen Index return in percentage from the period of 2006 to 2012.

Item	People's Republic of China's Shenzhen Index return in percentage
Observations	1406
Mean	0.000619
Median	0.001295
Maximum	0.091615
Minimum	-0.097501
Std.Dev	0.021727
Skewness	-0.383502
Kurtosis	4.814752
JB	227.3983
Probability	0.000000

Source: Computation

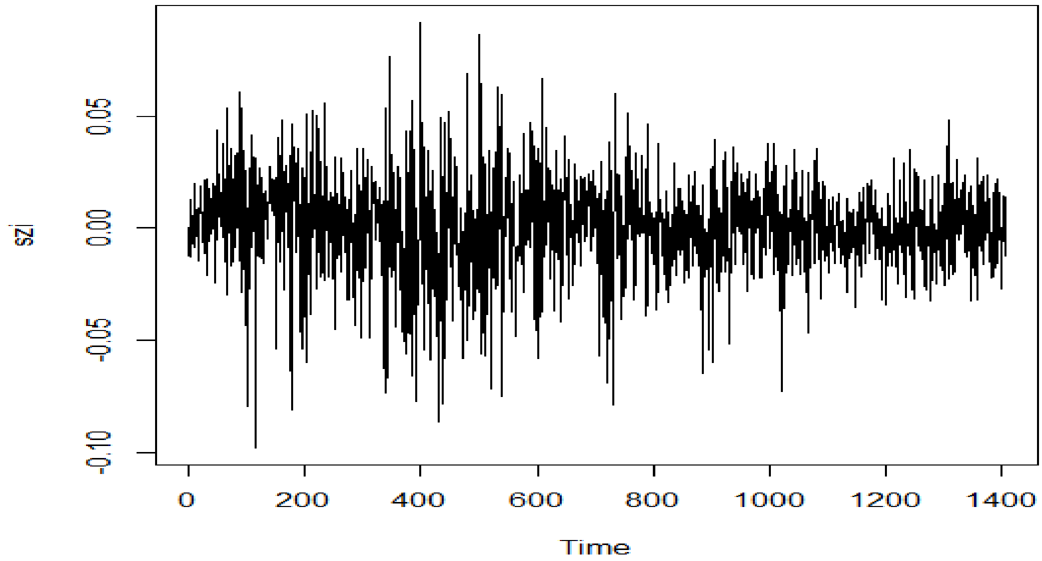


Figure 3: The historical daily data of People's Republic of China's Shenzhen Index return in percentage during the periods of 2006 to 2012.

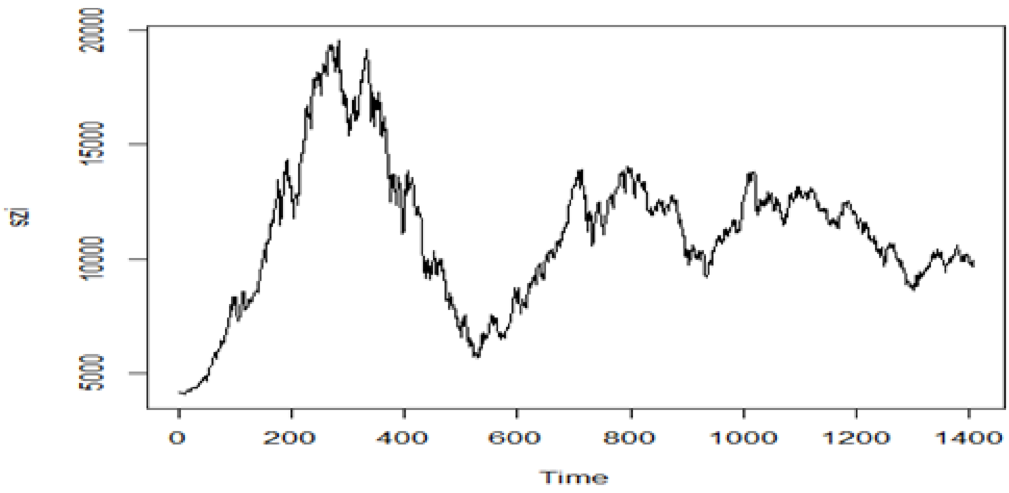
Source: Computation

TABLE 4: Results of People's Republic of China's Shenzhen Index rate of return in percentage Unit Root tests

Item	ADF Tset	Item	PP Test
Data	szi	Data	szi
Dickey-Fuller	-9.8685	Dickey Fuller Z(alpha)	-1363.59
Lag order	11	Truncation lag Parameter	7
p-value	0.01	p-value	0.01
Alternative hypothesis	Stationary	Alternative hypothesis	Stationary
Result	Stationary	Result	Stationary

Note: Significant at 1% level
Source: Computation

Figure 4: The People's Republic of China's nominal Shenzhen Index from 2006 to 2012.



Source: Computation

5. Empirical Results

5.1 The appropriate model of People's Republic of China's Real Estate Sector Stock

We use AIC, BIC and MAPE (Mean Absolute Percent Error) help us to select the appropriate model for People's Republic of China's Real Estate Sector Stock return in percentage estimated by linear and nonlinear approaches.

TABLE 5: The model selection of People's Republic of China's Real Estate Sector Stock return in percentage based on AIC, BIC and MAPE (%)

Item	Autoregressive Linear Model (AR)	Self-Exciting Threshold Autoregressive Model (SETAR)	Logistic Smooth Transition Autoregressive Model (LSTAR)	Neural Network Model (NNET)	Additive Autoregressive Model(AAR)
AIC	-10246.84	-10243.83	-10240.68	-10226.86	-10214.84
BIC	-10231.10	-10207.10	-10198.71	-10158.64	-10115.15
MAPE (%)	1.129636	1.207508	1.241155	1.131131	1.129636

Source: Calculation

From Table 5, the forecasting evaluation statistics indicated that selected Autoregressive Linear Model (AR Model) is the best model to forecast the People's Republic of China's Real Estate Sector Stock return in percentage of exploration period, which minimizes AIC and MAPE (%) among all candidate models.

5.2 The appropriate model of People's Republic of China's Shenzhen Index

The function AIC, BIC and MAPE (%) can be used to compare all models fitted to the same data. Therefore AIC, BIC and MAPE (%) will help us find the appropriate model for People's Republic of China's Shenzhen Index return in percentage by linear and nonlinear approaches.

TABLE 6: The model selection of People's Republic of China's Shenzhen Index return in percentage based on AIC, BIC and MAPE (%)

Item	Autoregressive Linear Model (AR)	Self-Exciting Threshold Autoregressive Model (SETAR)	Logistic Smooth Transition Autoregressive Model (LSTAR)	Neural Network Model (NNET)	Additive Autoregressive Model(AAR)
AIC	-10767.01	-10769.91	-10765.05	-10747.69	-10762.36
BIC	-10751.26	-10733.18	-10723.06	-10679.46	-10662.64
MAPE (%)	1.440390	1.856281	1.734101	1.465916	1.743608

Source: Calculation

From Table 6, the forecast evaluation statistics found that selected Autoregressive Linear Model (AR model) is the best model to forecast the People's Republic of China's Shenzhen Index return in percentage of exploration period because this model has minimize value of BIC and MAPE (%).

These results indicate that the linear models are the optimal forecasting models of the real estate sector stock and Shenzhen Index. It shows that the trend of each index is similar, and linear model can capture the characteristics of these stock indexes. The main reason is that the real estate sector stock is one of the important components of Shenzhen index.

5.3 The dependence measures of People’s Republic of China’s Real Estate Sector Stock return in percentage and Shenzhen Index return in percentage based on Empirical copula approach

In order to capture the overall dependence measures between returns in percentage of real estate sector stock and Shenzhen Index, this paper uses a non-linear correlation method, namely, including Kendall’s tall and Spearman’s rho. Meanwhile, in order to compare with the nonlinear correlation the Pearson's linear correlation will compute.

TABLE 7：The dependence measure of People’s Republic of China’s real estate sector stock and Shenzhen Index based on Empirical Copula, 2006-2012

Correlation items	People's Republic of China's real estate sector stock and Shenzhen Index (Dependence Coefficients)
Kendall's tau	0.6962
Spearman's rho	0.8703

Source: Calculation

TABLE 8：The dependence measure of People’s Republic of China’s real estate sector stock and Shenzhen Index based on Pearson's correlation coefficient, 2006-2012

Correlation items	People's Republic of China's real estate sector stock and Shenzhen Index (Dependence Coefficients)
Pearson's corr.	0.8961

Source: Calculation

From Table 7 we will get that based on Empirical Copula the Kendall’s tau statistics of dependence measure between People’s Republic of China’s real estate sector stock and Shenzhen Index is 0.6962. In addition, the Spearman’s rho statistics of dependence measure between People’s Republic of China’s real estate sector stock and Shenzhen Index is 0.8703.（see more detail in appendix）

From Table 8 we will get that based on Pearson's correlation coefficient statistics of dependence measure between People’s Republic of China’s real estate sector stock and Shenzhen Index is 0.8961. The linear approach should be used when one country’s economy affected by global financial crisis.

6. Conclusions and Discussions

This paper investigates the relationship between People's Republic of China's real estate sector stock and Shenzhen Index from August, 30th, 2006 to June, 13th,2012 use Linear, Nonlinear and Empirical Copula Approach.

On the one hand, this paper use linear method and nonlinear method find the appropriate models for forecasting the real estate sector stock and Shenzhen Index in People's Republic of China, respectively. The empirical results show that the Autoregressive-linear model (AR-linear Model) was suggested as appropriate model for forecasting the real estate sector stock and Shenzhen Index over the period of 2006 to 2012, respectively. Therefore the linear approach should be used when one country's economy affected by global financial crisis.

On the other hand, according to the appropriate model, this paper will analyze dependence relationship between these two kinds of stock indexes in China based on empirical copula method. The empirical results of this study confirmed that based on the empirical copula approach, the dependence measures between returns in percentage of real estate sector stock and Shenzhen Index is very strong.

Due to the China as an emerging economy, real estate market is one of the pillar industries of Chinese economy, it playing as a key driving force for economic development. Moreover, the real estate sector stock is one of the important parts of Shenzhen Index. Therefore, the dependence measures between returns in percentage of these two kinds of stock indexes are very strong.

From the micro perspective, the study of interaction mechanism between them can help investors to understand the current capital market and establish an effective portfolio of assets to make a reasonable choice; From the macro perspective, under the financial crisis, Chinese government in order to drive GDP growth, and then it makes some measures to promote the development of financial market and real estate market. In order to prevent the real estate market recession, Chinese government should confine the excessive depreciation of real estate prices and provide a sustainable and stable development of the real estate market and stock market.

For the further research, on the one hand, in order to make more accurate understanding the operation of financial market, we can increase the variables. On the other hand, according to the spillover effect help investors establish an effective portfolio of assets to make a reasonable choice, and we also can analysis the portfolio between financial assets, between capital goods and between financial assets and capital goods.

REFERENCES

Aas, K., 2004. Modelling the dependence structure of financial assets: A survey of four copulas. Research Report SAMBA/22/04, Norwegian Computing Center.

Chaudhry, M.K., Myer, F.C., Webb, J.R., 1999. Stationarity and co-integration in systems with real estate and financial assets. Journal of Real Estate Finance and Economics. 18, 339–349.

Chen, C. I., Chen, H. L., & Chen, S. P. (2008). Forecasting of foreign exchange rates of Taiwan's major trading partners by novel nonlinear grey Bernoulli Model NGBM (1, 1). Communications in Nonlinear Science and Numerical Simulation, 13(6), 1194–1204.

Gao Xiaohui and Li Jingyi, 2009. Summary on relationship between real estate prices and stock prices. Market Aspect, 39-41.

He, L.T., Webb, J.R., 2000. Causality in real estate markets: the case of Hong Kong. Journal of Real Estate Portfolio Management. 6, 259–271.

Jinguo Gong, Zuoyu Li, 2005. Copula and Nonparametric Kernel Density Estimation: Empirical Study on the Dependence Structure between Shanghai and Shenzhen Stock Markets. Sichuan University

Ling, D.C., Naranjo, A., 1999. The integration of commercial real estate markets and stock markets. Real Estate Economics. 27, 483–515.

Li, J. Jia, M. Y., (2010) Empirically analysis on the relationships between Shanghai composite index and real estate index. Science Technology and Industry.10 (3)

Liu Qiongfang and Zhang Zongyi, 2011. Investigating the Dependence Structure between Real Estate and Finance Industries Based on the Copula Function. Journal of Industrial Engineering, 1, 165-170.

Nelsen, R. B, 1999. An introduction to copulas. Lecture Notes in Statistics . Springer,

New York, NJ, USA.

Okunev, J., Wilson, P., Zurbruegg, R., 2000. The causal relationship between real estate and stock markets. Journal of Real Estate and Economics. 21, 251–261.

Quan, D., Titman, S., 1999. Do real estate prices and stock prices move together? An international analysis. Real Estate Economics. 27 (2), 183–207.

APPENDIX

Empirical Copulas for People's Republic of China's Real Estate Sector Stock (x) and Shenzhen Index (y).