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ABSTRACT

Relationship between the Real Estate Sector and the Stock Market in Chinese Provinces

In China, real estate and the stock market are the two main markets favored by both individual and institutional investors. There is a significant economic link between the two. Therefore, their relationship and long-term and short-term causality can provide good guidance for investors. This paper studies the causality and correlation relationship between the stock market and real estate sector's trading volumes in 31 provinces of China. Its empirical results are based on panel data from 2000 to 2016. Various panel unit root, co-integration, and model specification and estimation tests are carried out. The panel mean group is found to be the most suitable method for the analysis. The study finds that the main industries in different provinces may affect the short-term causal relationship between the real estate sector and the stock market. But in the long-run, the causal relationship between the two is 2-way and stable.

JEL Classification: E22, H54, O16, O18, R53

Keywords: real estate, stock market, causal relationship, asset allocation, portfolio, economic area, Chinese provinces

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1. Introduction

According to Liow (2006), the stock market and the real estate sector are very important components of an economy. The stock market shows enterprises and listed companies' financial position, investor investment demand and trading transactions. For both companies and individuals, real estate is an indispensable and rigid asset. Liow also notes that when the economy is growing, benefits to companies and manufacturers can lead to a boom in the stock market. With the supply and demand ratio unchanged, real estate prices rise accordingly. Therefore, there may be a long-term or short-term relationship between the stock market and the real estate sector.

In China, commercial housing is not only for the citizens' demand, but the commodity property of real estate that is infinitely magnified (China Building Industry Press, 2009). Also, a considerable number of citizens choose commercial housing as their first choice for investments. However, as a traditional investment choice, stocks still occupy an important investment position (Wang, 2015). Wang also states that the real estate sector and stocks are two economic commodities held by most Chinese households. In other words, portfolios of stocks and real estate are extremely popular in China. Individuals can freely allocate funds between real estate and the stock market. Companies, especially public corporates, hold both property and shares. According to Chen et al. (2012), enterprises' net profits, stock market value, and real estate prices also have a mutually influencing relationship. At the national level, the Chinese government formulates monetary and industrial policies for influencing the stock market and the real estate sector (Guo and Li, 2013). Therefore, the stock market and real estate, as two major sectors in the economy, interact directly or indirectly.

The property market has been an important part of China's economy. Glaeser and Gyourko (2005) investigated the Chinese real estate market under its reform and open door policy between 1970 and 2000. During this period, housing prices in some coastal cities soared; but in the rest of China (such as the western and central areas), the prices were lower and supply was plentiful. Since the beginning of the 20th century, China's economy has entered an era of rapid development. At the same time, the real estate industry is developing particularly fast. Since 2003, the value of China's real estate sector has increased 10-fold, contributing 6.87 percent to its GDP in 2018 (CEIC, 2020). The real estate sector is a comprehensive market, it involves raw materials and tangible and intangible capital. Therefore, the real estate sector is thriving because of developments in other industries.

China's real estate sector is fundamentally different from that of western countries. According to Glaeser et al. (2017), the real estate sector in China has the characteristics of high vacancy rates where the ownership of land is with the government. Individuals are only allowed to own a home for 70 years, and since the policy was enacted and implemented, it is unclear whether the government will reclaim the right to use the land when ownership expires. But the government's policy on real estate development since 2003 has not stopped investments, especially in coastal cities where the real estate sector has been doing well. Fang et al. (2016) point out that in the second decade of 2000, the average annual growth rate of housing prices in 40 major Chinese cities was 13 percent while the net price of land increased 5-fold during this period.

In the same way, the stock market in China also had excellent development from 2000 to 2020, but compared to the real estate sector its development was not smooth. According to Trading Economics (2020), China's stock market reached its peak in nearly 20 years in 2007 and fluctuated periodically in the following decade. The stock market is a comprehensive and complex system. According to Kang et al. (2002), individuals and institutional investors' investment behavior affects price fluctuations in the stock market. Chinese investors' expectations of the stock market are rising year by year. In addition, Chinese stock market capitalization of GDP grew from 3.93 percent in 1992 to 36.98 percent in 2003 (Wong, 2006). The capitalization of the stock market has been accelerating. Wong also claims that the Chinese stock market is characterized by its use as a financing vehicle for state-owned enterprises. However, shareholders' rights and interests cannot be fully protected. But even so, citizens and institutional investors are more likely to invest in stocks.

There are 31 provinces and municipalities in China which have different levels of development and dominant industries. Every province and municipality's economy is affected by the stock and real estate markets. Therefore, it is interesting to see whether the same relationship between the real estate sector and the stock market exists among the provinces. Since the provinces have differing features, the long-term and short-term relationship between the real estate sector and stocks may be regionalized inducing the need for different state policies. This research distinguishes between two stock markets -- one for domestic and another for foreign investors. It is also worth analyzing the heterogeneous effects of the two stock markets on the real estate sector.

Some existing studies focus on the relationship between financial leverage and the real estate sector in China (Liu and Lei, 2017). Yang (2005), for instance, did a research based on housing prices and the price of real estate stocks in Sweden and found a long-term equilibrium relationship between the two. Okunev et al. (2002) studied the relationship between the Australian real estate sector and its stock market. They found that the fluctuations in stock prices led to rapid fluctuations in real estate prices. Liow (2006) used the autoregressive distributed lag (ARDL) model for studying the dynamic relationship between the real estate sector and the stock market in Singapore and found that the real estate sector affected the stock market in the long-run, but in the short run, fluctuations in the stock market affected the real estate sector. Some researchers have studied the two markets by region while some others have introduced indicators of other industries as control variables in their specified models.

It is possible to overestimate the impact of the stock market on the real estate sector. China is a policy-oriented country and two regions can respond differently to policy changes. Hence, for capturing heterogeneity in effects, this paper divides China into three economic areas: [1] eastern, central, and western. Further, this paper introduces new control variables such as the number of medical institutions, consumption levels, and foreign exchange incomes from tourism, which may influence local housing prices.

The purpose of this research is exploring the relationship between the real estate sector and the stock market in different provinces of China. The two contribute a significant portion to China's gross domestic product (GDP), and there is a long-term equilibrium between them. However, whether this holds true for all provinces is unclear. The stock market affects the price of real estate in the short-run, while the price of real estate affects the value of the stock market in the long-term. However, this correlation is not universal in all the provinces. Therefore, this paper focuses on exploring the conditions in the sample provinces with different major industries to find evidence of heterogeneous market associations.

The methods and viewpoints used in existing relevant studies are integrated as the theoretical basis for exploring and studying the relationship between the real estate sector and the stock

[1] Map of China's 31 provinces, by region (eastern, central, western) is found at: https://www.researchgate.net/figure/Map-of-Chinas-31-provinces-by-region-eastern-central-western-Eastern-region_fig5_282812129. Eastern region provinces include: Beijing, Fujian, Guangdong, Guangxi, Hainan, Hebei, Jiangsu, Liaoning, Shandong, Shanghai, Tianjin, and Zhejiang. Central region provinces include: Anhui, Heilongjiang, Henan, Hubei, Hunan, Inner Mongolia, Jiangxi, Jilin, and Shanxi. Western region provinces include: Chongqing, Gansu, Guizhou, Ningxia, Qinghai, Shaanxi, Sichuan, Xinjiang, Yunnan, and Xizang.

market. The ARDL method in a dynamic heterogeneous panel is used for exploring the housing-stock market relationship.

The rest of this paper is organized as follows. Section 2 gives the literature review and theoretical basis of the study, while Section 3 gives the methodology. This is followed by a description of the data and a correlation test, with a brief overview of the reasons for selecting these variables in Section 4. Section 5 discusses the empirical research and its analysis. The final section gives a conclusion and discusses the potential limitations of this research.

2. Literature Review

2.1 Theories related to the housing-stock market relationship

The literature on the housing-stock market relationship attempts to shed lights on how the real estate sector and the stock market establish themselves in an economic relationship. Markowitz (1959) believes that the portfolios include all types of assets held by investors. This collection of assets should include not only a variety of securities, but also assets or items with investment attributes. As a result, stocks and fixed assets can make up some form of a portfolio that can be held by investors. The real estate sector and stocks are two special commodities with investment attributes with different nominal prices. The substitution effect works when their relative returns change. Lin and Lin (2011) studied the housing-stock market relationship in six Asian economies and concluded that these two investment methods can be mutually substituted.

Kiyotaki and Moore (1997) studied the roles of real estate assets and stock assets in the credit process and proposed the theory of credit expansion effect. According to them, real estate and stocks can be accepted as collateral in the loan process by various financial institutions, where the amount of the loan is adjusted by the value of the mortgaged assets. When stock prices or property prices rise, the total assets of borrowers holding these assets increase, reducing the risk of loans and the amount of loans offered by banks increases. When a loan is granted, the borrower's cash flow increases, and some assets may be invested in the stock market and the real estate sector, leading to an increase in the prices of both. Thus, the credit expansion effect provides an explanation for the alternating rise and fall in real estate and stock prices.

From a macroeconomic perspective, the stock market and the real estate sector are linked by other macroeconomic factors such as monetary policy, inflation, and interest rates. According to Ba et al. (2009), on the premise of free capital flows, the real estate sector and stocks are highly complementary. Any volatility in the real estate sector is relatively small and the liquidity is low. On the contrary, stock price volatility is large and liquidity is strong. Provided the money supply is adequate and capital flows freely, the returns on the capital invested in different sectors should be the same. As a result, capital is withdrawn from low-yielding investments and invested in higher-yielding investments. Due to the low liquidity of the real estate sector, it is difficult for investors to withdraw capital in time and allocate it to the stock market. Ba et al. (2009) maintain that the adjustment of the stock market with the housing sector should be relatively rapid, while the impact of the housing sector on the stock market has a long-time lag.

2.2 Empirical studies on the housing-stock market relationship

This section reviews empirical literature on the housing-stock market relationship. The main focus is on how stocks affect real estate and vice versa, evidence of long-term equilibrium, and the 2-way causal relationship and influence of the 'special time' factor on the housing-stock market relationship.

There is no clear understanding of how best to study the relationship between the real estate sector and the stock market. Most scholars use time series methods such as vector autoregressive (VAR) for their analyses and study whether there is a cointegration relationship between them. Some studies are also based on panel data, using fixed effects or random effects models for studying the interaction between the two markets or using the dynamic heterogeneity panel and error correction model (ECM) for studying the causal and long/short-term relationship between the two. In addition, several researchers use non-linear models for analyzing the relationship. These different analytical methods do not lead to completely different conclusions. For some countries, there is a long-term and 2-way interaction between housing and equity; in others, the estimated relationship is short-term and one-way.

First, the results of a considerable number of studies show that stock prices affect real estate prices, that is, fluctuations in stock prices can lead to fluctuations in real estate prices. This view is referred to as 'conventional wisdom.' Gyourko and Keim (1992), analyzed the risks and returns of real estate companies in two different stock exchanges (the New York Stock Exchange (NYSE) and American Stock Exchange (AMEX)). They argue that estimating the value of real estate is more complicated and a lengthier process as compared to finding the value of the stock market. The authors claim that real estate market prices are affected by a change in the stock index, while real estate prices have a very limited impact on stock market.

Similarly, Chen (2001) used bivariate and multivariate VAR estimation to analyze the real estate and stock market in Taiwan between 1973 and 1992. Chen believes that there was a correlation between the price fluctuations of these two assets and that their prices may be related to bank loans and central bank interest rates. Stock prices significantly affect real estate prices in Taiwan.

In addition, Green (2002) found that fluctuations in the stock market may affect the real estate sector from the perspective of consumption. Green used the home price index and the Russell index for several American cities to represent the housing sector and the stock market, and conducted a simple Granger causality test. He found that the wealth effect of the stock market varied widely among the US cities. So, there was no general correlation between stocks and real estate. But stock prices had a positive effect on real estate prices in northern California. It is worth noting that both Chen (2001) and Green (2002) focus on a specific region. Their conclusions may not apply to the whole country.

Okunev et al. (2002) not only fully catered to traditional views, but also complemented them. By analyzing the real estate sector and the stock market in Australia between 1980 and 1999, they found that real estate and stocks did not necessarily influence each other, but there was a one-way causal relationship between them. When they used the linear causality test a price change in the stock market affected real estate prices. When they used the non-linear causality test the stock market still affected the real estate sector in a one-way relationship.

Yang (2005) analyzed monthly data from the Swedish real estate sector and the stock market from 1980 to 1998 by establishing the ECM model, and concluded that there was a cointegration relationship between the two. Yang chose the real estate price index and the stock index to describe the two markets. Yang points out that the real estate sector and the stock market showed a long-term equilibrium relationship, and stock prices had an indicative effect on real estate investors.

Shen and Lu (2008) concluded that there was a close relationship between the price of real estate and the violent fluctuations in stock prices in China. They used the Johnsen cointegration test and the Granger causality test to empirically study the Chinese stock market and the real estate sector. They found that between 1998 and 2007, the increase in real estate prices had a significant effect on the rise in stock prices, while the increase in stock prices had a slight effect on the increase in real estate prices. There was a gap of about two quarters between the increase in real estate prices and the increase in stock prices. They concluded that in mainland China, the stock exchange and the real estate sector had a mutual relationship but the lag period between changes was long.

According to Lu and Dong (2017), both the real estate sector and the stock market play an essential role in China's economic development and there is a certain correlation between prices fluctuating in the two markets. They start by implementing the strength of the policies and then dividing the stages according to the intensity of real estate regulations and policies and by constructing a VAR model for each stage. Finally, they do a comparative analysis of the Granger causality test, impulse response, and variance decomposition. The authors believe that although changes in stock prices play a leading role in the causal relationship between the two, the impact of housing prices on stock prices is more significant.

There might also be a 2-way causality or long-term equilibrium between the real estate sector and the stock market. The relationship can differ by location and time periods and be dynamic. According to Stone and Ziemba (1993), Japanese real estate prices peaked in 1991 and accounted for almost 20 percent of global wealth. Similarly, the Japanese stock market peaked in 1989, but by early 1992 the stock market was down 60 percent and land prices were falling rapidly. Stone and Ziemba selected the land price index and the stock index of Japan from 1950 to 1980 for analyzing this period of steady development. They argue that there was a consistent trend between the two markets, and the stock market lagged behind the property market. This finding contradicts the traditional conclusion that stocks affect house prices in the short-term.

Quan and Titman (1997) reached a conclusion similar to that by Stone and Ziemba (1993). They argue that previous research has underestimated the volatility of real estate prices by relying too much on time series models. In their study, they used a simple regression model for analyzing stock and property data from 17 countries between 1977 and 1994. They find no correlation between real estate and equities in the United States, Australia, and Canada which contradicts most research. In some countries, however, the relationship between equity returns and fixed asset rents was significant which affected property prices. According to Jud and Winkler (2002) who used the fixed-effects model for analyzing American residential prices and the S&P500 index, fluctuations in house prices not only were related to fluctuations in stock prices, but were also affected by other factors such as population and construction costs. These authors believe that the real estate market will change in the same direction with the change in stock index, and that there is a long-term equilibrium relationship between the two.

Green (2002) referred to Jud and Winkler's (2002) variable selection method and added Nasdaq index to optimize the original model. Using the Granger causality test, Green found that the real estate sector and the stock market showed the same fluctuation trends, and the stock index played a leading role in the relationship. In other words, the stock index Granger caused a change in real estate prices, whereas real estate prices did not Granger cause the stock index.

Chiang and Lee's (2002) research opened up new ideas for research on the real estate sector and the stock market. They chose the real estate trust fund instead of real estate prices as one main variable. They selected monthly data from 1975 to 1997 and used the return-based style analysis, which is a non-quantitative method. They argue that real estate and fixed assets are viable investments when they are not securitized, but they take a long time to pay off. However, it is undeniable that there is a strong correlation between the two markets.

Shun (2004) explored the relationship between the real estate sector and stocks. He believes that as a part of the financial market, the stock market has an interaction with the real estate sector which indirectly establishes a relationship with the stock market. Shun used monthly data from mainland China from 1997 to 2003 and specified an error correction model between the two markets. He points out that Chinese real estate and financial markets have a significant two-way causal relationship in both the long and short-term. The real estate is less volatile than the financial market but the two markets are 'inseparable.'

Moreover, a novel idea has emerged in recent years that 'special times' may affect the interaction between the real estate sector and the stock market. Special times can be political or financial such as the timing of policy announcements or the onset of a financial crisis. Hui and Ng (2012) studied the long-term and short-term causality relationship between the housing sector and the stock market in Hong Kong from 1990 to 2006. The market was volatile during this period. Since Hong Kong transferred sovereignty in 1997, its economy was strongly affected by the economic fluctuations in mainland China. Hui and Ng claim that the correlation between stocks and the real estate sectors was strong but weakened over the period with shifts in cause and effects. Initially the stock market affected real estate prices, but this did not explain the change in real estate prices later. As a result, the relationship between the real estate sector and the stock market is dynamic.

Nicholas and Scherbina (2013) studied the early stage development of the real estate sector and the stock market by selecting the real estate sector in Manhattan in New York City from 1920 to 1939 for their analysis. They concluded that the correlation between high-value real estate and stock prices was significant, but the price of ordinary real estate and stock prices developed in opposite directions. Especially after the 1933 financial crisis, there was no correlation or cause and effect between stocks and the real estate sector. This finding challenges conventional wisdom. Thus, their conclusions may not apply to the housing sector and the stock market in recent years.

Yang and Liu (2015) used the generalized autoregressive conditional heteroscedasticity (GARCH) model for studying the dynamic relationship and spillover effects between the Hong Kong real estate index and the stock index. They argue that the correlation between the two reached a high level during the financial crisis when the two markets moved in the same direction. But in a boom, changes in the stock market can take up to three weeks to feed through to the housing sector. The real estate sector in Hong Kong has no significant spillover effects on the stock market, while the stock market has positive or negative effects on the real estate sector.

Table 1 provides a summary of empirical literature on the relationship between the real estate sector and the stock market and findings about their causal relationships.

Insert Table 1 about here

3. Data and Description of Variables

This paper covers the period 2000-2016. This period covers the rapid development of China's real estate sector and stock market. Further, this period also includes the time before and after the global economic crisis. The data covers the population in 31 provinces and major cities; all of them were observed on an annual basis. Therefore, each variable contains 527 data points. The data is from the China Stock Market and Accounting Research (CSMAR) database and the National Bureau of Statistics of China (NBSC). All monetarily measured variables are converted to real 2015 values using the consumer price index. The data covering before and after the period was not available.

The main variables are housing price (CHSOR), the stock market that can be invested in by domestic investors (NSR), and the stock market for foreign investors (INSR). Housing prices are measured by the total number of sales of commercial housing including both office and residential buildings. The data for the stock market is represented by the annual transactions at the stock market and includes four different stock markets of Shanghai A, Shanghai B, Shenzhen A, and Shenzhen B. Since A-shares are only for domestic citizens and B-shares are only for foreign investors to trade in, stock data is classified into national and international stocks. Since each province has its own real estate sector but only a few provinces have independent stock markets, this paper uses the provinces' GDP share of the aggregate national GDP as weights for obtaining province-specific stock market turnovers.

In estimating the interaction between the stock market and the real estate sector, the following control variables are introduced. For the selection of control variables, this research refers to previous literature. According to Égert and Mihaljek (2007), changes in real estate prices are usually directly related to changes in supply and demand. In the process of changing the supply and demand relationship, real GDP per capita (RGDPPC), average wage (AWA), and the household consumption (CONS) level play an essential role. They represent the annual levels of the urban and rural populations in each province.

Dröes and Koster (2016) point out that wind power affects housing prices through its dual impact on electricity prices and the environment. Therefore, electricity generation and prices can be considered as related control variables. The annual generating capacity of different provinces in KWH is used for measuring electricity. Infrastructure is also a key factor that is worth considering. According to Efthymiou and Antoniou (2013), transportation infrastructure affects the prices of housing around it. Similarly, Luttik (2000) points out that the attractiveness of the environment such as water resources, air quality, degree of greening, and public infrastructure have a direct impact on housing prices. Several control variables are introduced in this paper. PARK represents the number of large parks; MEEST represents the number of health organizations and institutions; UNICOL shows the number of universities and vocational colleges in the province. Utilities, green areas, health and educational facilities influence labor productivity and real estate prices.

In China, housing prices in the eastern provinces are generally higher than those in the western provinces. Real GDP (RGDP) is introduced to capture the relationship between GDP and house prices. Different provinces have their own pillar industries and tourism resources, which may affect GDP and housing prices. Therefore, the total annual foreign exchange revenues from tourism (RFET) with the total annual imports and exports by the province (RTIE) are introduced to represent the provinces' trade openness and tourism. Population growth rate (POPUL) is selected for eliminating the potential overvaluation of stocks and house prices.

Table 2 provides summary statistics of the main and control variables. The table shows large dispersion among the provinces.

Insert Table 2 about here

4. Methodology

For verifying the relationship between the real estate sector and the stock markets in different provinces of China, the empirical model takes the annual sales of commercial houses as the dependent variable and annual transactions at the different stock markets as the independent variables. The long-term relationship between them is found using the autoregressive distributed lag (ARDL) model and the causality between them is explored using the error correction model (ECM).

According to Kim and Korhonen (2005), several previous studies have used the pooled ordinary least squares (OLS) estimation method for analyzing data from multiple countries over a period of time. This classical method has a drawback in its inability to consider non-stationary data. However, in the dynamic heterogeneous panels approach proposed by Pesaran and Smith (1995), the dynamic characteristics of the model are no longer ignored. The real estate sector and the stock market have clearly dynamic characteristics. Therefore, the ARDL model is more suitable than the pooled OLS estimation method. Pesaran et al. (2001) also mention the bound testing approaches of the ARDL model in their subsequent studies, which have greater tolerance for the stationarity of the variables.

The ADRL model proposed by Pesaran and Smith (1995) is written as：

(1) $y_{it} = \alpha_{1i} + \alpha_{2i}t + \beta_{1i}y_{i,t-1} + \ldots + \beta_{pi}y_{i,t-p} + \gamma_{1i}x_{it} + \gamma_{2i}x_{i,t-1} + \ldots + \gamma_{qi}x_{i,t-q} + \varepsilon_{it}$

where y is logarithm of the dependent variable (CHSOR) which represents commercial housing sales. It can be explained by its own lag values, so the model is autoregressive. x is a vector of logarithms of the explanatory variables (NSR and INSR) which are related to two different stock markets for domestic and international investors. They also appear in lag form as the other independent control variables (Z). The subscript i (i = 1, 2, …, N) represent provinces and t (t = 1, 2, …, T) is the time period. ε_{it} represents the random error term.

Pesaran et al. (2001) discuss the ARDL bounds testing approach of cointegration. According to Ozturk and Acaravci (2010), this approach has three advantages. Firstly, this model can be analyzed using a formula with regressors of different orders such as integrated of orders 0, and 1, I(0), and I(1). Secondly, the classic Johansen cointegration method is highly reliable only when the number of samples is large, but the ARDL bounds testing approach can accurately handle the cointegration relationship in small samples. Finally, the ARDL method can be used for the cointegration test without testing the unit root of the variables in advance. In the following, the unit root test is conducted to make the results more reliable. Pesaran et al.'s (2001) 'optimized' ADRL bound testing approach is:

(2) $\Delta y_{it} = \beta_0 + \sum_{i=1}^{k} \beta_i \, \Delta y_{it-i} + \sum_{j=0}^{l} \beta l \, \Delta x_{1it-j} + \delta_1 y_{it-1} + \delta_2 x_{it-1} + \varepsilon_{it}$

where Δ describe the first difference of the variables, l is the control variables, and j the lag length. Ozturk and Acaravci (2010) suggest using the Akaike Information Criterion (AIC) or the Schwarz Information Criterion (SBC) for selecting the optimal lag length. Pesaran et al. (2001) also provide the essential hypothesis of this model, that is, the error terms must be independent and identically distributed. This hypothesis also affects the choice of the optimal lag length. In Equation (2), the null hypothesis is H_0: $\delta_1 = \delta_2 = 0$. A rejection of this hypothesis means there is a long-term relationship between the two variables.

Since the ARDL model has an autoregressive structure, the model needs to be dynamic and relatively stable. This means that the inverse roots of the feature equation associated with the model are strictly within the unit circle. When this prerequisite is met, bounds testing can be conducted. According to Pesaran et al. (2001), only when bound testing provides evidence of cointegration, it can be predicted that there is a long-term equilibrium relationship between the variables. Similarly, although the ARDL model can determine the long-term relationship between the variables, it also has a defect, that is, it cannot determine the causal relationship between the variables and nor can it describe the direction of this causal relationship. Therefore, this paper uses the dynamic VEC model for exploring the causal relationship between the independent and dependent variables. The dynamic VEC model following Ozturk and Acaravci (2010) is specified as:

(3) $\Delta y_{it} = \alpha_1 + \sum_{i=1}^{k} \beta_i \Delta y_{it-i} + \sum_{j=1}^{l} \beta_j \Delta x_{it-j} + \gamma_1 v_{it-1} + e_{1it}$

(4) $\Delta x_{it} = \alpha_2 + \sum_{i=1}^{k} \delta_i \Delta y_{it-i} + \sum_{j=1}^{l} \theta_j \Delta x_{it-j} + \gamma_2 v_{it-1} + e_{2it}$

It is assumed that the error terms in Equations (3) and (4) have mean 0 and constant variance. The null hypothesis is that x_{it} is not as a result of Granger causing of y_{it}, and y_{it} is not because of the Granger causing of x_{it}. If the null hypothesis is rejected, y_{it} and x_{it} are Granger causing each other. Ozturk and Acaravci (2010) proposed three methods for detecting Granger causality. First, weak Granger causality can be obtained by checking whether the value of β_j is equal to 0. Second, the velocity of long-term equilibrium dissipation can be obtained by observing the coefficient of the error correction term v_{it-1}. Third, strong Granger causality can be determined by H_0: $\beta_j=\beta_j=0$ or H_0: $\theta_j=\delta_i=0$. The coefficient of the error correction term v_{it-1} reflects the rate at which the variable can eliminate the long-term equilibrium bias. The dynamic VEC model captures the strong and weak Granger causality and it is an effective complement to the ARDL bounds testing method.

5. Estimation and Analysis of the Results

5.1 Descriptive statistics and multicollinearity tests

The mean value of commercial building sales (CHSOR) (except in 2008) reported in Table 2 continued to increase from 12.69 in 2000 to 379.44 billion CNY[2] in 2016. It decreased in 2008 which was largely due to the global financial crisis. CHSOR's standard deviation also increased over time. Therefore, this phenomenon is believed to indicate that there were great differences in real estate prices in different provinces and that real estate development was heterogeneous during the study period.

For the two aggregated stock markets, the market for domestic investors (NSR) was more volatile over the study period. The mean had a minimum value of 150.05 and a maximum value of 6,786.95 billion CNY. As can be seen from the standard deviation, this value was relatively small before 2006. Since 2007, the standard deviation has increased by 5 times, indicating that the stock market had been polarized from 2006 to 2007. However, the standard deviation reached its maximum in 2015 which was the year of the sudden boom in China's stock market, but the sharp increase in dispersion reflects that the boom was 'non-equilibrium' for different provinces.

Moreover, the aggregate stock market (INSR) for foreign investors was relatively small. In the study period, the fluctuations were relatively stable, and the dispersion degree did not change much. However, this market also experienced a sudden increase in trading volumes and dispersion in 2007 and 2015, which is consistent with the national market's (NSR) development patterns. Overall, the development of INSR in different provinces was relatively stable.

Table 3 illustrates the Pearson correlation coefficient matrix for all the variables. It can be seen that there is no high correlation between the three main variables, so there is no multicollinearity problem. However, for the control variables, real GDP and real estate sales are highly correlated. Therefore, RGDP is not considered as the main control variable when the dependent variable is CHSOR. Similarly, there is a high correlation between GDP per capita and household consumption levels. At the same time, the provinces' import and export levels and foreign tourism exchange incomes also had a significant correlation. These findings help us to conduct follow-up robustness tests. For instance, when the trade volume is used as

[2] CNY is Chinese currency Yuan Renminbi, \$1=6.54 CNY on 26 March 2021.

the control variable for the robustness test, tourism is not taken into account to overcome the errors caused by multicollinearity in the regression.

Insert Table 3 about here

5.2 Panel autoregressive distributed lag (ARDL) estimation method

When estimating the panel ARDL model, we need to carry out three steps -- model specification, descriptive statistics, and the correlation test. We should go straight to the unit root test and the selection of the optimal lag length. Then the cointegration test helps observe the long-term relationship between the main variables. The Hausman test helps choose the best estimation method among the mean group (MG), pooled mean group (PMG), and dynamic fixed effects (DFE) methods. Finally, we need to estimate the model and do the causality test.

One of the benefits of the panel ARDL method is that it can contain both integrated I(0) and I(1) variables, but not integrated I(2). For overcoming potential multicollinearity and the high degree of autocorrelation between the variables, all the monetarily measured, continuous and positive variables are in natural logarithms. In addition, this research uses the Im et al. (2003) method for unit root testing that assumes the variables have heterogeneous slopes which is in line with the actual data situation. Meanwhile, variables' time trends are not included in the unit root inspection process. All variables are stationary under the condition of I(0) or I(1). For lnGDP) the test statistics is significant at the 0.10 significance level, and its I(1) is non-stationary. Therefore, lnGDP is included in the I(0) stable group. The panel unit root test's results for all the groups are given in Table 4.

Insert Table 4 about here

This paper also selected the optimal lag length. Few previous studies on panel ARDL have included control variables. Therefore, this study first determined the optimal lag length unconditionally and then conditionally using control variables. We can compare whether the optimal lag lengths of the main variables change before and after adding the conditional variables. So as not to lose too many degrees of freedom, we set the maximum lag length at 1. After that, we selected the most common lag length across the provinces. The optimal lag of lnGDP, lnRFET, and lnTIE is 0 and 1 for other variables.

The next step is the cointegration test proposed by Pedroni (2004). There are three kinds of Pedroni cointegration tests -- time fixed effects, individual fixed effects, and both cases. This paper first explored the cointegration relationship among the three main variables. Table 5 shows that at the 0.01 significance level, the null hypothesis can be rejected. Note that the alternative assumption is that all panels are cointegrated. Therefore, lnCHSOR, lnNSR, and lnINSR have cointegration relations. The cointegration test gradually included gradually different control variables. It turns out that for the absolute value of ρ, the null hypothesis can be rejected at the 0.01 level, so after adding different control variables the variables are still found cointegrated.

Insert Table 5 about here

Similarly, we also need to choose the most efficient estimation method between MG, PMG, and DFE models using the Hausman test. In doing so, this study uses only the three most important variables for the regression analysis because a large number of control variables will lead to many iterations in generating the PMG's results, which affects the Hausman test's results. Table 6 shows that the null hypothesis cannot be rejected at the 0.05 level. The Hausman test is carried out on the relatively efficient PMG model and DFE (see Table 6). The insignificant test results show that PMG is more efficient than DFE for the main variables.

Insert Table 6 about here

When using PMG for estimating the model, only a broad result can be obtained in the long-run relationship due to its assumption of homogeneity. However, for the short-term relationship between the variables, the differences between provinces are more evident. In fact, when we used the MG estimation method, we observe differences in the long-term relationship between the variables among the 31 provinces due to the absence of the homogeneity assumption. However, because the Hausman test's results do not support the use of the MG model, this research takes the MG method as a supplement to the conclusion, rather than as the main focus of the study. In PMG's estimation, the results cannot be obtained when there are more than three control variables. When the fourth control variable is included in the regression no valid results are obtained even after 74 iterations. Therefore, the 11 control variables in this paper were added to 5 different groups of PMG's estimates.

Table 6 gives the PMG's results. Firstly, when the control variables only include lnGDP and lnGDPPC, in the long-run lnNSR has no significant impact on lnCHSOR, which means that the growth rate of the domestic stock market's turnover has no direct impact on the growth rate of the real estate sector's turnover. In the short-term, lnNSR in most provinces had no significant effect on lnCHSOR at the 0.01 significance level, and only three provinces had a significant relationship. For lnINSR, only seven provinces had a correlation between lnINSR and lnCHSOR, and the regression results of most provinces were still insignificant at the 0.10 level.

New control variables POPUL and KWH were replaced in the next regression. In the long-run, lnINSR still had a significant positive effect on lnCHSOR but not on lnNSR. However, in the short-term we note that lnNSR had a significant effect on lnCHSOR in 12 provinces with positive or negative effects. Similarly, lnINSR also significantly affected lnCHSOR in 14 provinces. The new control variables changed the significance of the coefficients of lnNSR and lnINSR in some provinces. In addition, when lnAWA and lnCONS were used as control variables, the significance between lnCHSOR, lnNSR, and lnINSR did not change over the long-term. But in the short-term, only three provinces had a significant lnNSR effect on lnCHSOR. The difference is that when we change the control variables to MEEST and UNICOL, the p-value of lnNSR is 0.008, and the hypothesis of a no correlation type can be rejected. In this case, when lnNSR increases by 1 percent, lnCHSOR increases by 0.1365 percent. However, in this case, lnINSR's effect on lnCHSOR is not significant, so we cannot reject the null hypothesis that the two variables are unrelated.

When we introduced PARK, lnRFET, and lnRTIE, the p-values of all the variables were less than 0.05. In the long-term, for every 1 percent increase in lnINSR, lnCHSOR decreased by 0.3875, and there was a negative correlation between the two. In the short-run, the main variables in each province still showed different correlations. Among them, the major variables of provinces 19, 20, 24, and 25 showed a strong correlation, and both lnNSR and lnINSR were significantly correlated with lnCHSOR. This means there was a correlation between the real estate sector and equities in the four provinces. In the other provinces, however, the regression results did not indicate strong correlation between the two variables.

The final step was the causality test. A causality relationship can also be determined by using the significance of ECT, and long-run and short-run coefficients which capture the causality. Since we used panel data which contains multiple provinces and times, the traditional VEC model cannot be used. This paper first used the PMG approach to causality test without including the control variables (Table 6). By examining PMG's regression results, we found that lnNSR and lnINSR had a significant long-run causal relationship with lnCHSOR. When lnNSR and lnINSR were used as the dependent variables, the other two variables still had a long-run causal relationship and were significant at the 0.05 level, suggesting significant causal relationships between lnNSR, lnINSR, and lnCHSOR in the long-run. Interestingly, in the short-run, there was also significant causality between the three major variables. It is worth noting that the short-run PMG regression can provide an error correction term that reflects the joint result. It can be seen that when lnCHSOR is taken as the dependent variable, the two independent variables related to stocks tend to be balanced at a speed of 0.2588. When lnNSR is taken as the dependent variable, the rate becomes 0.9013 and in case of lnINSR the equilibrium rate is 1.5863.

In addition, when we used PMG for estimating the relationship between the three main variables we could capture the causal relationship between the variables in a single province. Table 7 shows that the two independent variables of provinces Jiangsu, Chongqing, Guangdong, Fujian, Ningxia, and Zhejiang had a short-run causal relationship with the dependent variables. For lnNSR and lnCHSOR, only Henan and Qinghai provinces had a short-run causal relationship; lnINSR and lnCHSOR had a short-run causal relationship in all other provinces. This means that the relationship between the real estate sector and equities varied from province to province suggesting no unified universal countrywide relationship.

Insert Table 7 about here

5.3 A discussion of the results

Most previous studies are based on analysis of international representative stock market and real estate indicators. Since China mainland's provinces are unlikely to have their own independent stock markets, this research divides the stock market into two parts and carries on their province level GDP weighted treatment. This has the advantage of weakening the homogeneity of the aggregate stock market. But in the long-run, the causal relationship between the stock market and the real estate sector can only be accurately observed at the national level. The short-term cause-and-effect relationships between them can be captured at the provincial level. This study captures inter-provincial differences in information which are lost when using aggregate national level data.

This research assumed that in China mainland, the real estate sector and stock markets had a 2-way causality relationship. Our empirical analysis shows that this was not the case. For example, the short-term causality between Chinese housing and housing stocks went both ways only in very few provinces. On the other hand, the stock market for foreign investors may have a greater impact on the real estate market in the short-term than the stock market for domestic investors. The reason for this may be that China's foreign direct investments continued to increase from 2000 to 2016. For domestic investors' investments, the increase in foreign investors' investments were relatively significant.

It is important to note that different provinces have different industrial structures, reflecting their possible different causal relationships. Initially this paper predicted regionalized correlation and causality between housing and stocks. For example, the eastern region is relatively well-developed so the housing sector and stocks markets are more active, and they show a 2-way causality relationship. The central and western provinces show a single causal relationship in different directions. The results further show that the causal relationship does not have much influence on the economy of the region where the province is located. On the contrary, the province's main industry or the pillar of the region's economy may indirectly determine the cause and effect of the two markets. In other words, real estate and the two aggregate stock markets mutually influence and cause and effect each other in the long-run.

However, in the short-term their relationship is affected by other factors, some of which were identified in this study and considered as control variables.

6. Conclusion and Recommendations

Our results confirm correlation and causality between the real estate sector and the stock market both in the long-term and in the short-term. However, this causal relationship varies from one province to another, and there is no uniform conclusion that can be generalized across provinces. The relationship between stocks and the real estate sector was estimated using different testing procedures and estimation methods. The pooled mean group was found to be the most suitable for analyzing the data. The results show that in the 31 provinces there was a long-term cause-and-effect relationship between the property market and the two domestic and foreign investor stock markets that had a significant effect on each other. But in the short-term, the causal relationship between the real estate sector and the stock market was insignificant.

This research divided the provinces of China into three economic regions -- eastern, central, and western. For provinces Jiangsu, Chongqing, Guangdong, Fujian, Ningxia, and Zhejiang, both stock markets had a significant causal relationship with the real estate sector. Four of them are located in the east and another two in the west region. In addition, there was only significant causal relationship between the stock market and the real estate sector for domestic investors in two of the central provinces. The remaining 23 only had a short-term causal relationship between the stock market and the property market for foreign investors. The linkage between the real estate sector and the stock market was closer in these provinces. This may be the root cause of the short-term causality between the two in these provinces. The results of a short-term causal relationship between the national stock exchange and the real estate sector in only two provinces was surprising. Among them, Henan province has the largest population, and its main industries are agriculture, industry, and mining minerals.

The results show the existence of large heterogeneity across provinces and over time. The specified model and estimation approach accounted for such heterogeneity. The main industry in Qinghai province is natural resource extraction. Therefore, it can be inferred that provinces with major industries related to natural resources are more likely to observe a common short-term relationship between the national stock exchange and the real estate sector. Finally, there was a significant short-term causal relationship between the international stock exchange and the real estate sector in most provinces. This suggests that the behavior of foreign investors affected the property market in the short-term.

To sum up, there was a long-term equilibrium and a significant causal relationship between the real estate sector and the stock market in 31 provinces of China. In the short-run, this causal relationship varied from province to province, and was influenced by the main industries in each province, foreign investments, and domestic investors. The data period is up to date, the sample covers the population of provinces and its estimation methods are advanced. Hence, this research provides interesting results and contributes not only to the growing literature on the subject but will also be a source of useful information for policymaking.

This research has some limitations. Studying the relationship between the real estate sector and the stock market in different provinces is innovative, but it also means many challenges. First, there are six different stock markets in China. The Growth Enterprise Sector (GEB or Chinext) and the Sci-Tech Innovation Sector (STAR Market) were not considered in this study because their trading volumes are relatively small compared to the other four stock markets. Importantly, Chinext was introduced in 2009 and STAR in 2019. Given data availability they should be included in future studies.

It is difficult to consider dynamic changes in the exchange rate for some control variables. Exchange rate is a unit that changes frequently and some of the raw data is monthly and yearly data in US dollars or Hong Kong dollars. The use of monthly exchange data and annual data results in slight statistical errors. Further, the money supply of the provinces is not balanced. Thus, it may not be optimal to obtain the provinces' transaction of shares by multiplying their share of real GDP with the trading volume of shares. Further, provinces are unlikely to have distinct stock markets and the center of China's economic development is increasingly shifting from the east to the west. This approach is both innovative and challenging for estimating the causal and dynamic relationship between stocks and the housing sector at the province level.

Concerning special time, it was pointed out that after the financial crisis in 1933, the correlation between real estate and the stock market was significantly reduced. Therefore, it can be concluded that investors could benefit by changing their asset allocations during a financial crisis, because the relationship between the two markets is dynamic in the short-term. At the same time, the relationship varies among the provinces. In mainland China, property prices rose 10-150 times in the decade after the 2008 financial crisis. The development of the stock market during the same period did not have such growth. But in the long-run, the real estate sector and the stock market have a 2-way causal relationship. In the short-term, there are causal differences among the provinces which may catalyze the imbalance in rising house prices. Future research should consider the special time related to the 1998 and 2008 financial crisis.

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Table 1. Summary of literature on the relationship between real estate and stock market

Author(s)	Theory	Data period	Sample Countries	Estimation Method	Key findings
Gyourko and Keim (1992)	CAPM	1978-1990	The U.S.	Dynamic fixed effects	Stock→Real estate
Stone and Ziemba (1993)	CAPM	1982-1992	Japan	Data analysis	A consistent trend between the two markets
Quan and Titman (1997)	CAPM & Wealth effect	1977-1994	17 countries	Time-series method	Stock→Real estate
Chen (2001)	Rational bubble theory	1973-1992	Taiwan	Bivariate VAR	Stock→Real estate
Green (2002)	Wealth effect	1989-1998	The U.S.	Granger causality test	Stock→Real estate
Chiang et al. (2002)	CAPM	1975-1997	The U.S.	Fixed effect	Stock←→Real estate
Jud and Winkler (2002)	Wealth effect	1984-1998	The U.S.	Fixed effects	Stock→Real estate
Okunev et al. (2002)	CAPM	1980-1999	Australia	Bivariate VAR	Stock←→Real estate
Shun (2004)	Substitution effect	1997-2003	China	Error correction model	Stock←→Real estate
Yang (2005)	CAPM	1980-1998	Sweden	ECM	Cointegration relationship
Shen and Lu (2008)	Wealth effect	1998-2007	China	Granger causality test	Real estate →Stock market
Hui and Ng (2012)	Wealth effect	1990-2006	Hong Kong	Granger causality test	"Special time" will change the causality
Nicholas and Scherbina (2013)	CAPM	1920-1939	New York	VEC	Causality depends on real estate prices
Yang and Liu. (2015)	CAPM	1998-2012	Hong Kong	GARCH	Lag effect
Lu and Dong (2017)	CAPM	2005-2016	China	VAR	Real estate →Stock market

Table 2. Summary statistics of the data, 2000-2016, NT=31x17=527 observations.

Variable	Definition, units	Mean	Std. Dev.	Minimum	Maximum
Y	Dependent variable:				
CHSOR	Total annual commercial housing sales (in billion CNY)	134.60	185.80	0.05	1621.00
X	Independent variables:				
NSR	Total transaction of the stock market for domestic investors (billion CNY)	1385.00	2294.00	5.78	21195.00
INSR	Total transaction of the stock market for international investors (in billion CNY)	7.53	10.94	0.10	96.19
Z	Control variables:				
RGDP	Real GDP (in billion CNY)	1391.00	1352.00	20.17	8000.00
RGDPPC	Real GDP per capita (in thousand CNY)	3.32	2.27	0.45	11.69
POPUL	Population growth rate (in %)	0.55	0.30	-0.13	1.29
KWH	Annual power generation (in billion kwh)	813.40	697.50	3.56	3601.00
AWA	Average wages (in 10 thousand CNY)	3.20	2.04	0.69	11.99
CONS	Consumption level (in 10 thousand CNY)	1.00	0.79	0.16	4.96
MEEST	Number of medical establishment	19762.00	18717.00	1237.03	81403.00
UNICOL	Number of universities	65.40	36.65	3.00	166.00
PARK	Number of parks	291.20	438.70	1.00	3986.00
RFET	Foreign exchange earnings from tourism (in billion CNY)	11.01	17.67	0.01	127.60
RTIE	Total import and export (in billion CNY)	606.40	1158.00	1.29	6686.00

Note: CNY is Chinese currency Yuan Renminbi, $1=6.54 CNY on 26 March 2021.

Table 3. Pearson correlation coefficients, 17x31=527 observations.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	CHSOR	1.0000													
2	NSR	0.7434	1.0000												
3	INSR	0.2223	0.3849	1.0000											
4	Real GDP	0.8916	0.7536	0.3615	1.0000										
5	GDP per capita	0.6606	0.4778	0.1025	0.5651	1.0000									
6	Population	-0.1974	-0.1359	-0.1651	-0.2424	-0.4058	1.0000								
7	Electr. kwh	0.7007	0.6441	0.2804	0.8537	0.3963	-0.1616	1.0000							
8	Wages	0.6064	0.4719	-0.0719	0.4434	0.7925	-0.0834	0.3660	1.0000						
9	Consumption	0.7271	0.5411	0.0535	0.5876	0.9371	-0.3023	0.4199	0.8876	1.0000					
10	Medical establ.	0.5175	0.4992	0.1212	0.6238	0.1614	-0.1018	0.6648	0.2816	0.2305	1.0000				
11	Universities	0.6962	0.5946	0.3113	0.8463	0.4176	-0.4038	0.7449	0.3033	0.4322	0.6770	1.0000			
12	Parks	0.7224	0.5516	0.3266	0.7705	0.3190	-0.0691	0.6222	0.2366	0.3536	0.3625	0.5564	1.0000		
13	Tourism	0.6590	0.4383	0.3460	0.6476	0.5475	-0.1630	0.4130	0.3305	0.5238	0.1146	0.4488	0.8183	1.0000	
14	Import/export	0.7078	0.4883	0.3607	0.7424	0.5628	-0.1573	0.5001	0.3528	0.5516	0.1420	0.5035	0.8225	0.9325	1.0000

Notes:
1. CHSOR is total housing sales, NSR represents the total transactions in the national stock market; INSR refers to transactions in the stock market for international investors.
3. Tourism shows the foreign exchange earnings from tourism.
4. Import/export describes the total import and export.

Table 4. The panel unit root test results for all the groups.

	I(0)	I(1)
Variable	IPS	IPS
lnCHSOR	-1.3767** (0.0843)	-4.5035*** (0.0001)
lnNSR	3.3954 (0.9997)	-8.S233*** (0.0001)
lnINSR	-9.2501*** (0.0001)	..
lnGDP	-1.5845*** (0.0505)	..
lnGDPpc	-1.7529** (0.0398)	..
Population	-0.7987 (0.2122)	-6.5777*** (0.0001)
KWh	5.6279 (1.0000)	-6.2389*** (0.0001)
lnAWA	1.3706 (0.9148)	-2.1031*** (0.0177)
lnCONS	5.6070 (1.0000)	-6.1146*** (0.0001)
Medical estab.	2.7301 (0.9968)	-3.1892*** (0.0001)
Universities	-3.5827*** (0.0002)	..
Parks	13.3341 (1.0000)	-3.5264*** (0.0002)
lnTourisms	3.9722 (1.0000)	-10.0775*** (0.0001)
lnRTIE	-4.6596*** (0.0001)	..

Notes: standard errors in parenthesis. ***, **, * significant at 1%, 5%, 10% levels of significance.

Table 5. The result of Pedroni cointegration test, NT=527 observations.

Pedroni test for cointegration				
Ho: No cointegration	Number of	panels	=	31
Ha: All panels are cointegrated	Number of	periods	=	16
Cointegrating vector: Panel specific				
Panel means: Included	Kernel:	Bartlett		
Time trend: Included	Lags:	6		
AR parameter: Panel specific	Augmented	lags:	1 (AIC)	
Cross-sectional means removed				
Statistic	p-value			
Modified Phillips-Perron t	5.6228	0.0001		
Phillips-Perron t	-3.6737	0.0001		
Augmented Dickey-Fuller t	-1.4761	0.0700		

Pedroni's cointegration tests:						
No. of Panel units: 31 Regressors: 7						
No. of obs.: 527 Avg obs. per unit: 17						
Data has been time-demeaned.						
Test stats	Panel 1	group 1	Panel 2	group 2	Panel 3	group 3
v	-3.065	.	-1.741	.	-1.17	.
rho	6.332	8.593	4.700	6.861	2.793	4.940
t	-1.602	-1.379	-6.174	-8.320	-2.493	-3.311
ADF	6.753	8.958	1.039	1.180	5.384	5.901
All test statistics are distributed N(0,1), under a null of no cointegration and diverge to negative infinity (save for panel v).						

Table 6. Summary of 3 different estimation method and Hausman test, NT=527 observations.

lnChsor	Model 1 (MG)	Model 2 (PMG)	Model 3 (DFE)
ECT			
lnNSR	0.5854*** (0.1987)	0.7710*** (0.0350)	0.7284*** (0.0567)
lnINSR	-0.7716*** (0.1271)	-0.8993*** (0.0714)	0.7284*** (0.1117)
SR			
ECT	-0.3332*** (0.3238)	-0.2588*** (0.0224)	-0.2136*** (0.0287)
lnNSR	0.2076*** (0.0274)	0.1607*** (0.0193)	0.1264*** (0.0279)
lnINSR	0.1196*** (0.0163)	0.1079*** (0.1080)	0.0972*** (0.0186)
Hausman	0.5854	0.7710***	
	-0.7716	-0.8993***	
	chi2 = 1.02, p-value = 0.6010		
	C	0.7710***	0.7284
		-0.8993***	-0.9049
		chi2 = 0.02, p-value = 0.9889	

Notes:
1. *p<0.10, **p<0.05, ***p<0.001
2. In the estimation between MG and PMG, H0 confirm that PMG more efficient than MG;
In the estimation between PMG and DFE, H0 confirm that PMG more efficient the DFE.
3. In the most cases, the Hausman test cannot include the conditional variables.

Table 7. Causal relationship in the short-run between real estate and stock market in 31 provinces of China, NT=527 observations.

Dependent variable: lnCHSOR			Short-run causality		Dependent variable: lnCHSOR			Short-run causality	
Province	lnNSR	lnINSR	lnNSR	lnINSR	Province	lnNSR	lnINSR	lnNSR	lnINSR
Shandong	0.1253 (0.133)	0.0905 (0.042)	no	yes	Qinghai	0.3006 (0.004)	-0.7704 (0.221)	yes	no
Guangxi	0.1312 (0.087)	0.1652 (0.000)	no	yes	Heilong-jiang	0.0478 (0.670)	0.1080 (0.130)	no	no
Jiangsu	0.2795 (0.030)	0.1366 (0.047)	yes	yes	Shanghai	0.2217 (0.109)	0.1532 (0.090)	no	yes
Henan	0.2163 (0.022)	0.0040 (0.942)	yes	no	Guang-dong	0.2457 (0.040)	0.1621 (0.042)	yes	yes
Chong-qing	0.2263 (0.042)	0.1149 (0.046)	yes	yes	Tibet;	0.4050 (0.249)	0.1107 (0.448)	no	no
Shaanxi	0.0749 (0.463)	0.0901 (0.124)	no	no	Jilin	0.0558 (0.661)	0.0867 (0.242)	no	no
Beijing	0.0788 (0.598)	0.1220 (0.169)	no	no	: Shanxi	0.0287 (0.791)	0.0998 (0.039)	no	yes
Jiangxi	0.1092 (0.295)	0.1216 (0.015)	no	yes	Fujian	0.2626 (0.048)	0.1950 (0.012)	yes	yes
Gansu	0.1272 (0.212)	0.0466 (0.410)	no	no	Ningxia	0.2480 (0.042)	0.1769 (0.005)	yes	yes
Guizhou	0.1158 (0.238)	0.1094 (0.051)	no	no	Zhejiang	0.4591 (0.003)	0.2300 (0.006)	yes	yes
Inner Mongolia	0.1471 (0.168)	0.0824 (0.164)	no	no	Hainan	0.0092 (0.941)	0.0572 (0.431)	no	no
Tianjin	0.1136 (0.468)	0.1625 (0.031)	no	yes	Sichuan	0.1835 (0.139)	0.1642 (0.008)	no	yes
Xinjiang	0.1238 (0.374)	0.1802 (0.009)	no	yes	Anhui;	0.1372 (0.105)	0.0592 (0.193)	no	no
Hebei	0.0627 (0.468)	0.0628 (0.227)	no	no	Yunnan	0.1931 (0.150)	0.0789 (0.300)	no	no
Hubei	0.1299 (0.151)	0.0967 (0.068)	no	no	Hunan	0.1162 (0.115)	0.0651 (0.106)	no	no
Liaoning	0.0049 (0.972)	0.0886 (0.265)	no	no					

Note: Eastern region provinces include: Beijing, Fujian, Guangdong, Guangxi, Hainan, Hebei, Jiangsu, Liaoning, Shandong, Shanghai, Tianjin, and Zhejiang. Central region provinces include: Anhui, Heilongjiang, Henan, Hubei, Hunan, Inner Mongolia, Jiangxi, Jilin, and Shanxi. Western region provinces include: Chongqing, Gansu, Guizhou, Ningxia, Qinghai, Shaanxi, Sichuan, Xinjiang, Yunnan, and Xizang.