Dynamic Correlations between Real Estate Prices and International Speculative Capital Flows: An Empirical Study Based on DCC-MGARCH method

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Abstract

This paper employs DCC-MGARCH to calculate the dynamic correlation coefficient between international capital flows and real estate prices. Then it uses VAR model to analyze the relationship between the dynamic correlations between international capitals flows and real estate prices. The empirical study shows that there is a steady positive correlation between real estate prices and international short-term capital flows. When the real estate prices go up, the correlation coefficient is higher, which will lead the short-term international capital to entry. However, when the prices suffer a downturn, the correlation coefficient is lower, which will lead it to quit. The entry of short-term international capital will contribute to the increase of the real estate prices.

Keywords: real estate prices; international speculative capital flows; dynamic conditional correlation coefficient; VAR model

1. Introduction

The rapid appreciation of housing prices and the growth of investment-oriented housing purchases have been continuing in the past few years. Lured by the rising prices of housing and the steady revaluation of the Chinese currency RMB, foreign funds entered the real estate markets in some popular regions, such as Shanghai and Beijing, through various channels. The entry of international capital brings huge capital and advanced management experience, helps accelerate an increase of supply in real estate market directly and indirectly. Prasad & Wei (2005) reported that starting from 2003, there has been huge capital inflows into
China that can't be explained by trade surplus or foreign direct investment [1]. Zhang & Fung (2006) indicated the speculative capital inflow is believed to have fuelled inflation, driven up stock prices, and helped accelerate a worrisome bubble in the real estate market [2].

The real estate market is one of the pillars of the Chinese economy and its development has fuelled the economic growth and promoted a restructuring of the economy. The fluctuation of real estate prices relate to cities’ potential development ability and competition, and moreover influences the stability of financial system and the establishment of macroeconomic policy. It is indicated that the international capital flow could easily produce a bubble and be one of the reasons of the collapse of housing bubble. Coupled with the sudden increase in China's foreign exchange reserves in the past several years, the domestic real estate market experienced a protracted bull run during the same period, causing many to wonder whether China may be the next country to suffer sharp real estate price declines, or whether it may escape relatively unscathed.

Under the background of real estate prices inflation, it will help to formulate supervision polices of foreign investment, reduce the negative effect caused by international capital flow and stabilize the real estate prices to promote the sustainable, healthy and stable development of real estate industry.

The remainder of this paper is organized as follows: Section 2 gives some background discussions on international capital inflows resulting from the financial liberalization in China and the relevant literature review. Theoretical background is described in Section 3. Section 4 provides empirical analysis. The last section summarizes the main findings and draws some relevant policy implications.

2. Literature Review

2.1. The Reason Resulting in International Capital Flow

According to interest rate parity theory, the difference of interest rate is the main season that results in the short-term international capital flow.

The capitals will inflow the country with higher interest rate when the difference of interest rate can make up capital gains tax and this currency will continue. Fleming (1962) indicated that the international capital flow is more sensitive to floating interest rate than fixed interest rate [3]. Mundell (1962) demonstrated that the international capital flows are responsive to interest rate differentials [4]. Branson (1968) suggested that the short-term international capital flows depends on the imports and exports balance, interest-rate and exchange rate [5]. Calvo & Reinhart (1993) argued that capital inflows into Latin America are partly explained by conditions outside the region, and the importance of external factors suggests that a reversal of those conditions may lead to future capital outflow, increasing the macroeconomic vulnerability of Latin America economics [6].

2.2. The Effect of International Capital Flows

Owing to capital premium in stock market and real estate market that affects the short-term international capital flows, the correlationship of them has become a new research focus. As indicated in Kim & Singal (2000), the movements of speculative funds, particularly in emerging markets, are allegedly highly sensitive to differences in interest rates, expectations of currency revaluations, and expected returns from holding securities [7]. Gerlach & Peng (2004) studies the relationship between residential property prices and bank lending in Hong Kong and suggest that excessive bank lending was not the root cause of the boom and bust cycles of the property market in Hong Kong [8]. Chari & Kehoe (2003) indicated the nature of the portfolio investments is that they are very yield sensitive, volatile, of shorter duration and are easily exposed to some information frictions, expectations, and herd behaviour of the investors in comparison to other forms of capital flows [9]. During the study of Thailand in the pre-crisis period from Jansen (2003), private capital inflows are found to be
associated with higher asset prices, lower lending rates, surges in bank lending and domestic spending driven by higher investment, higher output, modest inflation, and modest real exchange rate appreciation [10].

Meanwhile, in the past few years the effervescent Chinese real estate market has been surging rapidly. Chu & Sing (2004) believe that the growth of real estate prices in China is largely because of significant influx of foreign capital into the market [11]. Meng (2006) studied influence mechanism of international capital flows on real estate prices and found that the fluctuation of international capital flow would lead to the fluctuation of real estate prices [12]. Xia (2007) classified the foreign investment and indicated that short-term international capital invested in central cities would boost the housing price and lead to the bubble of real estate [13]. Guo & Huang (2010) indicated that hot money had driven up property prices as well as contributed to the accelerating volatilities in both China’s real estate market and stock markets due to its enormous size and its short-term characteristic of investing [14]. Zhao et al. (2011) establishes a VAR model and analyze the impulse responses and its intensity degree of short-term international capital flows to China’s foreign exchange market, monetary market, stock market and the real estate made and established a threshold model and analyze the threshold effect under different variables as threshold variables [15]. In addition, data mining method is gradually applied to relative field of research [16-18].

There is little evidence in the extant literature on the role of speculative capital inflow in the recent evolvement of China’s real estate market and the empirical question as to what extent the speculative capital factor is transmitted to the behavior of housing prices remains unaddressed. Therefore, we intend to explore and shed more light on this issue, which not only warrants a timely study but also could be of considerable concern to scholars and policymakers worldwide. Toward this end, we utilize a dynamic conditional correlation multivariate GARCH model and a multivariate vector autoregressive (VAR) model. Our empirical results demonstrate that there is a steady positive correlation between real estate prices and international short-term capital flows. When the real estate prices go up, the correlation coefficient is higher and when the prices suffer a downturn, the correlation coefficient is lower. The higher correlation coefficient will lead the short-term international capital to entry and the lower one will lead it to quit. The entry of short-term international capital will contribute to the increase of the real estate prices.

3. Theoretical Background

3.1. The View of Money Supply Theory

In an open economy, the money supply can be written as:

\[ M_s = k \cdot MB = k \cdot (R + W) \]  \hspace{1cm} (1)

where \( M_s \) is the money supply, \( k \) is the money multiplier which tells us what multiple of the monetary base is transformed into the money supply. \( MB \) is the money base which equals currency \( W \) plus reverse \( R \). Under fixed exchange rate system, the exchange rate \( e \) is a constant and \( R \) equals the foreign exchange reverse times the exchange rate:

\[ M_s = k \cdot (e \cdot U + W) \]  \hspace{1cm} (2)

The international capital flows will make the change of foreign exchange reverse. The number of money supply will change in the multi-change through the multiplier effect of base money. One unit change of international capital flows will lead to the \( k \cdot e \) unit change of money supply. We will investigate how the international capital flows act on the real estate prices through the channel of money supply with IS-LM and AS-AD model under the situation of international capital inflows.

As Fig. 1 shows, \( i \) is the interest rate and \( Y \) is the output. The IS curve is the equilibrium line of product market and the LM curve is equilibrium line of money market. The equilibrium point is the intersection point of LM line and IS line. In this point, the economy is in the equilibrium status in that the supply equals to the
demand. Initially, the equilibrium is at point $E_0$. The interest rate is at point $i_0$ and the output is at point $Y_0$. If the money supply increases steadily owing to the international capital inflows, the aggregate $LM_0$ curve shifts rightward to $LM_1$. At the new equilibrium, this is point $E_1$, the interest rate level has decreased from $i_0$ to $i_1$ and the output level has increased from $Y_0$ to $Y_1$.

![Fig. 1. IS-LM model](image1)

![Fig. 2. AS-AD model](image2)

In Fig. 2, $P$ is the aggregate price level and $Y$ is the equilibrium output. The aggregate supply curve AS will keep unchangeable. When the output increases to point $Y_1$, the aggregate demand curve AD shifts rightward from $AD_0$ to $AD_1$. At the new equilibrium, that is point $E''$, the price level has increased from $P_0$ to $P_1$. The aggregate price level will increase by the excess money supply owing to the international capital inflow. Meanwhile as part of property prices, the real estate prices will follow the currency or lead to the inflation.

In recent years, the rapid increase of foreign exchange reverse makes the central bank issue lots of money, which leads to excessive liquidity and enlarge the scale of debt of commercial bank. The capital will look for the profit chance owing to expansion of credit debt. With the commercial reform of commercial bank, considering the profit and risk the commercial bank would provide more and more debt to the housing buyers and real estate developers aiming at the maximization of their interests. The excessive capital aggregation in real estate industry will increase the real estate prices and boost the real estate bubble.

3.2. The Review of Terms of Trade

With the development of economic integration process, there is a relationship of mutual development between international capital flows and trade liberalization. The international capital flows have an influence on the commodity prices of the country with trade liberalization. We utilize the terms of trade to analyse the impact that the international capital flows have on real estate prices.

In Fig. 3, we will analyse the consumption effects of price change. $T$ is trade goods that can be traded in the international market. Its price is an endogenous variable depended on the international market. $N$ is non-tradable commodity that can’t be traded in the market and its price depends on the domestic market that is an exogenous variable. The house belongs to one of non-tradable commodities. The line $PP''$ is the curve of production capacity. $U_1$ and $U_2$ are the indifference curves of consumers. $I$ is the budget line of domestic consumers that depends on the consumers’ income level and commodity prices. We can write it as:

$$I = T \times P_T + N \times P_N$$

(3)
where $e$ is nominal exchange rate under the indirect quotation method, $q$ is real exchange rate, $P_T$ is the international price of tradable commodity and $P_N$ is the price of non-tradable commodity that can be written as: $q = eP_T / P_N$, a rise in $q$ means devaluation of domestic currencies. According to the international economics theory, the international capital will have an influence on the real exchange rate. Because the prices of tradable commodity are depended on the international market, the international capital will have an impact on the prices of non-tradable commodity under the fixed interest-rate system.

Initially, the economy equilibrium is at point $A$ where the aggregate expenditure equals to the aggregate output. The quantity is measured by the value of tradable commodity $E$ which can be written as: $E = T_e + eP_T$. In this sense, the economy reaches to internal equilibrium. Meanwhile, owing to the lack of trade deficit, the economy reaches to external equilibrium. At point $A$, the production possibility curve $pp'$ is tangent to the indifference curve $U_1$ to realize the maximization of efficiency. Now considering the international capital inflows, the international capital inflows make the demand of money increase, which makes the domestic currencies valuation. Under the fixed interest-rate system, $P_T$ is depended by the supply and demand of international market, which makes a rise in $P_N$. We can write the above equation as: $T = 1 / eP_T - (P_N / eP_T) \cdot N$, where the absolute value of slope of income curve is the inverse of real interest-rate $q$. As is shown in Fig. 3, the income curve $I$ shifts from $I_1$ to $I_2$ and the new equilibrium is at point $B$. At point $B$, the income line and utility curves shift to $I_3$ and $U_2$ in a parallel way owing to the international capital inflows. At point $C$, the real consumption of tradable commodity is $T_c$ and $T_r - T_c$ means the trade deficits $BC$. We can conclude that the capital flows will have an impact on non-tradable commodity and the long-term capital inflows will make the prices of non-tradable commodity rise. As part of non-tradable commodity, the rise of real estate prices could be illustrated by the mechanism of “the international capital flows-the rise of non-tradable commodity”.

![Fig. 3. Terms of Trade](image)

4. Empirical Analysis

4.1. Data and Preliminary Analysis

We turn now to define and present relevant data in this section. Monthly data from January 2003 to December 2011 are utilized for the study, instead of the annual or quarterly data employed by the earlier studies.
which may suffer from considerable size distortion and loss of power. Using higher frequency data allows us to better capture the fluctuations of international capital flows in driving the property market during periods of policy changes in China. The economic variables included in the analysis, which are retrieved from the CEIC Database, are defined as follows:

International Speculative Capital Flows (ISC) — Following Martin and Morrison (2008) and Zhang and Fung (2006), we calculate the amount of hot money inflow as follows: (change in foreign exchange reserves) minus (trade and service balance) minus (foreign direct investment). In the analysis, the ISC is International Speculative Capital inflow measured in billion RMB in the preceding month.

Housing price (HP) — It is defined as the national average selling price of commodity building per square meter. This is the only available monthly time series to reflect property prices for long-term analysis, because there are no official aggregate real estate price series or indices in China until the very recent past.

We adjust the housing completion (HC) variable to account for their exhibited seasonal volatilities. ISC, HP measured in nominal terms, are deflated by the consumer price index (CPI, 2000=100) to reflect the real activity in these areas. Table 1 provides some summary statistics for International Speculative Capital (ISC), housing price (HP).

It indicates that, over the sample period, all the series evidence significant skewness and kurtosis. Jarque–Bera test statistic suggests rejection of the null hypothesis of normal distribution. Furthermore, the Box-Pierce Q and Q-squared statistics with 6 and 12 lags show a strong degree of autocorrelation in these variables.

Fig. 4 displays the movements of key variables of interest over the sample period. Overall, we see that behaviours of housing price and ISC were quite similar. Fig. 1 also shows that China's real estate market has been booming for the past several years, despite a slight price adjustment in 2008. The swift rise in China's real estate prices is believed to be affected by rapid economic growth and the process of urbanization (Fung et al., 2006). The speculative funds tend to have substantial volatilities after 2006. In particular, it jumps to extremely high levels between 2008 and 2010, reflecting possible increased sudden speculative attacks on China's markets.

Table 1. Summary statistics of international speculative capital and housing price

<table>
<thead>
<tr>
<th></th>
<th>International Speculative Capital</th>
<th>Housing Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>507.5110</td>
<td>3863.564</td>
</tr>
<tr>
<td>Std.dev</td>
<td>2003.385</td>
<td>1025.769</td>
</tr>
<tr>
<td>Max</td>
<td>5276.270</td>
<td>6436.990</td>
</tr>
<tr>
<td>Min</td>
<td>-5417.270</td>
<td>2254.230</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.578398</td>
<td>0.271884</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>4.889626</td>
<td>2.053755</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>22.08990</td>
<td>5.359789</td>
</tr>
<tr>
<td>BP(6)</td>
<td>42.598***</td>
<td>75.845***</td>
</tr>
<tr>
<td>BP(12)</td>
<td>52.962***</td>
<td>161.01***</td>
</tr>
<tr>
<td>BP2(6)</td>
<td>58.788***</td>
<td>98.805***</td>
</tr>
<tr>
<td>BP2(12)</td>
<td>68.554***</td>
<td>195.81***</td>
</tr>
</tbody>
</table>

![Fig. 4. Housing Prices and ISC Movement (Jan 2003-Dec 2011)](image-url)
4.2. Estimation of DCC-MARCH model

(a) Estimation Results

The DCC model was designed to allow for two stage estimation, where in the first stage univariate GARCH models are estimated for each residual series, and in the second stage, residuals, transformed by their standard deviation estimated during the first stage, are used to estimate the parameters of the dynamic correlation.

i) Conditional Correlation

The GARCH(1,1) model can be depict the volatility of the housing prices and international speculative capital movement, which can be used to analyse the conditional variance of samples. Prior to the identification of possible long-term relations of the variables specified in GARCH model, it is necessary to verify that all variables are stationary since lack thereof can make any empirical results deceptive. The housing price in natural logarithm in levels is I(1) and the ISC in all levels is I(1). It seems to be appropriate for analysing the GARCH model consisting of ISC, \( \ln(HP) \). The estimation results show that there exists conditional heteroskedasticity for housing price and international speculative capital series. The parameter of GARCH is higher the parameter of ARCH for each series, which means that the conditional variances are effected by the prior ones for sample series. Meanwhile, the parameters \( \alpha \) and \( \beta \) are nonnegative with the additional constraint that \( \alpha + \beta < 1 \).

Table 2 Time-varying volatility of housing price and international speculative capital

<table>
<thead>
<tr>
<th></th>
<th>Housing Price GARCH(1,1)</th>
<th>ISC GARCH(1,1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient CONSTANT</td>
<td>0.001</td>
<td>0.1526</td>
</tr>
<tr>
<td>Std.dev</td>
<td>0.001</td>
<td>0.0818</td>
</tr>
<tr>
<td>T-value</td>
<td>0.946</td>
<td>1.9857</td>
</tr>
<tr>
<td>P-value</td>
<td>0.343</td>
<td>0.0017</td>
</tr>
</tbody>
</table>

(b) The Dynamic Correlation Coefficient

According to the parameters of GARCH model, we utilize DCC-MGARCH model to analyse the dynamic correlation between housing price and international speculative capital. The method to estimate the parameters is to maximize the Logarithm likelihood function. The result is shown as:

\[
Q_t = 0.413\bar{Q} + 0.132\varepsilon_{t-1}\varepsilon_{t-1}' + 0.455Q_{t-1}
\]

(11)
The $\beta$ is 0.455, which means that the current conditional heteroskedasticity is affected by the prior one. According to the results, we can draw the graph for the time-varying conditional correlation coefficient between ISC and Housing Price.

Fig. 6 shows that the time-varying conditional correlation coefficient between ISC and housing price. The maximum and minimum of the time-varying conditional correlation coefficient is 0.36 and -0.21 respectively. The correlation coefficient is positive except few months. Except for the market factors, the reasons for the negative correlation coefficient are that the exchange rate of RMB raised from 8.2765 to 8.0702 from 2005.6 to 2005.12 and the return profit of real estate market in China decreased from 2008.6 to 2008.12. The correlationship between international speculative capital can be divided into three stages:

Stage One: From 2003.1 to 2005.8, it is the initial period of reformation of real estate market in China. The aggregate housing price was in a steady level. The correlation coefficient is in a lower level except few months and the average is about 0.13.

Stage Two: From 2006.6 to 2008.6, the fixed asset investment and the real estate development investment kept rising in this period. Some real estate enterprise developed quickly in the scale and capital. The correlation coefficient is in a higher level comparing to stage one and the average of correlation coefficient is about 0.15.

Stage Three: From 2009.1 to 2011.5, the real estate industry of China experienced a protracted bull run during the period. The housing prices in some cities such as Beijing, Shanghai, Guangzhou, Shenzhen experienced rapid growth. And the speculative demand factors influence the real estate price. It is the asset bubble period. The correlation coefficient during this period reached a higher level comparing to the prior two stages. The average of correlation coefficient reached 0.21.

Above all, in the asset bubble period, the dynamic correlationship between international speculative capital and housing price is obvious and positive.

![Dynamic Correlations](image)

**Fig. 6. Time-varying Conditional Correlation Coefficient between ISC and Housing Price**

### 4.3. Empirical Results based VAR

#### 4.3.1 VAR model

To further study on the dynamic correlationship between international speculative capital and housing price, we establish the VAR model consisting of housing price and international speculative capital. The estimation result is shown as:

$$
\begin{bmatrix}
D(HP) \\
D(ISC)
\end{bmatrix} =
\begin{bmatrix}
-0.567863 & -0.452316 & 0.096395 \\
-0.147869 & 1.073974 & 0.576141 \\
0.0123753 & 0.00019319 & 0.001861 \\
0.669153 & -0.454862 & -0.1017986
\end{bmatrix} \begin{bmatrix}
D(HP)_{t-1} \\
D(HP)_{t-2} \\
D(HP)_{t-3}
\end{bmatrix}
+ \begin{bmatrix}
0.0019319 \\
-0.454862 \\
-0.001861 \\
-0.1017986 \\
-0.576141 \\
-107.0892
\end{bmatrix}
\begin{bmatrix}
D(ISC)_{t-1} \\
D(ISC)_{t-2} \\
D(ISC)_{t-3}
\end{bmatrix}
+ \begin{bmatrix}
49.71959
\end{bmatrix}
\begin{bmatrix}
12
\end{bmatrix}
$$

(12)
The VAR model above is stationary through the test. Owing to the variables in 1 difference level, we can’t make the illustration for the economic meaning of variables through the coefficients. But we can make an initial judgment to the short-term dynamic correlation of housing price and international speculative capital through observing the coefficients.

Through the equations above, the changes of housing price in short term are affected by itself. The international speculative capital inflows have a positive effect on the rise of housing price, but it is not the main reason. The rise of housing price has a positive effect on international speculative capital inflows in short term obviously. The international speculative capital is only affected by the number in t-1 time, which shows the characteristic to chase the profit.

4.3.2 Impulse Response Results

The impulse response results are shown in Fig. 7. We conclude that the response of housing price to a shock of itself is an instant and positive response, while the response of international speculative capital to a shock of housing price is not significant. The response of housing price to a shock of international speculative capital is no significant, while the response of international speculative capital to a shock of itself is very significant, but it can’t continue for a long time.

The change of international speculative capital in the first time is negative, which is opposite to the normal. But we think that although the international speculative capital has the feature to chase the high profit, the response of international speculative capital to a shock of housing price is lagged owing the decision delay and capital supervision and regulation. After one month, the effect will be significant.

5. Summaries and Conclusions

This paper utilizes the theory of money supply-demand and terms of trade to analyse the effect of international speculative capital on housing price. We employ DCC-MGARCH to calculate the dynamic
correlation coefficient between international capital flows and real estate prices. Then it uses VAR to analyse the relationship between the dynamic correlations between international capitals flows and real estate prices. The empirical study shows that there is a steady positive correlation between real estate prices and international short-term capital flows. When the real estate prices go up, the correlation coefficient is higher and when the prices suffer a downturn, the correlation coefficient is lower. The Higher will lead the short-term international capital to entry and the lower will lead it to quit. The entry of short-term international capital will contribute to the increase of the real estate prices.

Above all, in short time, the rise of housing price will make the international speculative capital inflow and the inflows of speculative capital will lead the housing price to rise. The dynamic correlation between them will increase the violability of housing price. The over-inflows of international speculative capital will boost the real estate bubble. It is urgent to how to utilize the foreign capital to protect negative effect of the over-inflows of international speculative capital on real estate market.

Our findings have at least a couple of important implications for policymakers regarding the real estate market in China, so as to avoid any reckless lack of oversight. First, they should carefully examine and uncover the underlying primary driving forces in housing price which is unique to the Chinese economy, and take precautions against the potential risk factors in making future policy decisions. Second, it is critical for policymakers to guide investors to pay special attention to those unexpected factors, in particular the seeping in and out of the economy of speculative money.

References