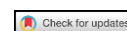




THE IMPACT OF THE 4 TRILLION RENMINBI STIMULUS PACKAGE ON THE CHINESE REAL ESTATE MARKET: A REGIONAL COMPARATIVE STUDY



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ABSTRACT

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The Four Trillion Renminbi Stimulus Package is one of the most important measures introduced by the Chinese government to deal with the subprime mortgage crisis and stabilize the real estate market. This study categorized 62 prefecture-level cities into six types of real estate markets using a hierarchical clustering method, and built a global vector autoregressive model (GVAR) model to compare and analyze the impact of the stimulus package on these different real estate markets using data covering the period from February 2006 to December 2012. According to the findings, before the stimulus package, monetary policy affected real estate prices and investment as expected across all regions, and any variations were not significant. Afterwards, however, the impact of monetary policy on both prices and investment exhibited heterogeneity. Moreover, the regulatory effect of monetary policy was no longer significant.

Contribution/Originality: This study is one of very few investigating the impact of China's 4 Trillion Renminbi Stimulus Package on regulating the regional real estate market. It not only examines the regional differences in the effect of monetary policy on the real estate market but also proposes a more scientific segmentation of that market.

1. INTRODUCTION

As a pillar industry, the real estate sector is pivotal to the development of China's economy (Aoki, Proudman, & Vlieghe, 2004). Some scholars have provided a selective survey of the few nascent research studies into the relationship between the housing market and macroeconomy (Beltratti & Morana, 2010), between which a significant multidirectional link has been found (Goodhart & Hofmann, 2008). Indeed, the real estate market has played an invaluable role as a transmission mechanism of China's monetary policy to regional economies.

The recent rapid development of the real estate market has increased financial risks, while rising house prices have created housing and other social problems (Jichang, 2015); however, macro controls implemented between 2004 and 2008 achieved different degrees of either slowdown or falloff (Shiyi & Xiang, 2016). Nevertheless, the 2008 US subprime mortgage crisis resulted in the global financial crisis, from which China, as the engine of the global economy, was not exempt. Consequently, the State Council of China announced a large economic stimulus

package on November 5, 2008 to mitigate any adverse impact: a coordinated program of ten measures to promote economic growth alongside an investment plan of 4 trillion renminbi over the following two years (Xiuting & Jichang, 2014). This program provided two funding streams for a range of new projects to be completed by the end of 2010. The first targeted infrastructure: road, rail, and airport construction; power (energy) infrastructure; rural infrastructure; environmental protection; and technological innovation, The second was aimed at people's livelihoods: low-cost housing; healthcare; social welfare; education; and agricultural subsidies (Feixue & Yun, 2010). The 4 trillion renminbi was allocated as follows: 1.8 trillion to build transport infrastructure and power grids; 1 trillion for the reconstruction of areas devastated by the May 2008 Sichuan earthquake; 370 billion to improve rural livelihoods and infrastructure; 350 billion for environmental protection; 280 billion to provide social welfare and housing; 160 billion for technological innovations; and 40 billion to fund public healthcare and education (Xianzhu & Hongyu, 2011). The 4 Trillion Renminbi Stimulus Package did contribute to economic development following the global financial crisis, but only in the short term (Jichang, 2015). Eventually, the rapid rise and significantly greater fluctuations in real estate market prices weakened the effectiveness of the monetary policy and other real estate market regulations. Most studies investigating the effect of the stimulus package on the macroeconomy (Zheng & Chen, 2009) recognized that despite the central government's intention to spend mainly on improving people's livelihoods, local governments and state enterprises, backed by powerful vested interests, preferred to fund profitable infrastructure projects (Shuyi & Mingming, 2015). However, few studies have examined the specific impact on China's real estate market; therefore, this study aims to focus on this area.

Due to the significant differences between China's four major economic regions, the implementation of national macroeconomic policy varied in each, which was reflected in not only the long-term effects but also the widening interregional differences (Shaoying & Rui, 2016). Regional feedback on economic policy offer practical suggestions, though, such as how to narrow the gap between regions and promote regional economic development. In terms of the real estate market, previous studies have divided China into three regions: Eastern, Central, and Western (Yunfang & Tiemei, 2007). Among these, Bo and Xianzhu (2009) determined the contribution of market fundamentals to house prices in urban areas based on annual data between 1998 and 2009 from 29 provinces; (Zhang, Hui, & Wen, 2017) investigated the ripple effect of house prices in 35 metropolitan areas; while (Zhou & Jichang, 2018) adopted an agent-based model to examine the impact of distorted supply and demand on the resale housing market. This study applies a weight matrix to each area (Hong & Yang, 2013) to observe the regional variations in house prices between regions due to the 4 Trillion Renminbi Stimulus Package. This study is based on the monthly prices (sales price divided by sales area) of newly built houses in 62 prefecture-level cities across six regions between February 2006 and December 2012. In line with earlier studies, interest rates and money supply are also included as important factors. The different regional effects of the monetary policies are then analyzed by means of the Johansen cointegration and Granger causality tests, as well as the impulse response function (IRF) based on the global vector autoregressive (GVAR) model.

Previous studies have already proved that monetary policy affects not only China's real estate market but also regional economies, albeit differently in each. However, the empirical study of monetary policy and variations across regional markets in China remains neglected, although essential to a centrally regulated housing market. Thus, the current study explores both the dynamic relationship between monetary policy and the real estate market and different regional effects of monetary policy using a large scientifically selected sample and the GVAR model.

2. GVAR MODEL ASSUMPTIONS

The GVAR model is a new model that extends the VAR model. Starting with the VAR model, each region's $VARX^*$ matrices were connected to generate a final synthetic $VARX^*$ matrix for global-level analysis. The real estate market is then categorized into six clusters, to which the VARX model is applied: the price of and investment

in real estate is expressed as an endogenous variable ($X_{i,t}$) for Cluster 1, while for Clusters 2–6, which might indirectly influence Cluster 1, price and investment are expressed as exogenous variables ($X_{i,t}^*$). It is assumed that $X_{i,t}^*$ has weak exogeneity on Cluster 1, and the corresponding VARX model can be characterized by the following equation:

$$X_{i,t} = a_{i0} + a_{it}t + \Phi_i X_{i,t-1} + \Lambda_{i0} X_{i,t}^* + \Lambda_{i1} X_{i,t-1}^* + \varepsilon_{it} \tag{1}$$

Where: Φ_i, Λ_{i0} , and Λ_{i1} are $K_i \times K_i$ coefficient matrices; ε_{it} is a $K_i \times 1$ variable in Cluster 1, which is treated as a spontaneous impact. This spontaneous impact is assumed to have a mean of zero and no serial correlation for Clusters 1–6: $\varepsilon_{it} \sim \text{i.i.d.} (0, \Sigma_{ii})$.

Finally, to determine whether a GVAR model is possible, a cointegration test is performed before combining all the synthetic matrices. The spatial distance matrix is selected, weighted according to the distance between different cities, and the resulting GVAR model is represented by the following equation:

$$GX_t = a_0 + a_1 t + HX_{t-1} + \varepsilon_t \tag{2}$$

$$a_0 = \begin{pmatrix} a_{00} \\ a_{10} \\ \dots \\ a_{N0} \end{pmatrix}, \quad a_1 = \begin{pmatrix} a_{01} \\ a_{11} \\ \dots \\ a_{N1} \end{pmatrix}, \quad \varepsilon_t = \begin{pmatrix} \varepsilon_{0t} \\ \varepsilon_{1t} \\ \dots \\ \varepsilon_{Nt} \end{pmatrix}, \quad G = \begin{pmatrix} A_0 W_0 \\ A_1 W_1 \\ \dots \\ A_N W_N \end{pmatrix}, \quad H = \begin{pmatrix} B_0 W_0 \\ B_1 W_1 \\ \dots \\ B_N W_N \end{pmatrix};$$

$$A_t = (I_{k_i} - \Lambda_{i0}); \quad B_i = (\Phi_i, \Lambda_{i1});$$

Where: W_i is a $(k_i + k_i^*) \times k_i$ connection matrix comprising the different cluster cointegration models, in which The vectors are calculated from the distance between different cities: W_{ij}^y .

3. VARIABLES AND DATA

The current study adopted the clustering method proposed by Dong, Li, Li, and Dong (2015): a two-stage clustering of 283 cities was performed, according to housing supply–demand and market performance, to identify 3 clusters and 13 subclusters. Table 1 presents the cities selected as representative of each of the six regions (clusters), according to the data available.

Table-1. Cities selected as representative of each region.

Regional Cluster	City
Cluster 1	Chengdu, Dalian, Guangzhou, Hangzhou, Qingdao, Shanghai, Shenyang, Shenzhen, Tianjin
Cluster 2	Changchun, Changsha, Fuzhou, Harbin, Hefei, Jinan, Kunming, Nanchang, Nanjing, Nanning, Ningbo, Shijiazhuang, Taiyuan, Tangshan, Urumchi, Wuhan, Wuxi, Xi'an, Xiamen, Zhengzhou
Cluster 3	Erdos, Shaoxing, Taizhou
Cluster 4	Sanya, Wenzhou
Cluster 5	Baotou, Haikou, Hohhot, Huizhou, Luzhou, Mudanjiang, Shaoguan, Xuzhou, Yangzhou, Yinchuan
Cluster 6	Anqing, Bengbu, Beihai, Dandong, Ganzhou, Guilin, Jilin, Jining, Jinzhou, Jiujiang, Lanzhou, Luoyang, Nanchong, Qinhuangdao, Xining, Yichang, Zhanjiang

Source: China Statistical Yearbook, 2006–2012.

Money supply and interest rate were selected as the global exogenous variables, with regional real estate prices and completed investment as endogenous economic variables. A total of 83 datasets, from February 2006 to December 2012, were then extracted from the Wind Economic Database for money supply and interbank interest rates and from the national and regional statistical yearbooks for regional prices of commodity housing and investment in commodity real estate development in urban areas. In addition, consumer price index (CPI) data provided by the regional statistical yearbooks were used to convert nominal to real values. Furthermore, year-over-year change was used to represent the seasonal variations in commodity housing prices and investment, while the natural logarithm of all the variables, except for interest rate, was used to resolve the heteroskedasticity between the sequence of variables.

Finally, the current study followed Hong and Yang (2013) by constructing a spatial distance matrix for different areas, then inverting it to produce a reciprocal matrix for the weighting process, and converting it to a connection matrix that reflects the effect of each area.

4. EMPIRICAL ANALYSIS AND MODEL ESTIMATION

In the first stage of the analysis the necessary statistical tests were conducted: augmented Dickey–Fuller (ADF) unit root, Johansen cointegration, weak exogeneity, and Granger causality tests.

Table-2. ADF test results.

Variables	Inspection form (C , T , K)	ADF	PP	Conclusion
$\ln p$	(C , T , 0)	0.578266	0.870459	Nonstationarity
$\Delta \ln p$	(C , 0 , 2)	-6.808990***	-6.937651***	Stationarity
$\ln invest$	(C , T , 0)	0.89965	0.8175875	Nonstationarity
$\Delta \ln invest$	(C , 0 , 2)	-3.218475***	-3.946264***	Stationarity
$\ln p *$	(C , T , 0)	1.50570	1.383654	Nonstationarity
$\Delta \ln p *$	(C , 0 , 2)	-5.285017***	-5.297116***	Stationarity
$\ln invest *$	(C , T , 0)	1.435705	0.925586	Nonstationarity
$\Delta \ln invest *$	(C , 0 , 2)	-6.787440***	-5.04717***	Stationarity
$\ln m$	(C , T , 0)	-0.695818	-1.472252	Nonstationarity
$\Delta \ln m$	(C , 0 , 2)	-7.771073***	-7.9478***	Stationarity
$\ln i$	(C , T , 0)	-1.7247563	-2.147563	Nonstationarity
$\Delta \ln i$	(C , 0 , 2)	-6.843856***	-6.983746***	Stationarity

Notes: (C, T, K): C = constant; T = time tendency; K = order of hysteresis; PP: Phillips–Perron test.
***, $p < 0.01$.

Table 2 presents the stability results of the ADF unit root for all the variables in Cluster 1, in which the interest rate, money supply, and regional economic variables were known to be integrated of the order of I(1).

Table-3. Johansen test results.

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Probability
None*	0.567712	70.35285	47.85613	0.0001
1 max.**	0.449089	31.77433	29.79707	0.0292
2 max.	0.061489	4.350001	15.49471	0.8734
3 max.	0.030626	1.430824	3.841466	0.2316

Notes: CE: cointegration equations; critical value: $\alpha = 0.05$; probability: $p < 0.05$; *: no lag length of time; **: a lag length of one month.
Source: China's national and regional statistical yearbooks, and Wind database.

Applying Akaike's Information Criterion (AIC) to the cointegration test results shown in Table 3, a lag length of two months was selected to estimate the parameters in the GVAR model. The resulting model estimation then led to the use of the generalized impulse response function (GIRF) to analyze the regulatory effect of monetary policy on the real estate market in different regions.

Finally, the Granger causality test was performed to explain the effect of the selected variables on real estate prices.

Table-4. Granger causality test results.

Null Hypothesis	Observations	F-Statistic	Probability
LNM does not G-cause LNP	83	7.36395	0.0063
LNP does not G-cause LNM		0.68523	0.6292
LNI does not G-cause LNP	83	4.71639	0.0095
LNP does not G-cause LNI		0.06768	0.3059
LNM does not G-cause LNI	83	3.62953	0.8734
LNI does not G-cause LNM		1.48587	0.2316

Source: China's national and regional statistical yearbooks, and Wind database.

Table 4 shows that both money supply and interest rate G-cause real estate prices.

5. GENERALIZED IMPULSE RESPONSE OF THE MODEL

The GIRF was used in the current study because, unlike the Sims method, the results are unaltered by the chosen ordering of the variables, which is a more appropriate approach to a large-scale model incorporating numerous variables and complex matrix connections. The response of the real estate market to the variables was analyzed for each individual region to determine the different effects of monetary policy. Furthermore, a standard deviation of 1 was adopted as representing a positive impact of an expansionary monetary policy, while the standard deviation of interest rates represented that of a tight monetary policy. The 4 Trillion Renminbi Stimulus Package was taken as a variable of China's fiscal policy in this paper, taking the first sample interval as February 2006–December 2008, prior to the stimulus package, and the second sample interval as February 2009–December 2012, after the allocation of funds.

5.1. Impulse Response of Commodity House Prices to Interest Rates

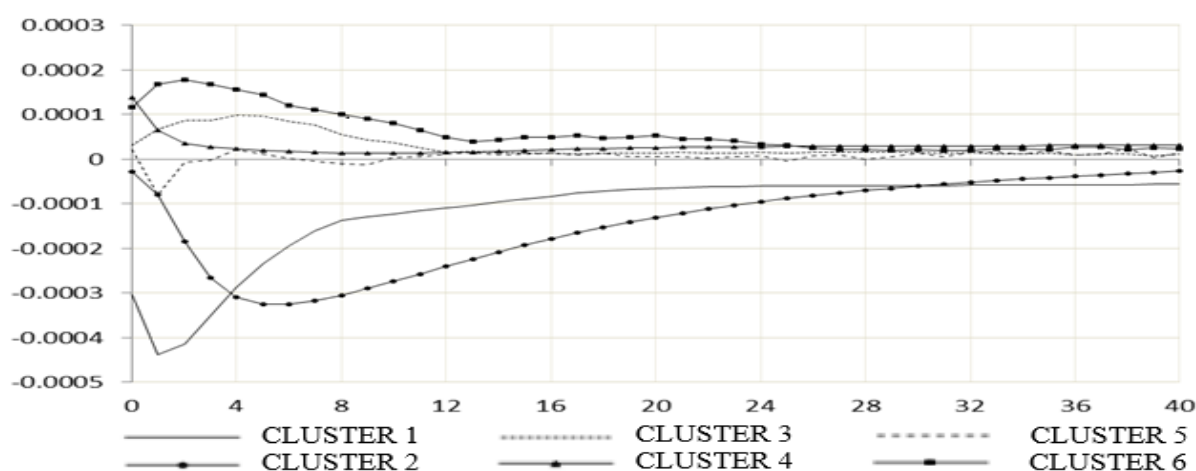


Figure-1. The impulse response of commodity house prices to the impact of interest rates prior to the stimulus package.

Source: China's national and regional statistical yearbooks, and Wind database.

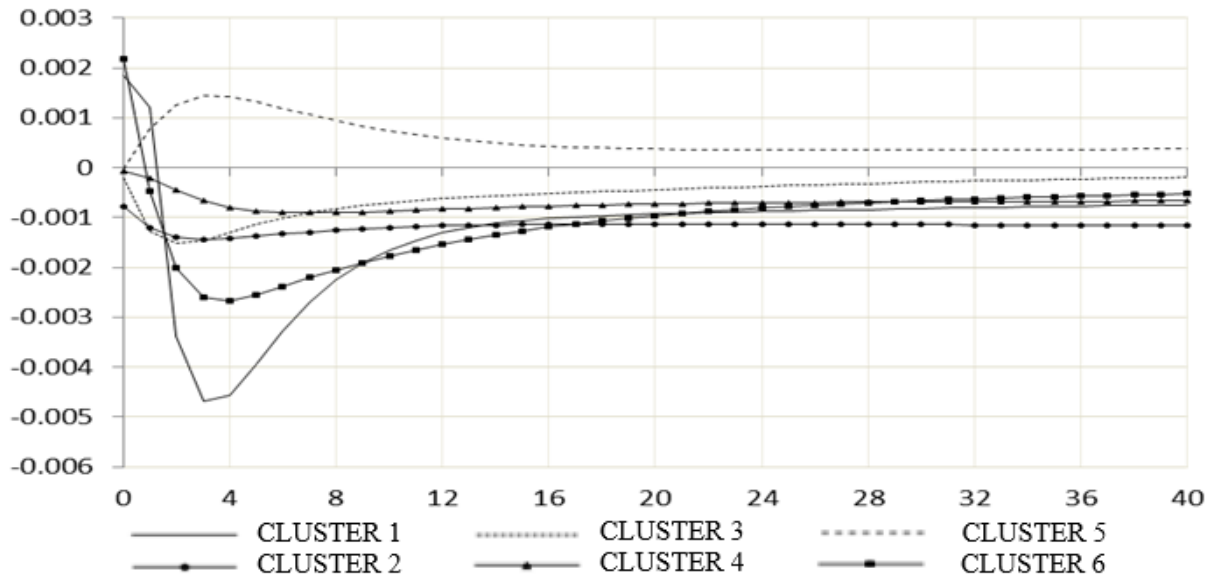


Figure-2. The impulse response of commodity house prices to the impact of interest rates after the allocation of funds. Source: China's national and regional statistical yearbooks, and Wind database.

Figure 1 shows that the cities in Clusters 1 and 2 were negatively affected by interest rates during the first sample interval, and in line with the law of economics, an inverse relationship exists between interest rates and real estate prices. The greatest impact occurred in Cluster 1 at around two months and about four months in Cluster 2, due to the financial markets of Cluster 1 being more mature and thus more responsive to changes in interest rates. In contrast, a positive impact can be seen in Clusters 3–4 initially, before prices gradually return to their original level. This difference is because of the lack of economic development in the cities of these Clusters, which means monetary policy exerts no regulatory effect on their real estate market.

During the second sample interval, Figure 2 reveals the heterogeneous effects of interest rates on prices across the six Clusters. In Cluster 1, real estate prices responded positively to changes in interest rates, with a greater response as interest rates were further adjusted. However, Cluster 2 still experienced a negative impact, although reaching its climax more quickly: at two rather than four months. Curiously, interest rates exerted a positive effect in Clusters 3 and 4 that became negative after the first quarter, for which there are two possible reasons: first, real estate prices in the cities of these Clusters were no longer susceptible to interest rates after 2009; second, the impact of interest rates show a three-month time lag. Real estate prices also responded negatively in Clusters 5 and 6, where support was needed; however, monetary policy proved ineffective.

5.2. Impulse Response of Commodity House Prices to the Money Supply

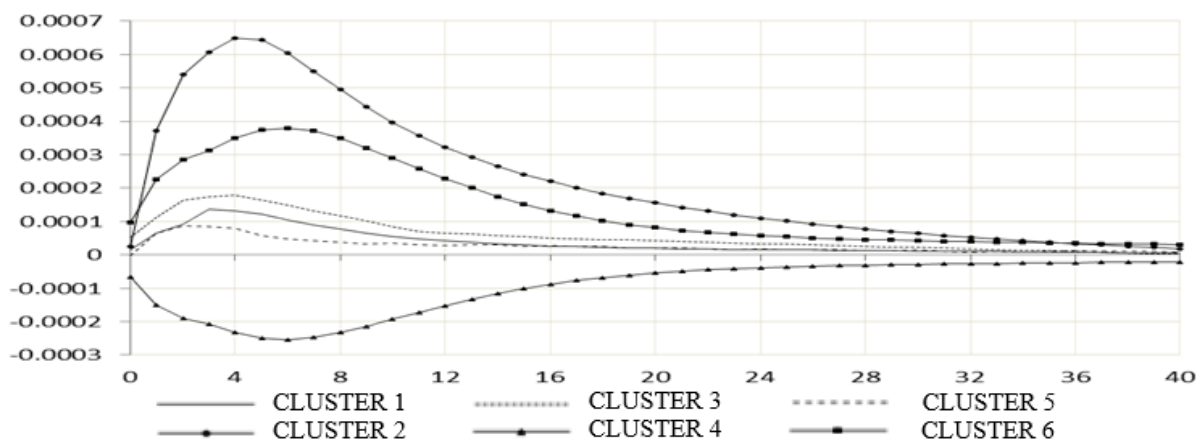


Figure-3. The impulse response of commodity house prices to the impact of money supply prior to the stimulus package. Source: China's national and regional statistical yearbooks, and Wind database.

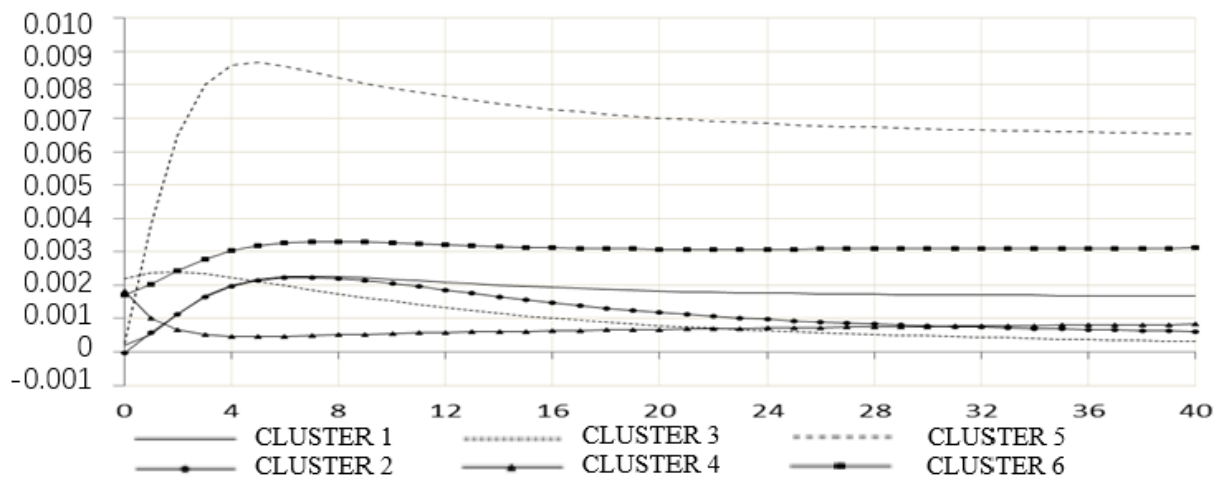


Figure-4. The impulse response of commodity house prices to the impact of money supply after the allocation of funds. Source: China's national and regional statistical yearbooks, and Wind database.

Figure 3 shows that during the first sample interval, the real estate prices in all six Clusters reached their peak in the first quarter, owing to the positive impact of one unit of money supply; however, this was gradually offset by the impact of inflation. The greatest impact occurred in Cluster 1, followed by Clusters 2 and 3. However, the response to an increase in the money supply is negative, since the real estate prices in Wenzhou and Sanya are more susceptible to speculators than monetary policy. In summary, increasing the money supply led to higher real estate prices before February 2009. In contrast, Figure 4 shows that in the second sample interval, the impact of money supply differed across the Clusters. The huge and mainly positive impact in Clusters 1, 2, and 3, though, was even greater than before February 2009. Hence, the growth rate of real estate prices is faster than that of money supply in these three Clusters.

5.3. Impulse Response of Real Estate Investment to Interest Rates

In the first sample interval, Figure 5 shows a large negative response to interest rates in Cluster 1 until returning to its original level after a long period of around 16 months. Similarly, Cluster 2 the greatest negative response in Cluster 2 persists for the first quarter, and is then sustained afterwards, albeit relatively stable. Conversely, interest rates exert no effect on real estate investment in Clusters 4–6, due to the small extent of real estate investment and greater government investment or owner-occupier housing.

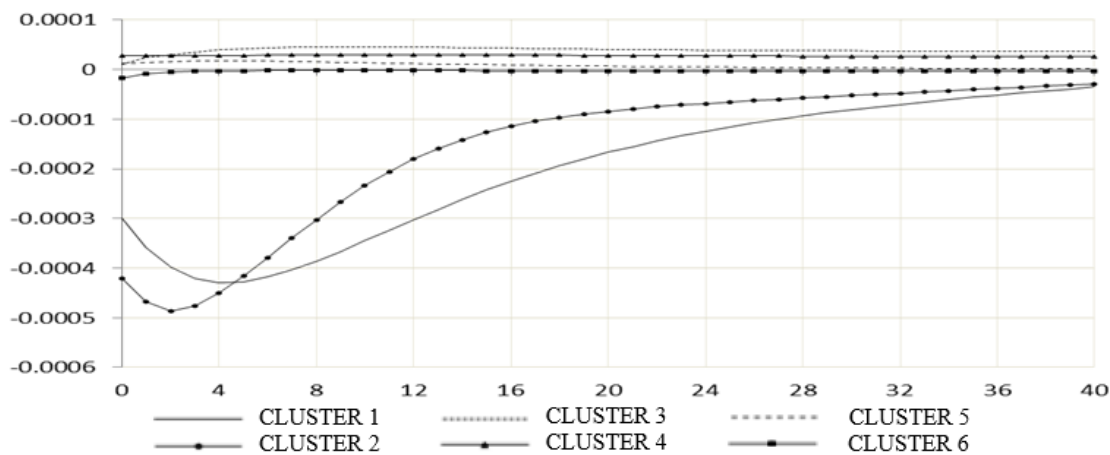


Figure-5. The impulse response of real estate investment to the impact of interest rates before the stimulus package. Source: China's national and regional statistical yearbooks, and Wind database.

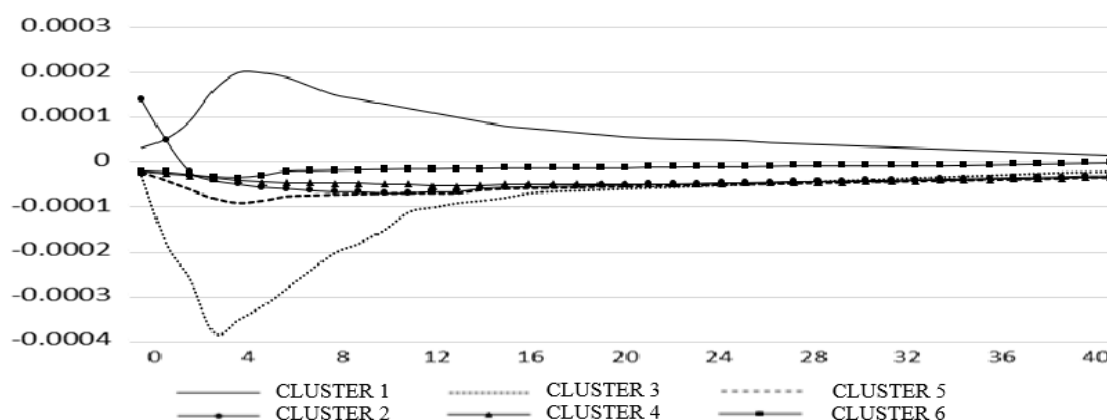


Figure-6. The impulse response of real estate investment to the impact of interest rates after the allocation of funds.
Source: China's national and regional statistical yearbooks, and Wind database.

In Figure 6, the response of real estate investment to interest rates in the second sample interval appears to be heterogeneous. Cluster 1 was positively affected by interest rates, but Clusters 2–6 all responded negatively, to a greater degree in Cluster 3 and significantly in Clusters 5 and 6. However, real estate investment remained unaffected by interest rates. Furthermore, Clusters 2, 5, and 6 reached their maximum response by around eight months. In conclusion, the monetary policy effectively controlled the real estate market before the stimulus package—the effects being as expected in Clusters 2, 5, and 6, owing to faster growth rates of real estate prices. Following the allocation of funds, the interest rates have exerted a heterogeneous effect, which is more evident in Cluster 2. Comparing the first with the second sample interval, changes in both direction and intensity of the response can be seen in all six Clusters. Real estate prices in Cluster 1 changed from a negative to positive response, indicating that more recent changes in interest rates have failed to control prices. In contrast, prices have been controlled more effectively in Clusters 2 and 3, signifying how both their economies have developed since 2009 and monetary policy has achieved the anticipated effect. However, although support was needed in Clusters 5 and 6, not only was the impact slight but the actual direction of the response was also inconsistent with that expected. These unexpected effects may be due to China implementing a uniform monetary policy across the country without taking account of regional differences.

6. CONCLUSIONS AND POLICY IMPLICATIONS

This study used monthly data from February 2006 to December 2012 for 62 prefecture-level cities to construct a GVAR model and investigate the different effects of monetary policy on six types of real estate market before and after the introduction of China's 4 Trillion Renminbi Stimulus Package.

The GIRF in the GVAR model confirmed the varied impact finding that real estate prices and investment were generally more sensitive to changes in money than interest rates before the stimulus package, which is consistent with the conclusions of earlier studies. However, this was not the case afterwards, while fluctuations in interest rates affected the real estate market of different regions differently. Using interest rates to control the real estate market failed in Cluster 1, which had the highest level of economic development. Thus occurred the counterintuitive phenomenon: "The more the real estate market is controlled, the higher the house prices." Clusters 2 and 3 are less economically developed and the regulatory effect is significant; however, in the other Clusters where support is needed, no significant regulatory effect has occurred, albeit some individual cities have experienced changes.

Based on the current study's main findings as well as the current status of China's real estate market, four implications have been identified for policymakers.

6.1. Stabilizing Interest Rates

Sharp adjustments in interest rates will exert a greater effect on the Chinese real estate market, but maintaining stability in interest rates will ensure the real estate market operates smoothly. To achieve macroeconomic goals, the Chinese central bank should take into account the possible reaction of the real estate market when formulating monetary policy: associated housing finance policies must be developed to limit the impact of fluctuations in interest rates on the real estate markets in a range of economic zones. For instance, when the loan interest rate is lowered, downpayments on properties should be appropriately increased to prevent drastic fluctuations in market demand and house prices.

6.2. Promoting Housing Savings Banks

Sharp adjustments in interest rates will exert a greater impact on lending institutions, and may even lead to financial crisis. The growth rate of real estate prices is much faster in China than that of disposable income; therefore, most residents purchase their houses using bank loans. Volatile interest rates may also result in breaches of contract and affect the steady development of the real estate market. In 2004, China established the Sino-German Housing Savings Bank that offers fixed interest rates and is a closed system independent of fluctuations in the capital market. This model should be promoted, especially in similar areas to Cluster 1, to provide residents with more finance channels and prevent the financial risks more effectively.

6.3. Using Targeted Currency Tools

As the findings of this study reveal that neither interest rates or money supply effectively regulate the real estate market, the Chinese government should adopt targeted monetary instruments. National monetary policies take no account of regional variations and are not conducive to the effective allocation of resources. However, targeted monetary policies not only support industrial development but also avoid the financing of the fictitious economy, which may aggravate financial risks. To formulate such monetary policies suited to conditions in China, the new currency tools incorporated into the US and European policies should be reviewed and adapted as required.

6.4. Focusing on Real Estate Market Differences in Regional and Monetary Policy Asymmetry

The speed and intensity of responses to the same monetary policy varies according to region in China; therefore, the central government should not only adjust regulatory measures to local conditions but also permit each region to further adjust those measures based on local circumstances. The resulting targeted monetary policy can thus guide a more stable development of the real estate market, as well as ensure that the real estate sector continues to play an important role in both the national economy and people's livelihoods; hence, the Chinese economy will be able to continue to grow and be healthy in a more open environment. With regard to first-tier cities, the main factors in the real estate market are supply and demand and the size of credit, in which case the government should continue with the current tight monetary policies, such as the housing and second-home restriction policies, which should better control the highly speculative activities.

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