Capital Inflows and House Prices: Aggregate and Regional Evidence from China

AUSTRALIAN
ECONOMIC PAPERS

CAPITAL INFLOWS AND HOUSE PRICES: AGGREGATE AND REGIONAL EVIDENCE FROM CHINA

HUI AN
Dalian University of Technology

LIJIE YU
Dalian University of Technology

RAKESH GUPTA
Griffith University

Rising house prices in China have been of concern for investors and policymakers. Prices have risen substantially in the last decade, especially in large urban cities, and some economists have expressed concerns about the affordability of residential housing for young adults. This phenomenon becomes a major concern for policymakers, in terms of managing policies to balance the residential needs of individuals and the transition to a market economy. Theoretically, house prices ought to be linked to economic factors such as disposable income, availability of land to build and credit policy. However, it appears that traditional economic theories fail to appropriately explain house prices in China. We provide an explanation from the perspective of capital inflows into China. In terms of per capita remittances, China receives the highest inflow of foreign capital, and this may have a significant impact on risk adjusted returns in the Chinese market. To investigate this relationship, we use the vector error correction model to assess the impact of capital inflows on house prices. We find that capital inflows have a significant positive effect on house prices. The study makes important contributions to understanding the relationship between house prices and foreign remittances after controlling for other economic factors. China is a large economy. Because the impact of economic development in China has not been consistent across the country, we address the regional differences in the house price changes to capital inflows. Using regional data, we show that capital inflows have an asymmetric effect on the housing market across different provinces and cities of China. This has important implications for the development of economic policies in China that aim to provide fair access to residential housing for everyone. These findings are also relevant to investors in the housing market, whether investing for a personal residential home or as part of their diversified investment portfolio. It will also be informative to see how a reversal of capital inflows associated with tighter financing conditions in advanced countries will affect house prices in China.

I. Introduction

The housing industry in China developed quickly after the reforms in 1998. Per capita floor space may be considered as a measure of the general living standard, especially for a rapidly growing

doi: 10.1111/1467-8454.12095
Correspondence: Rakesh Gupta, Department of Accounting, Finance and Economics, Griffith Business School, Griffith University, Nathan Campus QLD 4111. r.gupta@griffith.edu.au

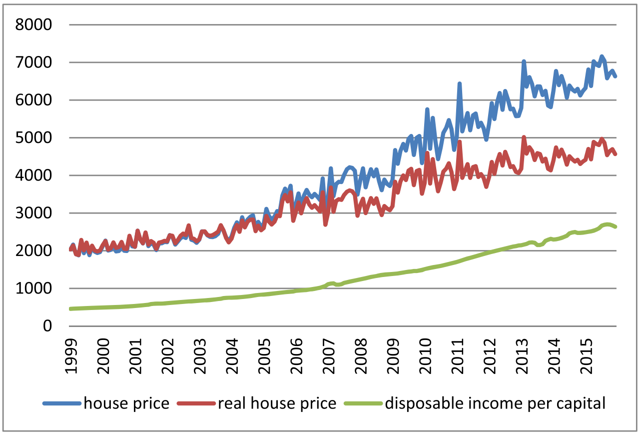

Figure 1. House price and disposable income in China between 1999 and 2015

emerging economy. The dwelling floor-space per capita has increased from 6.7 square metres in 1978 to 34.6 in 2014. The number of new constructions for every thousand people added to the population has increased from 15 in 1999 to 55 in 2015. Another aspect of the housing industry is its increasingly important role in the development of the national economy. The proportion of added value of the real estate sector in gross domestic product (GDP) has risen from about 3% in 1992 to more than 6% in 2015. Real estate (also referred to as a pillar of the economy) is a leading sector of the economy, promoting overall economic growth via a chain reaction in the economy. With this rapid development of the real estate industry, housing prices and sales in China have risen substantially in the last decade. The floor area and aggregate value of residential houses sold in 1998 were 95.11 million square metres and 171.83 billion yuan (RMB); the numbers in 2015 were 1124.06 million square metres and RMB7275.30 billion. Nationally, house prices increased by 40 times, with an annual growth rate of 14.06%, while the average stock market growth, economic growth, one-year-deposit returns and inflation were 10.55%, 9.36%, 3.02% and 1.88% respectively in the corresponding period. The trend over time (Figure 1) shows house prices consistently rising, albeit with some minor corrections, as expected from profit taking in any financial asset. Although the overall house price is rising, the rise in house prices varies considerably across regions. With China's large economy, the impact of economic development in China has not been consistent across the country, so studying the variation in housing market growth across regions may be of interest for academics, policy makers and market participants. Both the average house price and the volatility in the eastern region are significantly higher than found in the central and western regions (Table I).[1] House prices across cities are also very different. The fastest growing cities in 2015 were Shenzhen, Wuhan and Shanghai with 37.8%, 15.7% and 14.4% annual growth rates respectively; at the same time, the house prices decreased in Zhanjiang (by 9.7%), Dandong (by 8.9%) and Jinzhou (by 8.8%).

[1] We divide the provinces into three parts: eastern, central and western, according to the National Bureau of Statistics. Western region does not contain Xizang because of missing data.

Table I Regional house price (2001–2015)

Index	*Region*			
	National	*Eastern*	*Central*	*Western*
Number of provinces	30	11	8	11
Average house price (yuan/square metre)	4163.89	6163.26	3020.38	2991.43
Maximum (yuan/square metre)	25 779.64	25 779.64	6276.70	7188.05
Standard deviation	3206.45	4298.02	1406.08	1333.08

As house prices continue to increase, households with low and moderate incomes find it increasingly difficult to afford housing. The price-to-income ratio[2] for urban residents in China was 9.1[3] (China's Annual Statistical Yearbook). By contrast, according to Demographia International (2010), which computes median housing price-to-income ratios for 227 regions, the comparable national data are 2.9 for the US, 5.1 for the UK and 6.8 for Australia. The house price, per capita GDP and per capita disposable income in four first-tier cities (Figure 2) show that the gaps between house price and per capital disposable income in Beijing and Shenzhen are wide. Some economists have also expressed concerns about the affordability of residential housing for young adults. This phenomenon has become a major concern for policymakers in terms of managing policies to balance the residential needs of individuals and the transition to a market economy.

Theoretically, house prices ought to be linked to economic factors such as disposable income, availability of land to build and credit policy. However, in the case of China, it appears that traditional economic theories fail to appropriately explain this increase in house prices (Zhang *et al.,* 2012). With the acceleration of global economic integration and with China's opening to the outside world, international capital inflows are playing an increasingly important part in China's economy. A large amount of capital enters China through direct and portfolio investments. The average annual growth in capital inflows from 1999 to 2014 is 27.44%. This inflow of capital into China's economy is not uniform across sectors. For example, from foreign direct investments (FDI) in the first half of 2015, the eastern region received US$58.61 billion, 83.8% of the total FDI inflow, while the central and western regions received only US$5.67 and US$4.14 billion, respectively, accounting for less than 20%.

The manufacturing industry attracts the largest FDI inflow; next comes the real estate sector. International capital can flow into the housing market through two channels: first, directly into the housing market through setting up foreign real estate enterprises or investing in domestic real estate enterprises; second, as speculation in the Chinese housing market because of the housing boom and the strong expectation of CNY appreciation (also referred to as 'hot money'). Movements in house prices and capital inflow show that the growth of the house price is closely related to capital inflows (Appendix A). Capital inflows may have a number of significant impacts on the real estate market. They can make up for the shortfall in capital,

[2] Price-to-income ratio is the ratio between house price and household annual income. It is used to measure whether the price is at a reasonable level that residents could afford and directly reflects the matching degree between house price and owner-occupied housing demand. According to the Chinese Research Lab, the reasonable ratio in China is from three to six.
[3] The national average new house price was 4695 CNY/m^2 in 2009. Thus, an apartment of 100 m^2 costs about 470 000 CNY. According to the National Bureau of Statistics, the per capita disposable income of urban residents in 2009 was 17 175 CNY, while the annual household income was 51 525 CNY for a family of three. Therefore, in 2009, the average housing price-to-income ratio was 9.1.

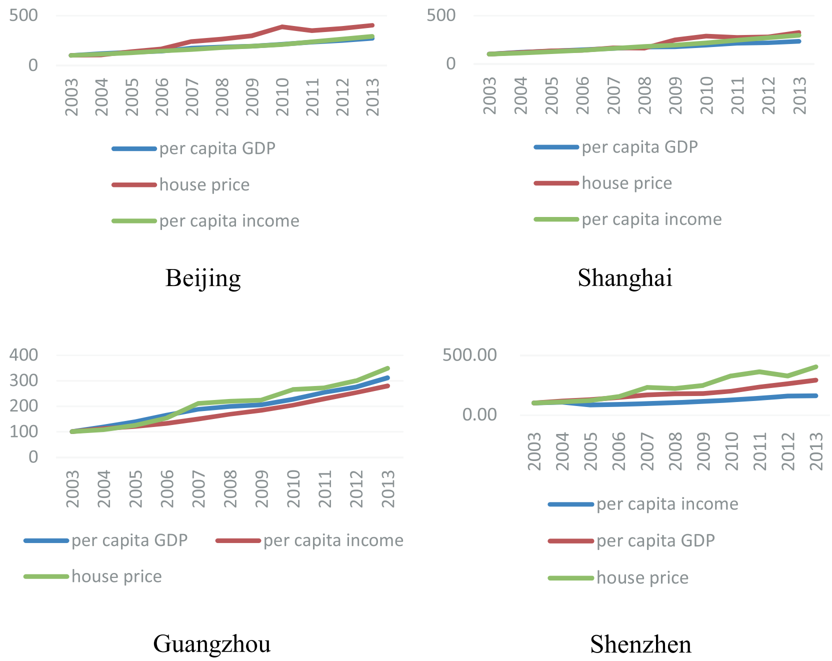

Figure 2. House price and disposable income in first-tier cities between 2003 and 2013

reduce the credit risk of domestic banks, expand the demand and supply and enhance the competition, thus contributing to the development of the real estate market. Capital inflows may have some unwarranted effects. First, they can exacerbate the imbalance of international payments, increasing CNY appreciation pressure and weakening the independence and effectiveness of monetary policy. Second, they can worsen the disequilibrium of demand and supply for real estate market because they mainly invest in high-grade real estate. Third, they can intensify speculation, bringing the 'herd effect', which triggers and prolongs house price bubbles, amplifying financial fragility. During this period, when China is in the process of capital account liberalisation and is undergoing a shift in economic priorities, it is important to understand the relationship between the capital inflows and the real estate market. Regional analysis provides a comprehensive understanding of the phenomenon, whereas regional FDI provides robustness to the findings of the study.

This study makes an important contribution to the body of knowledge by explaining the relationship between capital inflows and the real estate market, especially in the case of a large emerging economy such as China. Lessons learned from the study may be applied, in terms of understanding this phenomenon in other emerging economies such as Brazil, Russia and India. Findings of the study, which will have important implications for policy makers who aim to develop policies for capital account liberalisation, will also inform policy makers on the effective reallocation of resources, especially in the context of foreign capital inflows. This is of importance for an economy such as China, which relies significantly on the import of capital for its development. It is also important in the context of the shift in economic growth fundamentals, as China's next phase of economic growth is expected to be based on the export of services and high value-added manufacturing exports. These are the industries that may need a significant amount of capital input for global competitiveness.

The remainder of the paper is organised as follows. The next section briefly summarises the related literature. The dataset and the empirical model are introduced in Section III. Section IV discusses the main findings of the study. In Section V, we evaluate regional differences. Section VI is the robustness test. The final section draws conclusions.

II. Related Literature

Housing prices in China have risen significantly, which has become a serious problem for young adults wishing to afford a house. This phenomenon becomes a major concern for policymakers managing policies that balance the residential needs of individuals and the transition to a market economy. Many studies have investigated the nature and determinants of residential real estate values in China (Chen *et al.,* 2011; Du *et al.,* 2011; Liang & Cao, 2007; Liu *et al.,* 2002; and Wu *et al.,* 2012). The determinants investigated in these studies come from both the demand and the supply sides. From the demand side, rapid GDP and growth in disposable income, migration of rural populations to cities, urbanisation and bank lending are among the important determining factors (See, for example, Chen *et al.,* 2011; Fraser *et al.,* 2012; Hillebrand & Kikuchi, 2015; Leung, 2014; Liang & Cao, 2007; Wu *et al.,* 2012). From the supply side, construction costs, central–local fiscal relations and land prices are key factors (Liu *et al.,* 2002; Adams & Füss, 2008; Chen *et al.,* 2011; Wen & Goodman, 2013).

In the case of China, traditional economic theories appear not to be adequate for explaining house prices. For example, according to the data published by the National Bureau of Statistics of China, the gap between house prices and per capita income in China has widened since the mid-2000s. The house price index in Beijing increased by seven times from 2003 to 2014, while per capita income tripled. Because traditional theories explaining the relationship among real estate prices and the economic factors fail to explain the property price behaviour in China, and because there is an absence of literature offering an explanation for this property price behaviour in China, this study looks at reasons beyond traditional economic factors to understand the behaviour of property prices in China. Expansion and contraction of the global money supply from the mid-1990s strongly correlates with the dynamics of housing markets. Federal Reserve chairman Bernanke (2010) linked capital inflows to accelerating house price inflation and the bubble in property prices. This view is also supported by theoretical and empirical evidence (See, for example, Krugman, 1999; Caballero & Krishnamurthy, 2006; Aoki *et al.,* 2009; Korinek, 2010; Adam *et al.,* 2011; Korinek, 2011; Olaberría, 2012; Oug *et al.,* 2012). These studies, using different models to illustrate the possible link between capital flows and asset prices, make the same findings. From a theoretical standpoint, capital inflows cause an increase in demand, so asset prices go up with a fixed supply. In principle, the economy's borrowing capability is determined by the value of its assets, because of financial market imperfections such as adverse selection and moral hazard. Capital inflows therefore raise asset prices, in turn increasing the credit limit and attracting more capital inflows. The resulting capital inflows cause asset prices to boom, through a sort of circular process in which higher asset prices make financial conditions look sounder than they actually are, promoting more capital inflows that push asset prices even higher. The empirical work related to this issue divides into two strands.

The first strand of the literature studies investigates the relationship between house price and current account. With the financial liberalisation in emerging countries during the 1990s, Aizenman and Jinjarak (2009) examine the connection between current account and real estate valuation in 43 countries, 25 of which are Organisation for Economic Co-operation and Development. Using data from 1990 to 2005, their study shows a significant positive relationship between the current account deficit and house prices. By controlling other variables such as lagged per capita GDP growth, inflation and real interest rates, the study suggests that a single standard deviation increase of the lagged current account deficit results in a 10% appreciation of the real estate prices in real terms.

Jinjarak and Sheffrin (2011) examine the direction of causality behind the relations between real estate prices and the current account in the United States, England, Spain and Ireland. Their study uses a variety of quality real estate indices, but finds little evidence that the current account deficit directly and dramatically leads to real estate price appreciation. However, their findings suggest that current account surpluses have a direct influence on the mortgage rate and indirectly drive real estate prices through the financial markets.

Kannan *et al.* (2011) also evaluate how effective the variables such as large increases in credit, residential investment shares and deteriorating current account balances are as indicator of asset price bust. They find that a deteriorating current account balance is shown to be a useful leading indicator of house price busts in OECD countries after 1985. Their results also suggest that economies experiencing the largest house-price depreciation in 2007 had the poorest current account balances. These findings are reinforced by Filipa *et al.* (2014).

A counter-argument claims that asset price changes drive current account imbalances. According to this view, the rising house prices contribute to an increase in consumption and in turn cause the current account deficit. Using a Bayesian structural vector autoregression (VAR) model based on quarterly data from 1974Q1 to 2008Q2, Fratzscher *et al.* (2007) find that asset prices explain about 30% of the movements of the US trade balance. Similar findings are documented by Laibson and Mollerstrom (2010), who argue that causality runs from asset prices to the current account. Using a sample of 18 OECD countries and China, they show that asset price movements explain half of the variation in the trade deficits.

The second strand of the literature studies the sensitivity of house prices to monetary policy. Goodhart and Hofmann (2008) estimate a panel VAR model to assess the linkages between monetary policy and house prices in 17 0ECD countries. Using the quarterly data from 1970 to 2006, they show that monetary policy has effects on house prices and that the links are more significant after 1985. Similar results are documented by Gerlach and Assenmacher (2008), Vargas-Silva (2008), Carstensen *et al.* (2009) and Hristov *et al.* (2011).

Mallick and Sousa (2012) focus on house prices in Brazil, Russia, India, China and South Africa. They employ Bayesian methods and identify monetary policy shocks using a sign restrictions approach. The Panel VAR analysis suggests that contractionary monetary policy stabilises inflation at a high level and has a strongly persistent negative influence on asset prices.

This paper also investigates the ongoing debate on the side effects of the exceptionally loose monetary policies that advanced economies have conducted to deal with financial crises.

These studies have primarily examined the issue for a group of markets. Other papers look at the relationship between the capital inflows and the house price in a single market, such as China. Some researchers examine the interaction between short-term capital inflows, exchange rate and asset prices. For example, Pu *et al.* (2015) build a directed acyclic graph model to examine the relationship between exchange rate, asset prices and short-term capital inflows after the RMB exchange rate reform. Using monthly data from July 2005 to December 2013, their study shows that there is a one-way causal relationship between exchange rate, stock price and short-term capital inflows. There is also a one-way causal relationship between stock price, short-term capital inflows and house prices.

Some studies have applied the VAR-based method to examine the dynamic relationship between the exchange rate, asset price and short-term capital inflows (See Li & Li, 2014; Wang & Tao, 2015; Wang *et al.,* 2013; Yan, 2013; Yang & Zhang, 2014; Zhu & Liu, 2010). Their findings have implications for policy makers regarding the stability of the exchange rate and the capital market. Zhu and Liu (2010) who offer a causal relationship between short-term capital inflows, exchange rate, stock price and house price, demonstrating that short-term capital inflows leads to RMB exchange rate appreciation and to expectations of RMB exchange rate appreciation, which give rise to the increase in stock price and house price. The RMB exchange rate appreciation, expectations of RMB exchange rate appreciation and stock price rise also attract short-term capital inflows. The evidence also suggests that stock price growth contributes to house price rise while rising house price results in capital outflows.

Other studies focus on the effect of FDI on the Chinese real estate market. Using data for the period 1998–2006, Song and Gao (2007) examine the linkage between FDI and house price after considering inflation. The vector error correction model (VECM) analysis suggests that the rising house price attracts FDI in the short term while the FDI have a significant effect on house price in the long run. Their study concludes that controlling the excessive inflow of foreign investment into the real estate market is conducive to maintaining the stability of house prices at that stage. Similar findings are documented by Wei and Qu (2010) and Shen and Li (2012).

These studies are primarily based on the Mundell–Fleming model (1962), although the assumptions cannot be satisfied in reality. The theoretical framework of the relationship between capital inflows and asset prices may require a more sophisticated model. Compared with the single-equation models, the VAR-based model is more appropriate for testing the dynamic relationship of variables within the system. The VAR model does not require all independent variables to be exogenous. It is able to capture possible long-run equilibrium relationships as well as the short-run lead–lag relationships among the variables tested. Given these advantages of the VAR model over a single regression model, more recent studies have applied the VAR approach widely to investigate the interdependence of the stock market and the real economy.

This section has reviewed research on the relationship between capital inflows and house prices. In general, early research has tended to examine the effect of capital inflows for a group of economies. Few of them look at the relationship between capital inflows and house prices in a single market; none of the studies have looked at the regional differences in the relationship. This study aims to fill this gap in the literature, especially in regard to China. China is currently the fastest growing economy in terms of per capita remittances, as China receives the highest inflow of foreign capital, and this may have a significant impact on risk-adjusted returns in the Chinese market. Another important factor is that the benefits of rapid economic growth have been unequal in China. Tier A cities have perhaps benefited most from economic growth, followed by lower tier cities and finally by rural China, which has had the least benefits from the rapid economic growth. We also address the regional differences to account for the inconsistent economic growth across regions. It will be of interest to policy makers and practitioners to understand how the sensitivity of house prices to capital inflows differs across regions. We use the vector VECM to assess the impact of capital inflows on house prices in China. This model, which tests the dynamic relationship of variables within the system, is able to capture possible long-term equilibrium relationships as well as the short-run lead–lag relationships among the variables tested. We find that capital inflows have a significant positive effect on house prices. We then examine the effect of capital inflows on house prices across provinces in China, as the Chinese real estate market shows strong regional characteristics. To the best of our knowledge, this paper is the first to thoroughly examine the regional differences in the response of house price to capital inflows in China. Using regional data, we show that capital inflows have an asymmetric effect on the housing market across the different provinces and cities of China.

This study makes important contributions for understanding the relationship between house prices and foreign remittances after controlling for other economic factors. This has several important policy implications for policy makers in China who are developing economic policies aimed at providing fair access to residential housing for everyone. First, while continuing to open the market to attract foreign capital, the Chinese government should also carefully monitor the real estate market to stabilise the house price. Second, in macro prudential policy, for example, the property purchasing limitations policy in China might be more/most suitable for controlling house prices, as these measures can be tailored to regional housing markets. Findings are also relevant for investors in the housing market, whether for a personal residential home or for an investment as part of their diversified investment portfolio.

III. The Empirical Model

a) The data set

The sample period used in this study begins in January 2002 and ends in September 2015. The starting date of the sample is set by the availability of data. Each model contains the following monthly data series: capital inflows in percent of GDP (FLOWS), disposable personal income (INCOME), inflation (CGPI), exchange rate (ER), house price (HP) and short-term rate (SHORT). The choice of these variables should be as close as possible to standard models used in the literature. All of the data are taken from Wind Database.

a.1. Capital inflow (FLOWS) Since the regulation of China's capital account, capital inflow cannot be fully reflected in capital and financial accounts. In this paper, we calculate capital inflows based on the World Bank standard, using the amount of change in foreign exchange reserves minus the difference of the current account.

a.2. Disposable personal income (INCOME) Household income or disposable personal income, which has been increasing in China due to 30 years of rapid economic growth, results in a huge demand for residential housing. To contrast the response of house price to capital inflows across countries, DPI represents either national disposable personal income or disposable personal incomes of different provinces.

a.3. Inflation (CGPI) Cost is an important factor of house price as the real estate market involves a wide range of upstream raw materials. In this paper, we use the corporate goods price index (CGPI) to measure inflation because it covers a wider range of items and instantly captures the trend on the costs, compared with the consumer price index and the producer price index.

a.4. Exchange rate (ER) Exchange rate is a measure of relative competitiveness that reflects movements in the inflation rates, production costs and nominal exchange rates of all trade partners. As previously discussed, the exchange rate is closely connected with capital inflows and house prices in an open economy. We use the direct quotation of RMB in this paper, thus a higher value of ER indicates a depreciation of RMB.

a.5. House price (HOUSE) House price is our key variable. We use the sale price of residential houses as the house price index. To examine regional differences, we replace the nationwide house price by region house prices.

a.6. Short-term rate (SHORT) Interest rate, the leverage of capitals, can adjust capital supply and demand through a money multiplier. Because interest rates in China are not completely market-based, the nominal interest rate cannot reflect the market price and the dynamics of capitals. In this paper, we use the inter-bank offered rate, as it is considered to be close to the market rate.

b) Preliminary analysis

We conduct a preliminary analysis to check for the stability of the data, based on the augmented Dickey–Fuller (ADF) tests (Dickey & Fuller, 1979), to detect whether unit roots exist in the data. We perform two forms of the ADF tests: the model with an intercept and no trend and the model with an intercept and trend. The results of the ADF tests are reported in Table II.

All data series at the first differences used in this study are stationary at 5% level (Table II). The following section will explain the econometric models used in this study.

Table II Augmented Dickey–Fuller (ADF) tests for stationarity

	Price level		*First differences level*	
Variables	*with intercept without trend*	*with trend and intercept*	*with intercept without trend*	*with trend and intercept*
FLOWS	−2.7662*	−3.2419*	−15.1865***	−15.2042***
INCOME	−1.1416	−1.4018	−3.6145***	−3.7685**
CGPI	−2.9536**	−2.8236	−5.6655***	−5.7115**
ER	−1.2043	−0.4307	−3.6906***	−3.7221**
HOUSE	0.1011	−3.7709**	−4.7828***	−4.7890***
SHORT	−3.3086**	−3.1939*	−15.4484***	−15.4023***

Notes: This table presents the ADF test statistics for all data used in this study. The optimal lag lengths for the ADF test is determined by using the AIC method. The critical values for the ADF test statistics are −3.47, −2.88 and −2.58 on models without trend, and −4.01, −3.44 and −3.14 on models with trend for the 1%, 5% and 10% levels of statistical significance, respectively. The null hypothesis of a unit root (non-stationary) can be rejected if the ADF test statistic is less than the critical value at the chosen level of significance. ***, ** and * represent rejections of the null hypothesis of a unit root at the 1%, 5% and 10% levels, respectively.

c) Methodology

We estimate a VAR model to investigate the relationship between capital inflows and house prices. This VAR of order q can be expressed as

$$Y_t = B_0 + \sum_{i=1}^{q} B_i Y_{t-i} + u_t \tag{1}$$

Y_t is an m * 1 vector of observables; B_i are m * n coefficient matrices; and u_t is an error term with covariance matrix $\sum$. All variables enter the VAR in levels. Thus, the vector Y_t consists of

$$Y_t = (\text{FLOWS}, \text{INCOME}, \text{CGPI}, \text{ER}, \text{HOUSE}, \text{SHORT}) \tag{2}$$

We make use of the Johansen co-integration tests to examine the long-run relationship between the variables. The tests identify the number of co-integrating relationships between the variables using a maximum likelihood estimation procedure. Trace and maximum eigenvalue test statistics can be used to identify the presence of a co-integrating relationship.

After examining the long-run relationship, we then investigate the short-run dynamic relationships. To examine the short-run dynamics between capital inflows and the house prices, this study conducts Granger causality tests, which provide an understanding of the direction of the lead–lag relationship among the variables tested. If the results of the Johansen co-integration tests suggest that there is a long-run relationship among the variables, a VECM will be employed to capture the short-run relationships between the variables and the adjustments over the short run. The equilibrium in the long run is captured by the error correction term. Otherwise, a standard VAR model will be sufficient to estimate the dynamic relationships between the variables. We also use an impulse response to measure the short-term response of selected variables to capital inflow shocks and variance decomposition in order to forecast any error variance of house price explained by the capital inflow.

IV. Results

a) Long-run relationship

Before estimating the VAR or VECM, we determine that the optimal lag length is 2 under the FPE, AIC and HQ criteria. Table III shows the coefficients of the VECM. Capital inflows can be seen to play a positive role on house prices. The influences of disposable income and interest rates are not the interests of this paper. The results of the Johansen co-integration tests between capital flows and the house prices are reported in Table IV.

The results in Table IV show at most one co-integrating vector associated with the relationship of capital inflows and the selected variables at 5% level. Hence, there is a long-run relationship between capital inflows and house prices. We next perform the weak exogeneity test. The results in Table V show that we can accept the hypothesis that the coefficients of CGPI and ER are zero under the 10% level of significance. Therefore, the variables CGPI and ER are excluded from the co-integration equation. The coefficients of the co-integrating equation with respect to each variable are presented in Table VI.

The results in Table VI show that INCOME, HOUSE and SHORT significantly affect capital inflows in the long run. INCOME, contrary to expectation, is negatively associated with capital inflows; HOUSE and SHORT, as expected, positively impact capital inflows.

Table III Coefficients of vector error correction model

Error correction	*D(FLOWS)*	*D(INCOME)*	*D(CGPI)*	*D(ER)*	*D(HOUSE)*	*D(SHORT)*
CointEq1	−0.0995	0.0000	0.0001	0.0000	−0.0001	0.0000
	[−4.0351]	[0.8372]	[2.4853]	[0.1885]	[−5.4709]	[2.1093]
D(FLOWS (−1))	−0.5029	0.0000	0.0000	0.0000	0.000137	−0.0004
	[−6.5320]	[1.1677]	[0.3258]	[−0.7610]	[2.9099]	[−2.7653]
D(FLOWS (−2))	−0.2382	0.0000	−0.0001	0.0000	0.0000	−0.0002
	[−3.0791]	[−0.2812]	[−0.3829]	[−0.1898]	[1.3950]	[−1.2937]
D(INCOME (−1))	−2724.1030	−0.3792	−0.6773	0.3148	1.2829	3.6361
	[−1.3619]	[−5.0106]	[−0.1790]	[2.1350]	[1.0513]	[1.0083]
D(INCOME (−2))	−5417.7720	−0.3989	−1.2912	−0.0505	−5.0355	6.6339
	[−2.8139]	[−5.4754]	[−0.3546]	[−0.3561]	[−4.2867]	[1.9111]
D(CGPI (−1))	33.5529	0.0010	0.0326	−0.0009	0.0188	0.0797
	[0.7541]	[0.6124]	[0.3878]	[−0.2893]	[0.6909]	[0.9933]
D(CGPI (−2))	37.48302	0.0017	0.1288	−0.0033	0.0541	0.0233
	[0.8471]	[0.9960]	[1.5396]	[−1.0024]	[2.0045]	[0.2920]
D(ER(−1))	1893.0660	−0.0381	−2.3802	0.4714	−0.3804	0.8137
	[1.6747]	[−0.8915]	[−1.1133]	[5.6573]	[−0.5516]	[0.3993]
D(ER(−2))	−2284.5470	−0.0311	1.8084	0.2354	0.4076	−1.8564
	[−1.6913]	[−0.6086]	[0.7078]	[2.3636]	[0.4946]	[−0.7623]
D(HOUSE (−1))	465.0929	−0.0197	−0.2697	0.0173	−0.1091	−0.8805
	[3.0497]	[−3.4188]	[−0.9350]	[1.54150]	[−1.1723]	[−3.2025]
D(HOUSE (−2))	495.3004	0.0021	−0.2690	0.0126	−0.0346	−0.3972
	[3.5938]	[0.4057]	[−1.0320]	[1.2380]	[−0.4120]	[−1.5986]
D(SHORT (−1))	98.8333	0.0006	−0.0546	0.0028	−0.0050	−0.2533
	[2.1888]	[0.3652]	[−0.6399]	[0.8323]	[−0.1832]	[−3.1111]
D(SHORT (−2))	−37.5493	−0.0015	0.0650	0.0010	−0.0230	−0.0660
	[−0.8690]	[−0.9168]	[0.7952]	[0.3135]	[−0.8730]	[−0.8471]
C	33.7265	0.0157	0.0363	−0.0059	0.0568	−0.0840
	[0.8457]	[10.4001]	[0.4819]	[−2.0104]	[2.3331]	[−1.1689]

Note: Numbers in '[ ]' are T-statistics.

Table IV Johansen co-integration test results

Number of co-integrating equations	*Eigenvalue*	*Trace statistics*	*0.05 critical value*	*Prob.'**'*
None	0.2805	120.4837**	95.7537	0.0004
At most 1	0.1557	67.1576	69.8189	0.0800
At most 2	0.1283	39.7328	47.8561	0.2322
At most 3	0.0757	17.4826	29.7971	0.6044
At most 4	0.0287	4.7314	15.4947	0.8367
At most 5	0.0001	0.0197	3.8415	0.8883

'**'indicates the rejection of null hypothesis of no co-integration at 5% significance level. The appropriate lag length has been selected based on AIC. We also made sure that the selected lag length is free from residual serial correlations. Each model is estimated using six variables such as FLOWS, INCOME, CGPI, ER, HOUSE and SHORT. The finite sample bias is corrected by multiplying the Johansen trace statistics with the scale factor (T − pk)/T, where T is the number of observations, p is the number of variables and k is the lag order of the underlying vector autoregression model in levels. The detailed discussion on this procedure can be found in Reimers (1992). The critical values are taken from MacKinnon *et al*. (1999) and are also valid for the small sample correction.

Table V Weak exogeneity test

Excluded	*Chi-sq.*	*Prob.*
INCOME	16.2032	0.0396
CGPI	6.1345	0.6322
ER	11.3540	0.1824
HOUSE	15.1134	0.0570
SHORT	14.4622	0.0705
All	80.2563	0.0002

Table VI Normalised co-integrating vector

Co-integrating Eq.	*FLOWS*	*INCOME*	*HOUSE*	*SHORT*
Coefficient	1.000	−4.2659***	2.8035**	1.1962***
T-value		(3.1600)	(2.1150)	(3.3197)

Notes: This table displays the estimated co-integration vector normalised on FLOWS and estimated co-integrating equation. The numbers in parentheses are t-statistics. If the t statistics are greater than the t critical values, we reject the null hypothesis that there is no significant relationship between the dependent variable and the independent variables. The critical values are 2.58, 1.96 and 1.65 for 1%, 5% and 10% levels, respectively. ***, ** and * represent rejections of the null hypothesis at the 1%, 5% and 10% levels, respectively.

b) Short-run dynamics

After considering the long-run relationship, this study investigates the lead–lag relationships among the variables in the short run. The direction and strength of the short-run causality between the capital inflows and house price is examined using the Granger causality test based on the VECM. The results are reported in Table VII.

Table VII illustrates that there is a short-run causality from capital inflow and disposable income to house price. The F-statistics are significant at the 5% and the 1% levels, respectively. On the other hand, the F-statistics suggest that the changes in past values of disposable income, house prices and interests rate are significant in the equations of capital inflows. Overall, there exists a bilateral causality between capital inflows and house prices.

The impulse response shows the influence of a random perturbed variable on each endogenous variable in the current period and the lag period. The results are shown in Figure 3.

Table VII Short-run Granger causality tests

	FLOWS	*INCOME*	*HOUSE*	*SHORT*
FLOWS	NA	6.4229***	6.4053***	4.1114**
INCOME	0.7524	NA	1.3680	0.9028
HOUSE	3.4364**	14.8585***	NA	1.0589
SHORT	6.1070***	3.7286**	7.2387***	NA

Note: This table displays the t-statistics from Granger causality tests based on the vector error correction model. ***, ** and * represent the rejection of the null hypothesis that A does not Granger cause B at the 1%, 5% and 10% levels, respectively.

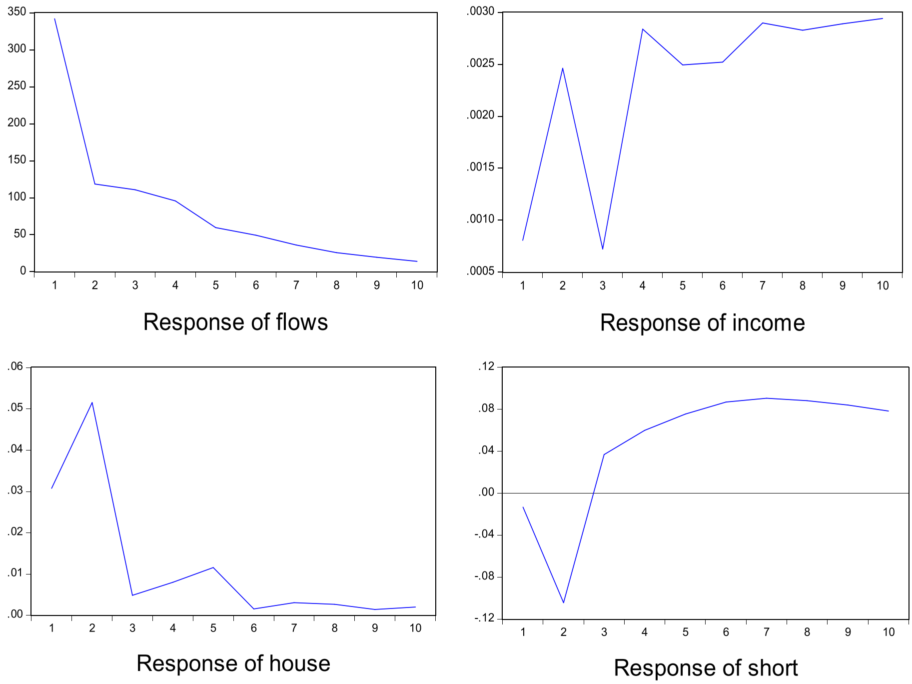

Figure 3. Impulse response after a capital inflow shock at national level

Figure 3 shows the responses of the four variables to a capital inflow shock one standard deviation in size. The response of house prices is the core empirical result of interest. House prices show a fast and positive response and reach a maximum value in the second period. Thus, capital inflow leads to a rise in the house price. The impulse responses also reveal that disposable income shows a positive response after capital inflow shocks, which suggests that capital inflows benefit the receiving country. Monetary policy, as reflected by the evolution of short-term interest rates, tightens after the shock.

Table VIII shows the fraction of the forecast error variance of house prices explained by the capital inflow. This decomposition, which shows that the effects of capital inflow rise from 2.04% to 6.20% at the initial stage, accounts for 5.65% of house price movements in the last period. It can also be seen that disposable income explains about 17% of house dynamics, which is the most important factor.

V. Regional Differences

The analysis in the previous section showed the response of house price to capital inflows at the national level. Given that China is a large economy and the impact of economic development in China has not been consistent across the country, we address the regional differences in the house price changes to capital inflows. For that purpose, we divide provinces into eastern, central and

Table VIII Variance decomposition

Period	*S.E.*	*FLOWS*	*INCOME*	*HOUSE*	*SHORT*
1	2.1389	2.0370	2.5003	95.4627	0.0000
2	2.2669	6.1972	10.8723	82.9253	0.0051
3	2.3282	6.1061	11.2522	82.6338	0.0080
4	2.3667	5.8879	12.5201	81.2857	0.3063
5	2.3871	5.9535	13.8185	79.7432	0.4847
6	2.4020	5.8792	14.5866	78.8912	0.6430
7	2.4147	5.8071	15.4799	77.8852	0.8278
8	2.4260	5.7512	16.2717	77.0275	0.9495
9	2.4365	5.6963	16.9886	76.2732	1.0419
10	2.4462	5.6469	17.6960	75.5479	1.1092

Table IX Johansen co-integration test results

Number of co-integrating equations	*Trace statistic (Guangdong)*	*Trace statistic (Jiangsu)*	*Trace statistic (Zhejiang)*	*Trace statistic (Shandong)*
None	73.9595**	77.8726**	62.8441**	94.2134**
At most 1	35.2356**	36.4923**	21.8739	49.3055**
At most 2	11.5521	13.1534	4.4364	14.6640

'**' indicates the rejection of null hypothesis of no co-integration at 5% significance level. The appropriate lag length has been selected based on AIC. We also made sure that the selected lag length is free from residual serial correlations. Each model is estimated using six variables such as FLOWS, INCOME, CGPI, ER, HOUSE and SHORT. The finite sample bias is corrected by multiplying the Johansen trace statistics with the scale factor $(T - pk)/T$, where T is the number of observations, p is the number of variables and k is the lag order of the underlying vector autoregression model in levels. The detailed discussion on this procedure can be found in Reinsel and Ahn (1992) and Reimers (1992). The critical values are taken from MacKinnon *et al*. (1999) and are also valid for the small sample correction.

western regions based on the Chinese National Bureau of Statistics.[4] Because of space limitations, we selected representative provinces with the largest share of GDP in each region. We replace the nationwide disposable income and house price data with regional series in each model. All other variables remain unchanged.

a) Eastern provinces

The sample includes Guangdong, Jiangsu, Zhejiang and Shandong. The results of the Johansen co-integration tests between capital inflows and the regional house prices are reported in Table IX.

The results show at least one co-integrating vector at the 5% level in all provinces, with a stronger association in Guangdong, Jiangsu and Shandong. Hence, there is a long-run relationship between

[4] Eastern region includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong and Hainan. Central region includes Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei and Hunan. Western region includes Neimenggu, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Xizang, Shanxi, Gansu, Qinghai, Ningxia and Xinjiang.

Table X Short-run Granger causality tests

Null hypothesis:	*F-Statistic (Guangdong)*	*F-Statistic (Jiangsu)*	*F-Statistic (Zhejiang)*	*F-Statistic (Shandong)*
HOUSE does not Granger cause FLOWS	2.4809**	2.4561**	1.8803*	2.6288**
FLOWS does not Granger cause HOUSE	1.8275*	2.4114**	2.2407**	1.4415

Note: This table displays the t-statistics from Granger causality tests based on the vector error correction model. ***, ** and * represent the rejection of the null hypothesis that A does not Granger cause B at the 1%, 5% and 10% levels, respectively.

capital inflow and house price in these provinces. The estimated results of Granger causality test are shown in Table X.

This analysis finds the existence of a bilateral causality between FLOWS and HOUSE at the 10% level in all provinces except Shandong. This result indicates that in the eastern region, capital inflows generate a house price boom and that rising house prices in turn attract capital inflows because of the profit-driven nature of capital.

We then use impulse responses to analyse the influence of capital inflows on house prices over time. From Figure 4, we can see that the response of house prices in Guangdong, Jiangsu

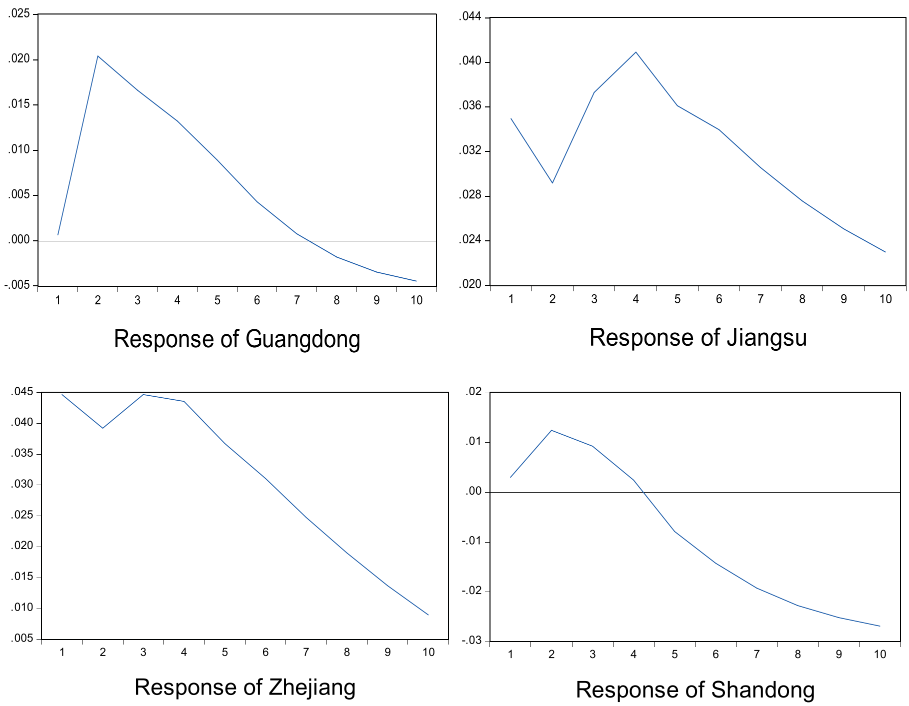

Figure 4. Impulse response of house price in eastern region

and Zhejiang is more significant and persistent, but that Shandong shows a negative response after several periods. This may be because Guangdong, Jiangsu and Zhejiang are more developed than Shandong. Their comprehensive economic strength, investment environment and real estate market development are all better; thus, the influence of capital inflows is more direct and significant.

Table XI Variance decomposition

Period	*Guangdong*	*Jiangsu*	*Zhejiang*	*Shandong*
1	0.0008	3.2503	8.3112	0.0228
2	0.5868	7.1578	10.7475	0.3638
3	0.7785	8.6600	12.3488	0.4863
4	0.8546	8.8094	13.5076	0.4407
5	0.8188	8.0162	13.5476	0.4872
6	0.7451	7.1145	13.1589	0.7112
7	0.6704	6.5002	12.4823	1.0933
8	0.6105	6.2506	11.6910	1.5621
9	0.5652	6.2829	10.8782	2.0583
10	0.5311	6.4842	10.0989	2.5482

Table XII Johansen Co-integration test results

Number of co-integrating equations	*Trace statistic (Henan)*	*Trace statistic (Hubei)*	*Trace statistic (Hunan)*	*Trace statistic (Anhui)*
None	82.1377**	87.2225**	67.8241**	73.1567**
At most 1	45.6628**	43.8495**	29.8640**	28.2390
At most 2	11.3643	10.1681	7.1076	12.2956

'**' indicates the rejection of null hypothesis of no co-integration at 5% significance level. The appropriate lag length has been selected based on AIC. We also made sure that the selected lag length is free from residual serial correlations. Each model is estimated using six variables such as FLOWS, INCOME, CGPI, ER, HOUSE and SHORT. The finite sample bias is corrected by multiplying the Johansen trace statistics with the scale factor $(T - pk)/T$, where T is the number of observations, p is the number of variables and k is the lag order of the underlying vector autoregression model in levels. The detailed discussion on this procedure can be found in Reinsel and Ahn (1992) and Reimers (1992). The critical values are taken from MacKinnon *et al*. (1999) and are also valid for the small sample correction.

Table XIII Short-run Granger causality tests

Null Hypothesis:	*F-Statistic (Henan)*	*F-Statistic (Hubei)*	*F-Statistic (Hunan)*	*F-Statistic (Anhui)*
HOUSE does not Granger cause FLOWS	2.7804***	2.1104**	2.2154**	2.9703***
FLOWS does not Granger cause HOUSE	1.2373	2.0056**	2.6786***	0.7770

Note: This table displays the t-statistics from Granger causality tests based on the vector error correction model. ***, ** and * represent the rejection of the null hypothesis that A does not Granger cause B at the 1%, 5% and 10% levels, respectively.

Variance decomposition shows the fraction of the forecast error variance of house prices explained by the capital inflow. The results show that capital inflows account for a relatively small part of house dynamics in Guangdong and Shandong, but it shows a strong effect on Jiangsu and Zhejiang.

b) Central provinces

The sample includes Henan, Hebei, Hunan and Anhui. The results of the Johansen co-integration tests are shown in Table XII.

The results show that all provinces have at least one co-integrating vector at the 5% level. Hence, there is a long-run relationship between capital inflows and house price in these provinces. The Granger causality tests also show that the causality from HOUSE to FLOWS exists in all provinces at 5% level and that there is also causality from FLOWS to HOUSE at the 5% level in Hubei and Hunan.

House prices in the central provinces show a quick positive response after capital inflow shocks, but the responses turn out to be negative after a lag period. Overall, the responses are relatively short-term compared with those in the eastern provinces (Figure 4). This may be because the central provinces' housing markets are less developed, and their investment environments are inferior compared with those in the eastern provinces. Thus, capital inflows may affect house prices in less direct and persistent ways.

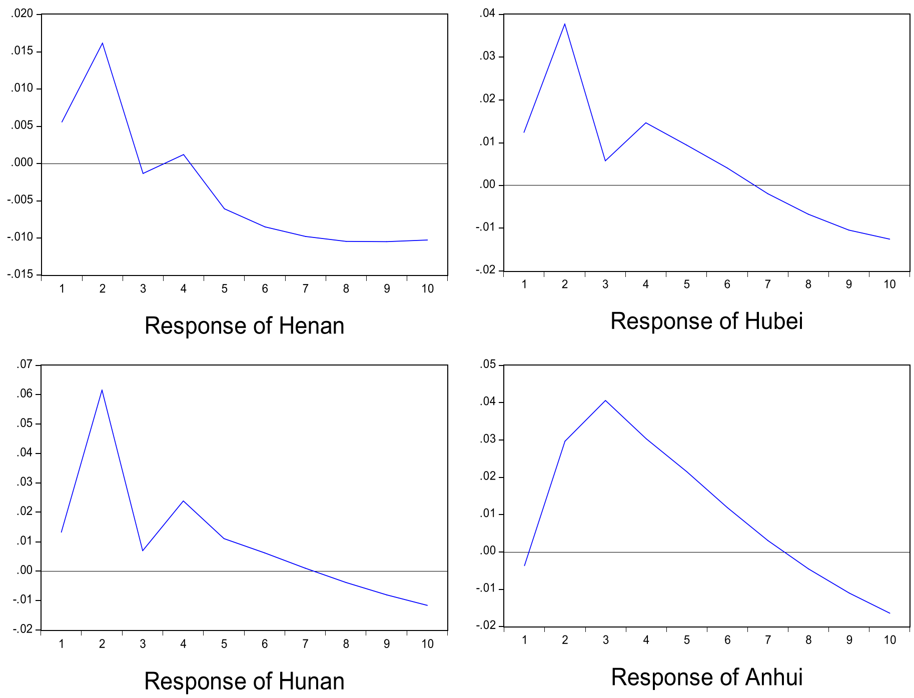

Figure 5. Impulse response of house price in central region

The variance decomposition shows more consistent results in the central provinces. The overall effect of capital inflows is relatively small, lower than the national average, which suggests that the influence of capital inflows is not significant in the central region.

Table XIV Variance decomposition

Period	*Henan*	*Hubei*	*Hunan*	*Anhui*
1	0.0636	0.1940	0.2280	0.0319
2	0.5259	1.8554	4.3940	1.5667
3	0.4688	1.6536	3.7705	3.8209
4	0.4261	1.7856	3.9116	4.7166
5	0.4362	1.7172	3.6905	4.9171
6	0.4868	1.5946	3.4592	4.7047
7	0.5558	1.4582	3.2305	4.3518
8	0.6281	1.3702	3.0367	4.0282
9	0.6913	1.3316	2.8911	3.8122
10	0.7429	1.3278	2.7967	3.7241

Table XV Johansen co-integration test results

Number of Co-integrating Equations	*Trace Statistic (Sichuan)*	*Trace Statistic (Shanxi)*	*Trace Statistic (Neimenggu)*	*Trace Statistic (Guangxi)*
None	85.3455**	85.1046**	87.4163**	86.7879**
At most 1	39.9227**	44.7849**	45.1833**	41.4459**
At most 2	14.8424	11.5088	13.1694	10.7504

'**' indicates the rejection of null hypothesis of no co-integration at 5% significance level. The appropriate lag length has been selected based on AIC. We also made sure that the selected lag length is free from residual serial correlations. Each model is estimated using six variables such as FLOWS, INCOME, CGPI, ER, HOUSE and SHORT. The finite sample bias is corrected by multiplying the Johansen trace statistics with the scale factor $(T - pk)/T$, where T is the number of observations, p is the number of variables and k is the lag order of the underlying vector autoregression model in levels. The detailed discussion on this procedure can be found in Reinsel and Ahn (1992) and Reimers (1992). The critical values are taken from MacKinnon *et al*. (1999) and are also valid for the small sample correction.

Table XVI Short-run Granger causality tests

Null hypothesis:	*F-Statistic (Sichuan)*	*F-Statistic (Shanxi)*	*F-Statistic (Neimenggu)*	*F-Statistic (Guangxi)*
HOUSE does not Granger cause FLOWS	3.4507***	3.0305***	2.6879**	2.7012***
FLOWS does not Granger cause HOUSE	1.1364	3.0591***	1.0044	1.8370*

Note: This table displays the t-statistics from Granger causality tests based on the vector error correction model. ***, ** and * represent the rejection of the null hypothesis that A does not Granger cause B at the 1%, 5% and 10% levels, respectively.

c) Western provinces

The sample includes Sichuan, Shanxi, Neimenggu and Guangxi. The resulting Johansen co-integration tests are shown in Table XV.

Table XV also shows a long-run relationship between capital inflows and house prices in the western provinces. The results of the Granger causality tests are shown in Table XVI.

For the case of the western region, the causality from HOUSE to FLOWS still exists at the 5% level. The reverse causality is also found in Shanxi and Guangxi. The results of impulse response

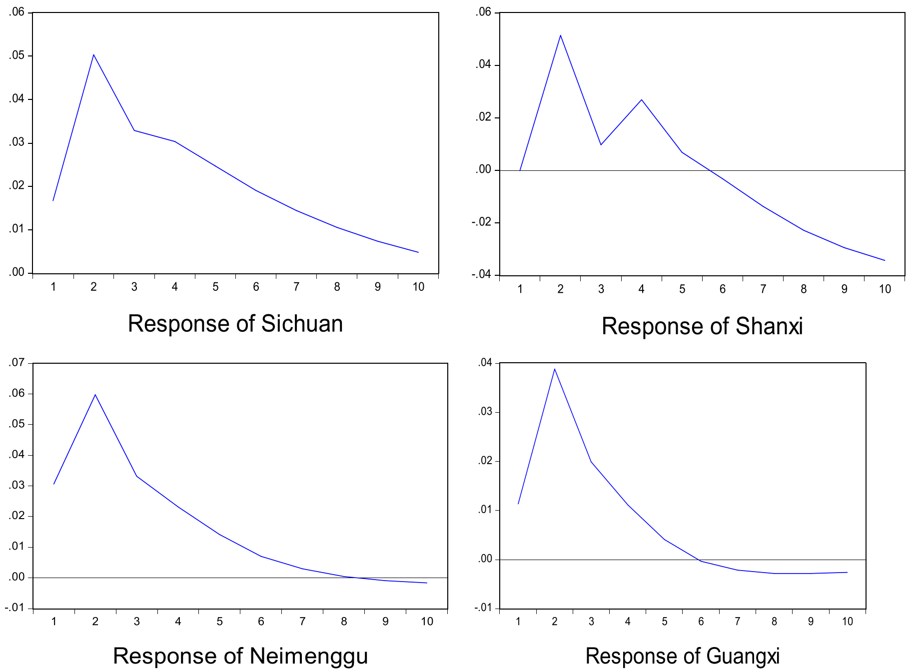

Figure 6. Impulse response of house price in western region

Table XVII Variance decomposition

Period	*Sichuan*	*Shanxi*	*Neimenggu*	*Guangxi*
1	0.6834	0.0000	0.2690	0.2367
2	5.3127	2.1164	4.0640	2.5562
3	5.7303	1.9226	3.3924	2.4891
4	6.0707	2.1488	3.0794	2.2254
5	5.9999	1.8811	2.6129	1.9073
6	5.7679	1.5857	2.2831	1.6702
7	5.4571	1.3894	2.0434	1.4867
8	5.1361	1.3222	1.8694	1.3451
9	4.8266	1.3459	1.7401	1.2293
10	4.5424	1.4207	1.6389	1.1327

are demonstrated in Figure 6. All provinces show quick positive responses after the shock, but the response in Sichuan is more persistent.

Table XVII illustrates that the capital inflows explain a larger portion in Sichuan than in the other western provinces. This may be because Sichuan is more developed and has a better investment environment than the other western provinces.

We conduct a robustness test by replacing the nationwide capital inflows with FDI in each province (Appendix B). The sample period, from 2001 to 2014, is set by the availability of data. All other variables remain unchanged.

We find similar results for the relationship between FDI and house prices. Replacing capital inflows with FDI inflows only makes no significant change to the overall results and findings of the study.

VI. Conclusion

This study examines the linkage between capital inflows and Chinese real estate prices in both the long and short runs. The analysis was conducted to provide an explanation of the house price rise in China. Capital inflows can create an increase in demand, causing asset prices to go up with a fixed supply. In principle, the economy's borrowing capability is determined by the value of its assets. Therefore, capital inflows raise asset prices, in turn increasing the credit limit and attracting more capital inflows. The resulting capital inflows cause an asset prices boom through a circular process in which higher asset prices make financial conditions look sounder than they actually are, promoting more capital inflows that push asset prices even higher. We also investigate the provincial differences across the country, which are due to China's inconsistent economic development.

The long-run analysis was conducted based on the Johansen co-integration tests while the short-run examination was based on Granger causality tests within a VAR context. Based on the Johansen co-integration tests, we find that there is a significant positive long-run relationship between the capital inflows and house prices. This study also examined the short-run relationship between the capital inflows and house prices using Granger causality tests based on the VECM. The results suggest that there is a short-run bilateral causality between capital inflows and house prices at the national level. At the regional level, the causality from HOUSE to FLOWS exists in all provinces, but the reverse causality does not exist in some provinces because of the unbalanced economic development. Using impulse response and variance decomposition, we find that capital inflows play a relatively more important role in the eastern region. Findings for the eastern region are intuitive because this region is significantly more developed than other regions and is politically more visible.

These findings highlight the need to closely monitor house price development in light of massive capital inflows. External capital inflows stemming from foreign investors searching for yield might lead to house price misalignment. Findings of the study also have important implications for policies that are directed towards stable and affordable real estate. Our results tend to favour macro-prudential policy measures, which can be tailored to the needs of regional housing market development. Capital inflows account for only a small part of house price movements. Finally, the sensitivity of house prices to capital inflows implies risks for the Chinese real estate market when capital inflows are reversed, for example, because of monetary tightening in advanced economies.

APPENDIX A

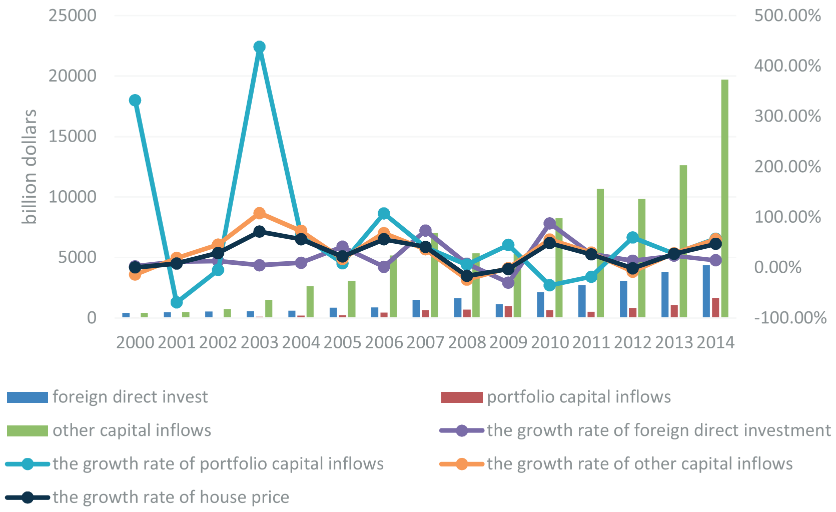

Figure A1. House price and capital inflows between 2000 and 2014

APPENDIX B

Robustness test

Table B1 Johansen co-integration test results

Number of co-integrating equations	*Eigenvalue*	*Trace statistics*	*0.05 critical value*	*Prob.***
None	0.2738	90.4302**	47.8561	0.0000
At most 1	0.1470	38.5933**	29.7971	0.0038
At most 2	0.0695	12.8222	15.4947	0.1215
At most 3	0.0071	1.1521	3.8415	0.2831

'**' indicates the rejection of null hypothesis of no co-integration at 5% significance level. The appropriate lag length has been selected based on AIC. We also made sure that the selected lag length is free from residual serial correlations. Each model is estimated using six variables, such as FLOWS, INCOME, CGPI, ER, HOUSE and SHORT. The finite sample bias is corrected by multiplying the Johansen trace statistics with the scale factor (T − pk)/T, where T is the number of observations, p is the number of variables and k is the lag order of the underlying vector autoregression model in levels. The detailed discussion on this procedure can be found in Reinsel and Ahn (1992) and Reimers (1992). The critical values are taken from MacKinnon *et al*. (1999) and are also valid for the small sample correction.

Table B2 Short-run Granger causality tests

	FLOWS	*INCOME*	*HOUSE*	*SHORT*
FLOWS	NA	33.3958***	27.5833***	5.7442***
INCOME	25.5709***	NA	18.5000***	0.4214
HOUSE	22.8889***	28.4558***	NA	0.3981
SHORT	0.5355	1.8206	5.2036***	NA

Note: This table displays the t-statistics from Granger causality tests based on the vector error correction model. ***, ** and * represent the rejection of the null hypothesis that A does not Granger cause B at the 1%, 5% and 10% levels, respectively.

Table B3 Pedroni residual co-integration test in eastern region

	Without trend	
Test method	*Statistic*	*Prob.*
Panel v-Statistics	−0.1999	0.5793
Panel rho-Statistics	0.8628	0.8059
Panel PP-Statistics	−1.4588*	0.0723
Panel ADF-Statistics	−1.5783*	0.0572

Note: '*' indicates the rejection of null hypothesis of no co-integration at 10% significance level. The Pedroni residual co-integrating test is usually conducted without trend (Huang & Wang, 2012). ADF, augmented Dickey–Fuller.

Table B4 Kao residual co-integration test in eastern region

	t-Statistic	*Prob.*
ADF	*−2.8649****	*0.0021*
Residual variance	0.0050	
HAC variance	0.0048	

Note: '***' indicates the rejection of null hypothesis of no co-integration at 1% significance level. ADF, augmented Dickey–Fuller.

Table B5 Pedroni residual co-integration test in central region

	Without trend	
Test method	*Statistic*	*Prob.*
Panel v-Statistics	1.0204	0.8462
Panel rho-Statistics	−0.9403	0.8265
Panel PP-Statistics	−0.6588	0.2550
Panel ADF-Statistics	−3.6495**	0.0001

Note: '**' indicates the rejection of null hypothesis of no co-integration at 5% significance level. The Pedroni residual co-integrating test is usually conducted without trend (Huang & Wang, 2012). ADF, augmented Dickey–Fuller.

Table B6 Kao residual co-integration test in central region

	t-Statistic	*Prob.*
ADF	*−1.5839**	*0.0566*
Residual variance	0.0043	
HAC variance	0.0040	

Note: * indicates the rejection of null hypothesis of no co-integration at 10% significance level. ADF, augmented Dickey–Fuller.

Table B7 Pedroni residual co-integration test in western region

	Without trend	
Test method	*Statistic*	*Prob.*
Panel v-Statistics	0.2003	0.4206
Panel rho-Statistics	0.8318	0.7972
Panel PP-Statistics	−0.5210	0.0312
Panel ADF-Statistics	−0.1587	0.4370

Note: The Pedroni residual co-integrating test is usually conducted without trend (Huang & Wang, 2012). ADF, augmented Dickey–Fuller.

Table B8 Kao residual co-integration test in western region

	t-Statistic	*Prob.*
ADF	*−2.3995****	*0.0082*
Residual variance	0.0234	
HAC variance	0.0257	

Note: '***' indicates the rejection of null hypothesis of no co-integration at 1% significance level. ADF, augmented Dickey–Fuller.

References

Adams, Z. and Füss, R. 2008, 'Macroeconomic Determinants of International Housing Markets', *Social Science Electronic Publishing*, vol. 19, pp. 38–50.

Adam, K., Pei, K. and Marcet, A. 2011, *House Price Booms and the Current Account*, National Bureau of Economic Research, Inc. NBER working paper no. 17224.

Aizenman, J. and Jinjarak, Y. 2009, 'Globalisation and Developing countries – A Shrinking Tax Base?' *Journal of Development Studies*, vol. 45, pp. 653–671.

Aoki, K., Benigno, G. and Kiyotaki, N. 2009, 'Capital Flows and Asset Prices', in R. Clarida and F. Giavazzi (eds), *NBER International Seminar on Macroeconomics 2007*, University of Chicago Press, pp. 175–216.

Gerlach S. and Assenmacher, K. (2008) 'Financial Structure and the Impact of Monetary Policy on Asset Prices', Cfs Working Paper, 29, 41–59.

Bernanke, B.S. (2010) 'Monetary Policy and the Housing Bubble', speech at the Annual Meeting of the American Economic Association, Atlanta.

Caballero, R.J. and Krishnamurthy, A. 2006, 'Bubbles and Capital Flow Volatility: Causes and Risk Management', *Journal of Monetary Economics*, vol. 53, pp. 35–53.

Carstensen, K., Hülsewig, O. and Wollmershaeuser, T. (2009) 'Monetary Policy Transmission and House Prices: European Cross-Country Evidence', *Social Science Electronic Publishing*, vol. 8.

Chen, J., Guo, F. and Wu, Y. 2011, 'One Decade of Urban Housing Reform in China: Urban Housing Price Dynamics and the Role of Migration and Urbanization, 1995–2005', *Habitat International*, vol. 35, pp. 1–8.

Du, H., Ma, Y. and An, Y. 2011, 'The Impact of Land Policy on the Relation between Housing and Land Prices: Evidence from China', *The Quarterly Review of Economics and Finance*, vol. 51, pp. 19–27.

Filipa, S., Pascal, T. and Tomasz, W. 2014, 'Capital Inflows, Financial Structure and Housing Booms', *Journal of the European Economic Association*, vol. 12, pp. 522–546.

Fraser, P., Hoesli, M. and McAlevey, L. 2012, 'House Prices, Disposable Income and Permanent and Temporary Shocks: The NZ, UK and US Experience', *Journal of European Real Estate Research*, vol. 5, pp. 5–28.

Fratzscher, M., Juvenal, L. and Sarno, L. 2007, 'Asset Prices, Exchange Rates and the Current Account', *European Economic Review*, vol. 54, pp. 643–658.

Goodhart, C. and Hofmann, B. 2008, 'House Prices, Money, Credit, and the Macroeconomy', *Oxford Review of Economic Policy*, vol. 24, pp. 180–205.

Hillebrand, M. and Kikuchi, T. 2015, 'A mechanism for Booms and Busts in Housing Prices', *Journal of Economic Dynamics and Control*, vol. 51, pp. 204–217.

Hristov, N., Hülsewig, O. and Wollmershäuser, T. 2011, 'Loan Supply Shocks during the Financial Crisis: Evidence for the Euro Area', *Journal of International Money and Finance*, vol. 31, pp. 569–592.

Huang, J. and Wang, H. 2012, 'Study on the Effects of Land Supply Modes on Housing Prices Based Panel Error Correction Model', *Journal of Shanghai University of Finance and Economics*, vol. 14, pp. 90–97.

Jinjarak, Y. and Sheffrin, S.M. 2011, 'Causality, Real Estate Prices and the Current Account', *Journal of Macroeconomics*, vol. 33, pp. 233–246.

Kannan, P., Rabanal, P. and Scott, A. 2011, 'Recurring Patterns in the run-up to House Price Busts', *Applied Economics Letters*, vol. 18, pp. 107–113.

Korinek, A. 2011, 'Hot Money and Serial Financial Crises', *Social Science Electronic Publishing*, vol. 59, pp. 306–339.

—— 2010, 'Regulating Capital Flows to Emerging Markets: An Externality View', *Ssrn Electronic Journal*. Cited May 2010 https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1330897

Krugman, P. 1999, 'What Happened to Asia?', in *Global Competition and Integration*, US, Springer, pp. 315–327.

Laibson, D. and Mollerstrom, J. 2010, 'Capital Flows, Consumption Booms and Asset Bubbles: A Behavioural Alternative to the Savings Glut Hypothesis', *Economic Journal*, vol. 120, pp. 354–374.

Leung, C. 2014, ‘Error Correction Dynamics of House Prices: An Equilibrium Benchmark’, *Journal of Housing Economics*, vol. 25, pp. 75–95.

Liang, Q. and Cao, H. 2007, ‘Property Prices and Bank Lending in China’, *Journal of Asian Economics*, vol. 18, pp. 63–75.

Li, F. and Li, Q. 2014, ‘The Interaction between RMB Exchange Rate and Real House Price’, *Studies of International Finance*, vol. 3, pp. 89–96.

Liu, H., Yun, W.P. and Zheng, S. 2002, ‘The Interaction between Housing Investment and Economic Growth in China’, *International Real Estate Review*, vol. 5, pp. 40–60.

Mackinnon, A., Jorm, A.F., Christensen, H., Korten, A.E., Jacomb, P.A. and Rodgers, B. 1999, ‘A short form of the Positive and Negative Affect Schedule: Evaluation of factorial validity and invariance across demographic variables in a community sample’, *Personality and Individual Differences*, vol. 27, pp. 405–416.

Mallick, S.K. and Sousa, R.M. 2012, ‘Inflationary Pressures and Monetary Policy: Evidence from BRICS Economies’, *Open Economies Review*, vol. 24, pp. 677–694.

Oug, E., Fleddum, A. and Rygg, B. 2012, ‘Capital Inflows and Booms in Assets Prices: Evidence from a Panel of Countries’, *Journal of Experimental Marine Biology and Ecology*, vol. 42, pp. 717–725.

Olaberría, E. 2012, ‘Capital Inflows and Booms in Assets Prices: Evidence from a Panel of Countries’, *Working Papers Central Bank of Chile*, vol. 42, pp. 717–725.

Pu, L., Li, Z. and Zhang, X. 2015, ‘Short Run International Capital Flows, the RMB Exchange Rate and Asset Price: An Approach Based on the Directed Acyclic Graph’, *Economic Review*, vol. 1, pp. 140–151.

Reimers, H.E. 1992, ‘Comparisons of tests for multivariate cointegration’, *Statistical Papers*, vol. 33, pp. 335–359.

Shen, Y. and Li, S. 2012, ‘International Capital Shocks, Multiple Arbitrage and Heterogeneity of House Price Volatility’, *China Soft Science*, vol. 9, pp. 36–44.

Song, B. and Gao, B. 2007, ‘Influence of International Capital Flow on Housing and Land Price: Positive Test Based on the Data in China (1998–2006)’, *Research on Financial and Economic Issues*, vol. 3, pp. 55–61.

Vargas-Silva, C. 2008, ‘Monetary Policy and the US Housing Market: A VAR Analysis Imposing Sign Restrictions’, *Journal of Macroeconomics*, vol. 30, pp. 977–990.

Wang, S. and Tao, S. 2015, ‘RMB Exchange Rate, Short-Term International Capital Flows and Asset Price’, *Financial Forum*, vol. 7, pp. 59–70.

Wang, X., Wang, C. and Kang, H. 2013, ‘RMB Exchange Rate, Asset Price and Short-Term International Capital Flows’, *Price: Theory & Practice*, vol. 8, pp. 75–76.

Wei, M. and Qu, M. 2010, ‘International Capital Flows and House Prices in China’, *Market Modernization*, vol. 18, pp. 16–17.

Wen, H. and Goodman, A.C. 2013, ‘Relationship between Urban Land Price and Housing Price: Evidence from 21 Provincial Capitals in China’, *Habitat International*, vol. 40, pp. 9–17.

Wu, J., Gyourko, J. and Deng, Y. 2012, ‘Evaluating Conditions in Major Chinese Housing Markets’, *Regional Science and Urban Economics*, vol. 42, pp. 531–543.

Yan, T. 2013, ‘RMB Exchange Rate, Asset Price and Short-Term International Capital Flows: An Empirical Study Based on the Exchange Rate Flexibility Interval Adjustment’, *Economy and Management*, vol. 9, pp. 49–54.

Yang, D. and Zhang, Y. 2014, ‘RMB Real Exchange Rate, Short-Term International Capital Inflow and Asset Price: An Analysis Based on TVP-VAR Model’, *Journal of International Trade*, vol. 7, pp. 155–165.

Zhang, C., An, G. and Yu, X. 2012, ‘What Drives China’s House Prices: Marriage or Money?’ *China & World Economy*, vol. 20, pp. 19–36.

Zhu, M. and Liu, L. 2010, ‘Short-Run International Capital Flows, Exchange Rate and Asset Prices: An Empirical Study based on Data after Exchange Rate Reform since 2005’, *Finance & Trade Economics*, vol. 5, pp. 5–13.