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Discussion Paper No. 290

November 2010

ISSN 1860 0921

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Abstract: For many analysts, the Chinese economy is spurred by a bubble in the housing market, probably driven by the fiscal stimulus package and massive credit expansion, with possible adverse effects to the real economy. To get insights into the size of the bubble, the house price evolution is investigated by panel cointegration techniques. Evidence is based on a dataset for 35 major cities. Cointegration is detected between real house prices and a set of macroeconomic determinants, implying that a bubble exhibits mean-reverting behaviour. The results indicate that the bubble is about 25 percent of the equilibrium value implied by the fundamentals at the end of 2009. The bubble is particularly huge in the cities in the southeast coastal areas and special economic zones. While the impact of real house prices on CPI inflation appears to be rather strong, GDP growth may not be heavily affected. Thus, a decline of the bubble will likely have only modest effects on the real economy.

JEL: G12, R21, C33

Keywords: Chinese economy, panel cointegration, house price bubbles

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1 Introduction

For many observers, the Chinese economy is spurred by a bubble in the real estate market, probably driven by the fiscal stimulus package and massive credit expansion. For example, the stock of loans increased by more than 50 percent since the end of 2008. The government urged banks to increase lending to mitigate the economic slowdown (Nicolas, 2009). Home mortgage loans have played a significant role in the development, as they account for one third of the total lending activities. Currently, house prices are at all time highs, and have been increasing at high rates especially over recent years (Wu, Gyourko and Deng, 2010). Banks have provided easy credit for housing development, probably without sufficient evaluation of risks. State-owned enterprises may have stimulated the development, as they have access to low cost capital and may believe they are too big to fail.

To slowdown the development, the People's Bank of China has increased its nominal interest rate. The Chinese government has introduced measures to combat record prices, including higher mortgage rates. Down-payment requirements for second homes have been raised extensively. In some high housing price cities, house owners are restricted in further house purchases. Many state run mortgage lenders have started to cut mortgage discounts. Additional measures are in the pipeline, for example higher taxes on property. As a result, housing prices in the first-tier cities stopped rising further, but are still at record levels.

The housing issue is not only a problem from an economic perspective, but also an issue of the people's livelihood that can affect social stability. Households with average income feel that they cannot afford buying a house. Ratios of house prices to average an-

nual income exceed 18 in Beijing (Wu, Gyourko and Deng, 2010). The government's challenge is to scrap out speculative inflows, whilst not killing a major growth engine. However, while accelerating house prices may indicate the presence of a bubble, its existence is controversial. In fact, urbanization trends, rising incomes and low interest rates can have triggered the evolution. Higher house prices may be still broadly in line with the fundamental factors, and could be still supported by solid demand for residential housing (World Bank, 2010).

A burst of a house price bubble can endanger the stability of the real economy. For example, Helbling and Terrones (2003) have pointed out that house price busts are associated with output losses twice as large as equity bubbles. See also Goodhart and Hofmann (2008). In general, a slump in real estate prices might be more harmful than a stock market crash because real estate is the more important collateral underlying bank loans and house ownership is more widespread across the population. Shocks might transmit through a number of channels, including credit crunches and lower construction activities.

Because of a low leverage, the risk with respect to people not being able to fund their mortgage commitment might not be very high. However, housing investment is an important pillar for economic growth, even in the long run (Liu, Park and Zheng, 2002). Its share in GDP is 10 percent, much more than in the industrialized economies. Chen and Zhu (2008) have concluded from their analysis that an increase in housing investment of 1 percent will cause a rise in GDP of 0.2 percent. Due to the ongoing integration of China into the world markets, a bubble might also have an international dimension. If a decline house prices contributes to lower output growth, negative spillovers to other countries could occur. According to many analysts, the apparent house price bub-

ble is one of the major risks for a sound recovery of the global economy after the financial crisis.

In this paper, the house price development is investigated both at the national and regional level. The contribution is twofold. First, it is investigated whether a bubble exists. The point of departure is a long run equilibrium between real house prices and demographic and macroeconomic conditions. Using a regional dataset for 35 major cities, the size of the bubble is estimated relative to the fundamental level implied by the panel cointegrating relationship. Second, the impact of real house prices on CPI inflation and GDP growth is investigated at the national level using an in sample and out of sample framework.

The results indicate the presence of a house price bubble. At the end of 2009, real house prices are 25 percent above their equilibrium value. However, heterogeneities are striking across the country. The bubble is especially pronounced in the cities of the southeast coastal areas and the special economic zones. While the impact of real house prices on CPI inflation seems to be rather strong, GDP growth may not be heavily affected. Real house prices do not cause GDP growth, and point forecasts of GDP growth are not substantially improved if the house price evolution is taken into account. These findings might reflect a limited exposure of private households' expenditures to housing wealth. Therefore, a decline of the bubble could have only modest effects on the course of the real economy.

The paper is organized as follows. The next section (section 2) reviews major changes in the Chinese housing and land market. Methods to detect bubbles and econometric issues are discussed in section 3. Data and empirical results are presented in section 4. Finally, section 5 concludes.

2 The Chinese housing and land market

Prior to China's housing reform, virtually no private housing existed in the urban area. All housing properties have been owned by the state and allocated to urban dwellers by the government or state-controlled work units at very low rent. Due to lack of investment in residential property, housing conditions in the cities remained very poor. For example, the living space of urban dwellers was about 4 square meters per capita in the late 1970s.

Since the early 1990s, housing policies switched from the state allocation system to a market-oriented one. A series of reforms have been implemented, which have significantly reduced the role of the state as provider of housing and allowed for the emergence of a private housing sector. As a first measure, state controlled apartments have been sold to the tenants at a lower-than-market price. Since then, the government has consistently promoted investment and purchases in the real estate market. Over the last decade, housing investment has grown at annual rates of 20 percent. Housing has become the most important private property for urban Chinese (Wang, 2003). Living conditions improved steadily. For example, the urban housing space per capita increased to 24 square meters. In 2009, investment in the real state sector accounted for 16 percent of China's total investment. The housing industry has become a main engine of China's economic growth.

The state has still the ultimate ownership of urban lands. Local governments, as the representative of the central government, are empowered to allocate lands to different users. By controlling both land supply and the overall planning of land development for

the city, local governments can decide what can be built in their jurisdictions, subject to state regulation (Cai and Zhang, 2009). Initially, land transactions have been conducted with the price being either negotiated between the buyer and seller, or set by the local governmental. The land transaction price has been often lower than the market one, creating rent for corruption. Since 2004, all transactions in urban lands must be carried out through public auction or bidding to prevent rent seeking behaviour. The successful bidder would obtain a long-term leasing contract for specified use.

Individuals are permitted to purchase urban land-use rights for up to 70 years for residential, 50 years for industrial and 40 years for commercial use (Wu, Gyourko and Deng, 2010). Under this long term contract, the land price is believed to reflect developments in the housing sector with some delay. For example, Du, Ma and An (2010) have reported Granger causality running from land to house prices, but not vice versa. According to Peng and Thibodeau (2009), residential property prices do not have an impact on land prices after 2004. See also Zheng and Kahn (2008). In recent years however, with soaring land prices and rapid commercialization of the housing market, land auctions have become a major source of revenues for local governments. In Beijing, the land auction revenue currently accounts for 46 percent total revenue of the municipal government.

The rapid urbanization and the ongoing trend for smaller families have created strong housing demand. Since 1990, the number of city dwellers in Beijing has increased from 10.8 to 17.6 billion, while the household size decreased from 3.2 to 1.7. The newly registered marriage raised by 54 percent since 2007 (Beijing Statistical Yearbook). For many Chinese, especially for young couples, renting an apartment is not very popular. The regulation system does not give tenants much protection. For example, renters will

lose their apartments if the home owner decides of a different use. The preference to own a house has considerably driven up the demand in the housing market. Due to high economic growth, millions of Chinese join the middle class each year, thereby contributing to high housing demand. Because of high saving rates, many households are able to buy a house with cash and are rather independent on mortgage loans. In addition, the uneven regional development has enhanced the housing demand in the first-tier cities, as there are better living conditions, more job opportunities, and better social and public resources.

As a social housing provision system for low income families has not been fully established yet, housing affordability therefore becomes not only an economic issue, but also an issue of social stability (Deng, Shen and Wang, 2009, Zenou, 2010). One requirement for having access to the social housing is that at least one member of the household must have a local permanent non-agricultural *hukou* registration for more than five years. This regulation is intended to control migration from the rural areas. By allowing for a large amount of temporary migration, *hukou* has contributed to the creation of a group of urban residents with restricted rights. Excluded from the urban housing system, many of the rural migrants reside in the *urban villages* that are not integrated in the city administration.

3 Bubbles in housing markets

An asset price bubble is a price acceleration that cannot be explained in terms of the underlying fundamental economic variables (Flood and Hodrick, 1990, Case and Shiller, 2003). The most important nonfundamental element driving price increases is the

belief that prices will continue to rise in the future (Shiller, 2005). Therefore, prices are high just because the participants expect that they can sell the asset at a higher price in the future, i.e., the price evolution is affected by psychological components. The bubble might show a high degree of persistence, as the agents will not change their expectations frequently. In particular, they are uncertain with respect to the time when the market changes its perception.

Between 2001 to 2004, house prices increased by 25 percent or more in almost every major city in China (Deng, Shen and Wang, 2009). Prices continued to rise rapidly from 2004 to 2007 (Ye and Wu, 2008). The most recent development has been triggered by the fiscal stimulus program launched at the end of 2008 in response to the financial crisis (Cova, Pisani and Rebucci, 2010).

There are some indications that the market might have overheated in 2008/09. In some cities, house buyers are picked up by the seller through lottery. The rapid rise nourishes exuberant expectations and speculation. Some real estate developers have started hoarding of houses by delaying their sales hoping for bigger profits when prices rises further. Due to higher price expectations, families are stretching to pay prices at the edge of their means or beyond. The speculation in the housing market might have further stimulated an already existing housing boom.

Fundamental factors can be either derived from a present value or structural models. In any case, a cointegrating relationship between real house prices and the fundamental variables is implied. Deviations from the equilibrium might be interpreted as an indication of a house price bubble. The present value model ties house prices to a stream of earnings associated with the housing property. In a frictionless market, the value of a house should be equal to the present value of future housing service flows that are pro-

vided to the marginal buyer (Campbell and Shiller, 1987). The latter can be approximated by the rental value of the house. If the user costs of housing exceed the market rent, for example, it would be less expensive to rent than to buy, and demand to buy should fall, thereby reducing house prices. Hence, rents are a fundamental determinant of the value of housing and should not move too far away from prices, i.e. the price rent ratio should exhibit mean reverting behaviour. This condition is rejected in Chinese cities, see Figure 1. The evidence can indicate the presence of a bubble in house prices, but might be also explained in terms of the social and institutional environment, since renting is not very popular in China. Thus, the steep increase in the price rent ratio might not necessarily reflect speculative elements.

-Figure 1 about here-

Structural models are based on the demand and supply side of the housing market. For example, Capozza, Hendershott, Mack and Mayer (2002) and Gallin (2006) have advocated models to derive the stationarity of the price income ratio. This measure has increased steadily, especially in Beijing, Shanghai, Shenzhen and Hangzhou (Wu, Gyourko and Deng, 2010). It should be noted, however, that a nonstationary behaviour of the indicator does not inevitably imply the presence of a bubble. The structural parameters will generally depend on the elasticities governing housing demand and supply. It is also assumed that income is the only nonstationary driver of house prices. As relevant demographic and macroeconomic determinants such as population, land prices and real

interest rates might be integrated as well, the analysis should be extended by these measures.

Panel cointegration techniques are used to test for a long run relationship between real house prices and a set of fundamental factors. The panel includes information for 35 major Chinese cities over 1998-2009 period. Because of the short time span, residual based cointegration tests are preferred, with real house prices as the left hand side variable. On this route, however, two major problems need to be addressed. First, the tests often have low power because of an invalid common factor restriction, see Kremers, Ericsson and Dolado (1992). In particular, the long run parameters of the level variables should be equal to the short run parameters of the differenced variables. To solve this problem, Westerlund (2007) has proposed four panel cointegration tests for the null of no cointegration that do not impose the common factor restriction. They are based on the residuals obtained from individual error correction models. Thus, the short run dynamics and deterministic components can differ over the cross section. The two panel statistics investigate the alternative that the panel is cointegrated as a whole, while the two group mean statistics check the alternative that cointegration holds at least for one cross section unit. All tests are one sided, i.e. large negative values imply that the null hypothesis should be rejected.

Second, the panel cointegration tests often rely on the assumption of independent panel members. In the presence of cross section dependencies, large size distortions can occur (Banerjee, Marcellino and Osbat, 2004). The statistics fail to achieve the normal distribution under the null. In order to circumvent size distortions the critical values are constructed using bootstrap methods, see Chang (2004) and Westerlund (2007) for the details.

Note that the panel cointegration tests do not uncover the long run parameters. In the application presented below, the cointegration vector is assumed to be identical for all cities, as fundamental economic principles are involved. In fact, there is only little theoretical rationale for a wide dispersion of the cointegration parameters as the panel members are quite homogeneous. Therefore, after testing for cointegration, the pooled mean group estimator suggested by Pesaran, Shin and Smith (1999) is applied to reveal the common cointegration vector. It restricts the long run coefficients to be identical across the panel members, but allows short run coefficients and error variances to vary across cities.

In principle, deviations from the equilibrium might indicate the presence of speculative elements in the house price evolution. However, many analysts have argued that a bubble has emerged only in recent years, probably spurred by the fiscal stimulus package (Wu, Gyourko and Deng, 2010). Therefore, the evidence can be misleading if the cointegration relation is considered over the whole period. In fact, the cointegration parameters are estimated in a way to capture even the house prices at the end of the sample. As a consequence, the size of a bubble will likely be biased downwards. Thus, the long run is estimated only up to some point in time. Then, the house price evolution is predicted over the rest of the sample, assuming perfect foresight with respect to the fundamentals. This leads to an estimate of the fundamental development of house prices, and the size of the bubble can be addressed.

The short run implications of a house price bubble for GDP growth and CPI inflation are investigated at the national scale. The evidence is based on different methods to extract robust conclusions. In sample results are provided by a Granger causality analysis.

This is extended by an out of sample exercise, where the information content of real house prices is explored.

4 Data and empirical results

To explore the existence of a bubble in the housing market, the evidence is built on panel data for 35 major cities in China. Annual data are available for the 1998-2009 period. Besides the panel data, quarterly series are available at the national level. The national data are used to examine the short run consequences of a bubble decline. The relatively short time span arises from the fact that there was no real private market neither in land nor housing units in China until the late 1990s. Therefore, it is only possible to compare current conditions with little more than a decade of data. In fact, the data used in this study are all from a boom period.

Information on house prices, land prices, interest rates, GDP, population and the CPI (1998=100) are taken from the China Statistical Yearbook. Nominal figures are deflated by the CPI to obtain variables in real terms. Income per capita is the ratio between GDP and population, and the real interest rate is the difference between the nominal interest rate and CPI inflation for the period ahead. Potential determinants of real house prices (hp) may include real land prices (lp), real per capita income (y), population (pop), and the real interest rate (r). Despite the real interest rates, all variables are measured in their logs.

To investigate the cointegration properties, the panel and group mean statistics suggested by Westerlund (2007) are employed. Parameters such as the number of lags and leads in the individual error correction models are determined by the Schwarz informa-

tion criterion. As the cross sections are not independent, critical values are obtained by bootstrap methods, see Persyn and Westerlund (2008). The evidence for certain subsets of variables is reported in Table 1.

-Table 1 about here-

The empirical support for a cointegrating relationship between real house prices, real per capita income and real interest rates is rather weak, as the null hypothesis of no cointegration can be rejected only at the 0.1 level. However, the result is not robust, as it is only confirmed by two out of four tests. While this finding might reflect a low power problem due to the short time series dimension, the evidence can be improved, if real land prices are added to the analysis. In the extended model, most tests indicate the presence of a long run equilibrium, even at the 0.05 level. In contrast, the inclusion of population distorts the cointegration property. This could be due to the fact that the variable is an imprecise proxy of the sociodemographic trends that determine housing demand, as the presumably relevant factors such as the reduction of the family size are not included. According to this evidence, the further analysis is based on a model comprising real house prices, real per capita income, real land prices and the real interest rate. The cointegrating vector is exhibited in Table 2.

The equilibrium relationship is quite sensible, as the long run parameters are correctly signed. While real income per capita and real land prices have a positive effect on real house prices, the real interest rate is expected to exert a negative impact. In addition, the cointegrating vector seems to be relatively stable over time. Nonetheless, there is some

tendency of variation in the income and land price elasticities. While income becomes more important rises, if data of the more recent years are included, the land price elasticity shows a mild decline.

-Table 2 about here-

The existence of a long run equilibrium between real house prices and their fundamentals implies that a house price bubble, if there is any, is not persistent. Instead, there is mean reverting behaviour if deviations from the cointegrating relationship occur. The bubble can be inferred from the cointegrating residual. However, this can underestimate the true size of the bubble, as the cointegrating parameters reflect the house price development until the end of the sample. Since the bubble is a phenomenon of the recent years, the parameter regime for the 1998-2007 period is used to predict the fundamental development in 2008/09. In this exercise, the actual values of the right hand side variables are included. As an exception, real land prices are fixed to the 2007 levels. Otherwise, a potential land price bubble could eventually blur a bubble in the housing market.

-Figure 2 about here-

The size of the house price bubble is displayed in Figure 2. It can be seen that increasing imbalances have emerged over the past two years. For example, real house prices in Shanghai have been 28 percent above the long run equilibrium in 2008, and 35 percent in 2009. While the evidence is similar for Beijing, the increase is more spectacular in

Shenzhen. Compared to the cointegrating relationship, real house prices are overvalued by 66 percent in 2009, after 23 percent in 2008. In general, the bubble is more pronounced in the special economic zones and the southeastern coastal regions. Overall, the size of the bubble is 20 percent in 2008 and 25 percent in 2009, regardless of whether GDP or population weights are applied.

According to the mean reverting behaviour, a decline of the bubble should be expected over the period to come. The expected effects of this development on real GDP growth and CPI inflation can be investigated at the national level. First, Granger causality tests are applied (Table 3). While the null hypothesis that real house prices do not cause GDP growth cannot be rejected at conventional levels, it is soundly rejected in case of CPI inflation. According to this evidence, house prices cause inflation, but probably not GDP growth.

-Tables 3 and 4 about here-

A similar result can be obtained in an out-of sample exercise. Here, it is examined whether the inclusion of real house prices is able to improve the forecasts of year-on-year CPI inflation and GDP growth, compared to an autoregressive benchmark. The forecasts are obtained in a recursive manner. The first estimation subsample is 1998Q1-2005Q4 and the forecast subsample is 2006Q4-2009Q4. After producing the point forecast for 2006Q4, the estimation period is extended by one quarter (1998Q1-2006Q1) and the forecast for 2007Q1 is made. Hence, 13 annual forecasts are derived. The forecast accuracy is evaluated by the root mean square forecast error, expressed relative to

the benchmark model. For robustness, the relative mean absolute forecast error is also reported, see Table 4. It can be seen that the forecast errors of the benchmark are quite large, implying that an autoregressive model is not well suited for the Chinese economy. The root mean square forecast error exceeds the mean absolute error because of outliers. While the forecast accuracy can be increased in case of the CPI inflation, there is only a small change in the performance for GDP growth. Overall, these findings suggest that a decline of the house price bubble could reduce inflation, without exerting huge negative effects on GDP growth.

Conclusions

For many analysts, the Chinese economy is spurred by a bubble in the housing market, probably driven by the fiscal stimulus package and massive credit expansion, with possible adverse effects to the real economy. To get insights into the size of the bubble, the house price evolution is investigated by panel cointegration techniques. Evidence is based on a dataset for 35 major cities. Cointegration is detected between real house prices and a set of macroeconomic determinants, implying that a bubble exhibits mean-reverting behaviour. The results indicate that the bubble is about 25 percent of the equilibrium value implied by the fundamentals at the end of 2009. The bubble is particularly huge in the cities in the southeast coastal areas and special economic zones. While the impact of real house prices on CPI inflation appears to be rather strong, GDP growth may not be heavily affected. Thus, a decline of the bubble will likely have only modest effects on the real economy.

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Table 1: Panel cointegration tests

	G_{τ}	G_{α}	P_{τ}	P_{α}
<i>hp, y, r</i>	-1.840 (0.111)	-3.134 (0.324)	-9.317 (0.088)	-3.103 (0.179)
<i>hp, y, pop, r</i>	-1.645 (0.478)	-1.746 (0.638)	-7.028 (0.386)	-2.289 (0.243)
<i>hp, y, lp, r</i>	-2.206 (0.133)	-3.450 (0.063)	-12.717 (0.030)	-3.613 (0.033)
<i>hp, y, lp, pop, r</i>	-1.704 (0.594)	-1.163 (0.338)	-10.627 (0.201)	-1.590 (0.128)

Note: Data for 35 Chinese cities, sample period 1998-2009. Real house prices (*hp*), real per capita income (*y*), population (*pop*), real land prices (*lp*), real interest rate (*r*). Real house prices on the left hand side. Panel cointegration tests according to Westerlund (2007). Entries denote test statistics, *p*-values in parentheses. The *p*-values are based on bootstrap methods, where 800 replications are used. See Persyn and Westerlund (2008).

Table 2: Estimation of the cointegrating vector

	1998-2007	1998-2008	1998-2009
y	0.096 (0.010)	0.111 (0.009)	0.123 (0.007)
lp	0.119 (0.014)	0.092 (0.011)	0.076 (0.009)
r	-0.020 (0.002)	-0.021 (0.002)	-0.022 (0.002)
R^2	0.804	0.816	0.830

Note: Data for 35 Chinese cities, varying sample periods. Real house prices (hp) on the left hand side, real per capita income (y), real land prices (lp), and real interest rate (r) on the right hand side of the cointegrating equation. R^2 adjusted R -squared. Pooled mean group estimator of the cointegrating vector, according to Pesaran, Shin and Smith (1999). Entries denote elasticities of real house prices with respect to real per capita income and real land prices, and semi-elasticities with respect to the real interest rate, standard errors in parantheses.

Table 3: Granger causality tests

$\Delta(hp)$ does not cause $\Delta(cpi)$	6.590 (0.014)
$\Delta(cpi)$ does not cause $\Delta(hp)$	0.003 (0.958)

$\Delta(hp)$ does not cause $\Delta(y)$	2.078 (0.157)
$\Delta(y)$ does not cause $\Delta(hp)$	0.004 (0.951)

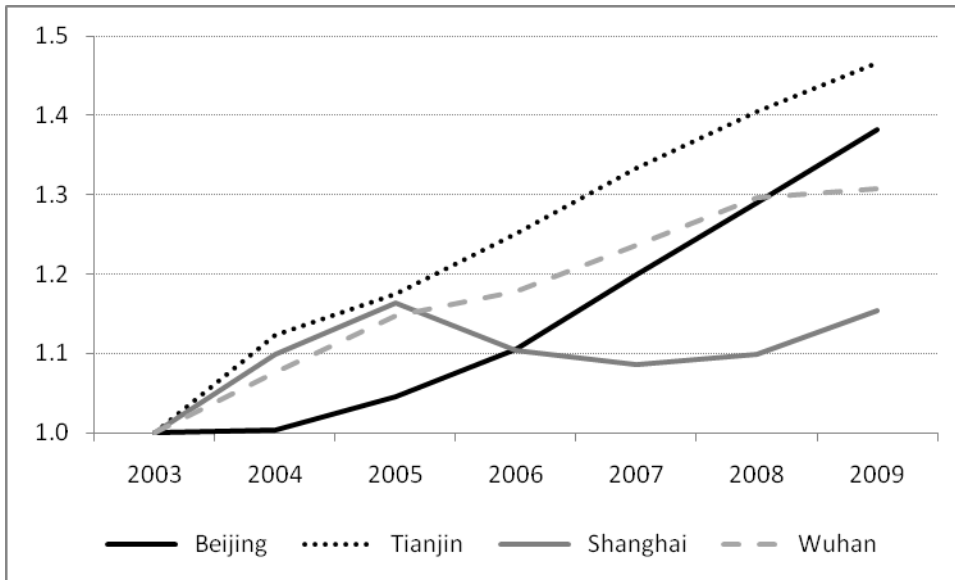
Note: National data, 1998.1-2009.4. Real house prices (hp), real per capita income (y), and cpi . Δ is the first difference operator. Lag length according to Schwarz information criterion. Entries denote F -values, p -values in parantheses.

Table 4: Out-of sample forecasting performance

	RMSFE	MAFE	Relative forecast accuracy
CPI inflation	5.0	4.5	0.844 0.829
GDP growth	4.1	2.9	0.924 0.958

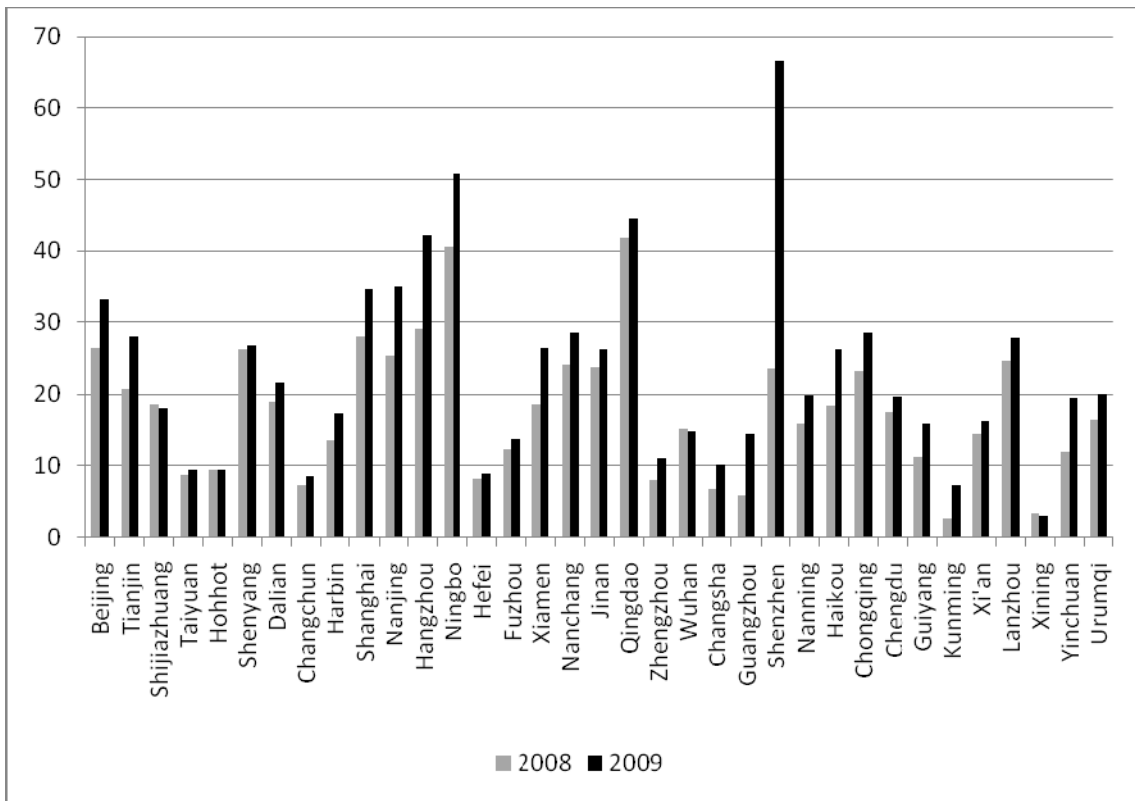
Note: The root mean squared forecast error (RMSFE) and mean absolute forecast error (MAFE) are taken from the autoregressive benchmark and expressed in percent. The relative forecast accuracy shows the RMSFE (left entry) or MAFE (right) relative to that of the benchmark.

Figure 1: House price rent ratios in selected Chinese cities



Note: Ratio between nominal house prices and nominal rents, both obtained as an index. The figures are normalized (2003=1).

Figure 2: House price bubble in major Chinese cities



Note: Size of the bubble expressed in percent of the fundamental value implied by the cointegrating relationship.