The Influence of Fundamental Factors on Chinese Residential Real Estate Prices: A Unique Data Panel Study

[Abstract] Using a unique set of quarterly residential real estate price data for 12 major Chinese cities during the period from 1999 to 2010, this paper employs both relative measures and well-specified regression models to examine the impact of key fundamental factors on home prices. Our empirical results confirm that per capita GDP growth, average wage rates, land prices, population, and implicit user costs have a significant and positive influence on Chinese residential real estate prices, with land prices and implicit user costs having the greatest impact.

Keywords: housing prices, household disposable income, land price, population, user costs

JEL Classification: E44 G12 R21 R31

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1. Introduction

Beginning in 1998 when the Chinese government deemed the free market as the main channel for allocating housing among its citizens, the volume and value of residential real estate construction and prices in all of China's major metropolitan areas have experienced explosive growth. As a result, housing assets today constitute the largest single source of household wealth in China; and because of its magnitude, the future value of that wealth has important implications for the Chinese economy in particular and the global economy in general. By the end of 2009, the total market value of China's residential real estate market reached 91.5 trillion Yuan, nearly three times China's GDP for the same year. In China's major urban centers such as Beijing and Shanghai, residential real estate prices more than tripled between 1999 and 2010.

In recent years, widespread concern that the rapid increase in China's property values represents an impending "real estate bubble" that will inevitably burst, similar to that which occurred in Japan beginning in 1990, is a significant concern for both scholars and policymakers around the world.[1] In the popular business press, some have recently argued that China's housing bubble is more portentous than the run-up and subsequent crash of U.S. housing prices, which arguably led to the onset of global financial crisis in 2007.[2] Given this unprecedented run-up in residential property values, along with the high concentration of Chinese household savings in real estate, and the fact that as much as 25 percent of China's GDP may be tied to real estate and real estate related industries (WSJ, 2011), the importance of identifying and understanding the factors that drive Chinese residential real estate values is essential.

[1] Forbes has recently ranked China's real estate market bubble second in the top seven looming financial bubbles in the world, see Randal D. K. and Hawkins A. (2010) Seven Looming Financial Bubbles, Forbes, December 15 2009; Gao, Shanwen, the chief economist at Anxin Securities, claimed the house market bubbles in some big cities will burst in the next 3 to 5 years; see 'The housing market bubble will burst in the next 3 to 5 years' (fangchan paomo jiang zai 3 dao 5 nian nei pomie), *Shenzhen Special Zone Daily (Shen Zhen Tequbao*), April 12, 2010.

[2] Vega R. (2010), China's housing market worse than US before subprime collapse, *Daily Reckoning,* June 2, 2010.

Although several papers have investigated the nature and determinants of residential real estate values in China (Ahuja et al., 2010; Chen, Guo and Wu, 2011; Du, Ma and An, 2010; Hou, 2010; Hou, 2009; Hui and Yue, 2006; Ito, 2010; Liang and Cao, 2007; Liu, Yun and Zheng, 2002; Sato, 2006; Wu, Gyourko, and Deng, 2011; and Xu and Chen, 2011), these papers suffer from what has since been acknowledged as unreliable Chinese housing price data as well as potential methodological and analytical shortcomings.

With respect to data, all previous studies of Chinese residential real estate prices have relied on the National Bureau of Statistics (NBS) of China as the source for real estate pricing information. The NBS China data consists of published home sales price indices for the entire country as well as 70 large and medium-sized cities (hereinafter referred to as the 70-city index) on a year-on-year growth base. Recently, however, this data has been criticized for significantly underestimating real residential real estate price increases in these major cities (Wu, Deng, and Liu, 2011; Ito, 2010; Ahuja et al, 2010). As a result of this criticism, in early 2011, NBS China abandoned the 70-city index and now publishes price changes in individual cities without any reference to a nationwide average.[3] Importantly, both the criticism and subsequent abandonment of the 70-city index raises serious questions about the reliability of the results of previous research about China's property markets that used this data as the basis for analysis. This paper tackles the issue of data reliability by constructing a quarterly housing price series for twelve of China's largest cities during the period 1999-2010 using three sources of data: the official Home Sales Price Index, yearly data available from the China Real Estate Information Corporation (CRIC), and monthly data from CRIC combined with official city statistics.

Methodologically, previous research about the determinants of China's residential real estate market also suffers from significant shortcomings. Perhaps most importantly, previous

[3] See Aaron Back and Esther Fung, "China Scraps Property Data, Clouding View," The Wall Street Journal Online, February 17, 2011. Accessed February 21, 2012. http://online.wsj.com/article/SB10001424052748703373404576147792827651116.html

studies fail to consider factors unique to China's real estate price dynamics such as the influence of government land sales and government land acquisitions on value. Although Wu et al (2011) considered this important Chinese variable, their analysis only considered its influence on prices in one market – Beijing. (Xiuping, you write about a 'quality land price series'…does that simply mean the influence of government activity or does this mean something else. If it means something else, can you please explain?) This study is the first study to employ this key variable to explain housing prices for 12 major Chinese cities.

Finally, this paper improves on previous papers about China's residential real estate price dynamics by using recently developed panel study techniques to examine the roles of four key fundamentals in housing price dynamics.

Based on both theoretical and empirical studies, we hypothesize that there may be four key fundamental factors driving housing prices at major Chinese cities, namely household disposable income growth, land price inflation, rural-urban migration and urbanization, and user costs. This paper adopts different proxies for these four fundamentals and then uses these criteria to put the current period of house price increases into historical perspective.

The rest of the paper is organised as follows. In Section 2 we construct a time series of quarterly housing prices for twelve major Chinese cities. We describe the data and collection methods and present four key fundamental factors underlying Chinese house price inflation. In Section 3, we construct different proxies and then use relative measures to access to these four fundamentals. In Section 4 we discuss the ordinary least squares panel estimation, and panel and pooled mean group cointegration results. Section 5 concludes.

2. Chinese Housing Prices, Housing Price Data Construction and Hypotheses

2.1. The 70-City Index: China's official housing price data between 1998 and 2010

In the planned-economy era of China before 1978, urban housing was basically owned by

work units or housing management departments of local governments. Since the initiation of economic reforms beginning in 1978, various new policies have been introduced to increasingly privatize and reform the public-sector-dominated housing system in China (Chen et al, 2011). In July 1994, the State Council in China issued a directive that provided the basic framework for housing reform in the 1990s, which aimed to abolish the work unit-based, welfare-oriented housing system gradually through housing privatization reform as well as rent reform. The second stage of housing reform started in July 1998, when the State Council announced the termination of in-kind distribution of public-owned housing (Sato, 2006). Work units were no longer permitted to develop new residential housing units for their employees in any form (Wu et al, 2011), and the free market was designated as the main channel for providing residential housing. This policy continues today.

Also beginning in 1998, National Development and Planning Commission (the former National Development and Reform Commission) and National Bureau of Statistics (NBS) began to jointly issue the real estate price indices for the entire country and 35 major cities in China[4]. For each of these markets, three different price indices were created: a home sales price index, a housing lease price index, and land transaction price index. All index data were collected by independent survey and calculated as year-on-year percentage growth rates with last year's index equalling 100. In July 2005, an additional 35 cities were included, resulting in what has become known as the 70-City Index of large and medium-sized cities. Figure 1 illustrates the quarterly values for the national level index for all three series between 1999 and 2010, while Figure 2 illustrates the quarterly value of the home sales price indices for 12 of China's largest cities including Beijing, Shanghai, Hangzhou, Shenzhen, Guangzhou, Tianjin, Nanjing, Wuhan, Chongqing, Chengdu, Xi'an, and Shenyang, with each of three panels (a) through (c) containing four cities respectively.

Insert Figure 1 Here

Insert Figure 2 Here

[4] The thirty-six housing price time series include a national index and indices for Beijing, Changchun, Changsha, Chengdu, Chongqing, Fuzhou, Guangzhou, Guiyang,. Ha'erbin, Haikou, Hangzhou, Hefei, Huhehaote, Jinan, Kunming, Lanzhou, Nanchang, Nanjing, Nanning, Ningbo, Qingdao, Shanghai, Shenzhen, Shenyang, Shijiazhuang, Taiyuan, Tianjin, Wulumuqi, Wuhan, Xi'an, Xiamen, Yinchuan, Zhengzhou, Xining, and Dalian.

As mentioned in the introduction, China's NBS recently faced a crisis of confidence in when its property price data was criticised for significantly underestimating real property price increases (Ito, 2010; Ahuja et al., 2010). The criticism was propagated by the release of the fourth quarter figures for 2009 in which, for example, the NBS reported an average year-on-year increase of 5.9% for Beijing, while the widespread belief was that the increase in price approached 50%. This disparity between the official statistics and the public's observation led to widespread mistrust and public scorn.

In response to public pressure and to avoid future embarrassment, in early 2011, the NBS announced a series of reforms under an umbrella called the New Home Sales Price Statistical Scheme which was designed to improve the quality and accuracy of the collection and reporting of real estate price data. Under the new Scheme: (1) sales volume and sales prices per square meter for construction of the new indices will be compiled from data provided by local real estate departments rather than from the previous 'independent' survey; (2) residential real estate data will be divided into two price subcategories (an index measuring the price of newly constructed residential buildings and an index measuring the price of second-hand residential buildings), and three floor area subcategories (less than 90 square meters, between 90 and 144 square meters, and exceeding 144 square meters); (3) future data will be compiled and disseminated using three growth bases (year-on-year, month-on-month and using a fixed base with Year 2010 = 100), while previous data was available only on a year-on-year growth base. The average indices for the entire country as well as the 70-City Index 1 were abandoned.

2.2. Construction of a new housing price index for 12 major Chinese cities

While future Chinese real estate transaction information is expected to possess greater integrity and should be more detailed and reliable, the results and conclusions of previously published research that used the NBS data must be considered questionable at best.

While the "official statistics" may lack integrity, several private real estate agencies and development firms independently compile these statistics for purposes of internal analysis and decision-making. Centaline, one of China's largest real estate agencies, is one such firm that compiles its own private real estate database. In addition, the China Real Estate Information Corporation (CRIC), a leading provider of real estate information, consulting and online services in China, has been compiling annual real estate data and information for dozens of China's largest

cities since 1998, and monthly data since 2006. Their data set does a better job to capture than change in official indices. Besides, official statistics of average yearly house prices for some cities are found in official city statistics such as Chongqing City Bluebook as well.

Our paper is filling in gap with constructing quarterly housing price series for 12 big cities, namely Beijing, Shanghai, Hangzhou, Shenzhen, Guangzhou, Tianjin, Nanjing, Wuhan, Chongqing, Chengdu, Xi'an, and Shenyang, for the period 1999-2010. Three sources of data are used in the constructing process: official Home Sales Price Index, yearly data available from CRIC, and monthly data from CRIC combined with official city statistics. The constructing procedures are as follows: first, anual price data was obtained from CRIC during the period from 1999-2010. Annual values were based on are taken as the prices at end of the fourth quarter, and the left three quarters' house prices are calculated employing the weighted official Home Sales Price Indices, which may be denoted as Price 2. Second, monthly prices from CRIC during the period from 2006 to 2010 and city statistics are also transformed to be quarterly frequency by using the last month's price in each quarter, which may be denoted by Price 2. Third, Price 2 is then combined with Price 1 to form the final price series with the first period (1999-2005) to be Price 1 and the second period (2006-2010) to be Price 2. Figure 3, panels (a) though (c), shows the movement of the price index for each of the twelve 12 Chinese cities evaluated in this study which was constructed using the three steps described above. As we can see, unlike the indices for China's property values using China's official statistics in Figure 2, our data demonstrates an obvious upward trends in average house prices.

Insert Figure 3 Here

3. The Fundamental Housing Price Model

3.1 Hypothesis: Four Key Fundamentals underlying China's housing price inflation

Dramatic housing price increases at Chinese cities may not be necessarily evidence of overvaluation. To address this issue, it is necessary to relate these prices to their underlying fundamental determinants. Numerous papers have explored the fundamental determinants of house prices across a number of countries. Demand fundamentals include income measures (affordability), user or occupancy costs, population growth or structure, interest rates, monetary policy, demographic developments, and so on (Goodman, 1989; Holly and Jones,1997; Iacoviello and Minetti, 2003; Tsatsaronis and Zhu, 2004; OECD, 2005; Iacoviello, 2005; Negro and Otrok,

2007; Wheaton and Nechayev, 2008; Costello et al, 2011). Supply fundamentals consist of rising land values, construction or house structure costs (OECD, 2005; Davis and Heathcote, 2007, 2008). However, in general there is a lack of a widely-accepted rational dynamic model of house prices.

The nature of literature focusing on China's real estate market generally overlaps with the literature focusing on real estate in other countries. However, because of the unique and unprecedented development of China's economy, especially its real estate sector, additional factors and explanations have been explored to help understand its determinants. On the demand side, unprecedented rapid growth in GDP and disposable income, user costs push, bank lending, and rural to urban migration and urbanization are among the most important determining factors (Liang and Cao, 2007; Chen et al, 2011). On the supply side, central-local fiscal relations and land developmentalism, land price push, inefficient economic housing supply are posited as the key factors (Liu et al., 2002; Du et al, 2010; Su and Tao, 2010).

In this paper, we argue that just four of these fundamental factors from both demand and supply sides are needed to understand the determinants of China's urban real estate market. We call this model the 'four key fundamentals hypothesis'. These four key fundamental factors include China's (1) rapid disposable income growth, (2) land price inflation, (3) rural to urban migration and urbanization, and (4) rapid increase in user costs or rents.

The enormous demand for residential housing unleashed by the significant housing reform initiatives introduced in 1998 was partly driven by the increase in savings and personal disposable income resulting from twenty years of rapid economic growth. During China's entire reform period and continuing today, Chinese households have had very limited investment and savings options available to them. According to the World Bank[5], between 1987 (the first year for which data was available) and 2010, the real return available to Chinese households on their deposit savings averaged -0.6%. In addition, China's stock markets which were formed and began trading in the early 1990s are generally viewed as inadequately regulated, inefficient, and excessively volatile. Given the limited options available to most Chinese households for savings and investment, the liberalization of the real estate sector in 1998 made housing an obvious best alternative.

Significant inflation in the price of land in many parts of China resulted not only as a consequence of China's rapid economic growth and expanding incomes, but also because of China's government land development models (Ahuja, et al, 2010; Su and Tao, 2010; Wu et al,

[5] The World Bank: World Development Indicators, http://data.worldbank.org/data-catalog/world-development-indicators. Accessed March 3, 2012.

2011). As a matter of government policy, the housing and urban land use reform beginning in 1998 targeted real estate and manufacturing as dual engines for stimulating urban physical and economic growth and for boosting local government revenues. As a result, local governments were cast into an unofficial competition for development and generation of tax dollars. As China's privatization of the housing sector resulted in an explosion in demand for new residential construction, local government monopolies on land enabled them to extract the maximum amount of revenue from land leases to business and residential land users. As a result, according to Wu et al (2011), the share of land in Beijing's property values, for example, rose sharply so that by early 2010 land constituted over 60% of averaging housing prices. According to Ahuja, et al (2010), rising land value is among the key fundamental factors determining housing prices in major Chinese cities.

A third key factor generally acknowledged as having an important influence on the increase in housing prices in China's larger cities is rural to urban migration and urbanization. Large cities such as Beijing, Shanghai, Hangzhou and Shenzhen have for years been cities of choice for vast populations of rural migrant workers in search of better opportunities. Between 1996 and 2005, China's urban population increased over 50% from 373 million to just over 562 million, and this migration has since continued. Since 2005, approximately 15 million migrant workers stream into China's major urban areas each year (Wu et al, 2011). In a recent paper, Chen et al (2011) explored the effect of rural to urban migration on China's urban housing prices and concluded that this migration has had a significant effect house prices in China' major urban centers.

A fourth key factor influencing China's urban housing prices is the rapid rise in user costs or rents (OECD, 2005; Ahuja et al, 2010). Loose monetary policy may produce positive shocks to both output and inflation, which result in rising inflation, user costs or house rents[6]. To hedge against inflation and rising user costs, purchasing residential real estate is particularly appealing in China because of the few alternative savings and investment options available to households. In the past, some have argue the rise in demand and resulting increase in property values was directly the result of a widespread fear of inflation or rising rents[7].

[6] House rents may be defined as the user or opportunity cost of occupying a house; and if house rents increase, demand for buying house is likely to increase. The rent index published by Chinese authority may also be seen as complementary to inflation measures used by Chinese government, as the proportion of house rents in Chinese consumer price index (CPI) is much lower than those of many other countries, and hence the effects of house rents on inflation or inflation expectations has been greatly underestimated on the basis of CPI figures.

[7] People's Daily Online, July 14, 2009. Is inflation expectation pushing housing prices up?

3.2. A Supply and Demand Model of Chinese Housing Price Dynamics

In the literature, two approaches for analysing the influence of fundamental factors on housing prices have been employed. The first approach is based upon both user costs and asset pricing models, which addresses both the consumption and investment aspects of housing values (Costello et al, 2011). This approach explicitly models key demand fundamentals such as income and rural to urban migration and urbanization. The second approach is based on the work of Davis and Heathcote (2007, 2008), and focuses on modelling key supply fundamentals such as land prices and user costs. As discussed in the last section, we model both the demand and supply approaches in our theoretical model and hypothesis development.

We define the dependent variable, the price of housing assets at time t, as P_t. Correspondingly, our independent variables include: household income at time t, denoted by Y_t; the price of land at time t, denoted by LP_t; the implicit and explicit user costs accruing to owners of housing assets (user costs) at time t, denoted by UC_t; and the cost of rental at time t, denoted by R_t.

Following Poterba (1992), we calculate the user cost of housing as shown in Equation (1):

$$UC_t = P_t(i + \tau + f - \pi), \quad (1)$$

Where i is the published nominal mortgage interest rate at time t, τ is the property tax rate at time t, f represents recurring holding costs consisting of depreciation, maintenance and the risk premium on residential property at time t, and π is the expected capital gains (or losses) at time t.

As show previously by Wu et al (2011), in equilibrium, the expected cost of owning a house should equal the cost of renting. Thus, the following equation is implied:

$$R_t = UC_t = P_t(i + \tau + f - \pi), \quad (2)$$

In this formulation, user costs may also be understood as a property owner's implicit equivalent rent.

With respect to rural to urban migration and urbanization, contemporary China differs from other countries because of its unique Household Registration System (Hukou) and huge population base. China's large internal migration is regulated by the Hukou system in that households migrating to a new city without 'Hukou' would do so without ready access to health,

education and other public services (Wu et al, 2011). Because detailed annual urban to rural migration data does not exist, we use city population at household registration system to proxy it. Hereafter, the city population based on household registration system (Hukou) is denoted by $HKP_{i,t}$.

We begin with an asset pricing approach similar to Costello et al (2011) and assume that the change in the value of a housing asset between time t and time $t+1$ is the sum of the expected capital gain (CG_t), and the cash or amenities flow net of costs, which we refer to as rent (R_t):

$$\Delta P_t = E_t(CG_t) + R_t, \tag{3}$$

where Δ denotes the first differences operation, E_t is the expectation operator, C is the constant term, and ε_t is the error term.

Next, we assume that $E_t(CG_t)$ is a function of the key demand and supply side fundamentals. As discussed above, the key demand side fundamentals include income and population growth and the key supplied side fundamental is land price. This relationship may be expressed as follows:

$$E_t(CG_t) \sim f(Y_t, LP_t, HKP_t) \tag{4}$$

Where $f(\ )$ denotes model terms that are a linear or nonlinear combination of variables.

Combining (2), (3) and (4), we obtain:

$$\Delta P_t = P_t - P_{t-1} = f(Y_t, LP_t, HKP_t) + UC_t \tag{5}$$

Next, by taking the natural logarithm of (5), we obtain:

$$\ln P_t = \ln(P_{t-1} + f(Y_t, LP_t, HKP_t) + UC_t) \tag{6}$$

While it is difficult to obtain the exact form of Equation (6), we may assume that are long run equilibriums among the variables $\{\ln P_t, \ln Y_t, \ln LP_t, \ln HKP_t, \ln UC_t\}$. In section 4 and 5, we examine these long run equilibriums using both relative ratios and various econometric models.

4. Evidence from Relative Ratio Measures

4.1. Affordability of housing

To study the possible influence of the rapid increase in Chinese disposable income growth on housing values, we examine housing affordability, which has been the subject of much investigation in the extant literature. The measure most commonly used in housing affordability research is the price-to-income ratio (OECD, 2005), which is generally calculated as the ratio of median housing price to median family disposable income expressed as years of income or as a percentage. In this section, we examine price-to-income ratios for 12 major Chinese cities in both absolute and relative terms.

4.1.1. Absolute Affordability: Price-to-income ratio – Years of Income

To calculate the absolute price-to-income ratio, we assumed that an average family would save a minimum of 30% of disposable income,[8] that they would purchase a two-bedroom 70 square meter apartment,[9] and would apply all savings to this purchase. Based on these assumptions, we constructed the price-to-income ratios in terms of years of income for 12 Chinese cities during the period from 1999 to 2010. The results are displayed in Figure 4. Individual disposable incomes at city levels across the time period we investigate are impossible to obtain, and hence they are approximated by two variables: GDP per capita (Yuan) and average wage of staff and workers (Yuan). Yearly data of these two variables are collected from China City Statistics of China Data Online, whereas we need quarterly observations. To overcome this problem, we use the method of Cubic Spline Interpolation to split the data.

Insert Figure 4 Here

In most Chinese cities, per capita GDP is higher than average wages and these proxies give different price-to-rent ratios. As shown in Figure 4, the price-to-income ratios vary considerably across cities. Specifically, for four cities (Tianjin, Chongqing, Xi'an and Shenyan) the price-to-income

[8] Wei and Zhang (2011) pointed out that the Chinese household savings increased from 16% in 1990 to 30% in 2007. IMF (2010) pointed out that China's national savings rate as of 2009 is more than twice the overall world rate and it has increased more than 15 percentage points, from 39% to 54% of GDP over the past five years.

[9] The commercial residential apartments in China are usually sold at gross floor space and hence the housing prices or indices from either official statistics or other sources are based on gross floor spaces. The net floor space shall be discounted from the gross floor space by a rate varying from 80-90%. In this case, the net floor space is around 56-63 square meters. In this paper, we follow Ahuja et al. (2010) who assume 70 squares in calculating price-to-income ratios.

ratio displays a downward trend. In contrast, Hangzhou displays an upward trend. Finally, Beijing, Shanghai, Shenzhen, Guangzhou, Nanjing, Wuhan, and Chengdu depict variable U or W shapes in which prices decline and then generally rise toward the end of the decade. In addition, as Hangzhou is the least affordable city in terms of the average years of income required to purchase a 70 square meter home at over 63 years in 2010. After Hangzhou, the least affordable of China's major cities include Shenzhen (45 years), Beijing (36 years) and Shanghai (30 years) despite of having the highest average incomes in China.

4.1.2. Relative Affordability: Price-to-income ratios with sample means = 100

In literature, relative affordability rather than absolute affordability has been used to measure overvaluation in housing markets (OECD, 2005). In general, these studies (CITATION) argue that if relative affordability rises above its long-term average, prices should be considered as overvalued. By dividing price-to-income ratios constructed in the last part and also assuming the sample mean equals to 100, the price-to-income ratios are transformed into relative indices in Figure 5.

Insert Figure 5 here

As seen in Figure 5, the price to income ratio varies greatly across Chinese major cities. Specifically, only Beijing, Shanghai, Hangzhou, and Shenzhen had the price-to-income ratios greater than 120 in 2010, and are substantially above their long-term averages. The ratios in Nanjing and Chengdu are slightly above their long-term averages and vary between 100 and 120, while the ratios in Guangzhou, Nanjing, and Wuhan in 2010 are rather close to their long-term averages. Those in the left four cities such as Tianjin, Chongqing, Xi'an and Shenyang in 2010 are well below their long-run averages. In general, the evidence suggests that recent substantial overvaluation may only apply to four big Chinese cities: Beijing, Shanghai, Hangzhou and Shenzhen. In some cities such as Tianjin, Chongqing, Xi'an and Shenyang, much of the concern about bubbles may be misplaced.

4.2. Land pricing inflation

Another reason often attributed to the rapid rise of China's real estate prices in the literature is local governments' dependence on land financing through the sale of 'land use rights'.

Du et al (2010) reviews the evolution of Chinese land policy since 1990 and examines its impact on the dynamic relationship between housing and land prices in the Chinese real estate market. Using panel datasets from Beijing, Shanghai, Tianjin, and Chongqing, they find that there exists a long-run equilibrium between Chinese urban housing prices and land values. Su and Tao (2010) argue that changes in the central-local fiscal arrangement and the state-business relation in the early 1990s limited the ability of local governments to collect incomes. To keep up with their rising expenditures, local governments turned to land and real estate development for revenues and demanded high prices from real estate developers. The result was rapid land price inflation.

To study the possible impacts of land price inflation on real estate values, we examine residential land prices (¥/m^2) in absolute terms and land-to-house-price ratios in relative term (Sample average =100). These measures are shown in Figure 6.

Insert Figure 6 here

As seen in Figure 6, although land price differs both in terms of timing and magnitude across cities, during most periods for most cities, land prices are highly correlated with and have a significant influence on housing prices. The Figures also show that land prices in Hangzhou, Shanghai, Shenzhen and Beijing have experienced the greatest inflation during the 1999 – 2010 period. At the end of 2010, average land prices for these four cities were 22,856, 19,941, 19,937 and 13,609 ¥/m^2, respectively. While Nanjing, Chengdu, Guangzhou and Tianjin also experienced substantial land price inflation, at the end of 2010 their land values were substantially lower at 8,649, 7,268, 5,917, and 5,234 ¥/m^2. Finally, the mainly inland cities of Xi'an, Wuhan, Chongqing and Shenyang experienced the least land price inflation with 2010 values of 3,357, 3,165, 3,034, and 2,410 ¥/m^2 respectively.

4.3. Rural to urban migration and urbanization

Since China began initiating economic reforms and liberalization more than thirty years ago, it has experienced massive urbanization as poor rural migrant workers have streamed into China's vast cities in search of work and opportunity. According to the World Bank,[10] when reforms began in 1978, the urban share of China's population stood at less than twenty per cent. At the end of

[10] The World Bank. www.worldbank.org. Accessed March 6, 2012.

2010, nearly 45% of China's 1.35 billion people had moved to its urban centres. This unprecedented shift in population has led to China's quarter century construction boom and and the increase in demand has put pressure on prices. Chen et al (2011) explore the possible effects of rural to urban migration and find significant effects on urban house prices in China.

Figure 7 illustration city population based on Household Registration System (Hukou), as well as price-to-population ratio.

Insert Figure 7 here

As seen in Figure 7, population growth or rural-urban migration has also grown substantially in the last decade in every major Chinese city resulting in an increase in demand and putting pressure on prices. However, housing prices have grown faster than population growth, and all price-to-population ratios for 12 cities exhibit striking upward trends. It implies that population growth itself is not sufficient to justify the surge of housing prices during 1999-2010. It has to be associated with other factors, such as increasing disposable incomes, to explain the housing price dynamics.

4.4. User Costs

Property investment is particularly appealing for Chinese households the China's relatively young and underdeveloped financial system offers very few investment and savings options. Due to China's savings and investment limitations, coupled with the explosion in average disposable incomes and improvements in urban infrastructures, the demand for housing in major Chinese cities has been robust. In housing investment decisions, user costs such as the costs of borrowing, transactions costs, holding costs, opportunity costs, and expected capital gains (or losses), is all very critical and influence demand.

Unlike many countries such as the United States, land and property taxes in China are levied on transactions rather than on asset holdings. Thus, for most housing transactions in China, taxes are assessed only at the time of purchase. In addition, while the rental income tax rate levied on annual rental income in China is only about 5%, most landlords chose not to pay it. As a result, it is reasonable to assume that the annual tax rate (τ) on Chinese housing investments is zero. Following the OECD (2005), holding costs consisting of depreciation, maintenance and the

risk premium on residential property in China are assumed to be constant at 4%, while the expected capital gains π may be defined as a moving average of consumer price inflation at city levels.

Figure 8 illustrates the user cost and user cost rate based on CPI inflation in 12 cities during 1999-2010.

Insert Figure 8 here

In theory, generally higher rents, higher housing prices, and hence positive effects of rents on housing prices are expected. Generally all user costs series in 12 cities have increased, and hence we expect they help raise housing demand as well as prices.

5. Evidence from econometric models

5.1. Tests of the significance of the four fundamental factors: Evidence from panel LS models

Using a panel least square estimation model, we test whether the positive effects of the four key fundamentals factors on housing prices for China's 12 major cities observed and discussed in the previous section can be confirmed statistically. Random effects across cities are incorporated in the estimations to accommodate heterogeneity.

Using standard panel data methodology, we make the following specification for our baseline model, which we call Model 1:

$$\ln P_{i,t} = \beta_0 + \beta_1 \ln Y_{i,t} + \beta_2 \ln LP_{i,t} + \beta_3 \ln HKP_{i,t} + \beta_4 \ln UC_{i,t} + \varepsilon_{i,t} \qquad \text{(M 1)}$$

Where the subscript i stands for a country index ($i = 1, \cdots, N$), t is a time index ($t = 1, \cdots, T$), $\ln P_{i,t}$ is the dependent variable representing the percentage change in housing prices by city across time, $\ln Y_{i,t}$ represents the percentage change in household income (GDP per capita or average wage of staff and workers) by city across time, $HKP_{i,t}$ represents population based on household registration system (Hukou) by city over time, and $\ln UC_{i,t}$ represents the percentage change in user costs (measured how?) by city over time. Finally, $\beta_{1\text{-}4}$ is a vector of parameters to be estimated for each of the independent variables, and $\varepsilon_{i,t}$ is the stochastic error term which is in general allowed to be serially correlated.

Because endogeneity may impact estimates of the independent variables, we control for this in Model 2 by introducing a variable representing the lagged change in price, $P_{i,t-1}$.

$$\ln P_{i,t} = \beta_0 + \beta_1 \ln P_{i,t-1} + \beta_3 \ln Y_{i,t} + \beta_4 \ln LP_{i,t} + \beta_5 \ln HKP_{i,t} + \beta_6 \ln UC_{i,t} + \varepsilon_{i,t} \quad \text{(M 2)}$$

It has also been argued that population growth may exhibit an influence on housing prices through changes in disposable income ($\ln Y_{i,t}$) and changes in wages (ln W) and that the interaction resulting from the product of $\ln Y_{i,t}$ and $\ln HKP_{i,t}$ and the product of $\ln Y_{i,t}$ and $\ln W_{i,t}$ may be able to capture potential non-linear effects existing in these factors. As a result, we mospecify Model 3 as follows:

$$\ln P_{i,t} = \beta_0 + \beta_1 \ln P_{i,t-1} + \beta_3 \ln Y_{i,t} + \beta_4 \ln LP_{i,t} + \beta_5 \left(\ln HKP_{i,t}\right) * \left(\ln Y_{i,t}\right) + \beta_6 \ln UC_{i,t} + \varepsilon_{i,t} \quad \text{(M 3)}$$

Cross-city random-effects estimations for Model 1 through Model 3 are presented in Table 1.[11]

Insert Table 1 here

As shown in Table 1, all fundamentals factors as well as their lags and interactions are shown to have positive and significant effects on housing prices. Our estimation results for the entire sample generally confirm our hypotheses that all these four fundamentals play important roles in driving housing price inflation.

5.2. Investigation of the long-run equilibrium relationship between housing prices and fundamental factors: Evidence from unit root processes and panel co-integration models

[11] We also conducted panel LS estimation with cross-sectional fixed effects, with similar results. To conserve space, we report the results only for the random-effects models.

In this section, we then investigate whether there is a long-run equilibrium relationship between housing prices the four key fundamental factors (and their interactions) identified in the previous section using unit root processes and co-integration models.

5.2.1 Common and individual unit root processes

Table 2 reports results for tests of common unit root process tests using Levin, Lin and Chu (2002), and individual unit root process tests using Im, Pesaran and Shin (1997), Augmented Dickey-Fuller (ADF)(year) and Phillips-Perron (PP) (year).

Insert Table 2 here

As seen in Table 2, on the one hand, the logarithms of housing prices, GDP per capita, land prices, and user costs display both common and individual unit root processes and are all I(1). Wage and population have no common unit root process, but do display individual unit root processes based on Im, Pesaran and Shin tests. Hence wage and population may also be taken as I (1) processes.

5.2.2 Evidence using panel group co-integration models

To further investigate the nature of the long-run relationship between our four fundamental factors and housing prices in China, we investigate further using co-integration tests with a system approach. A 5-dimensional vector time-series Z_t $\left\{\ln P_{i,t}, \ln Y_{i,t}, \ln LP_{i,t}, \ln HKP_{i,t}, \ln UC_{i,t}\right\}$ is considered and is modelled as a Vector Error Correction Model (VECM) as follows:

$$\Delta Z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta Z_{t-1} + \Pi Z_{t-1} + \mu + \varepsilon_t, \qquad t = 1, \cdots, T \tag{M 4}$$

where Δ is the first difference operator, Γ is coefficient matrix , μ is the drift parameter, and Π is a matrix of the form $\Pi = \alpha\beta^T$, where α and β are $(p \times r)$ matrices of full rank with β containing the r cointegrating vectors and α includes the corresponding adjustment coefficient in each of

the r vectors. Both the Kao (1999) and the Johansen Fisher tests indicate a cointegration relationship as shown in Table 3.

Insert Table 3 here

As indicated in Table 3, generally two to four cointegration vectors are found to exist in the panels. The same order of integration or multiple cointegration vectors indicate that long-run equilibrium conditions exist among house prices and other key fundamentals.

Table 4 presents panel group cointegration equations (CE) when we choose two cointegration vectors. As seen, in these two sets of cointegration equations, the coefficients for each of the three fundamental factors tested indicate they have positive effects on housing pricing. CE Set 1 indicates that when employing the change in GDP per capita as the proxy of household income, the change in GDP per capita and the change in land prices have significant long-run effects. In contrast, when using the change in average wage as the proxy for household income, the effects of average wages and population growth dominate in the long-run equilibriums.

Insert Table 4 here

Next, we impose identifying restrictions on housing prices and user costs in the cointegration equation (CE). Specifically, the coefficient of housing prices is restricted to a value of 1 in the first CE and the coefficient of user costs is restricted to a value of 1 in the second CE. By rearrangement the terms, the following two sets of cointegration equations are obtained:

$$\ln P_{i,t-1} = -2.685 + 0.717 \ln UC_{i,t-1} + 0.404 \ln GDPpercapita_{i,t-1} + 0.262 \ln LP_{i,t-1} + 0.096 \ln HKP_{i,t-1};$$
$$\ln UC_{i,t-1} = -5.35 + 0.673 \ln HP_{i,t-1} + 0.311 \ln GDPpercapita_{i,t-1} + 0.313 \ln LP_{i,t-1} + 0.013 \ln HKP_{i,t-1}$$

or

$$\ln P_{i,t-1} = -1.687 + 0.901 \ln UC_{i,t-1} + 0.442 \ln Wage_{i,t-1} + 0.023 \ln LP_{i,t-1} + 0.015 \ln HKP_{i,t-1};$$
$$\ln UC_{i,t-1} = -3.571 + 0.756 \ln HP_{i,t-1} + 0.313 \ln Wage_{i,t-1} + 0.087 \ln LP_{i,t-1} - 0.089 \ln HKP_{i,t-1}$$

.

As seen from results above, after imposing the restrictions, positive impacts of user costs, GDP per capita or average wage, land transaction prices and population are confirmed.

5.2.3 Evidence using panel pair co-integration models

Next we conduct panel Granger causality tests to determine… The results in Table 5 suggest that changes in GDP per capita, average wages, land transaction prices, and user costs are helpful in predicting changes in housing prices at 5% significance level, while changes in population are not significant. In addition, we find that changes in housing prices are usefult in predicting land transaction prices and user costs.

Insert Table 5 here

We also test for whether there is a long-run equilibrium relationship between housing prices and each individual fundamental factor. The results of these tests are provided in Table 6. Table 6 shows that based on panel cointegration tests, potential long-run equilibrium relationships exist between housing prices and wages, land prices, population and user costs. The most significant cointegration equations are found between housing prices and land prices or user costs, while for other three variables, relatively weaker evidence is found.

Lastly, Table 7 presents panel cointegration equations for the all these pairs as well as some of their combinations. As seen, other than population (CE 4 and 7) all long-run vectors are positive, which supports supporting our four key fundamentals hypotheses. This results our previous finding that population growth is the least convincing explanatory variable for housing price dynamics in China's major cities during the period 1999 to 2010.

5.3 Evidence from a pooled mean group estimator

In sections5.1 and 5.2, both panel LS estimations and panel cointegration models are employed to estimate the the relationship between housing prices and four key fundamentals. As an additional robustness check, in this section we turn to an alternative approach for estimating long-run parameters: a pooled mean group estimator suggested by Pesaran, Shin and Smith (1999). The method of pooled mean group estimations is an intermediate technique between the mean group estimation (where the regression coefficients and constants are different for individual countries) and a regression with fixed effects (where the coefficients are fixed and only constants can vary). In the pooled mean group method, the long run coefficients are constrained to be

identical, but the short-run coefficients and error variances are allowed to differ across groups in the panel.

The method of pooled mean group estimations can be applied to our data set and the autoregression model with a distributed lag and restrictions for housing prices may as specified in Equation (M 5).

$$\begin{aligned}\ln P_{i,t} = {} & \theta_i \left(\ln P_{i,t-1} + \beta_1 \ln Y_{i,t-1} + \beta_2 \ln LP_{i,t-1} + \beta_3 \ln HKP_{i,t-1} + \beta_4 \ln UC_{i,t-1} \right) \\ & + \sum_{j=1}^{k-1} \phi_{i,j} \Delta P_{i,t-j} + \sum_{j=1}^{k-1} \varphi_{i,j} \Delta \ln Y_{i,t-j} + \sum_{j=1}^{k-1} \gamma_{i,j} \Delta \ln LP_{i,t-j} + \sum_{j=1}^{k-1} \eta_{i,j} \Delta \ln HKP_{i,t-j} \\ & + \sum_{j=1}^{k-1} \lambda_{i,j} \Delta \ln UC_{i,t-1} + \mu_i + \varepsilon_{i,t}\end{aligned} \qquad \text{(M 5)}$$

As seen in Equation (M5), Pesaran's method allows for a common cointegrating vector and heterogeneous short-run dynamics. The model is estimated using maximum likelihood and estimation of the coefficients is consistent and asymptotically normal both for variables with order of integration I (1) and for variables with order of integration I (0).

Table 8 reports the cointegration tests and estimates of the coefficients of the long-run relationship between prices and four fundamental factors using the pooled mean group estimator. As shown in Table 8, the coefficients of the long-run relationships for GDP per capita, Wage, Land Price, and User costs are all positively related and statistically significant at 1%. The coefficients for Population have mixed signs: when using the logarithms of GDP per capita and Population in one cointegration equation, the coefficient of population becomes insignificant and has a negative sign; when using the logarithms of Wage and Population in one cointegration equation, the coefficient of Population is significant and has a positive sign. This result might be partly due to that fact that ln (GDPpercapita) = Ln (GDP) – Ln (Population). The validity of using pooled mean group estimations is tested using the Hausman test (null hypothesis: it is possible to use pooled mean group estimations) and the results are significant and supportive.

Insert Table 8 here

In sum, our results confirming the existence of a long-run relationship between our hypothesized four fundamental factors and housing prices using three different econometric approaches: (1) a panel LS estimation, (2) a panel VECM model, and (3) a pooled mean group

estimator. As a result, our specification of the determinants of Chinese house price dynamics is strongly supported by factors on both the supply and demand sides.

6. Discussion and Conclusions

China's rapid housing price inflation during the last decade has been a matter of concern and discussion in the popular press and a topic of investigation within the academic community. While this paper does not specifically investigate and address the extent to which Chinese housing prices are properly valued, we do study the factors that seem to be most relevant in contributing to their determination. employ recently developed panel data analysis techniques to examine the roles of four key fundamentals in housing price dynamics.

Using recently developed panel data analysis techniques and a unique data set that overcomes the known shortcomings of Chinese housing price data previously used to analyse Chinese housing price dynamics, statistical and econometric evidence confirms that growth in GDP per capita, average wages, land prices, population growth, and user costs have significant and positive explanatory power in the determination of Chinese housing prices. First, panel LS estimation results point to significant and positive effects of four key fundamental on housing prices in major Chinese cities. Secondly, based on panel cointegration techniques, uneven effects of these four key fundamentals are found as well. Changes in land transaction prices and user costs may have the most predictive power. GDP per capita and average wages are helpful in predicting changes in housing prices as well. In contrast and counter to expectations, the results for population growth are mixed and sometimes suggest an inverse relationship. Finally, the positive impact on housing prices of user costs, GDP per capita or average wages, land transaction prices and population are confirmed by long-run cointegration equilibriums using both a panel VECM approach and a pooled mean group estimator.

There are several possible further extensions of this study. At first, it shall be explored whether there is a statistical discrepancy between house prices and their fundamentals or not. Secondly, by comparing current housing price ratios to their long-run average levels, the evidence examined in this study suggests that recent substantial overvaluation may only apply to four big Chinese cities, Beijing, Shanghai, Hangzhou and Shenzhen. For some other cities such as Tianjin, Chongqing, Xi'an and Shenyang, much of the concern with bubbles may be misplaced.

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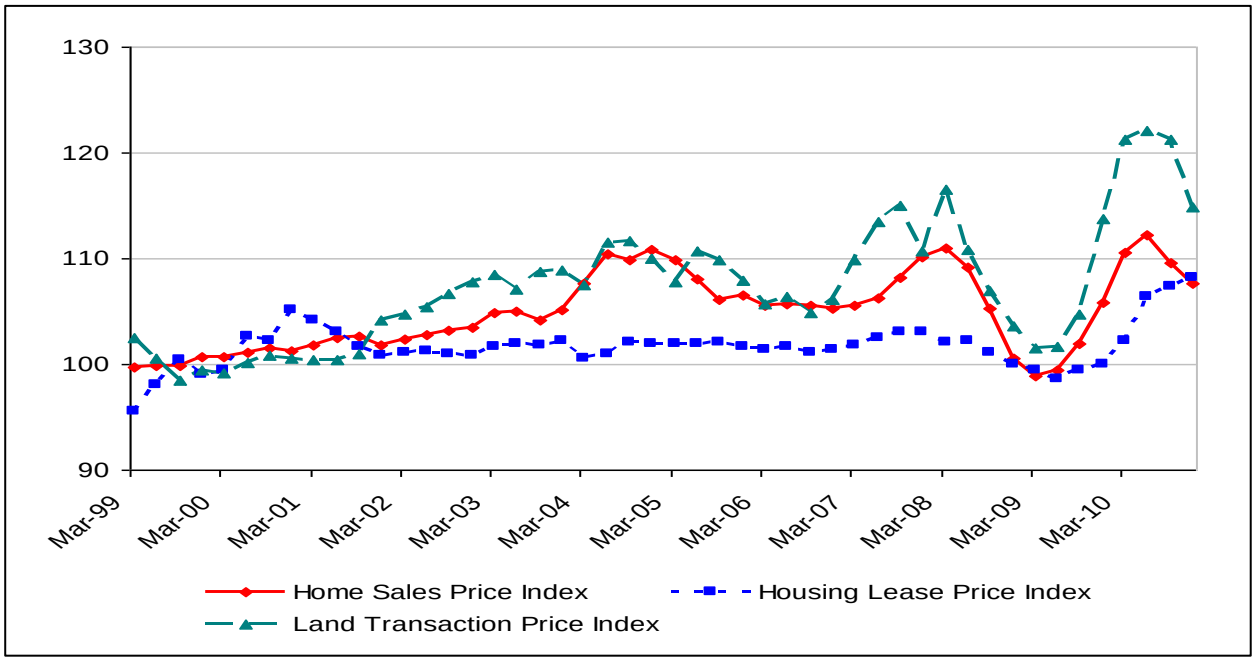
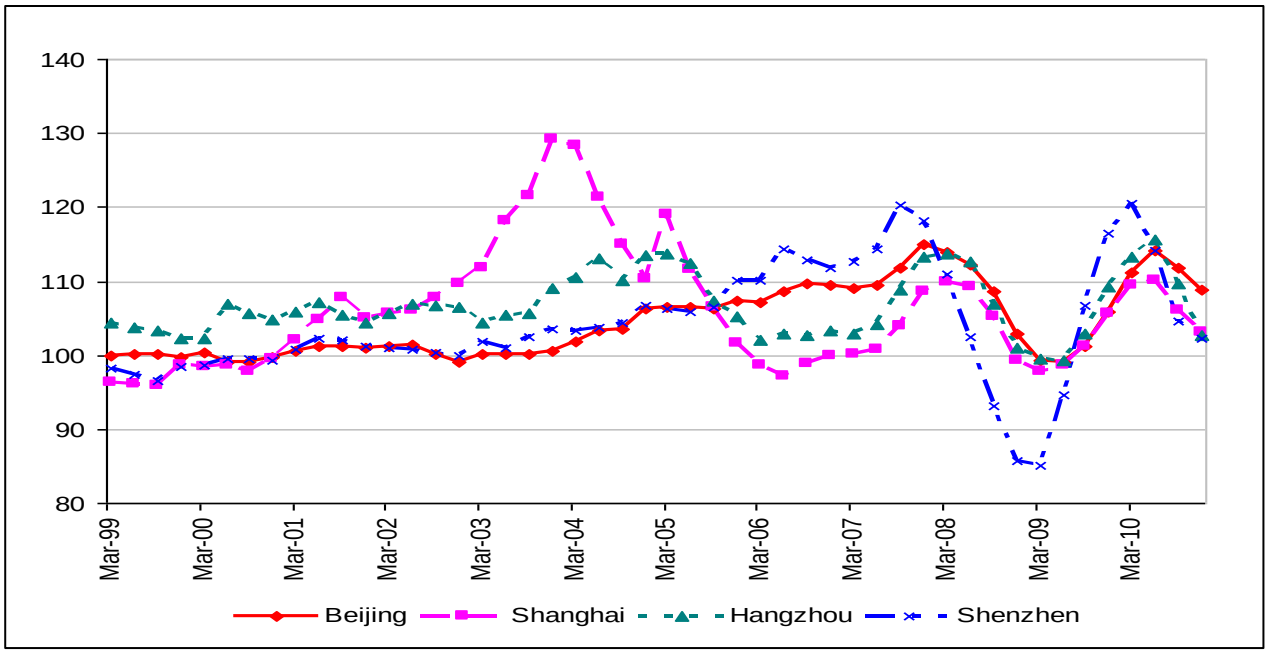
Figure 1 Property Price Indices at National Level in China, 1999-2010



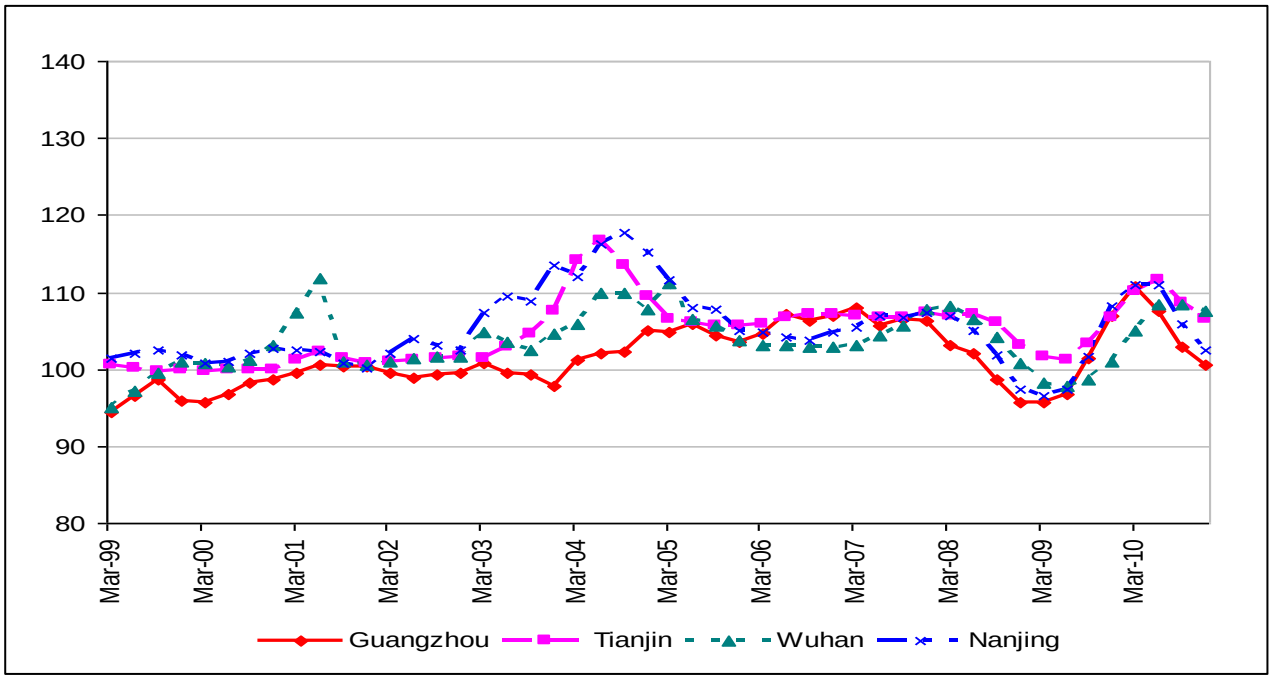
Data sources: National Development and Reform Commission; National Bureau of Statistics

Figure 2 Home Sales Price Indices for 12 big cities in China, 1999-2010

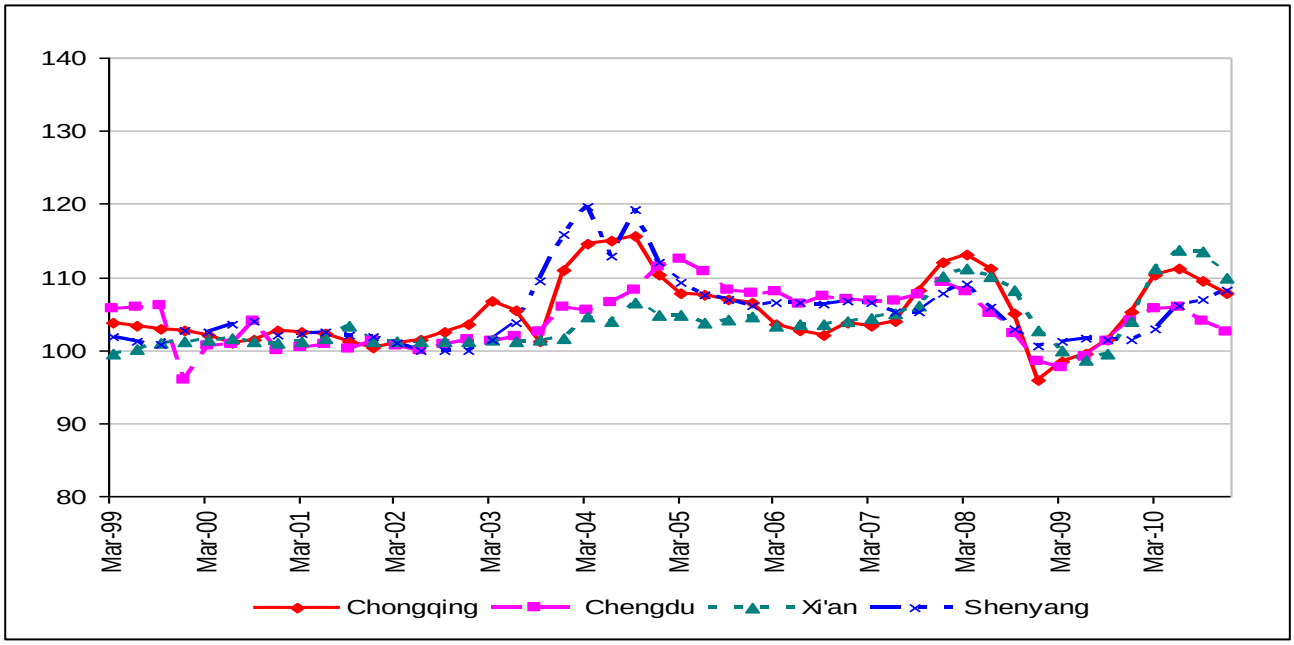
Panel a: Beijing, Shanghai, Hangzhou, Shenzhen



Panel b: Guangzhou, Tianjin, Wuhan, Nanjing



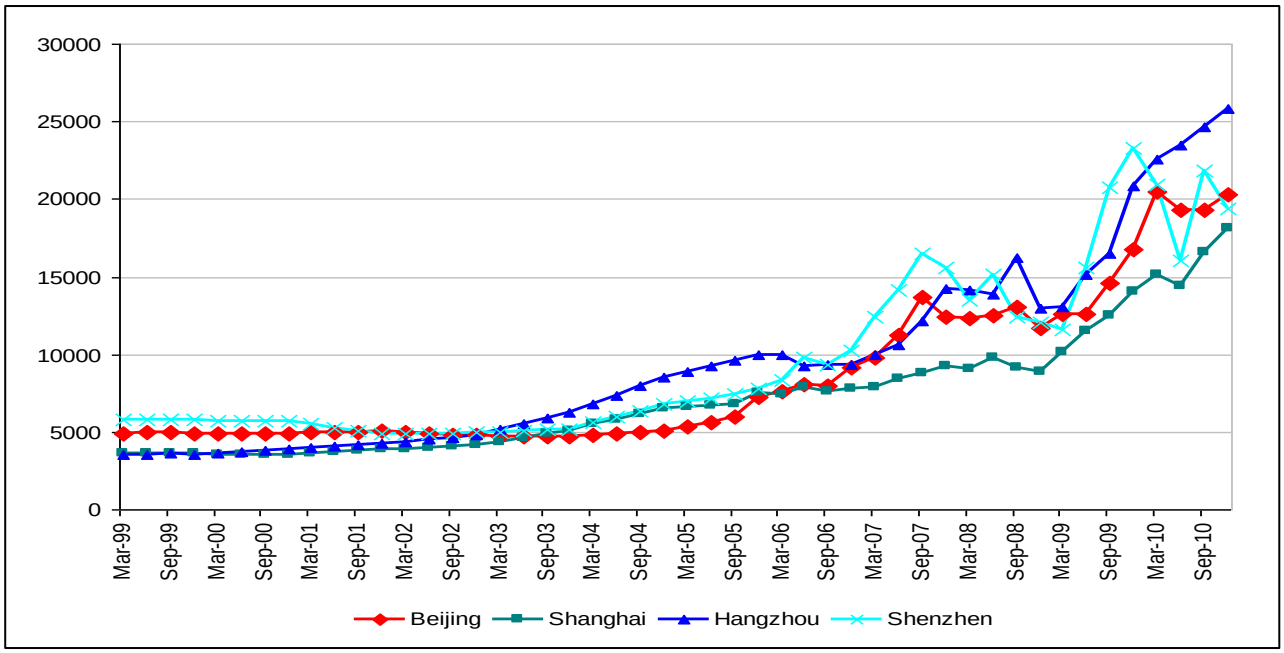
Panel c: Chongqing, Chengdu, Xian, Shenyang



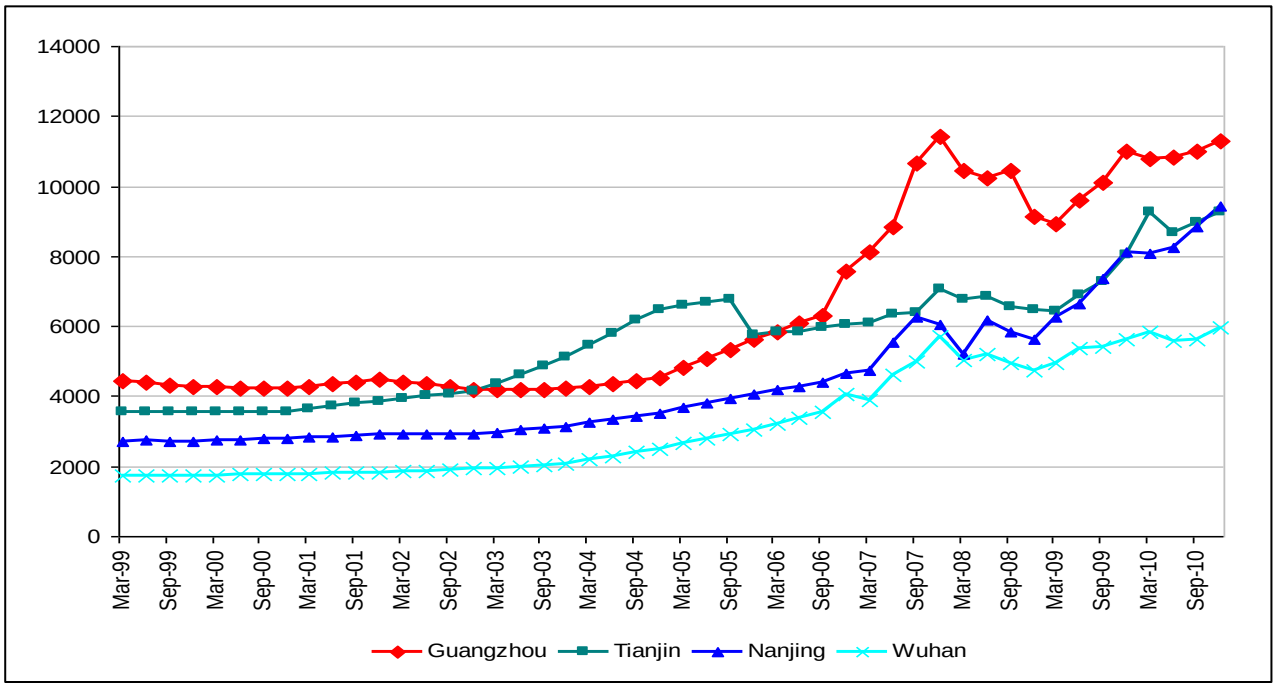
Data sources: National Development and Reform Commission; National Bureau of Statistics

Figure 3 Quarterly Housing Prices in 12 Chinese Cities (Yuan per Square Meter), 1999-2010

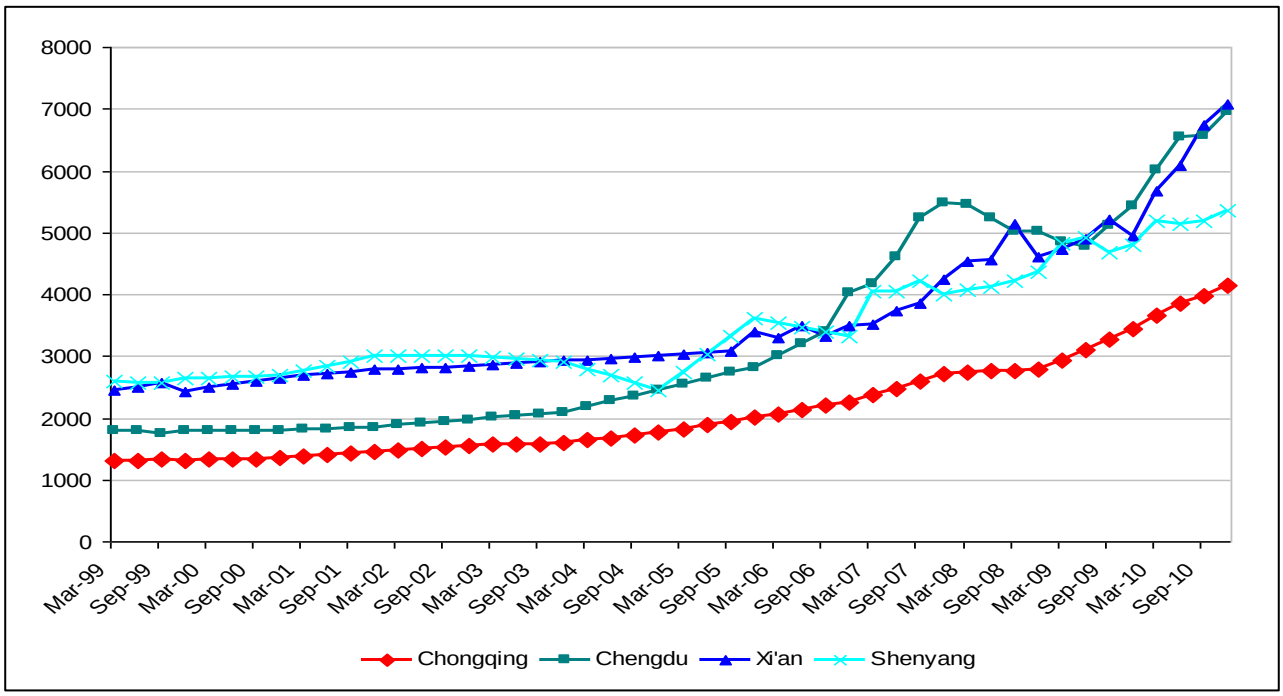
Panel a: Beijing, Shanghai, Hangzhou, Shenzhen



Panel b: Guangzhou, Tianjin, Wuhan, Nanjing

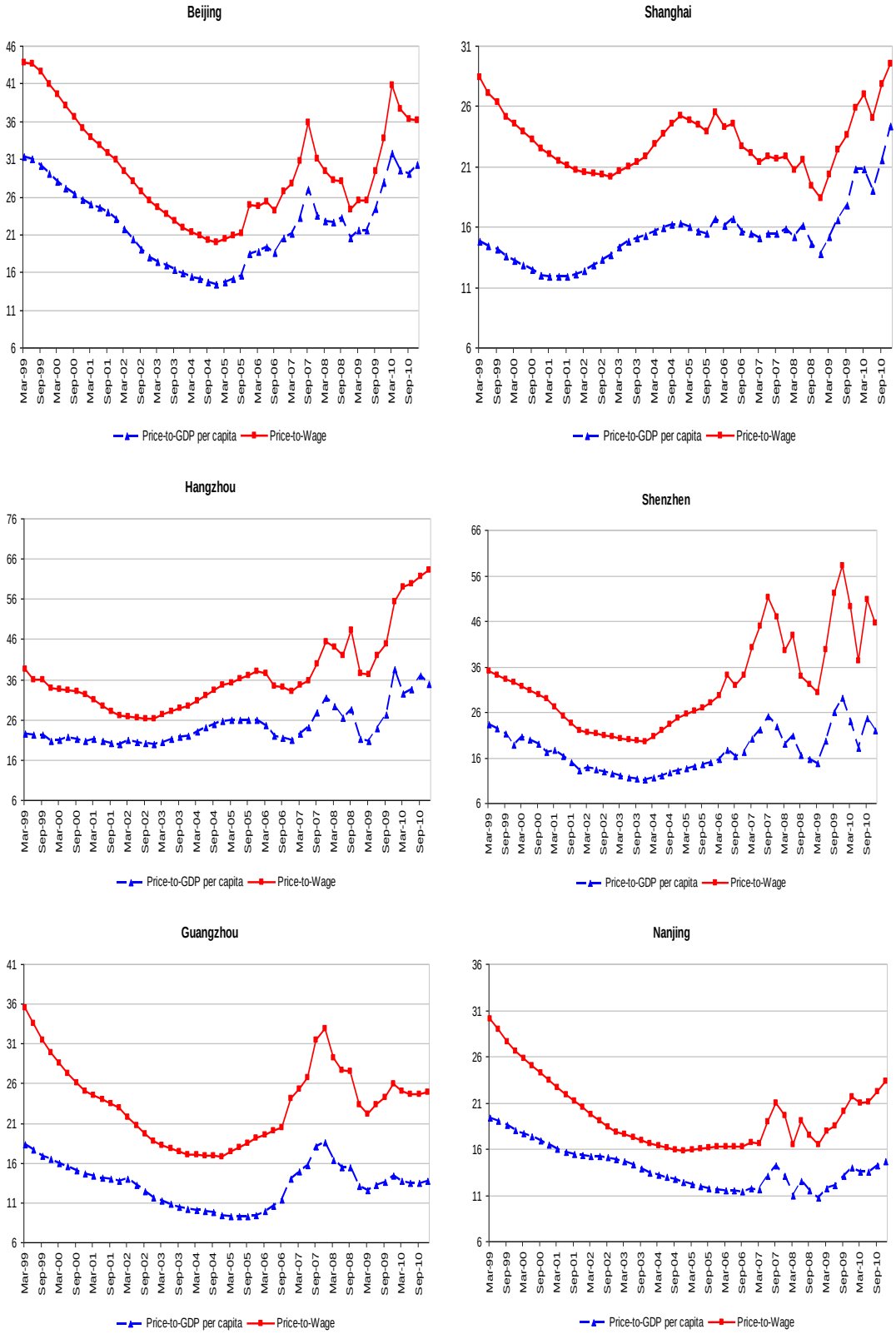


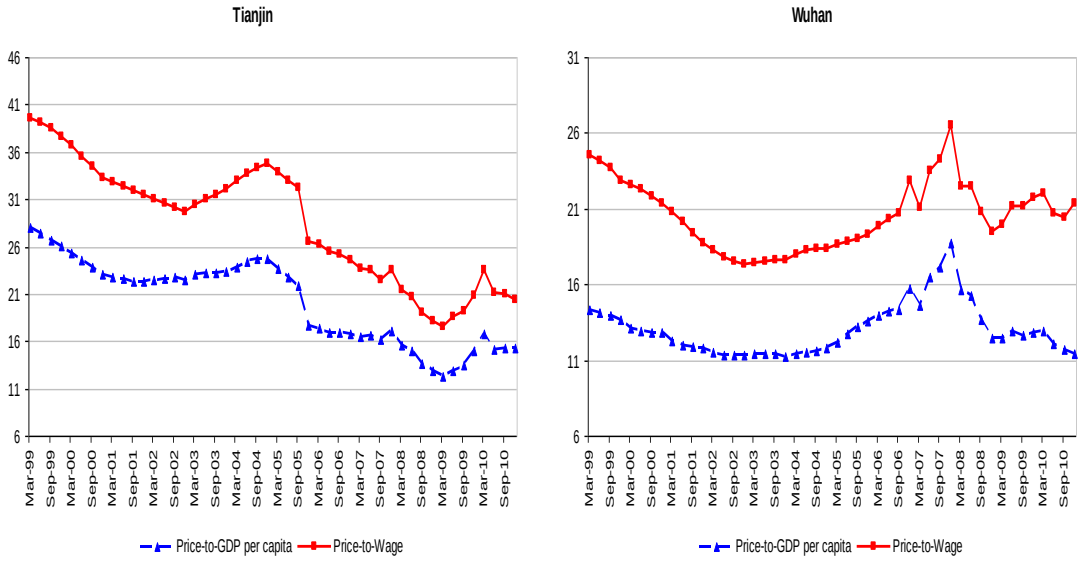
Panel c: Chongqing, Chengdu, Xian, Shenyang

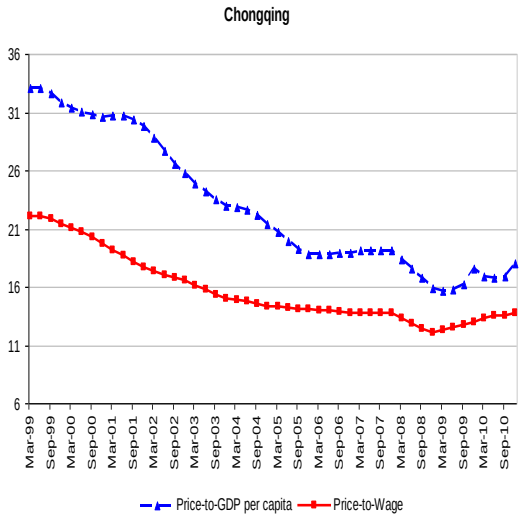


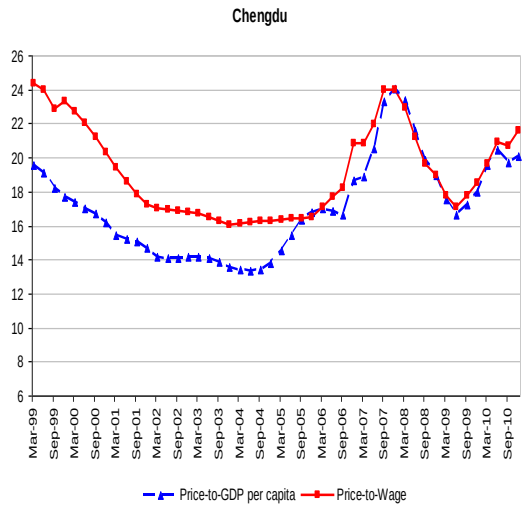
Data sources: National Development and Reform Commission; National Bureau of Statistics; China Real Estate Information Corporation

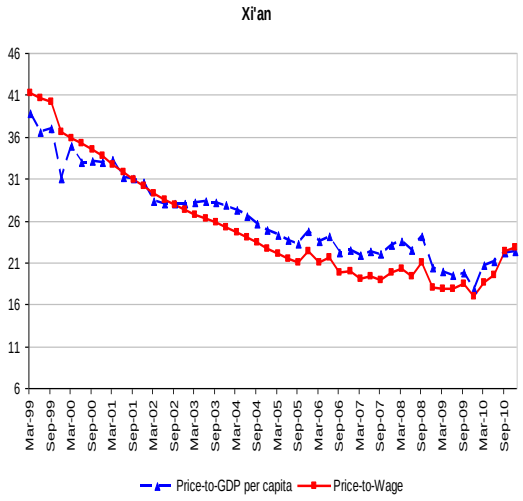
Figure 4 Price-to-income ratios for 12 major Chinese cities (Years of Income), 1999 – 2010

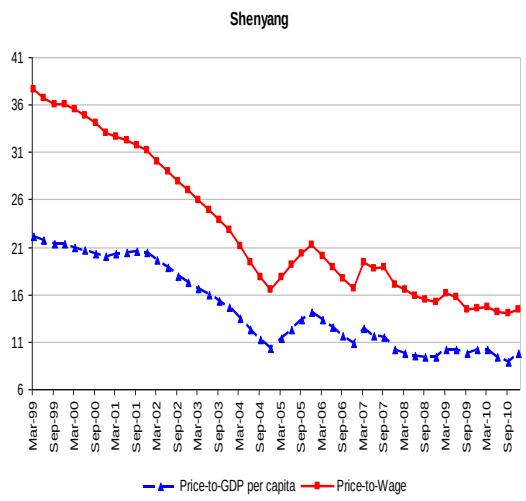






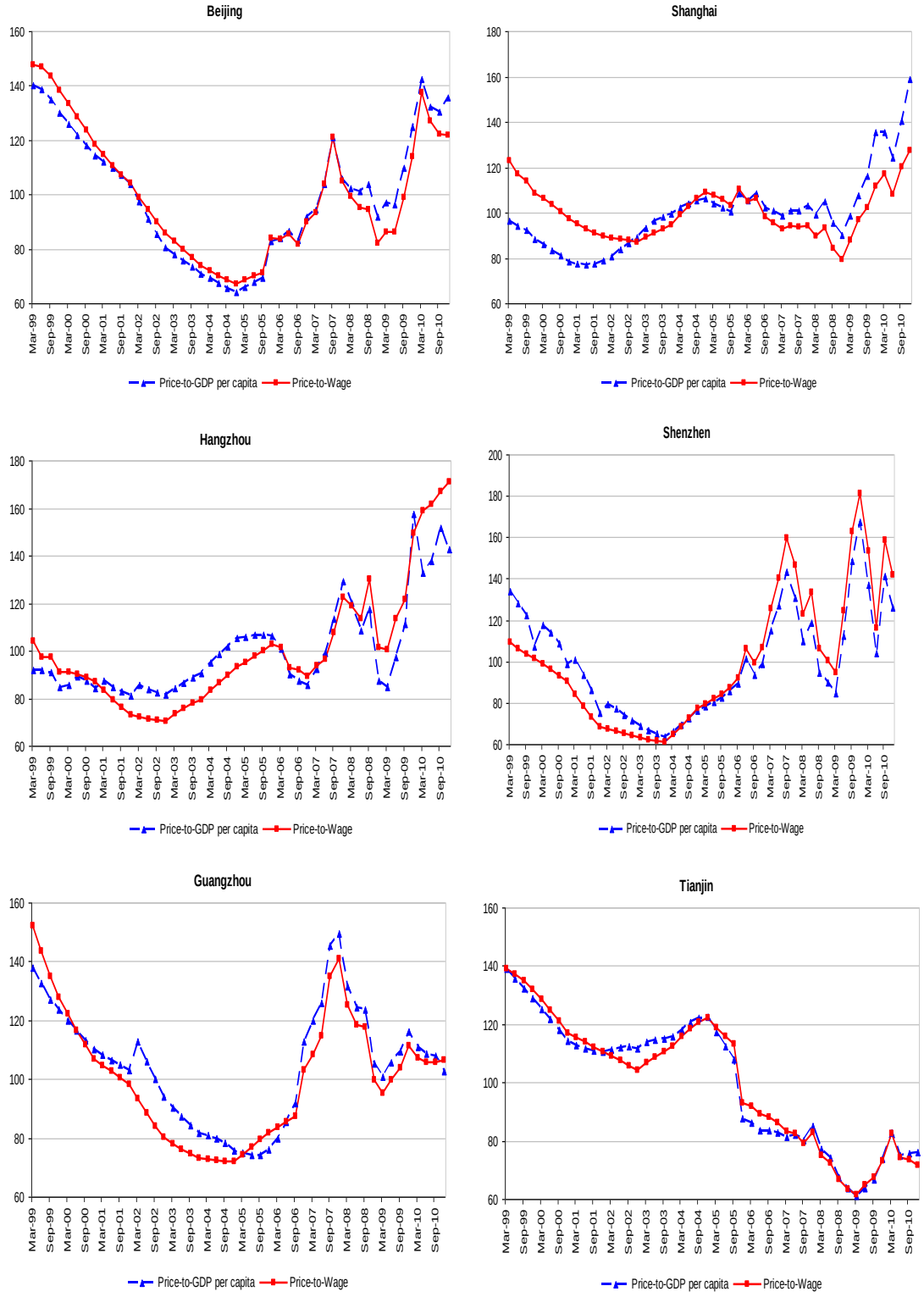


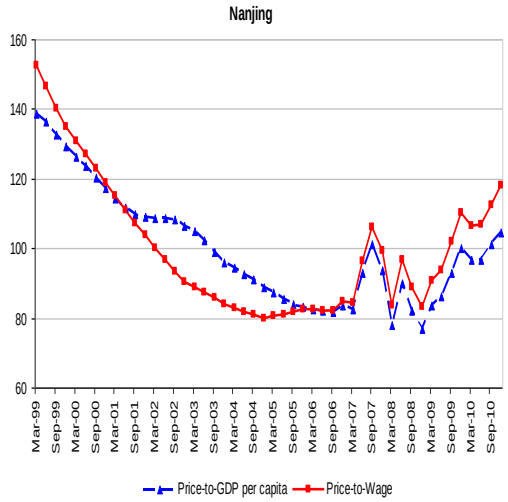


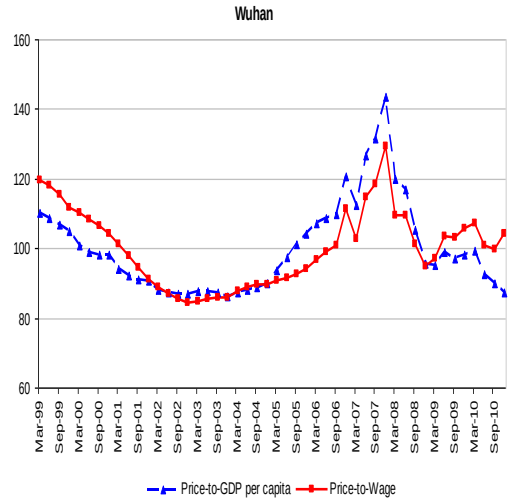


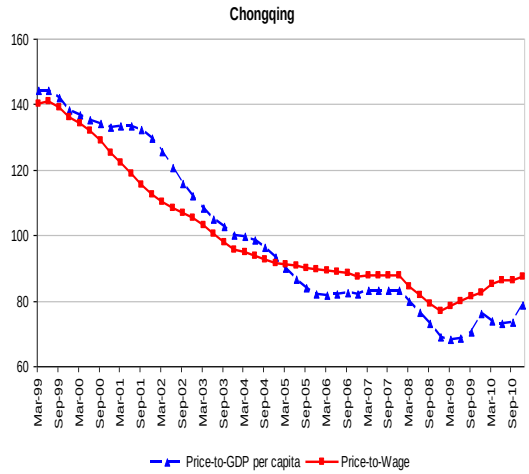
Data sources: China City Statistics, China Data Online, Authors' calculation

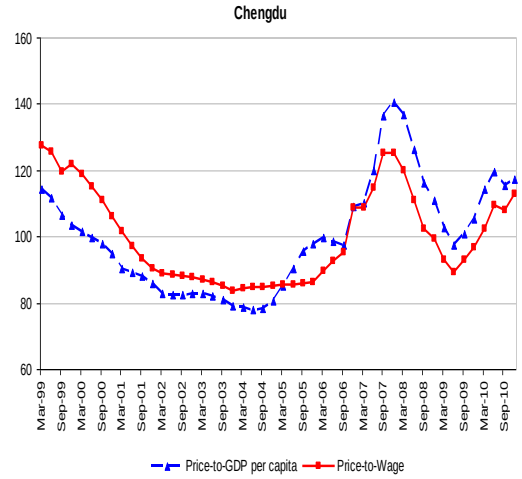
Figure 5 Price-to-income ratios (Sample average=100), 1999-2010

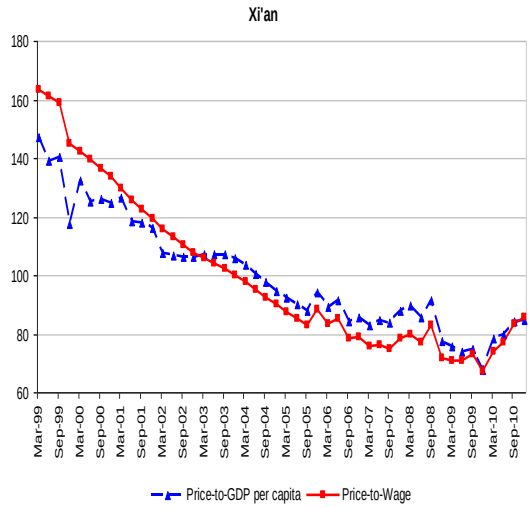


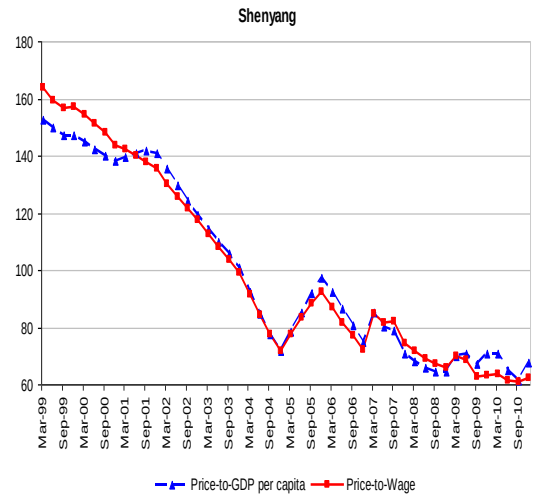






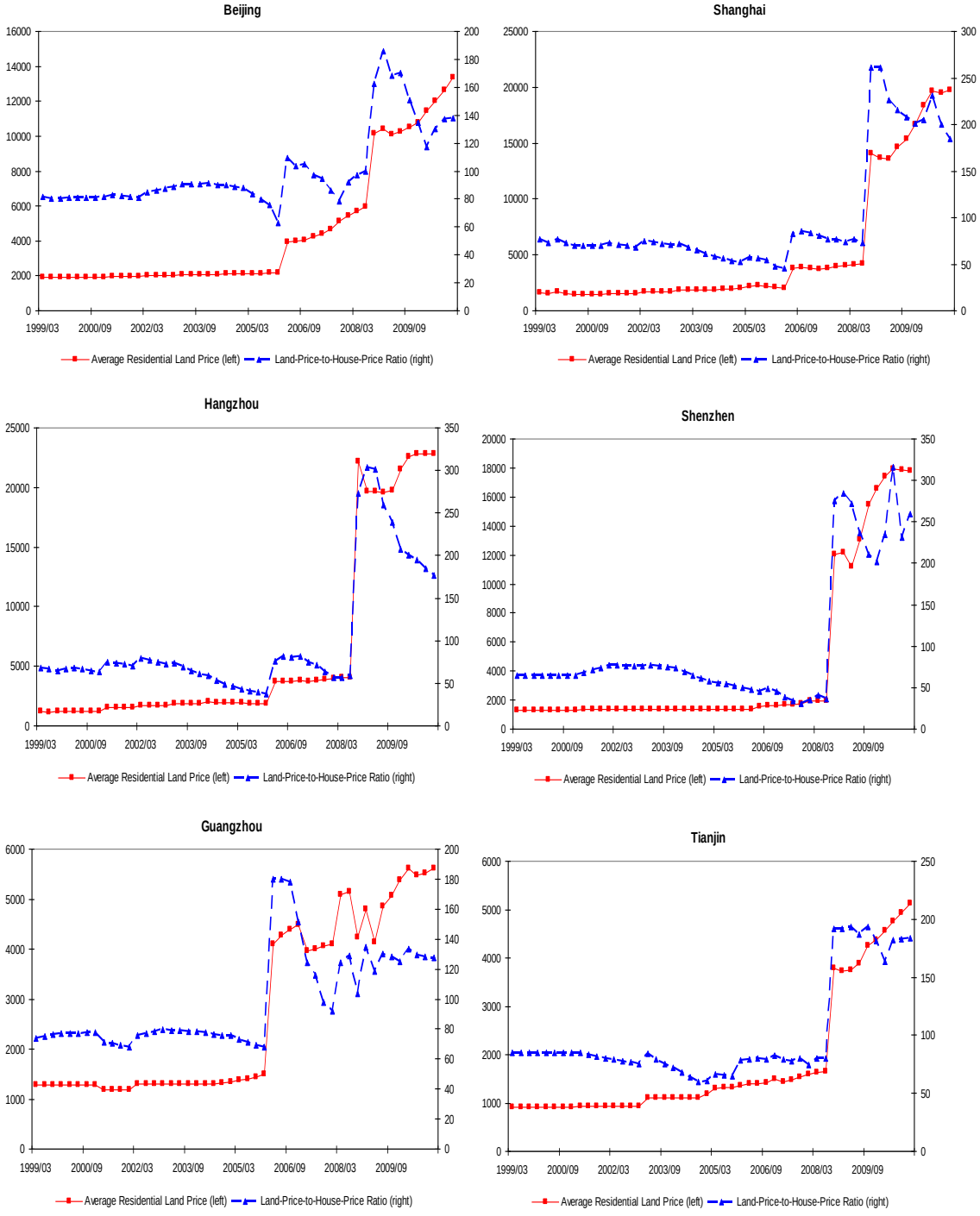


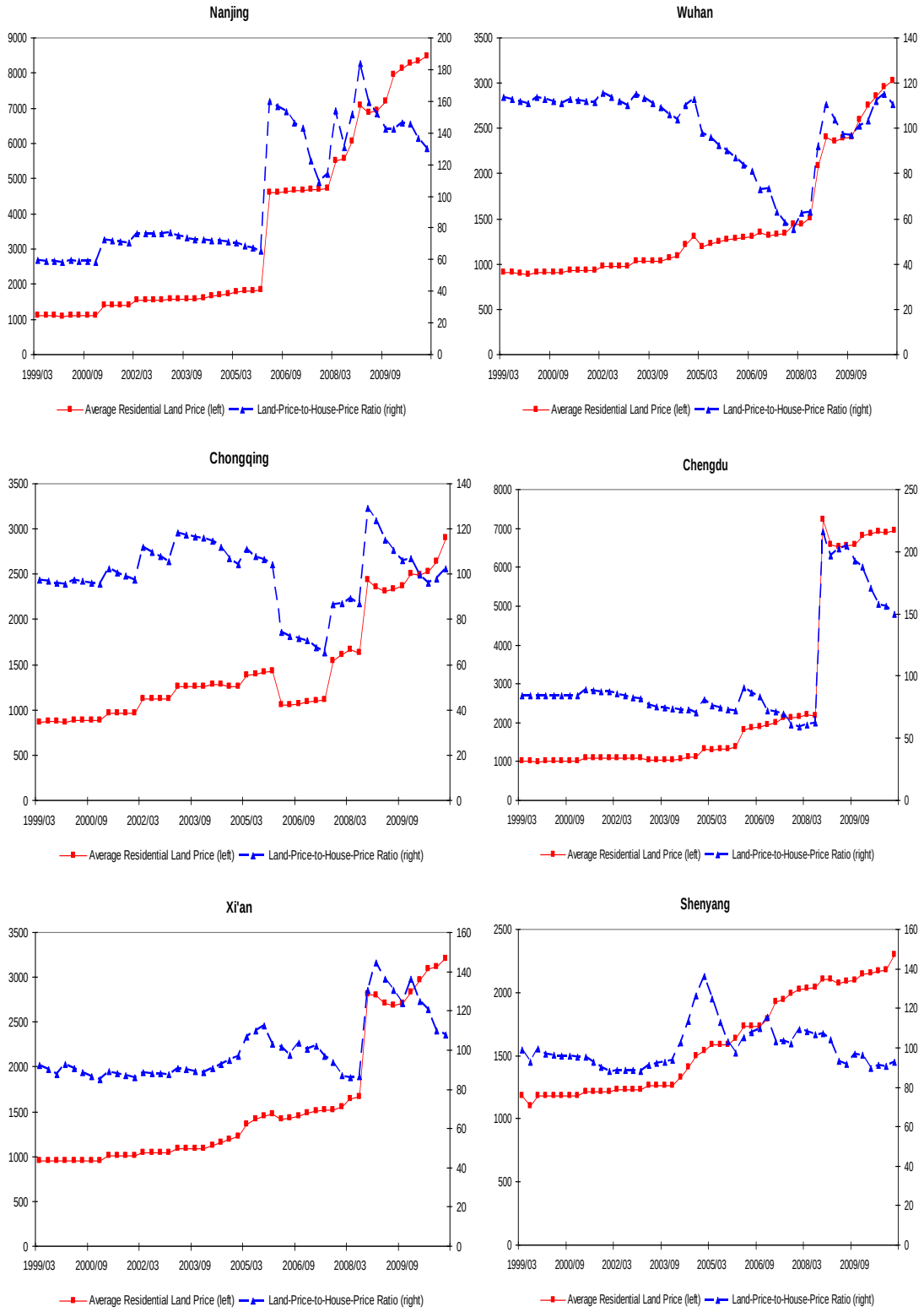




Data sources: China City Statistics, China Data Online, Authors' calculation

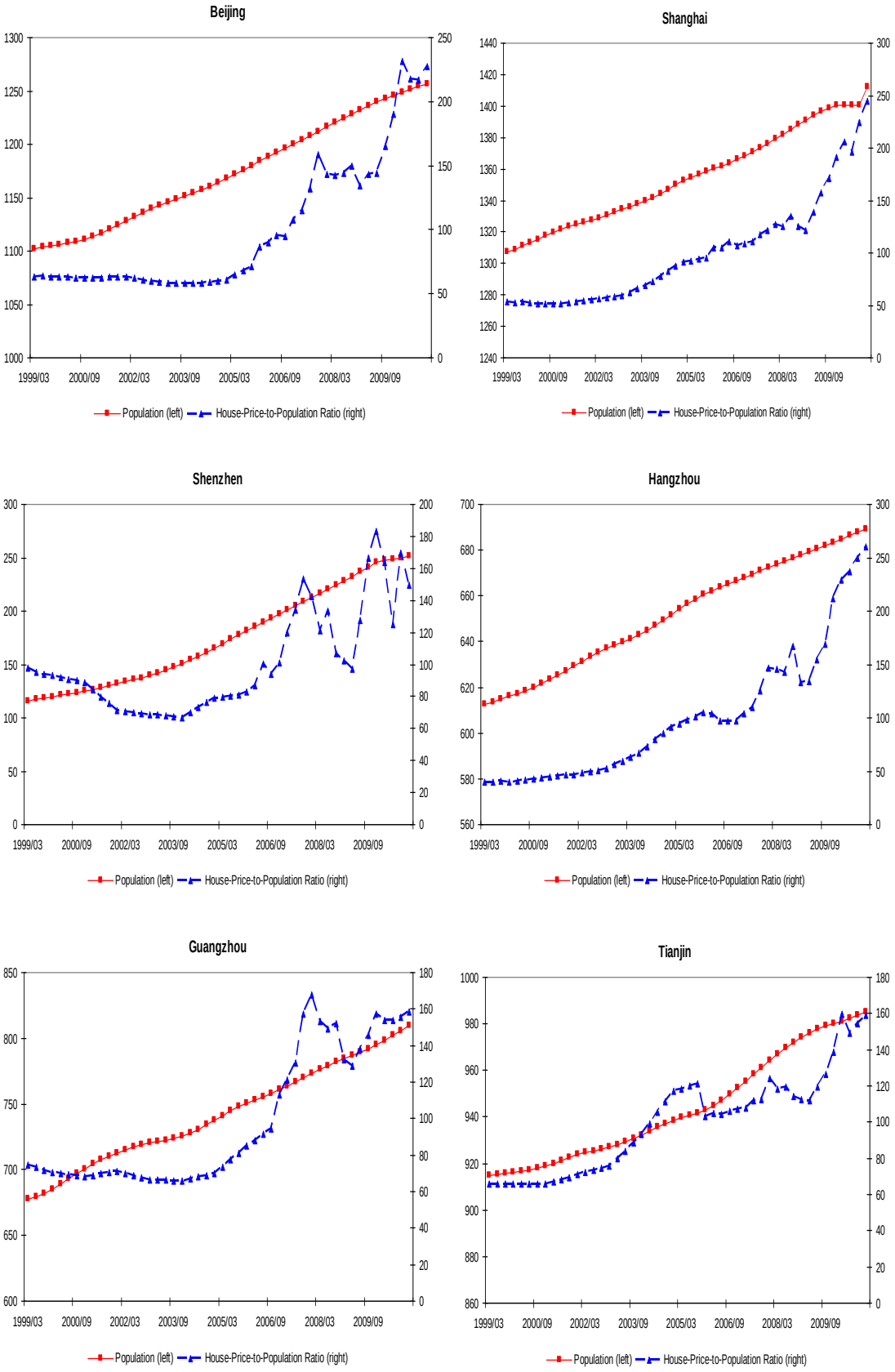
Figure 6 Average Residential Land Price (Yuan per square meter) and Residential Land-Price-to-House-Price Ratio (Sample average=100), 1999-2010

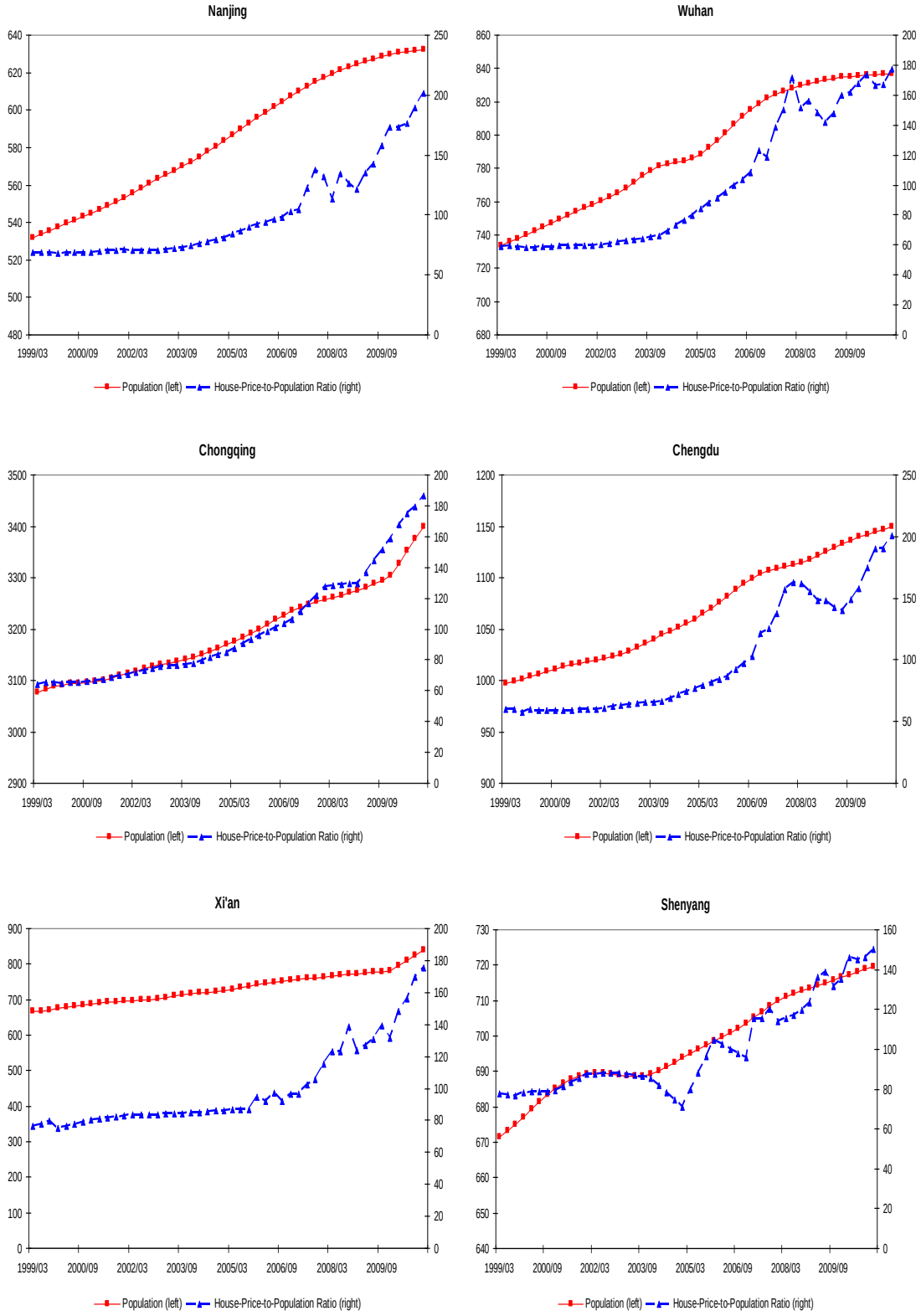




Data sources: China's Ministry of Land and Resources; National Bureau of Statistics; Authors' calculation

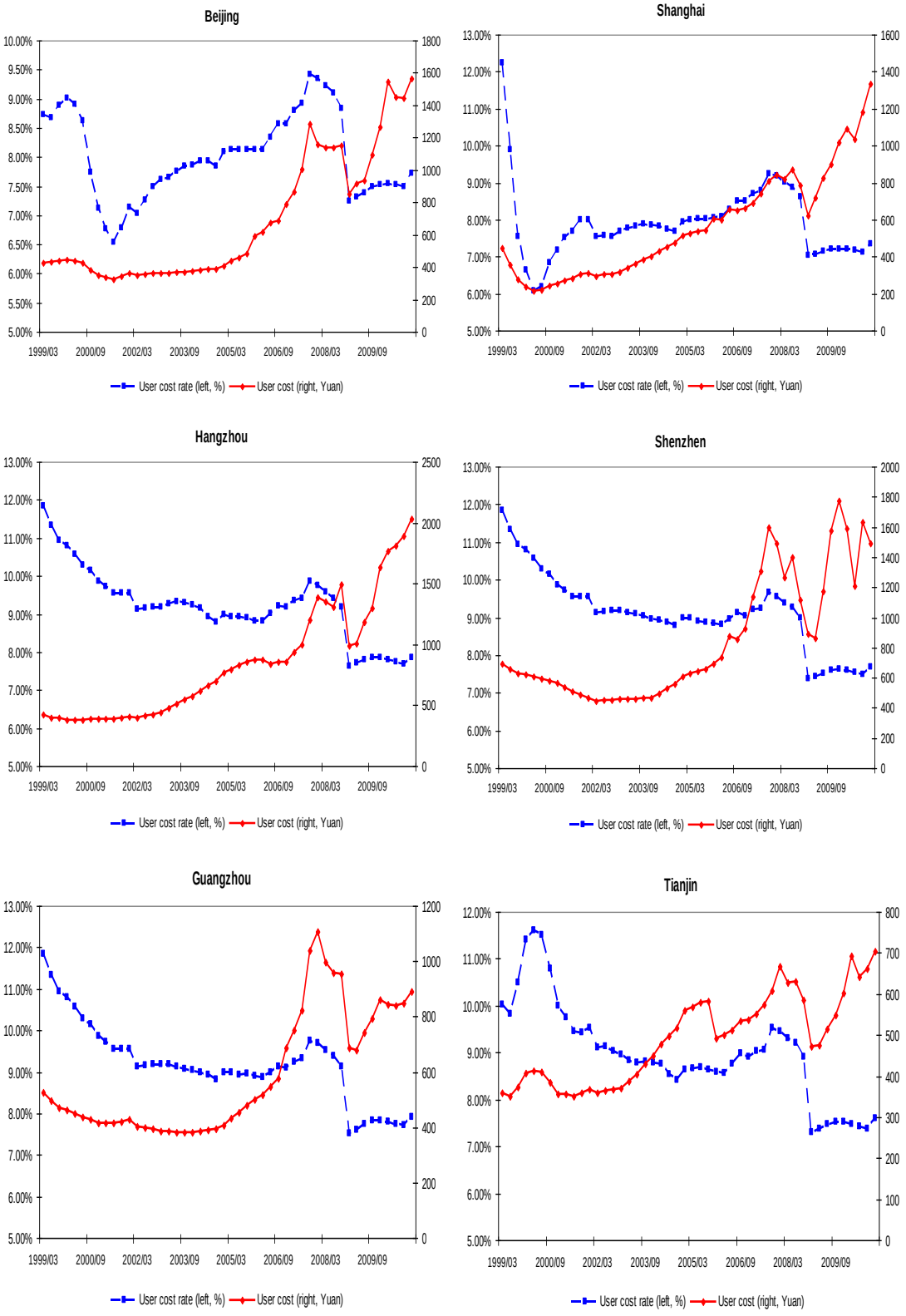
Figure 7 Population (Household Registration) and Price-to-Population Ratio (Sample mean=100), 1999-2010

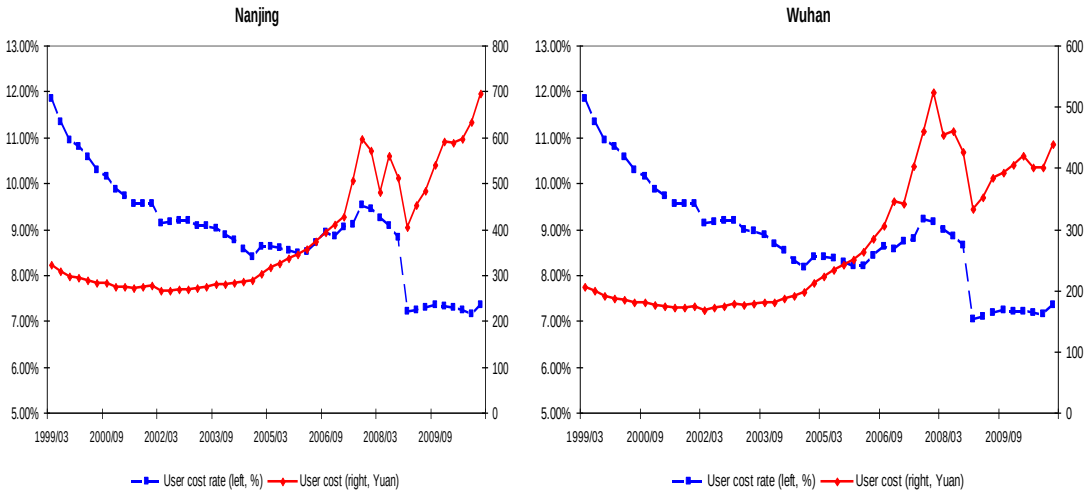


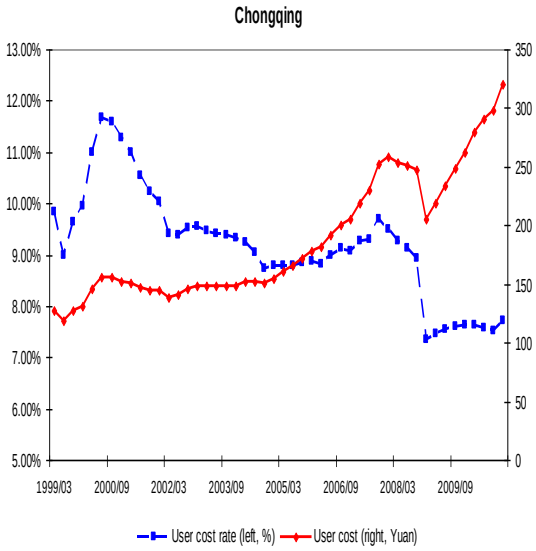


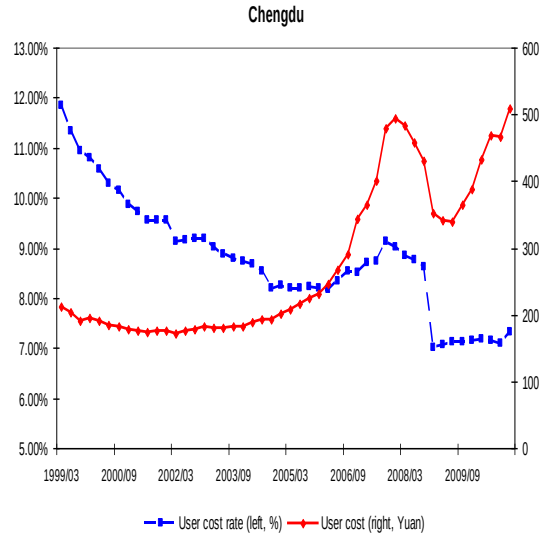
Data sources: China City Statistics Yearbook; National Bureau of Statistics; Authors' calculation

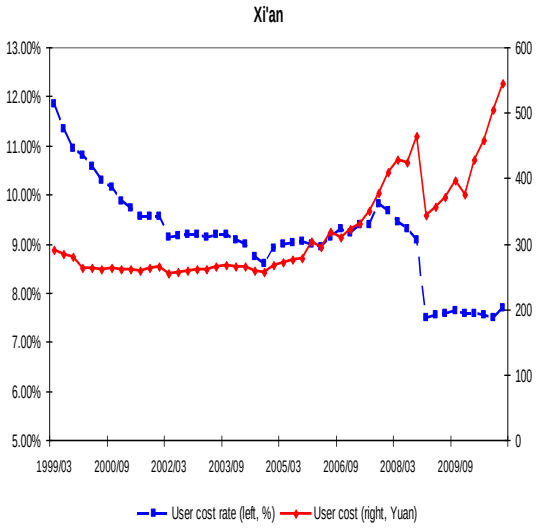
Figure 8 User Costs and the User Cost Rate, 1999-2010

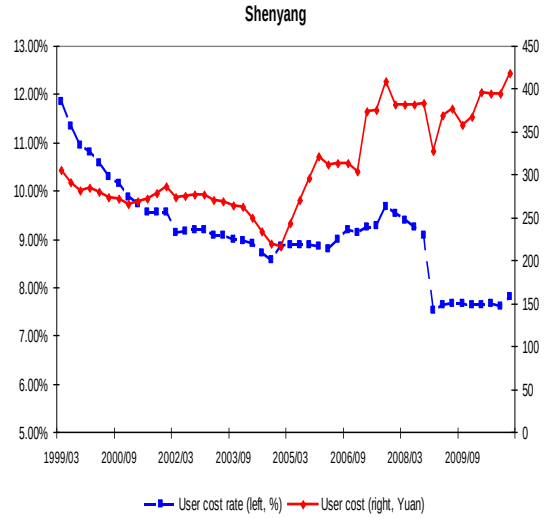












Data sources: China City Statistics Yearbook; National Bureau of Statistics

Table 1 Panel LS Estimation Results

Regressor	Model 1		Model 2		Model 3	
Constant	0.379*** (0.127)	0.656*** (0.124)	0.158*** (0.056)	0.110** (0.052)	0.314*** (0.041)	0.180*** (0.046)
ln (P_{t-1})	-	-	0.664*** (0.024)	0.661*** (0.020)	0.664*** (0.020)	0.661*** (0.020)
ln $Y_{i,t}$	0.236*** (0.010)	-	0.051*** (0.007)	-	0.036*** (0.006)	-
ln (Wage)	-	0.223*** (0.010)	-	0.073*** (0.008)	-	0.066*** (0.008)
ln ($LP_{i,t}$)	0.080*** (0.007)	0.086*** (0.007)	0.026*** (0.006)	0.019*** (0.005)	0.026*** (0.004)	0.019*** (0.005)
ln($HKP_{i,t}$)	0.076*** (0.017)	0.049*** (0.018)	0.022*** (0.004)	0.010*** (0.003)	-	-
ln ($UC_{i,t}$)	0.749*** (0.013)	0.758*** (0.013)	0.303*** (0.022)	0.304*** (0.018)	0.303*** (0.018)	0.304*** (0.018)
ln ($HKP_{i,t}$)* ln ($Y_{i,t}$)	-	-	-	-	0.002*** (0.000)	-
ln ($HKP_{i,t}$)* ln(Wage)	-	-	-	-	-	0.001*** (0.000)
City Random effects	Yes	Yes	Yes	Yes	Yes	Yes
Period random effects	No	No	No	No	No	No
R-Squared	0.980	0.978	0.994	0.995	0.994	0.995
Number of Obs.	576	576	564	564	564	564

Note: 1). ***, ** and * denote statistical significance at the 1%, 5% and 10% significance levels, respectively. 2). Standard errors are reported in parentheses. 3) The calculations have been performed by EVIEWS 7.

Table 2 Tests for long-run impacts of fundamental factors on housing prices: Common and individual unit root tests

Variable	common unit root		individual unit root					
	Levin, Lin & Chu t		*Im, Pesaran and Shin W-stat*		*Augmented Dickey-Fuller*		*Phillips-Perron*	
	Levels	Diff.	Levels	Diff.	Levels	Diff.	Levels	Diff.
Ln(P)	6.45	-5.37*	9.79	-8.61*	0.53	123.46*	0.35	256.90*
ln(GDPpercapita)	-0.53	-4.82*	5.39	-9.21*	4.96	137.37*	5.57	183.84*
ln(Wage)	-2.91*	-9.44*	2.47	-9.55*	10.17	161.63*	62.14*	51.22*
Ln(LP)	4.01	-14.93*	7.14	-13.18*	0.80	204.15*	0.64	356.45*
Ln(Population)	-5.06*	-5.94*	0.89	-8.63*	44.00*	133.49*	12.07	20.22
Ln(Usercost)	3.49	-5.41*	5.54	-9.98*	2.30	145.97*	1.69	242.28*

Notes: 1). The table presents the results of unit root tests for stationarity of the individual time series. 2). * and ** denote the rejection of the unit root hypothesis at the 1% level and 5% level of significance, respectively. 3) The calculations have been performed by EVIEWS 7.

Table 3 Panel Group Cointegration Tests

Cointegration Rank	r = 0	r = 1	r = 2	r = 3	r = 4	r = 5
Panel Kao Test	-6.367*	-	-	-	-	-
Panel Fisher Stat. (trace)	570.9*	280.2*	141.2*	68.83*	39.56**	47.38*
Panel Fisher Stat. (max eigen)	324.4*	170.3*	93.9*	50.38*	29.87	47.38*
Beijing	254.43*	110.47*	53.63**	19.59	6.06	2.23
Guangzhou	195.59*	112.15*	63.27*	33.55**	14.14	2.88
Shanghai	199.69*	122.34*	74.42*	31.37**	10.55	4.22**
Tianjin	213.43*	115.80*	56.20*	25.05	10.64	4.27**
Shenzhen	159.10*	108.39*	69.10*	32.76**	9.89	2.52
Nanjing	135.89*	79.13*	48.32**	27.82	15.17	3.06
Hangzhou	190.52*	94.53*	40.88	20.28	5.79	0.50
Wuhan	189.12*	104.72*	63.91*	33.19**	8.37	1.24
Chongqing	194.43*	101.99*	50.30**	18.61	6.89	0.00
Chengdu	165.55*	89.47*	54.49**	31.70**	15.62**	4.49**
Xi'an	172.02*	104.40*	67.26*	36.92*	18.26**	2.04
Shenyang	213.58*	120.54*	63.90*	33.34**	9.53	0.53

Notes: 1. Table 3 presents the results of cointegration test for six variables: ln ($P_{i,t}$), ln ($Y_{i,t}$), ln ($W_{i,t}$), ln ($LP_{i,t}$), ln ($HKP_{i,t}$), and ln ($UC_{i,t}$) . 2. * and ** denote the rejection of the none or at most 1-5 cointegration rank test hypothesis at the 1% level and 5% level of significance, respectively. 3. Intercepts (no trends) are assumed in cointegration equations. 3) The calculations have been performed by EVIEWS 7.

Table 4 Panel Group Cointegration Equations

CE set 1	Ln(P)$_{-1}$	Ln(Usercost)$_{-1}$	CE set 2	Ln(P)$_{-1}$	Ln(Usercost)$_{-1}$
ln(GDPpercapita)$_{-1}$	1.210***	1.125***	**ln(Wage)$_{-1}$**	8.834***	7.353***
	(0.323)	(0.328)		(3.608)	(2.952)
Ln(LP)$_{-1}$	0.940***	0.945***	**Ln(LP)$_{-1}$**	0.493	0.471
	(0.270)	(0.275)		(2.579)	(2.111)
Ln(Population)$_{-1}$	0.204	0.150	**Ln(Population)$_{-1}$**	4.097***	3.251**
	(0.227)	(0.231)		(1.759)	(1.439)
constant	-12.591	-13.821	**constant**	-79.880	-67.459

Notes: 1. The table presents the results of cointegration equations. 2). Intercepts (no trends) are assumed in cointegration equations and VAR. 3) Two lags are specified in the VAR structure. 4). ***, ** and * denote statistical significance at the 1%, 5% and 10% significance levels, respectively. 5) The calculations have been performed by EVIEWS 7.

Table 5 Panel Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
Ln(GDPpercapita) does not Granger Cause Ln(P)	552	7.162	0.001
Ln(P) does not Granger Cause ln(GDPpercapita)		2.260	0.105
ln(Wage) does not Granger Cause Ln(P)	552	13.737	0.000
Ln(P) does not Granger Cause ln(Wage)		1.729	0.179
Ln(LP) does not Granger Cause Ln(P)	552	19.997	0.000
Ln(P) does not Granger Cause Ln(LP)		9.962	0.000
Ln(Population) does not Granger Cause Ln(P)	552	1.239	0.290
Ln(P) does not Granger Cause Ln(Population)		0.026	0.974
Ln(Usercost) does not Granger Cause Ln(P)	552	10.288	0.000
Ln(P) does not Granger Cause Ln(Usercost)		23.494	0.000

Notes: Two lags are included in the tests.

Table 6 Panel Pair Cointegration Tests

Pair	Test	r = 0	r = 1
Ln(P) - ln(GDPpercapita)	Panel Kao Test	-0.93	-
	Panel Fisher Stat. (trace)	41.57**	22.27
	Panel Fisher Stat.(max-eigen)	35.88	22.27
Ln(P) - ln(Wage)	Panel Kao Test	-0.57	-
	Panel Fisher Stat. (trace)	215.1*	27.81
	Panel Fisher Stat. (max-eigen)	107.5*	27.81
Ln(P) - Ln(LP)	Panel Kao Test	-3.53*	-
	Panel Fisher Stat. (trace)	45.41*	18.47
	Panel Fisher Stat. (max-eigen)	45.27*	18.47
Ln(P) - Ln(Population)	Panel Kao Test	-0.47	-
	Panel Fisher Stat. (trace)	510.3*	27.65
	Panel Fisher Stat. (max-eigen)	185.8*	27.65
Ln(P) - Ln(Usercost)	Panel Kao Test	-6.32*	-
	Panel Fisher Stat. (trace)	51.35*	39.89**
	Panel Fisher Stat. (max-eigen)	41.41*	39.89**

Notes: 1). The table presents the results of cointegration test. 2). * and ** denote the rejection of the none or at most 1-5 cointegration rank test hypothesis at the 1% level and 5% level of significance, respectively. 3. Both intercept and linear deterministic trends are assumed in cointegration equations. 3) The calculations have been performed by EVIEWS 7.

Table 7 Panel Pair Cointegration Equations

Cointegration Equation (CE)	1	2	3	4	5	6	7
Variable	**$Ln(P)_{-1}$**	**$Ln(P)_{-1}$**	**$Ln(P)_{-1}$**	**$Ln(P)_{-1}$**	**$Ln(P)_{-1}$**	**$Ln(P)_{-1}$**	**$Ln(P)_{-1}$**
$ln(GDPpercapita)_{-1}$	1.796***					2.156***	1.888***
	(0.271)					(0.324)	(0.168)
$ln(Wage)_{-1}$		2.09***					
		(0.196)					
$Ln(LP)_{-1}$			4.896***				
			(0.755)				
$Ln(Population)_{-1}$				-1.03***		0.757**	-0.027*
				(0.363)		(0.321)	(0.132)
$Ln(Usercost)_{-1}$					1.065***		
					(0.028)		
constant	-10.115	-12.537	-28.811	15.365	2.043	-18.917	-8.729

Notes: 1. The table presents the results of cointegration equations. 2). Intercepts (no trends) are assumed in cointegration equations and VAR. 3) Two lags are specified in the VAR structure. 4). ***, ** and * denote statistical significance at the 1%, 5% and 10% significance levels, respectively. 5) The calculations have been performed by EVIEWS 7.

Table 8 Estimation of the Coefficients of the long-run relationship: Pooled Mean Group Estimator

CE	$Ln(P)_{-1}$	CE	$Ln(P)_{-1}$
	0.211***		0.147***
ln(GDPpercapita) $_{-1}$	(0.021)	**ln(Wage) $_{-1}$**	(0.019)
	0.093***		0.109***
Ln(LP) $_{-1}$	(0.008)	**Ln(LP) $_{-1}$**	(0.008)
	-0.000		0.098***
Ln(Population) $_{-1}$	(0.030)	**Ln(Population) $_{-1}$**	(0.028)
	0.839***		0.848***
Ln(Usercost) $_{-1}$	(0.014)	**Ln(Usercost) $_{-1}$**	(0.015)
Joint Hausman test	6.29	**Joint Hausman test**	4.99
p-value	0.179	**p-value**	0.288

Notes: 1. The table presents the results of cointegration equations. 2). Intercepts (no trends) are assumed in cointegration equations and VAR. 3) Two lags are specified in the VAR structure. 4). ***, ** and * denote statistical significance at the 1%, 5% and 10% significance levels, respectively. 5) The calculations have been performed by STATA.