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Housing Supply and Regulation in 35 Chinese Cities

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Housing Supply and Regulation in 35 Chinese Cities

Introduction

Over the past two decades China's housing market has seen a remarkable transition, in part due to major institutional changes and in part due to urbanization, economic growth, and demographic changes (Long and Wang 2009; Renaud 2009; Zang, Man and Ren 2009). The annual total investment in the real estate industry is about 20 percent of the stock of fixed property investment, and 10 percent of national GDP. According to Shanghai Bureau of Statistics, the real estate industry contributed 39 percent of Shanghai's GDP growth in 2009. Perhaps most remarkably, within the space of only two decades China's floor space per capita more than doubled (Chow and Niu, 2011, p. 48). Analysis of Chinese housing prices can shed light on some of these fundamental processes, as well as short-run concerns such as the existence, or not, of a housing "bubble" in major cities, and whether such a bubble is bursting as we write (Gough (2015) and Jim (2015), to give just two examples from the English press).

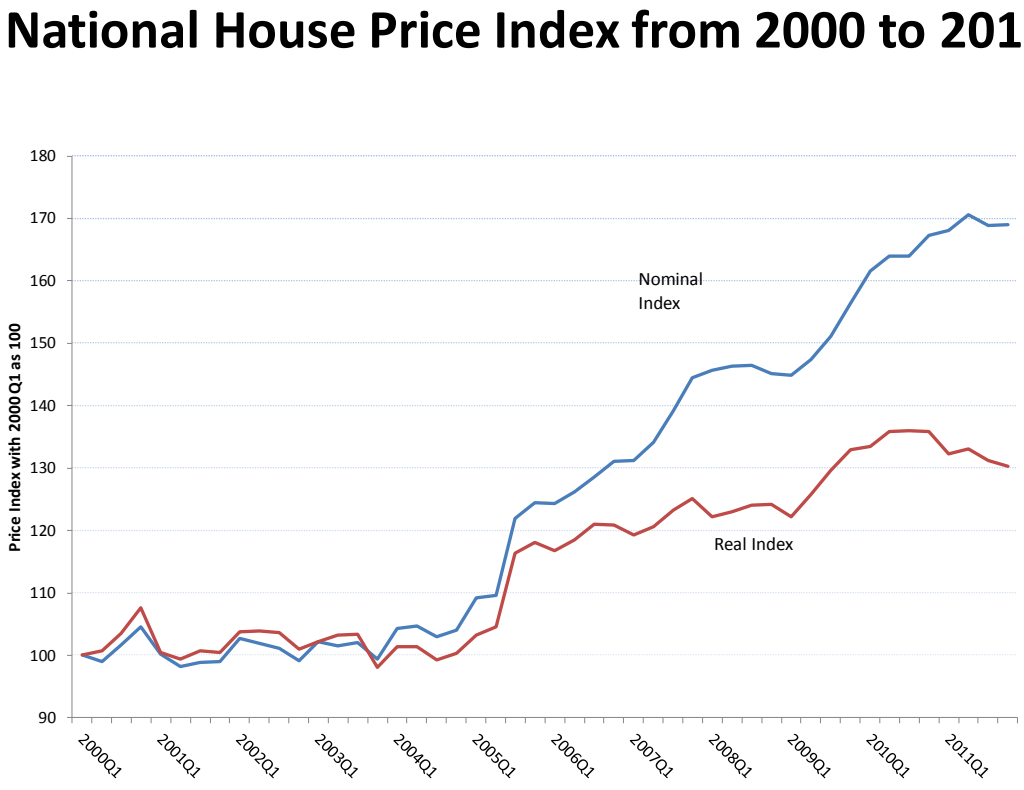
To be clear, we are not, in this paper, pronouncing on the existence of a Chinese housing bubble, or forecasting the future time path of China's housing prices. These exercises are difficult enough with large amounts of high quality data, and credible tests of bubbles and price forecasts are simply not possible, in our view, without a longer time span of high quality housing prices. Instead we focus on the related issue of housing supply, in particular the price elasticity of supply of housing, and its determinants. Papers by Wheaton (1999) and Malpezzi and Wachter (2005) have presented the argument that inelastic markets are necessary, though not sufficient, conditions for "bubbles." It's the necessary condition that we investigate in this paper. Further, international research has shown that demand patterns, e.g. how housing demand responds to changes in incomes and prices, are surprisingly regular and predictable; but supply responsiveness varies considerably from place to place. Other previous research, reviewed below, suggests this supply response would depend partly on natural constraint (physical geography), and partly on the regulatory regime for land use and real estate development. Investigating these relationships is the main contribution of our paper.

Our focus is China, of course. Using a panel data set of 35 major cities in China from the period 2000 to 2011, we examine several simple alternative housing price models that can be linked to a simple supply-demand framework similar to that used in Follain (1979), Malpezzi and Mayo (1997) and Malpezzi (1999). Until very recently most studies of Chinese housing prices to date use aggregate data, e.g. Chow and Niu (2011). However there is now an emerging literature using panel data, developed independently but in the same spirit as our work; see Wu, Gyourko and Deng (2011), and especially excellent papers by Wang, Chan and Xu (2012) and Wang, Yang and Lin (2011), which take an approach related to that we take in this paper, as we will discuss below.

We also draw on analyses of individual household decisions in China's housing market, e.g. Fu, Tse and Zhou (2000), and Zax (1997). Such analyses of microdata complement the approach we take in this paper; in particular such studies can be the source of identifying restrictions, as shown in Malpezzi and Mayo (1997) and discussed further below.

There are some differences between this paper and previous literature on both China and other countries. In addition to differences in model specification, time span of the data, etc., our paper adopts an informal Bayesian approach to deal with the (surprisingly common) tendency for some point estimates of housing supply elasticities to range outside theoretically plausible values. But our intended major contribution is to construct new supply-side measures, in particular of the regulatory environment for land use and housing development across Chinese cities. Previous studies such as Malpezzi (1990), Angel and Mayo (1996) and Kim, Malpezzi and Kim (2005) have constructed such measures across countries; Linneman and Summers (1991), Malpezzi (1996), Malpezzi Chun and Green (1998) and more recently Gyourko Saiz and Summers (2008) and Saiz (2010) have constructed such measures across cities within the U.S.

Figure 1



Before we analyze our panel, to further motivate our study, let us examine some national data. House price data have been available for China since 2000. Figure 1 shows that on average, real house prices began a rapid run-up around 2005, peaking in 2010, and then declined somewhat in 2011.[1] According to National Bureau of Statistics (NBS) data, the nominal national average

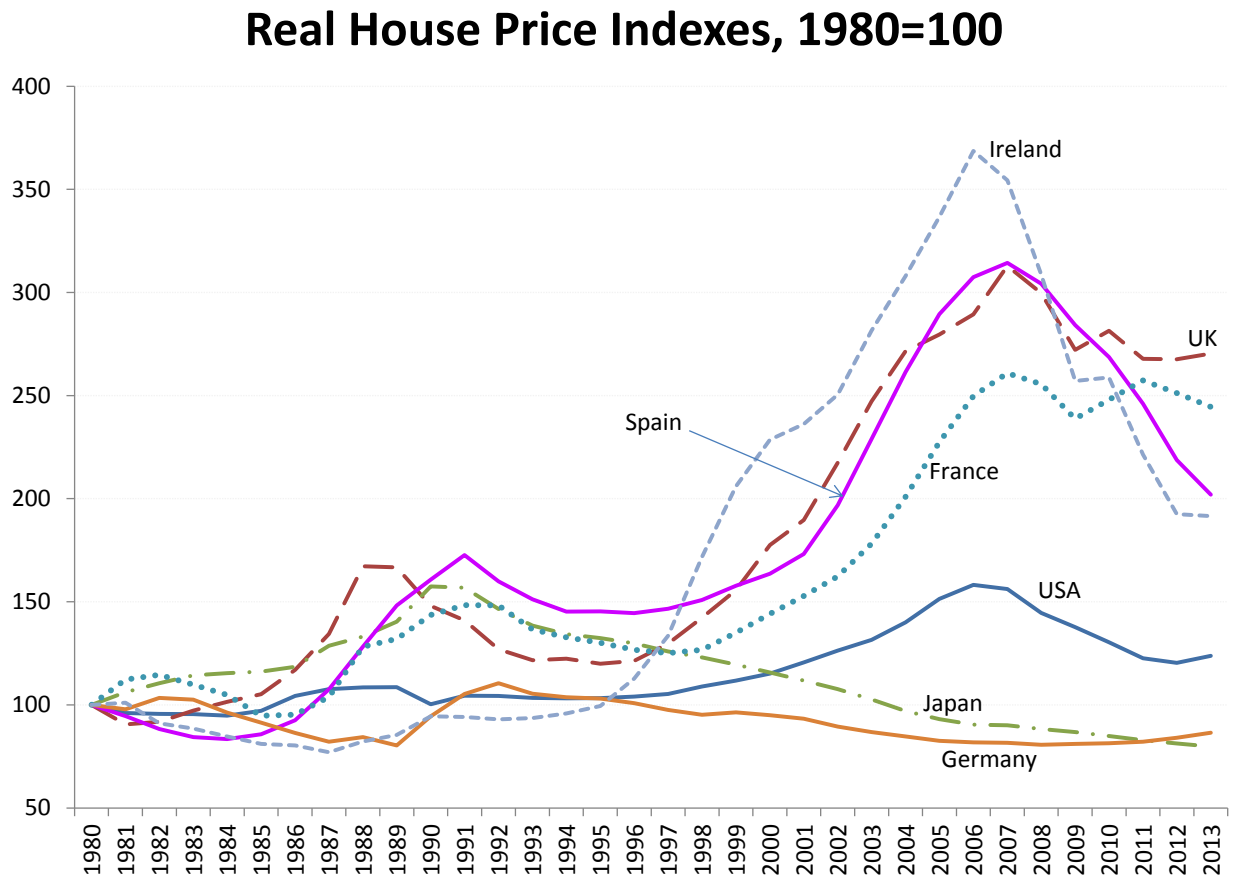
[1] House price data are from National Bureau Statistics of China (NBS) and will be discussed in more detail below. Man, Zheng and Ren (2011) document how the availability of house price data are tied to China's housing market reforms.

house price in 2011 was 2/3 larger than the 2000 level, or an average growth rate of 5.8 percent. In real terms, average house prices went up by about a third, or 3.3 percent each year. After adjusting for inflation, the 2011 real price index for housing is 1.35 times that in 2000, or an average growth rate of 3.3 percent.

Note that the pattern of price increase in Figure 1 is uneven. Real prices fluctuated up and down between 2000 and 2005. Then real prices increase of almost 22 percent between 2005 and 2011. A major challenge of research on China's housing prices is to explain this unusual pattern.

Of course China is not the first country to experience a rapid run-up in real housing prices. Figure 2, updated from Kim and Malpezzi (2010),[2] shows real house prices have doubled or more over a decade in France, Spain, the UK and Ireland; in the latter country, they more than tripled. But as the old saying goes, "every boom is followed by something else that starts with the letter 'b;'" the busts in Ireland and Spain have been especially notable.[3]

Figure 2



[2] Original data sources for Kim and Malpezzi include databases from BIS and OECD; 2010-13 updates were from the Dallas Fed, see Mack and Martinez-Garcia (2013).

[3] Of course the booms (and often subsequent busts) in France, Australia, the UK, Ireland, and other countries not listed are not the only interesting patterns in Figure 2; the long slump in Japan and the flat price in Germany over a long period have also attracted attention.

Comparisons among the countries in Figure 2 must be made cautiously, even more so when we add China to the mix; not only are the indexes constructed differently, but countries vary greatly in both their supply and demand conditions. The points we make are simple and robust ones. First, China's housing prices have risen rapidly in recent years, but that country is not alone in experiencing such a price boom. Second, in other countries full price cycles can last for two decades or so, so we should be very circumspect about reaching final conclusions from the dozen years or so of price data we have for China.

Recent research by Davis and Palumbo (2008) points out that land prices are often the driving force in U.S. housing prices and that in fact land prices are generally more volatile than housing prices *per se*. Figure 3 shows that this pattern also holds in China. Figure 3 presents the price index of land for residential building in China, based on 2000 land prices[4]. Land prices for residential building are increasing much faster than house prices. The 2008 nominal price index is about double its nominal value in 2000, or about 60 percent larger in real terms, much larger than the corresponding runup in housing prices in Figure 1. In China, as elsewhere, the bulk of house price increases can be traced to land prices; increases in construction costs play a secondary role.

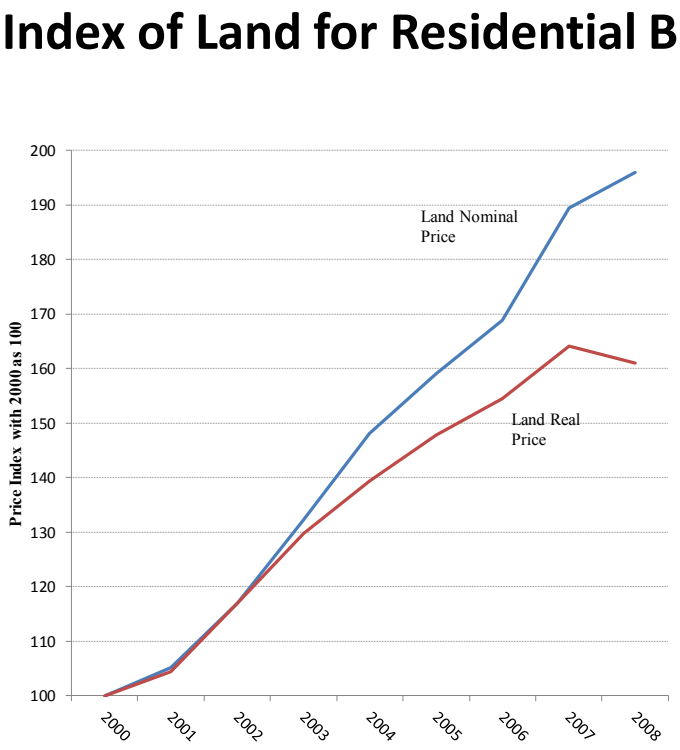
Strong economic growth and government support for the real estate industry have contributed to the rapid growth of real estate development in recent years. Chinese residents have remained very interested in real estate investment; the ratio of foreign investment in the property sector also remained well above 10 percent over the past 10 years, with such investment growing rapidly since 2006, according to the State Administration of Foreign Exchange (SAFE) 2010 annual report. According to the statistics from NBS, the price increase from 2000 to 2008 was very high for most major cities, especially the largest; the rise was 52 percent for Beijing, 67 percent for Shenzhen and 86 percent for Shanghai.

This rapid growth in housing price has also encouraged investors who do not themselves live in the units or "speculators". Concern with rising price led to a policy shift in 2004, when the China Development and Reform Commission targeted the real estate industry as one channel for macro economy control. To discourage "speculation" in housing, PBoC raised down payment requirements, to 40 percent for housing, and increased transaction fees for second-hand housing trades. However, strong confidence in real estate led to continuing increases in housing prices in 2008 (KPMG, 2008)

These price trends raise issues of affordability. For example, according to Wu, Gyourko and Deng (2010), the house price to income ratio in China falls in a range of 3.7 to 15.8 in different provinces. At national level, this ratio is around 9.8. Countries that Wu et al. use as comparisons have ratios between 3 and 6. The rising price of residential property makes it difficult for normal income family to afford a reasonable housing, especially in big cities.

[4] The land price data is from China Statistical Yearbook (2009)

Figure 3



What, then, lies behind the recent run-up in China's land and housing prices? Our intention is to focus on the relative roles of demand and supply conditions. In doing so, we move beyond national averages, and examine 35 large urban markets. Numerous studies across cities within countries have shown that housing markets are local and diverse. The role of supply constraints, some of which may vary with location, is an important question in Chinese housing markets (Bertaud 2007). To further our investigation of the supply elasticity in China, we have constructed several indexes of the regulatory environment in each of our 35 cities. We also construct a new measure of topographical constraints, a measure inspired by (though simpler than) Rose (1989).[5]

Our 35 cities are mapped in Figure 4. They include most of China's largest cities. They are not, however, a random sample of cities but rather driven by data availability. Figure 5 puts our sample selection in some perspective, compared to the broader range of Chinese cities.

[5] A recent paper by Saiz (2010) extends Rose's research and the simple geographical measures measures of Malpezzi (1996).

Figure 4

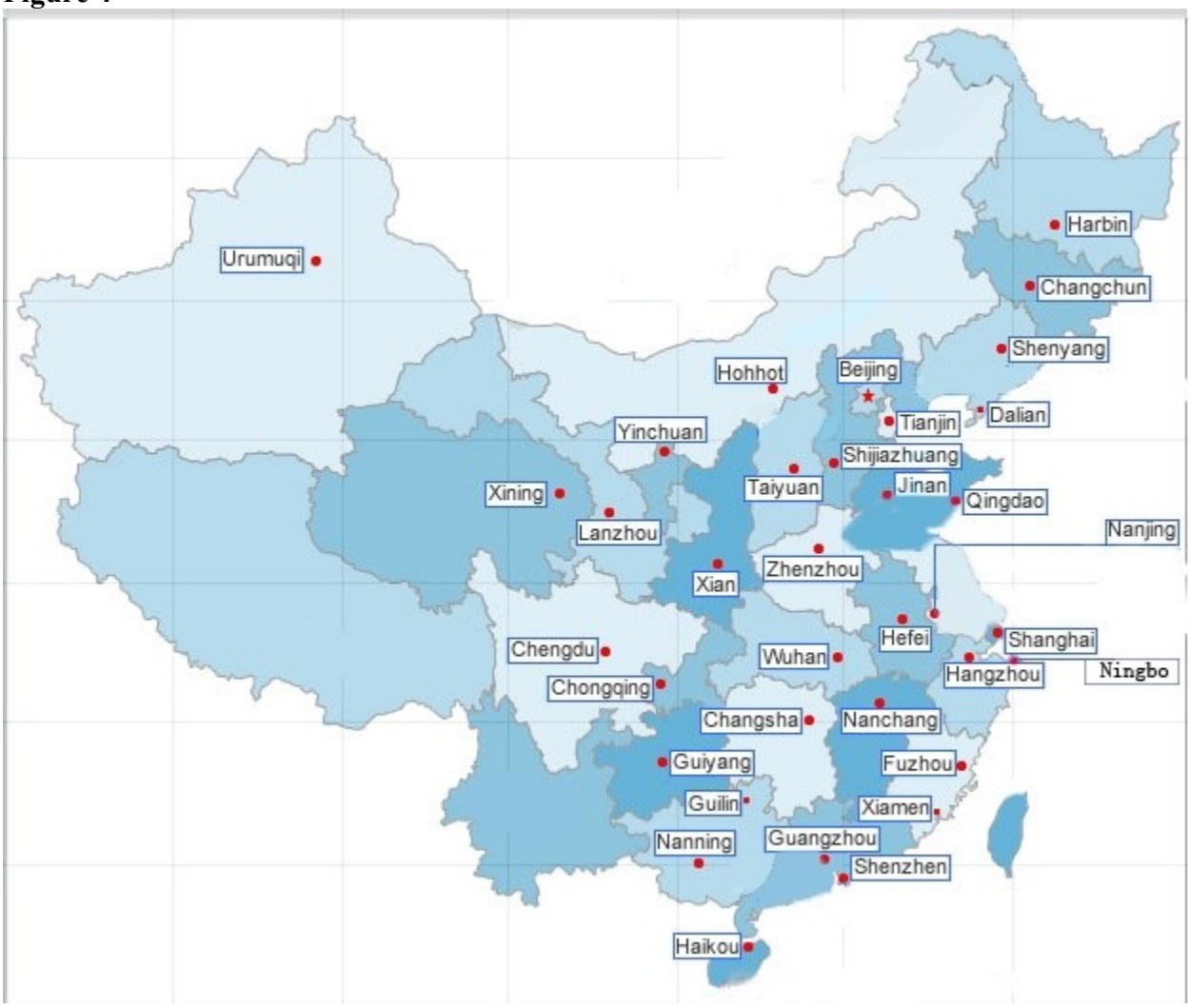
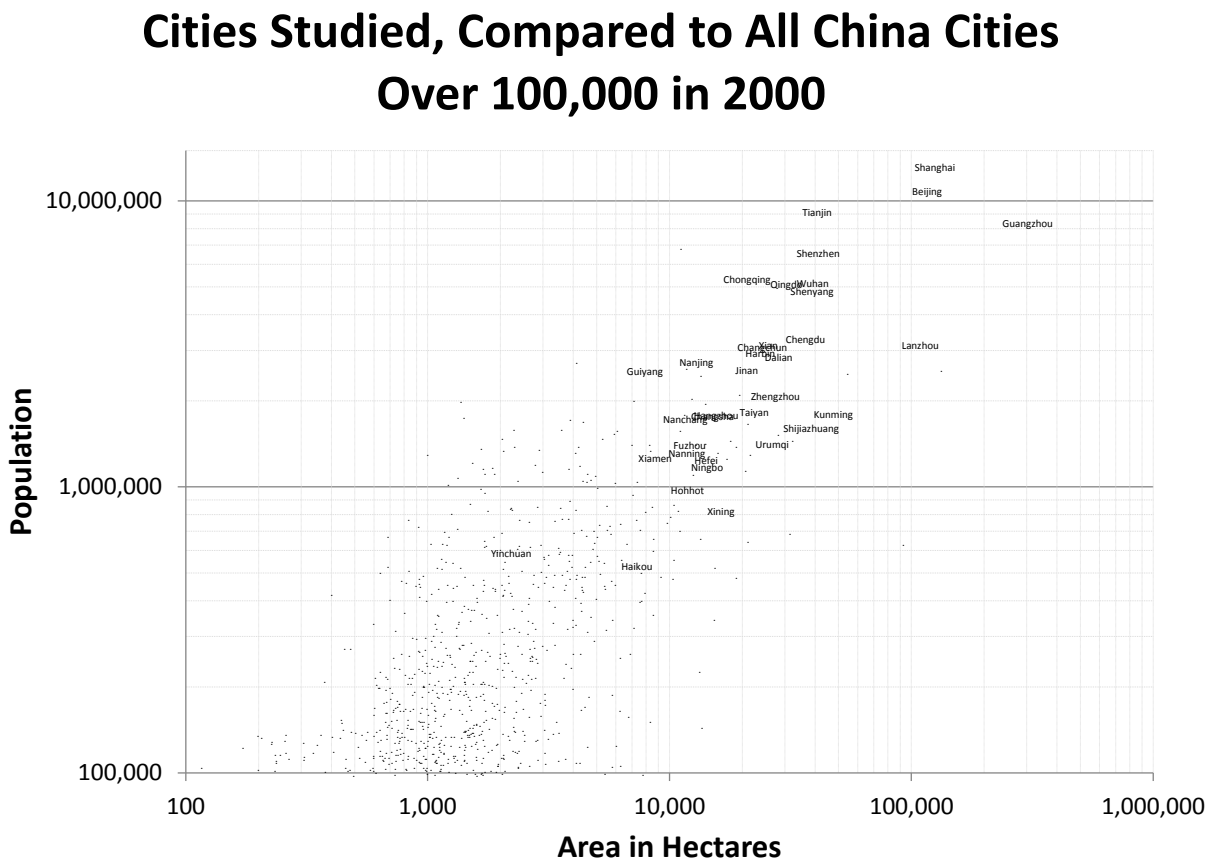

Harbin
Urumuqi
Changchun
Shenyang
Hohhot
Beijing
Dalian
Tianjin
Yinchuan
Shijiazhuang
Taiyuan
Jinan
Xining
Qingdao
Lanzhou
Nanjing
Zhenzhou
Xian
Hefei
Shanghai
Chengdu
Wuhan
Hangzhou
Ningbo
Chongqing
Changsha
Nanchang
Guiyang
Fuzhou
Guilin
Xiamen
Nanning
Guangzhou
Shenzhen
Haikou

Figure 5



The rest of this paper proceeds as follows. Section 2 reviews some simple models of housing market behavior; among other things this section helps to motivate our focus on the supply side of the housing market. The next two sections provide very brief reviews of China's recent economic and demographic trends, as well as housing and urban policies, that underlie recent trends in our 35 markets. Section 5 describes the model we use to identify supply elasticities from simple reduced form regressions. Section 6 then describes our dataset, and presents descriptive statistics as well as basic data on city-specific housing prices over 2000 to 2011. Section 7 presents these first stage regressions, and the elasticities themselves. The penultimate section examines determinants of supply responsiveness, including our new regulatory measures. The paper ends with conclusions and our bibliography.

Analyzing Housing Market Behavior: Supply, Demand and Prices

Figure 6

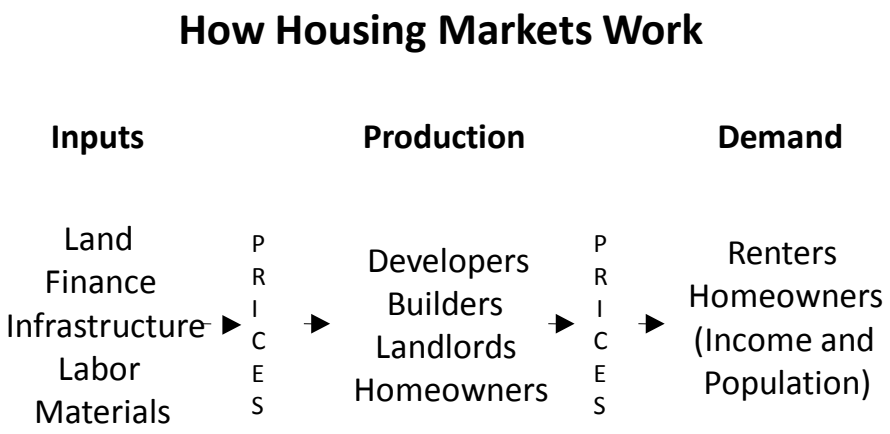


Figure 6, from Malpezzi (1990), presents a schematic diagram of how the housing market works. Demand is conditioned on fundamentals such as the incomes and demographics of homeowners and renters, as well as the prices of different kinds of housing. Inputs such as land, labor, finance, materials, and infrastructure are combined by supply-side agents such as landlords and developers to produce housing services. Homeowners, and to a lesser extent, renters, are also producers, if they maintain and upgrade their houses. Critically, relative prices inform producers of housing services about whether to provide more or less housing, and the input suppliers about providing more or fewer inputs.

Several other important features of housing markets are implicit in Figure 5. First, transactions within and across "boxes" work well only to the extent property rights are defined, recognized and enforced. Second, government interventions can have profound effects upon the operation of the housing market. Third, fully understanding housing markets requires analysis of key input markets and the regulatory environment, as well as revealed market behavior in the housing market *per se*.

Economists start with producers, consumers, and governments, as in Figure 6, but there are additional "actors" or "agents" that can also be important. In this paper, we focus on the role of government, particularly in the regulation of land use and housing development. But first let us lay out some simple supply and demand concepts we will use below.

Demand and Supply: First Principles

Demand for housing depends on, inter alia, changes in the price of the product; income; the price of substitute and complementary products; population and other demographics; preferences and tastes; and the availability and terms of mortgages and other end-user financing. The ***supply*** of housing changes because of, *inter alia*, changes in the price of the product; input prices, including land and construction costs; productivity changes (in labor; in capital; and "total factor productivity"); changes in technology; and the cost of financing the development process.

Thus, demand and supply are multivariate functions. By convention, we often hold most of the determinants of demand and supply fixed (ceteris paribus assumption), and graph a curve representing how demand and supply vary with a single determinant, viz. the price of the good. Changes in other variables (income, financing, price of inputs, etc.) are handled by shifting the curves. We will hew to this informative convention in the next few paragraphs, but in order to calibrate our eventual model, later we'll need to focus on the income-demand nexus as well, using the two-dimensional representation known as Engel curves.

Let us use the traditional demand-supply diagram to illustrate how the price elasticity of demand or supply influences the magnitude of the price change in response to a demand shock. First, consider an outward shift of the demand curve against two supply curves with different slopes. Malpezzi and Wachter (2005) illustrate how equilibrium housing price changes in response to a demand shock depending on the elasticity of supply. In Figure 7, in which housing supply is relatively inelastic, the equilibrium price rises from P_0 to P_1 as demand curve shifts to right in the medium run, and the price falls to P_2 in the long-run. On the other hand, in Figure 8, in which housing supply is more elastic than in Figure 7, the increase in housing price in response to an outward shift of the demand curve is smaller in magnitude than in Figure 7, both in the medium-run and in the long-run. Therefore, making supply more elastic will reduce the magnitude of house price fluctuations. Finally, Figure 9 illustrates the impact of government policy of shifting inelastic supply to right in response to a demand increase. An example is the five-year drive to build two million new dwellings in Korea during the 1989–92 period faced with the housing price hike in the late 1980s. The initial impact is the fall in house price from P_1 to P_2 following the massive increase in supply. However, if demand shifts to right again later, housing price rises back to P_3. Therefore, the magnitude of price fluctuation gets larger.

Figure 7

Demand shocks with inelastic supply: Boom and bust

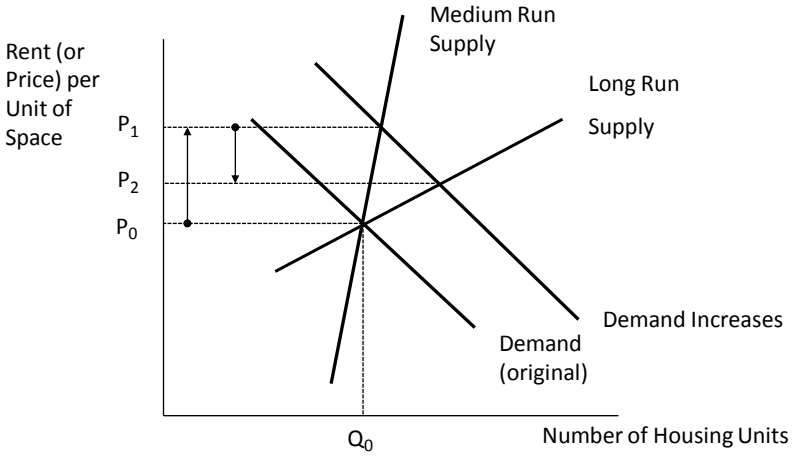
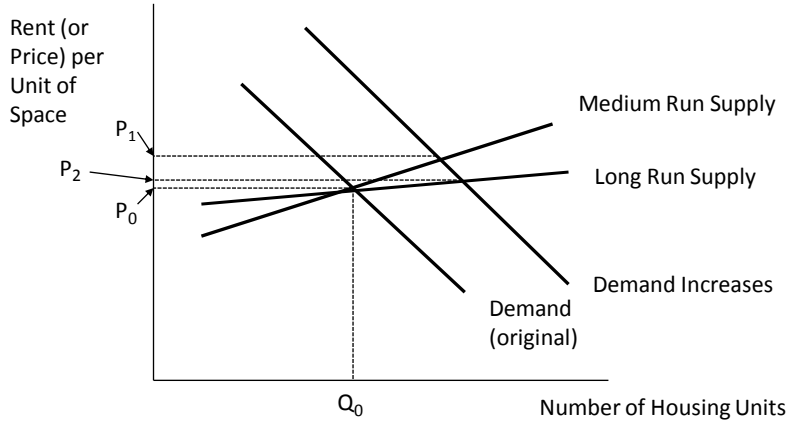


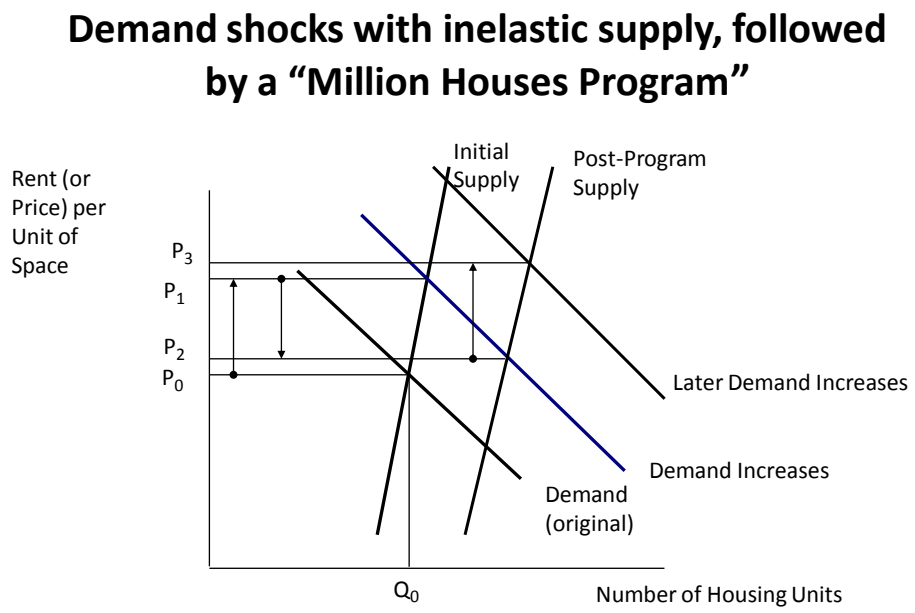
Figure 8

Demand shocks with elastic supply: Lower price shocks, less volatility



Source: Malpezzi and Wachter 2005

Figure 9



Source: Malpezzi and Wachter 2005

We can go much farther with this kind of analysis than space permits. For example, Malpezzi and Wachter (2005) demonstrates how inelastic supply curves can give rise to "boom and bust" markets, and are of the real cause of market instability, rather than "speculators."[6] They also show how such cycles are also exacerbated by badly designed government responses to rising housing prices by one-time programs to get the market moving, as in a "Million Houses Program;" these can be characterized as occasionally *shifting* an inelastic supply curve to the right.[7] This leads perforce to a boom and bust cycle, as in Kim and Renaud (2009) and Kim and Suh (1993). The analysis suggests it would be more effective to tackle rising prices by improving the efficiency of the supply of developable land, and real estate generally, including the development of an appropriate regulatory framework for real estate.

Reform measures that tackle the root causes of inelastic supply have the effect of *flattening* the supply curve and moderating the boom and bust cycle, reducing risk for investors.
Next we examine another type of demand curve, in which we hold the price of the good constant, and focus on the income elasticity of demand. Figure 10 shows three such stylized so-called Engel curves.[8] Let us posit that housing is a normal good, i.e. one with positive income elasticity of demand (when income increases, spending on the good increases).[9] But how positive? If housing's income elasticity is positive, but less than one, spending on rent increases as incomes

[6] Malpezzi and Wachter's model is a simple supply and demand model; see Wheaton (1999) for a more sophisticated treatment of these dynamics.

[7] Examples of such one-time shifts from a "million houses program" or its equivalent can be found from the United Kingdom, Korea, Sweden, and Sri Lanka, among others.

[8] See Deaton and Muellbauer (1980) for a broad overview, and Chai and Moneta (2010) for historical context.

[9] So-called inferior goods have negative income elasticities; for example, a poor quality basic foodstuff might have a negative income elasticity, if as our income increases we decrease our consumption.

rise, but the percentage growth in rent lags income growth. (Such goods are often termed necessities.) If the income elasticity of demand exceeds one, the percentage growth in rent exceeds the percentage growth in income. (Such goods are termed luxuries.) If the income elasticity of demand is exactly one, i.e. if we are on the "knife-edge" between necessity and luxury, then the percentage growth in rent is the same as the percentage growth in income. Figure 10 presents stylized examples.

A simple transformation clarifies the difference between necessities and luxuries more clear. Instead of plotting rent against income, plot the ratio of rent-to-income against income, as in Figure 11. If the income elasticity is less than one, then rent-to-income—the budget share devoted to housing—will fall as income rises. If the income elasticity of demand is greater than one, the budget share increases with income. If the income elasticity of demand is exactly equal to one, the budget share is constant.

Figure 10

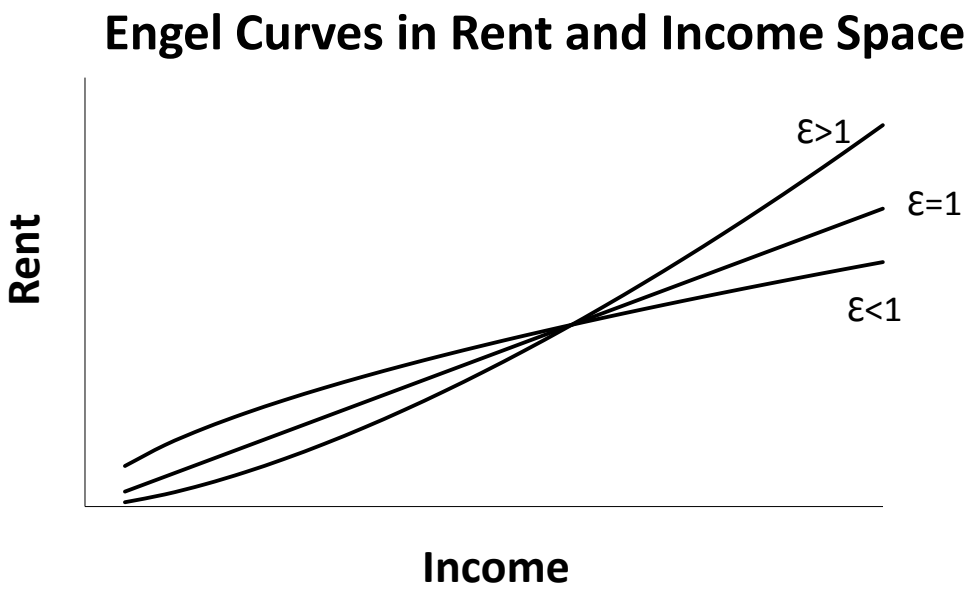
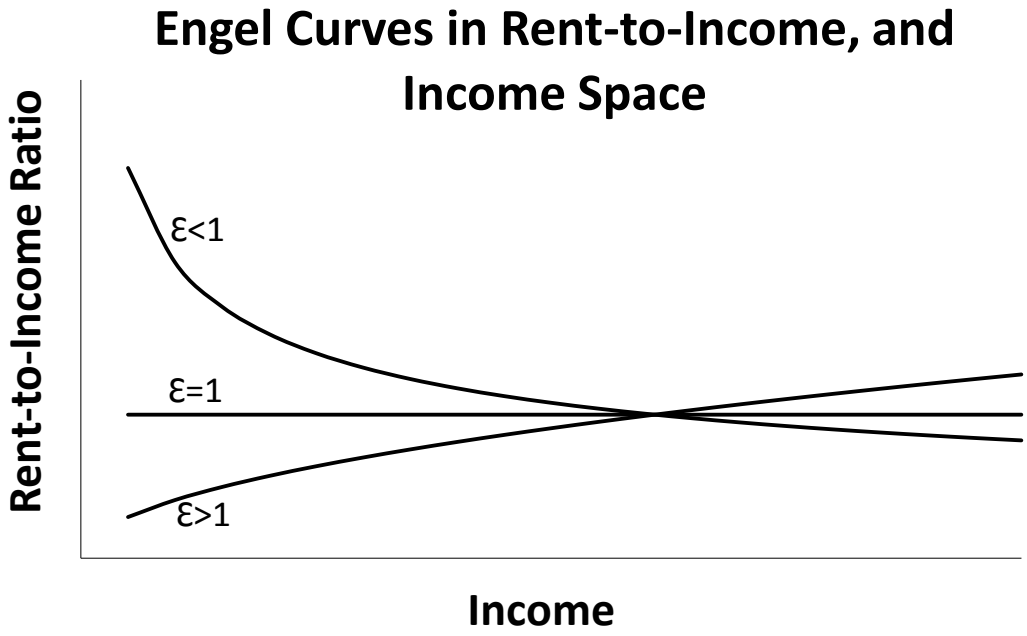


Figure 11



Empirical Evidence on Housing Demand

Surveys of empirical work on demand can be found in Mayo (1981), Olsen (1987) and Whitehead (1999) for richer countries, and Malpezzi and Mayo (1987) and Malpezzi (1998) for developing and emerging markets. Mayo's survey of U.S. research on the income elasticity of demand and reported a maximum of 0.70 for renters and 0.87 for owners. This is consistent with many other U.S. studies, for example, Hanushek and Quigley (1982) used a dynamic model and estimated income elasticity for the U.S. renters of 0.6. Price elasticities of demand, while (naturally) of opposite sign, are generally of similar magnitude. However given the wide range of studies, data sources, and methodology, there are a few studies with elasticities as low as 0.2 (Mulford et al. 1982) and some studies (especially those based on aggregate data) that suggest elasticities of one or even slightly higher (Reid 1962; Davis and Ortalo-Magné 2010).

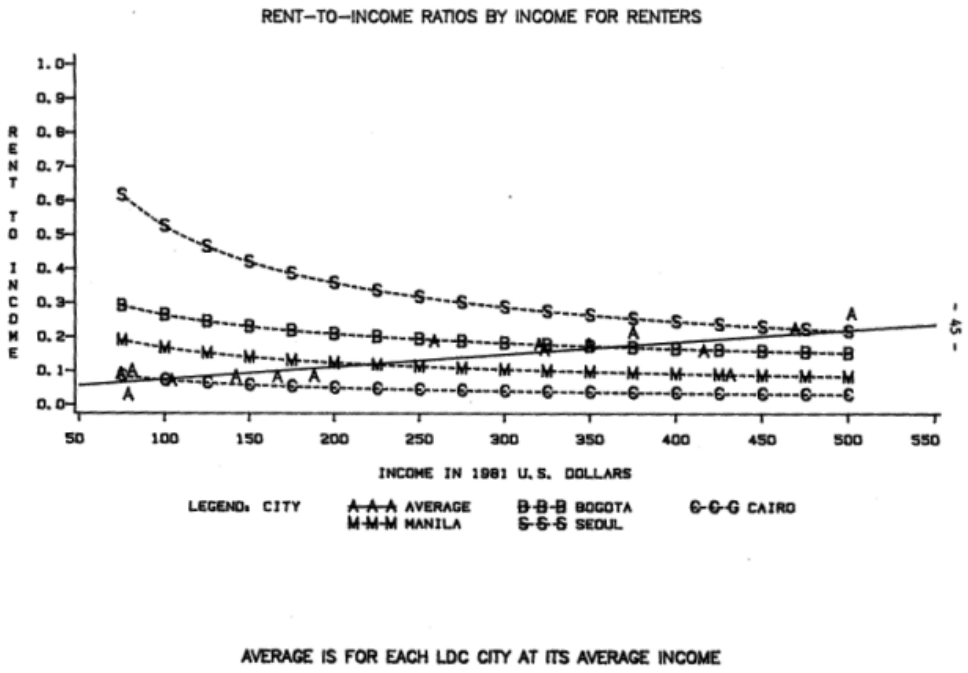
Despite significant difference in various aspects of developing countries, the majority of the credible estimates of income elasticity of housing demand in a wide range of countries fall between 0.5 and 1. In European context, Byatt et al. (1973) suggested that the income elasticity of demand was higher for owner-occupation than for private rented sector. Later work by Meen (1996) generates income elasticity as high as 1.25 with UK data. Whitehead (1999) review the literature on the demand side of housing and summarize that on the demand side both income and price elasticity are generally less than one but vary between tenures, income and demographic groups as well as between different housing attributes.

These results are broadly consistent with Malpezzi and Mayo's (1987) review of the demand for housing,and their own estimates for 14 developing countries. Figure 12, from Malpezzi and Mayo (1987), illustrates some of their key results, including the differences they found when examining housing expenditure patterns due to differences in income *within* markets, compared

to those due to differences in income *across* markets. (The figure focuses on renters, but broadly similar results are also obtained for homeowners). Cross-section elasticities within cities were generally in the range of .5 to .8 for owners and renters. The dotted lines in Figure 12, falling with income, are representative.[10] Tackling issues like price specification and permanent income as well as the simultaneity between demand and tenure choice tended to push elasticities up to the higher end of this range but they generally remained less than one in absolute value.

While within-market elasticities were broadly similar across markets, as Figure 12 shows, the intercept terms were quite different. Estimating cross-country models using (e.g.) the median rent-to-income ratio within markets, Malpezzi and Mayo found elasticities of one or a little higher; the solid line in Figure 12, rising with income, illustrates. Over the very long run, as cities develop, elasticities will tend to be higher than within cross section. That is to say that housing markets take significant time to adjust, and single cross sections do not reveal truly long run behavior.

Figure 12



Malpezzi and Mayo

[10] Compare Figure 12, based on data, to the stylized representations in Figure 11. Also, note that Figure 12 presents individual country results (dotted lines) for only four countries, when we estimated elasticities for 14. This is for readability; choosing another four, or all 14, does not change the qualitative conclusions we reach here. Also, note that at the time of data collection Cairo was the poorest of the four, followed by Manila, Bogota, and Seoul. The level curves shift up with income. While there are a few exceptions to the rule, this relationship between average city income and level of the curves is also robust. Note that we do not represent that these curves continue to shift up indefinitely (if that were the case in a world of growing incomes, housing would eventually crowd out all other consumption, which emphatically is not the case).

These demand results are generally consistent with country-specific studies of China. Zax (1997) studies the demand for urban housing in China using a micro-data survey in 1989. Since the data from that time did not include good estimates of market rate expenditures as such, he studied latent demand using categorical models rather than typical regression-based Engel curves. Zax finds that in urban China, own-built dwellings are 75 percent larger than state-owner dwellings. The relationships between family characteristics and dwelling sizes in the two sectors differ dramatically and unobserved characteristics, such as *guanxi* ("connections"), play important roles in both.

Fu, Zheng and Ren (2011) use a model of housing expenditure and demand for living quality to estimate the income elasticity of housing demand for different population groups stratified by housing tenure (own vs. rent), skill level (education attainment), migration status (*Hukou*[11] status and the stay length in current city), industry and occupation, social background and network, etc. Based on the data from a large national urban household survey in 2007, estimated income elasticities of demand ranging from 0.33 to 0.67.

Chow and Niu (2011) estimate a demand function characterized by disposable income and housing price. Their long run income elasticity is 1.14 and price elasticity is -0.71. Their short run estimates are 0.75 and -0.31 respectively. They point out that their estimates are very similar to the classic estimates of 0.94 for Beijing (in 1927) and 0.71 for Shanghai (in 1929–1930) estimated in Houthakker (1957).

Taken as a whole, previous research on housing demand, in China and elsewhere, gives us a solid foundation for assumptions about demand that we will use to identify our estimation of supply elasticities. In particular, we will parametrically assume an income elasticity range from 0.5 to 1, the range recommended by Malpezzi and Mayo (1987) for developing countries, and consistent with the finding of Zax (1997), Fu, Zheng and Ren (2011) and Chow and Niu (2011).

Empirical Evidence on Housing Supply

In his classic 1987 review, Edgar Olsen stated:

> Empirical studies of the supply of housing service are as scarce as studies of its demand are abundant. Indeed, there are not enough studies of any parameter to make it worthwhile to discuss the central tendency of the estimates (p. 1015). [I]t is abundantly clear that the marginal benefit from studying housing supply is much greater than the marginal benefit from studying housing demand (p. 1019).

In the years since Olsen's review was published, a number of studies have estimated supply elasticities, so that these number in the few dozens (compared to literally hundreds of demand studies). Of these, most—not all—have focused on developed countries, particularly the United States.

[11] A common name used in mainland China for the household registration system. Under the unique household registration (*Hukou*) system, each individual in China is classified as rural or urban household status, which embodies a sharp differentiation of rights and privileges.

Muth (1960) is often cited as the first econometric examination of the supply side of the U.S. housing market. Muth regressed the real value of new construction against the relative price of housing, and input prices; and also estimated an inverted model with housing prices on the left hand side. In both cases Muth found no significant relationship between price and quantity, consistent with elastic supply. However, Muth limited his investigation to the interwar years 1919–1934.

Following Muth, Follain (1979) estimated a series of similar regressions, using postwar data (1947–1975), and examining issues of simultaneity and serial correlation. Follain found qualitatively similar results, consistent with elastic supply. Malpezzi and Maclennan (1998) updated Follain's model, and confirmed elastic U.S. supply.

DiPasquale and Wheaton (1994) estimated a stock adjustment model that incorporated a simple model of urban form. In the standard urban model of Alonso, Muth and Mills, as the city grows the value of the "average" location in the city rises, as the bid-rent curve shifts upwards, even if the bid rent at the ever-expanding fringe is constant. In the event, using 1963–1990 data DiPasquale and Wheaton estimate some of the supply lowest elasticities extant, in the range 1.0 to 1.4.

Mayer and Somerville (2000) present results from an alternative stock adjustment model, in spirit related to DiPasquale and Wheaton's. While earlier work by Mayer and Somerville (1996) yielded estimates of between 1 and 4, this later effort found a stock elasticity of about 0.08 (i.e. a 10 percent increase in price yields a 0.8 percent increase in the total housing stock; a small number but a large magnitude, since in a given year the stock of housing is 50–100 times starts), but a flow elasticity of about 6 (starts increase 60 percent from a 10 percent price increase). Harter-Dreiman (2004) applied a VEC model based on errors from an estimated co-integrating relationship between price and income, as well as lagged price and income changes. Supply elasticities in the range of 1.8 to 3.2 were inferred from the model for 76 US MSA between 1980 and 1998.

Several other papers which are not labeled as "supply elasticity papers" contain explicit or implicit estimates of such a parameter. Most of these papers have found or implied low elasticities. Kearl (1979) reported an elasticity of 1.6 for new construction, and Huang (1973) 2 for starts. Topel and Rosen's (1988) research on starts found a long run elasticity of 3 using quarterly data from 1963–1983. Poterba (1991) also presented data that seemed to indicate a rising supply price. In general, this set of papers is characterized by models and data that constrain "long run" adjustment to a few quarters or years. Also the particular years chosen were in at least the last two cases periods real housing prices were rising. Had they extended their estimation forwards or backwards in time they would have included declining prices. Put another way, these estimates put lower bounds on the true long run elasticity, but say nothing about how close to the bound the true parameter might be.

Park *et al*. estimated Canada's housing supply elasticity. Using quarterly data from 1963 to 1990 in Canada, this paper develops a basic quarterly structural econometric forecast model of the Canadian housing sector and mortgage market; they estimate a supply elasticity of 0.51.

A number of papers and books have examined supply conditions in the UK housing market over time. Many of these (e.g. Habukkuk 1962) have been primarily historical and/or descriptive. While these have been invaluable, including providing the data for our present undertaking, only recently has a more analytic approach been taken. Nellis and Longbottom (1981) were among the first to estimate reduced form models of UK housing prices, but their focus was not particularly on behavioral elasticities. Drawing on their work, Buckley and Ermisch (1983) showed how results from Nellis and Longbottom, and from similar specifications, could be used to recover behavioral parameters, but they focused on the short run and on demand side parameters and said little about the long run supply elasticity.

Muellbauer (1992) presents data on the asset price of housing over time in the UK, using data from 1960 to 1989. His analysis is primarily descriptive, and he makes several interesting comments and comparisons to German price history, to which we will refer below. Stern (1992) uses 1971–1989 data to estimate a two stage least squares model. Stern's model is distinguished by explicit consideration of the lag structure; he says nothing direct about the long run supply elasticity, but he finds that prices adjust to increased supply only after a lag of several periods. One of the earliest, and most influential, UK studies is Whitehead (1974). Whitehead develops a series of related stock adjustment models, and estimates them using quarterly data from 1955 to 1972. She generally found inelastic supply, with various models yielding elasticities ranging from 0.5 to 2. Another study by Mayes (1979, cited by Bartlett 1989) also finds inelastic supply in the United Kingdom. Later research by Malpezzi and Maclennan (2001) also finds inelastic UK supply.

A number of other UK supply-oriented papers have on supply from the existing stock (e.g. Maclennan 1978), or have used a cross section approach rather than time series (e.g. Bramley 1993, Pryce 1999); these typically yield elasticities around 1 or less. Bartlett (1989) contains an excellent review, updated by Bramley, Satsangi and Pryce (1999). Another useful review was carried out by Barker (2003) for the UK Treasury. They drew heavily on Swank, Kanes and Tieman (2002), who estimated supply elasticities for a number of European countries. Their estimates of the price elasticity of supply of new housing ranged from 0.3 in the Netherlands, to 0.5 for the UK, 0.7 for Denmark, 1.1 for France, 1.4 for the U.S., and 2.1 for Germany.

Several studies have estimated housing supply elasticity estimates for developing and transition economies. Malpezzi and Mayo (1997) present estimates for Malaysia (between zero and one), Korea (between zero and one), and Thailand (statistically indistinguishable from infinity). Figure 12 presents their preferred point estimates for the four countries. Malpezzi and Mayo argue that the rank ordering is the same as the ordering of each country's regulatory environment, a point to which we return below. Mayo and Shephard (1996) extend the Malpezzi and Mayo model by presenting a time varying supply elasticity for Malaysia; they found it to be shrinking over time.

More recently, Buckley and Mathema (2008) estimate supply elasticities in several African cities. They find elasticities of 0.43 for Accra (Ghana), 0.94 for Nairobi (Kenya), 1.25 for Addis Ababa (Ethiopia) and 2.83 for Dar es Salaam (Tanzania).

Several papers have investigated the supply side of China’s housing markets. Peng and Wheaton (1994) estimate the elasticity under restrictive land supply using the housing data from Hong

Kong. Hong Kong is a city-state where the supply of new land is under strict government control. In their paper, the estimate of price elasticity of demand is -0.97, which is not surprising in the sense that lower prices will encourage more independent households when many families live in subdivided units. The price elasticity of supply is 1.11.

Chow and Niu (2011) estimate a traditional structural econometric model of the demand for and supply of housing such a model for China's urban housing. In their paper, demand is a function of disposable income and housing price, while supply is function of construction cost and housing price. Using a reduced form model, they found a supply elasticity of 0.74 between 1987 and 2006. Their estimate of income elasticity of demand for housing is 0.80, similar to the estimate in Houthakker (1957).

Most of the studies above—much of the older literature—estimated some kind of average supply elasticity for an entire country. Our paper focuses on city-specific estimates for China, which fits into another strand of research. Bramley (1993) shows that housing supply varies from place to place within Britain; London, in particular, is less elastic than many other British locations. Green Malpezzi and Mayo (2005), Quigley and Raphael (2005), and Saiz (2008) are among studies that estimate city-specific supply for U.S. metropolitan areas. Two papers that examine supply conditions in China's cities are Wang, Yang and Liu (2011), and Wang, Chan and Xu (2012); we discuss these papers, especially the latter paper, in more detail below.

To summarize, previous studies of supply elasticities demonstrate that there is a great variation in the estimation of price elasticity of supply across countries; and several studies of city-specific supply find variation within countries as well. In general, the supply elasticity in U.S. is often found to be higher than other countries, while Asian countries seem to have much lower supply elasticity, with the exception of Malpezzi and Mayo's (1997) high supply elasticity for Thailand.

Figure 13

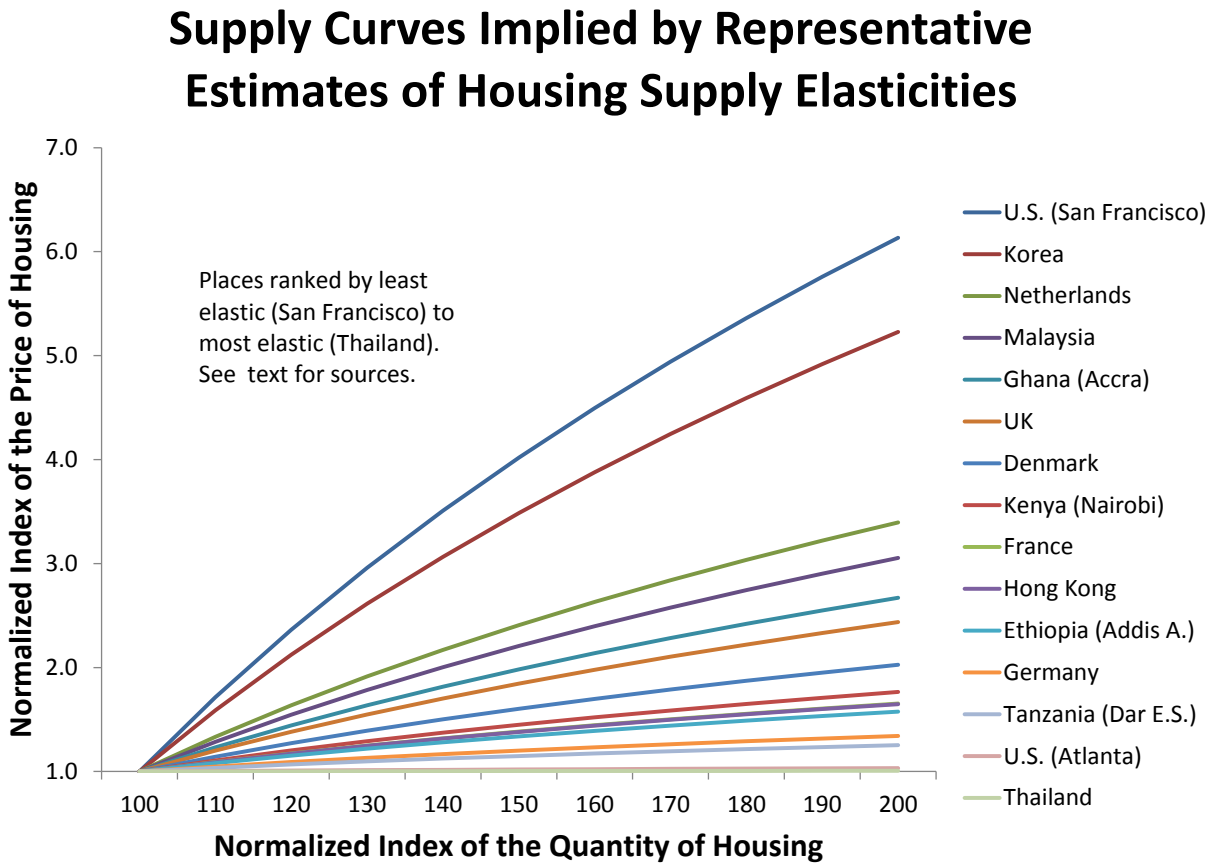


Figure 13 presents notional supply curves for a selection of countries/cities from the studies just reviewed. For each place, we normalized a quantity index set to an initial value of 100, and a starting price of housing normalized at 1.0. The variance in supply is striking, from flat, nearly perfectly elastic supply curves (Atlanta's and Thailand's are more or less coincident) to very steep curves for San Francisco and Korea. Contrast Figure 13, on supply, with Figure 12 above, on demand. Demand patterns were not the same but were regular and predictable, given income data, across countries. Here, we see that housing supply responsiveness varies considerably from place to place but is not so predictable; it's hard to see supply varying with income or size of place, for example. But there is some regularity: several studies reviewed in the next paragraph provide evidence that supply elasticities depend partly on natural constraint and partly on the regulatory regime. Investigating these relationships further is the main task of this paper.

In many (probably most) countries, there are literally hundreds if not thousands of individual regulations that can affect housing markets. One strand of previous research on the effects of regulation on housing markets has focused on the development and use of indexes that proxy for the stringency of land use, development, and related regulations. U.S. examples include Segal and Srinivasan (1985), Malpezzi (1996), Malpezzi, Chun and Green (1998), Pendall, Puentes and Martin (2006), Quigley, Raphael and Rosenthal (2009), and Gyourko Saiz and Summers (2008). International examples include cross-country studies such as Andrews et al. (2011), Angel and Mayo (1996), Angel (2000), Malpezzi and Ball (1993), and Kim, Malpezzi and Kim (2000).

Non-U.S. within-country multi-market studies include those of Argentina by Monkkonen and Ronconi (2013); of Brazil by Lall *et al*. (2007) and Biderman (2008); and of the UK by Hilber and Vermeulen (2012). Our goal is to contribute to this literature, and learn more about how China fits in.

China's Recent Development: A Brief Recap

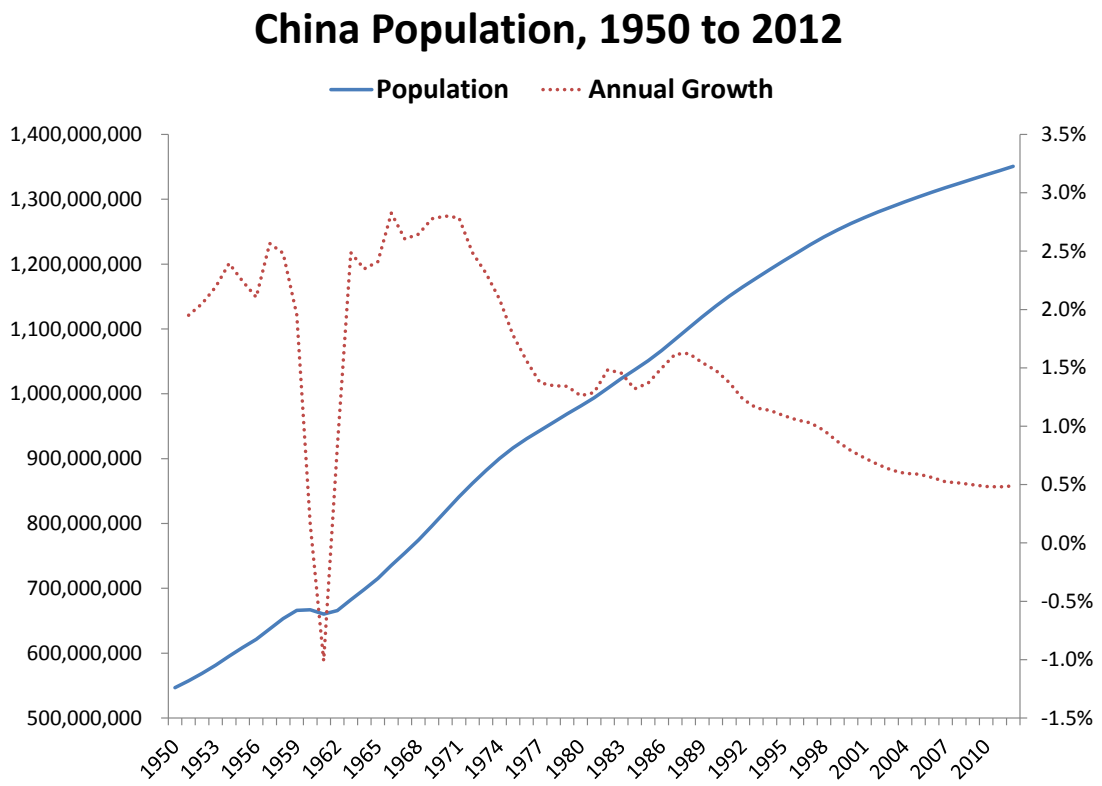
By many general measures, China's housing markets rank as the most dynamic in the world, and quite possibly in history. This dynamism, which we will explore throughout this paper, is not totally surprising given the sheer scale of fundamental changes in China's economy, demographics, and urbanization. Four decades ago China was a large, poor, rural country, convulsed by events including the so-called Great Leap Forward and the Cultural Revolution, laboring under a socialist economic system that held back its growth and development. But since that time, China has undertaken enormous economic reforms, including but by no means limited to substantial changes in the policy environment for housing. Enormous demographic shifts included a slowdown in population growth generally and a remarkable urbanization. While China still falls well short of the $40–50,000 GDP of the richest countries, readers will be well aware of the country's rapid growth from a poor country to a World Bank categorization of "upper middle income" and a GDP per capita in 2012 of about $6,000 (about $9,000 in purchasing power parity "international dollars"),

Demographics and Urbanization

One of 200 countries, but containing one in six of the globe's inhabitants, China's sheer size is rivaled only by India, its giant neighbor to the southwest. As Figure 14 illustrates, China's population is currently growing at about one half percent per year, roughly half the rate of global population growth (and about half of the U.S. rate).[12]

[12] Data in this section are primarily from the World Bank's World Development Indicators database, supplemented by Maddison (2007).

Figure 14



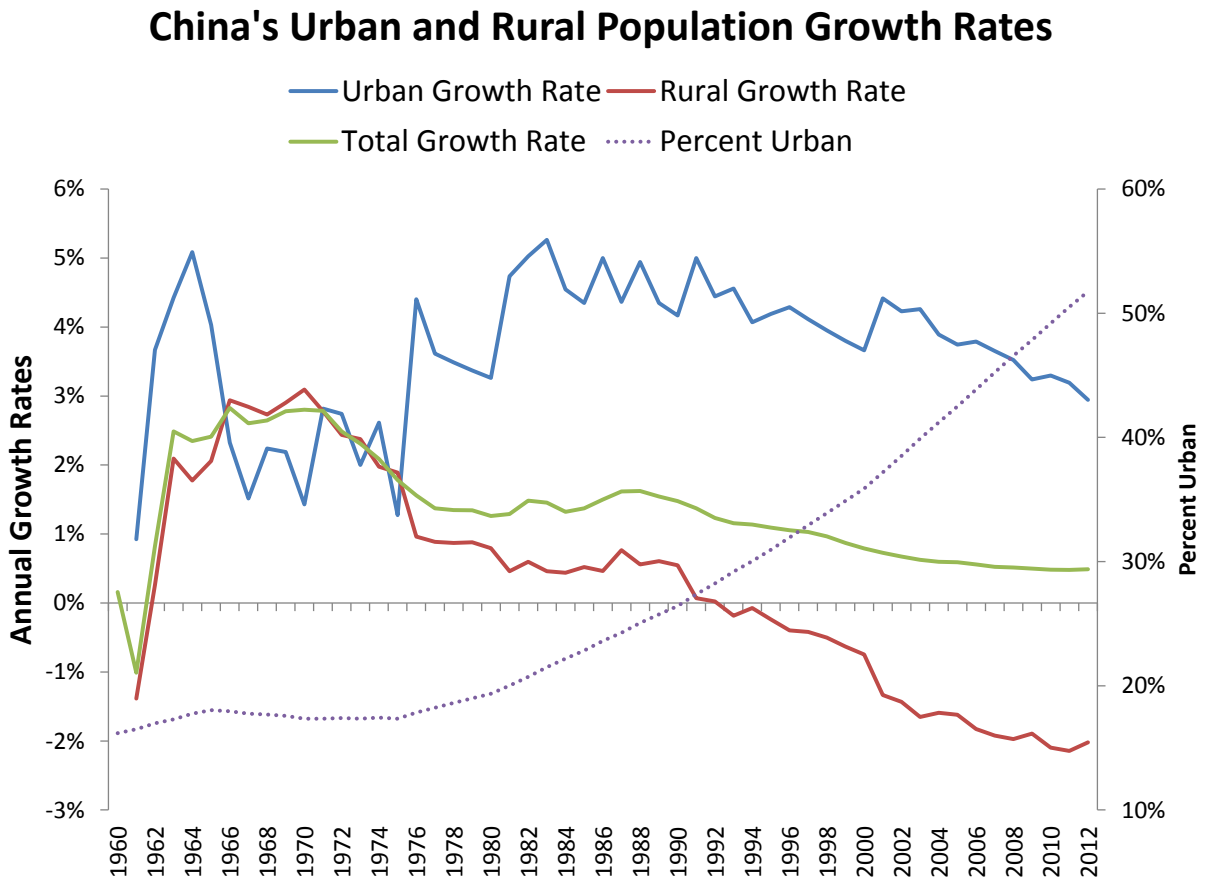
But the average population growth rate in Figure 14 masks a very large difference between urban and rural population growth rates in China. Figure 15 splits these out. Starting in the late 1970s—about the time of Deng Xiaoping-era reforms, though we are not ascribing causality—rural population growth rates, as measured, plummeted as urban growth rates increased.

Urban population growth shot up from about 2 percent per annum in the early 70s—a little below the then-prevailing overall population growth rate—to around 5 percent in the early 1980s. The urban population growth rate then slowly trended down to its current rate of about 3 percent per year (still a high rate of growth).

Over the same period, rural population growth fell from a bit over 2 percent in the early 70s to less than 1 percent in the early 80s. They then declined from this level to cross the zero growth threshold in the early 90s; rural population is shrinking at about 2 percent per year.

For comparison, China's overall population growth rate of about 0.5 percent per year is less than half the global (including China) population growth rate of 1.2 percent; on the other hand, China's current urban population growth rate of 3.0 percent is substantially above the current global urban growth rate of 2.1 percent per annum. On the opposite front, China's urban population is declining by 2.1 percent while globally rural population (again, including China) is growing by a modest 0.2 percent per annum.

Figure 15

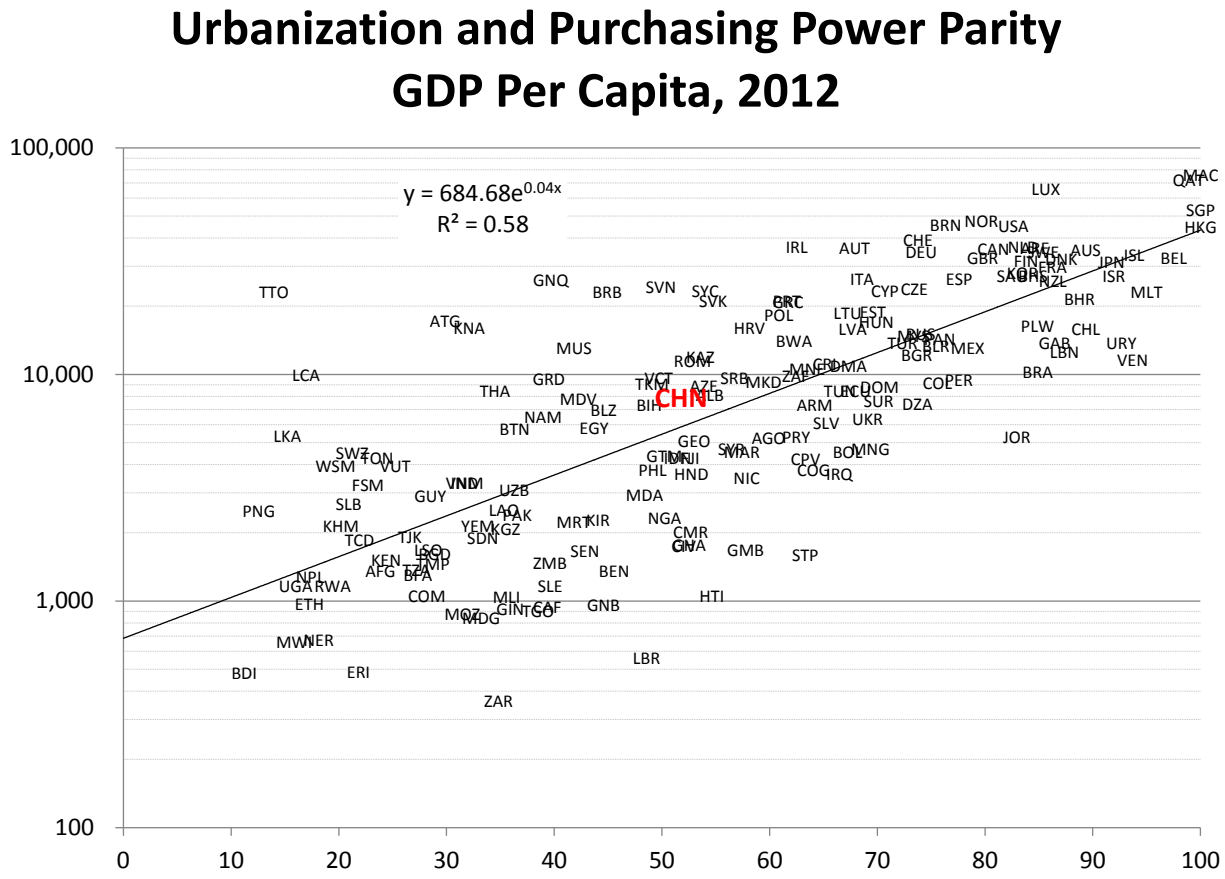


Put another way, the spread between China's urban and rural growth rates was small in the late 60s–early 70s (after an early-60s pro-urban spread due partly to the fact that the "Great Leap Forward" famine affected rural areas more than many cities). The big spread post late 70s grew to around 4 percent in the 80s and 90s, peaking at 6 percent around 2000, and now around 5 percent.

Rich countries are generally urbanized, as Figure 16 shows. The simple correlation between 2012 purchasing power parity GDP per capita and the percentage of population living in cities is 0.58, even without adjusting for obvious anomalies such as small oil exporters (that can be under-urbanized relative to their GDP, with a small petroleum- based enclave within an otherwise less developed economy) or city-states such as Singapore or Monaco.[13] Rich countries of any substantial population generally are 80 percent urbanized.

[13] We use World Bank World Development Indicators data, which accepts each country's preferred definition of "urban." Correcting for these definitional differences would further increase the correlation with GDP per capita. China, of course, has its own definitional challenges, some of which we will discuss below. See Chen (2010) for more detailed discussion of China's alternative urban definitions.

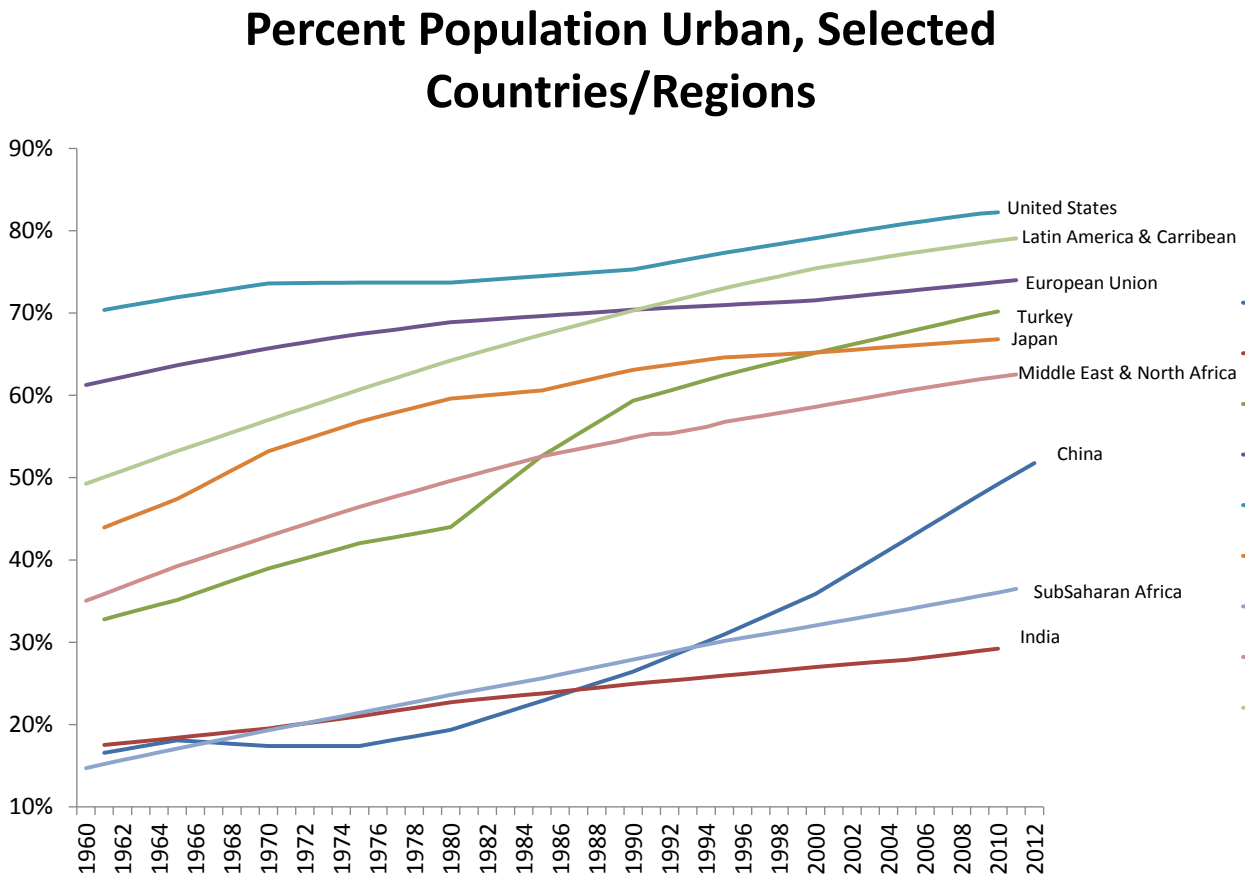
Figure 16



Given China's rapid increases in GDP, it is unsurprising that its population is rapidly urbanizing. As Figure 17 illustrates, when China's economic reforms began circa 1980, roughly 20 percent of China's population was urbanized; recently, according to the most widely used definition of urban, China crossed the 50 percent threshold.[14]

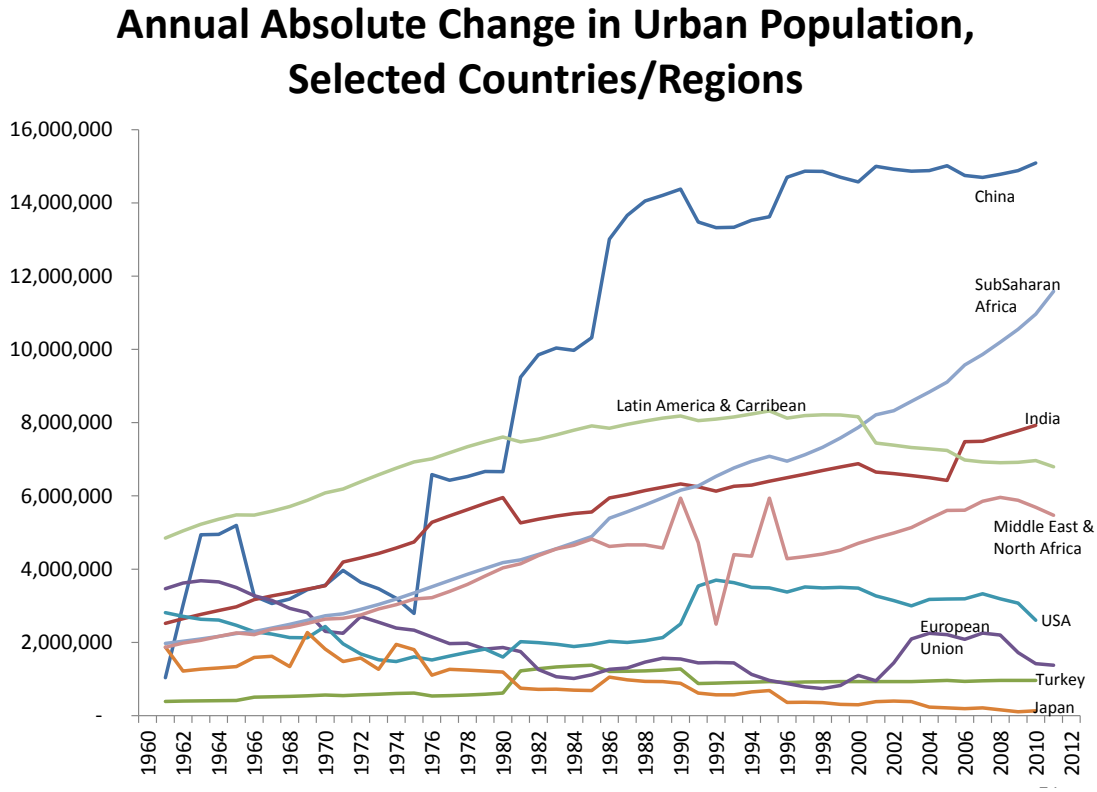
[14] As it happens, world urbanization also recently hit 50 percent.

Figure 17



Given China's above average growth rates, and the now-large base of urban population (around 700 million), over 15 million are added to cities every year according to the World Development Indicators population data (Figure 18). The United Nations *World Urbanization Prospects* database has a broader definition and an annual increment of just over 20 million. The UN's demographers project a decline in both the urban growth rate, and the net annual increment, which will, according to their best forecast, start falling now and stabilize at near-zero growth around 2050, when, according to the forecast, about 75 percent of China's population of 1.4 billion will be urbanized.

Figure 18



According to the estimate of the National Bureau of Statistics (NBS), there have been 132 million rural-urban migrants working in cities in 2006, accounting for around one third of the Chinese urban labor force. Over the next two decades, an additional up to 150 million rural workers are expected to move into the cities. On one hand, urbanization contributed to China's economic development, increasing efficient allocation of resources and information dissemination. China's 11th five-year plan recognizes that urbanization is necessary for stimulating and sustaining growth and a key contributor to alleviating rural poverty. On the demand side, accelerating urbanization will boost the development of the services sector. On the other hand, rapid urbanization challenges government policies regarding infrastructure, land use and housing. Nor is China alone in facing these challenges; according to Angel (2007), the urban population of the developing countries is doubling in 30 years, from 2 billion in 2000 to 4 billion in 2030.

An important and oft-discussed element of China's urbanization is the policy of issuing individuals Hukou (or "huji"), China's household registration system (Au and Henderson 2006; Chan 2009; Huang 2010; Bosker et al. 2012). The record identifies name, family members, birthdate, and your official residence. Many rural-to-urban migrants still hold the hukou from their original village. Without a hukou, access to schools, medical care, etc. is often constrained. Non-hukou holders are sometimes referred to as the "floating population." Recent reform proposals include reform/relaxation of the hukou system (Branigan 2014).

How does this growth break down across individual cities? China has 113 cities over 1 MM population (UN). For comparison, the U.S. has 47. Three major coastal agglomerations have long dominated China's urban landscape, each on a major river. Beijing (and Tianjin), near the Huang He (Yellow) River; Shanghai and Nanjing, near the Yangzi (Yangzte) River; Guangzhou and Shenzen and Hong Kong, near the Zhu JIang (Pearl) River. The largest interior agglomeration is Chongqing. Wuhan, Dongguan and Chengdu are among other major cities.

Figure 19

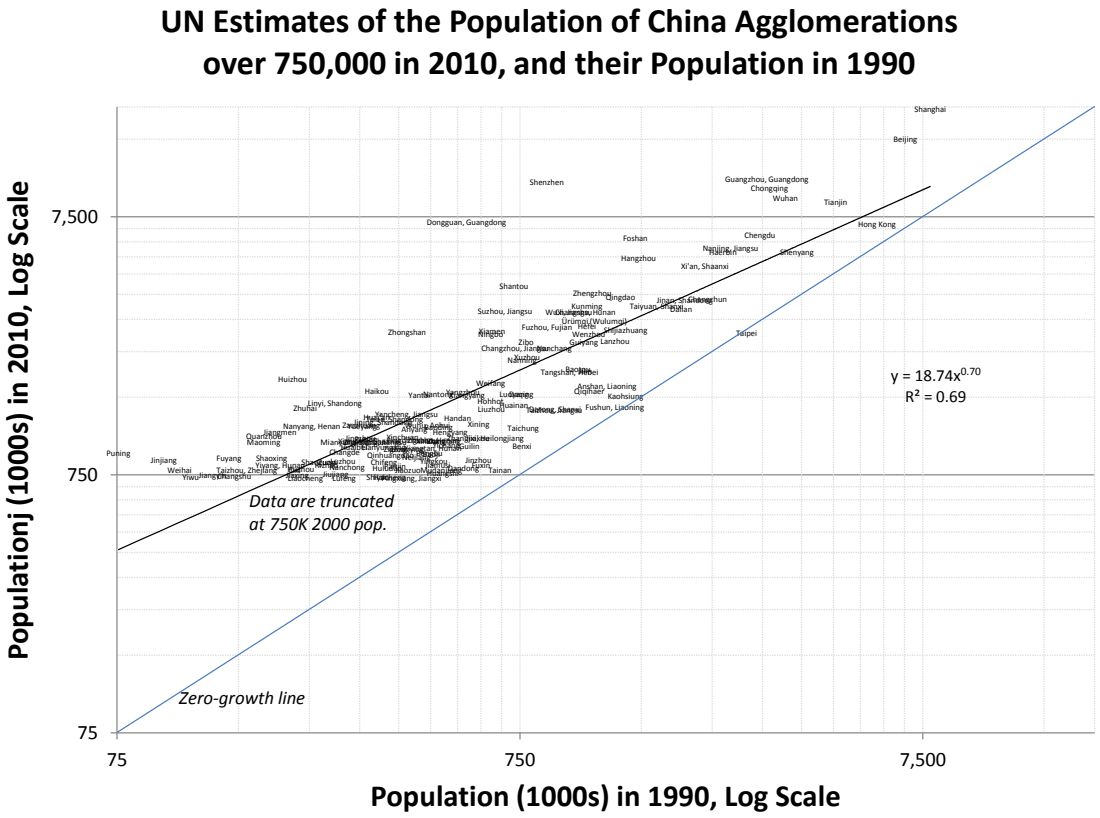


Figure 19 presents UN data on 200 large cities, namely those with 2000 population over 750,000. The double log plot of 2010 population and 1990 population gives a look at both the scale of cities and their growth; a few cities (Taipei, Fushun, Tainan, Kaohslung) are at or near the zero growth line, i.e. where 1990 and 2010 population are equal. Especially fast growing, as measured by the vertical distance from the zero-growth line, are cities like Puning, Huizhou, Zhongshan, Suzhou, Shantou, Dongguan, Shenzen, Guangzhou, Chonqing, Whuan, Foshan, Beijing and Shanghai.

A naïve interpretation of the chart will suggest that it shows faster growth among smaller cities, as the regression line through the cities plotted (and hence the average distance from the zero growth line) flattens as city size increases. But the fact that this is a truncated sample, including only cities over 750,000, makes it difficult to reach any conclusion on this question from this

plot. Other, more detailed studies such as Henderson (2005) suggest that in fact will come in China's many small and medium sized cities.

Other important demographic shifts are taking place in China. More and more young couples choose to not live together with old generations. This change from the traditional extended family also stimulates the demand for housing. Many young families manage to buy a property with financial support from parents and other family members. With increase in income, house consumption rises and people's living condition improves. According to the development review report of NBS published in 2007, the 2006 average living area is 22 m^2 for each person in the city, 3 m^2 higher than that in 2002, a 15.8 percent increase. Housing consumption is 972 yuan per person, 81.3 percent higher than that of 2002. Rural residents per capita living area is 30.7 m^2 in 2006, 15.5 percent increase from 2002.14.7 percent of rural residents enjoy flush toilet, 75.1 percent increase from 2002. 14 percent of rural residents use clean energy, a 51.4 percent increase from 2002. In rural area, residents have more access to clean water. Around 38.8 percent rural residents use tap water, 26.6 percent increase from 2002.The state of the roads also improved a lot. In 2006, 32.4 percent rural residents use cement concrete pavement, 25.8 percent use pavement with flagstones.

Output and Incomes

Figure 20

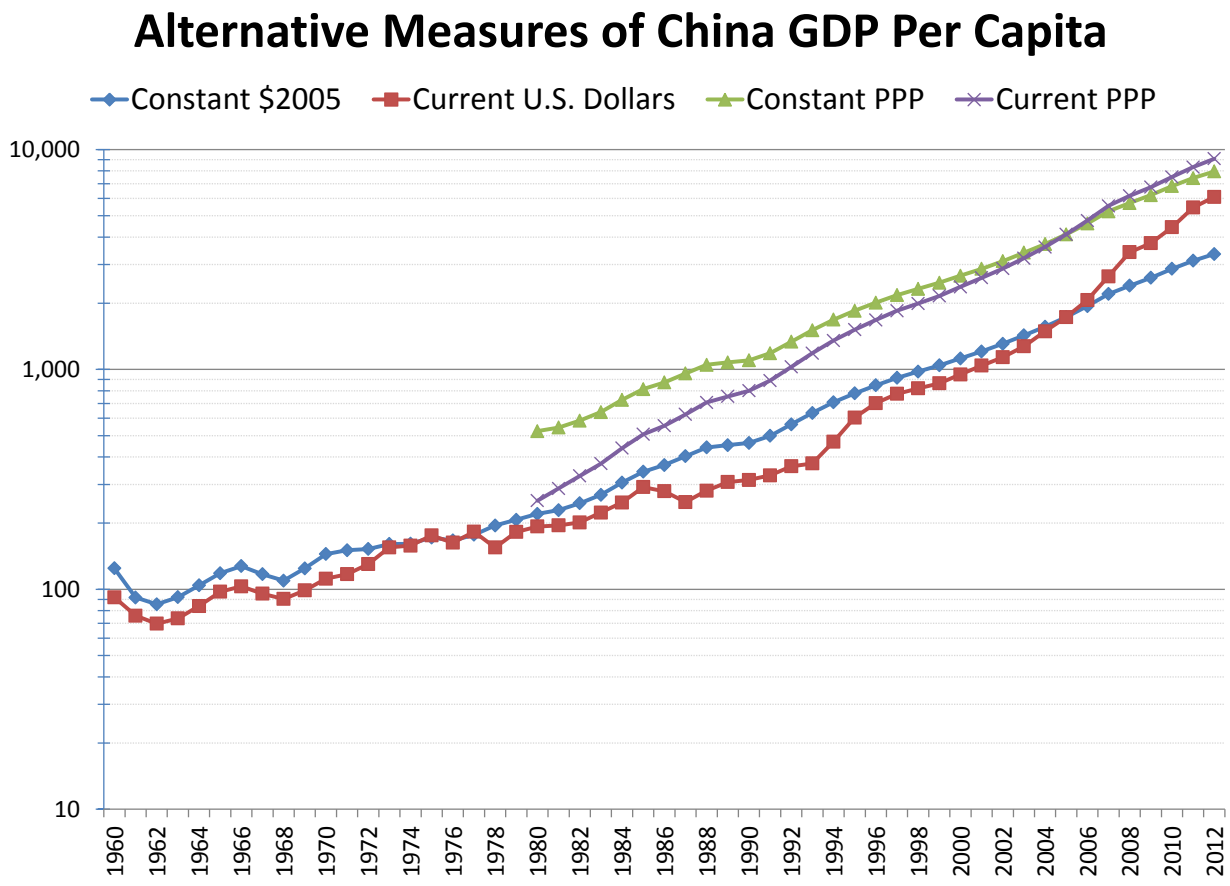


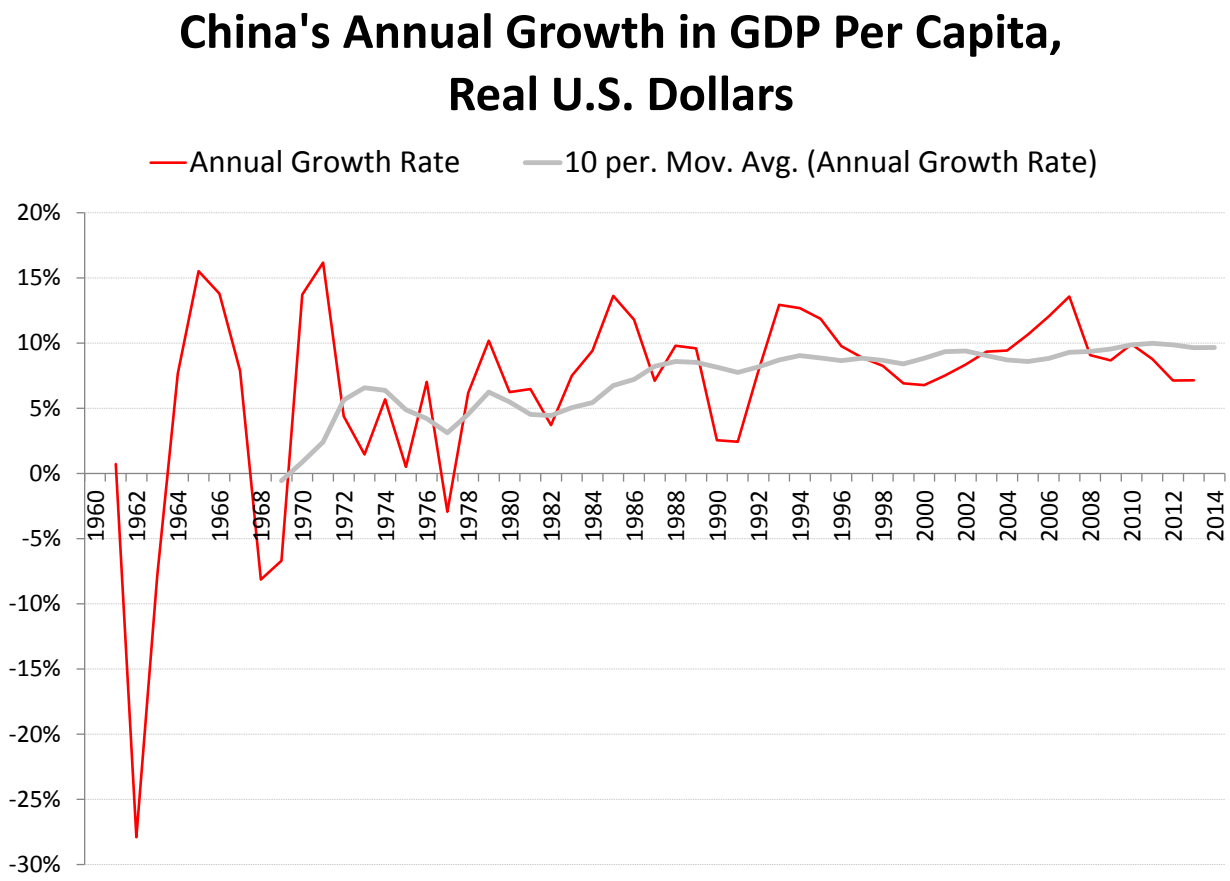
Figure 20 presents multiple measures of economic output (GDP) per capita, including:

- current US Dollars
- constant (real) US $2005
- current "international dollars" PPP
- constant (2005) PPP dollars.

However we measure it, China's economic growth over the past 35 years has been extraordinarily impressive; China has gone from being one of the world's poorer countries to its emergence as a middle income country (albeit, like most countries, a place where poverty remains problematic for some persons and regions).

As all readers know, China has experienced economic boom in recent decade; measured at market exchange rate, total GDP has growth at 10.3 percent in 2010 according to the report by NBS.

Figure 21



However measured, China's real GDP growth rates have been extraordinarily impressive. Growth in real GDP per capita, at market rates, 1990 to date has averaged 9–10 percent (Figure

21). All GDP data are subject to error, China's are especially suspect; but no one doubts that the past several decades have seen extraordinary growth in China's economy.

Growth has been accompanied by gains in (e.g.) life expectancy, literacy, access to water supply and sanitation, better housing, among other accomplishments. Growth has also been accompanied by problems, e.g. declines in air and water quality, and by a more skewed distribution of income. China's reported Gini coefficient has increased from around 0.3 in the early 1980s, to just under 0.5 in 2012; about the same as the U.S., and greater than most other countries at China's level of development. Both growth rates, and distribution, matter for housing markets.

What contributed to this impressive performance? Here we only highlight a few key elements.[15] China's high savings rate/low rate of consumption enables an export led economy. It's obvious that an export based economy must consume a lot less than it produces. Second, as a latecomer to development, China has enormous scope to increase productivity by adopting international standards of technology and business practices. But perhaps most importantly, over the past 20 years there were large gains as FDI streamed in, reforms relaxed central controls in favor of markets, and labor moved from low productivity communes to more productive market-based agriculture (on the one hand) and more productive urban employment (on the other hand).

A brief timeline is instructive. In 1978, two years after Mao's death, Deng Xiaoping and the 3rd Plenum of the 11th CCP Central Committee turned China to economic modernization. In 1979, five years after Nixon's visit, the U.S. and the PRC established diplomatic relations.

After 1947, China's agriculture was communal. Productivity was low in the best of times but the disruptions of the Great Leap Forward and the Cultural Revolution compounded problems. In 1979, the Household Responsibility System was introduced, permitting farmers to work personal plots. Output increased rapidly. Agriculture was about 70 percent of the economy at the time of 1978 reforms, it's about 11 percent today. In 1984, rural communes were disbanded, and replaced with Township and Village enterprises (TVEs).

In 1979 Shenzen became the first of 5 Special Economic Zones (SEZs) that initiated foreign direct investment (much of that initially from overseas Chinese). FDI brought technology and business practices as well as finance.

From the mid-1980s, planning becomes "indicative," price controls on almost all goods and services were relaxed or removed, state owned enterprises (SOEs) were given more autonomy, and other forms of business organization were permitted. (SOEs are now about a third of the economy).

Taken together, these reforms led to the concept of "Socialism with Chinese Characteristics:" organize the economy around markets, but the CCP retains a political monopoly. During this period, China urbanized, making substantial investments in transport and other infrastructure,

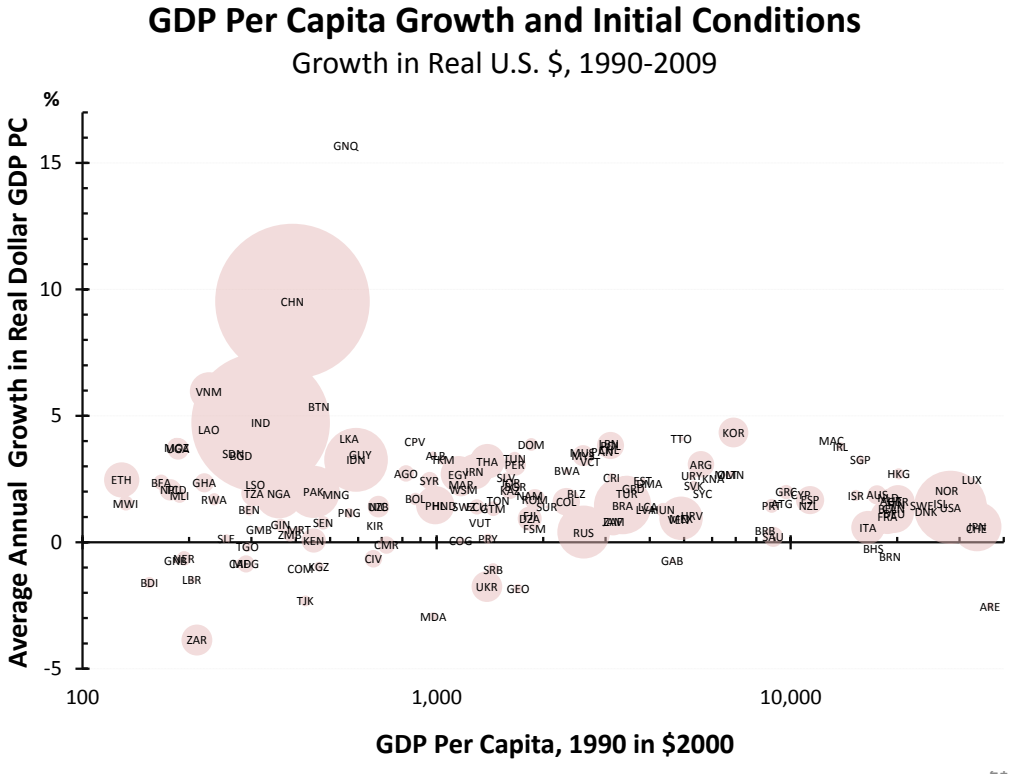
[15] There is an enormous literature on China's general development. We have drawn on, and recommend for deeper reading, Brandt and Rawski (2008), Lardy (2012), Naughton (2007), and World Bank/Development Research Center (2013)

housing and other real estate. Fiscal decentralization began in the 1980s; in 1994 china formalized a two-tier tax collection system.

In many respects 2001 was a watershed year recognizing many of these accomplishments: China joined the World Trade Organization. WTO accession agreement recognized, solidified, and further accelerated the reform process.

Figure 20 is one of many ways we can present China's economic performance in global perspective. This chart plots growth in real GDP per capita against "initial conditions," i.e. the GDP per capita at the start of the period. Each point is represented by a circle whose area is proportional to a third variable, here population.

Figure 22



Several important features of country-specific growth are apparent with even a cursory review of Figure 22. The simplest neoclassical growth models would predict that poorer countries would have higher returns to their scarcer capital; this diminishing marginal productivity of capital (and of skilled labor) would propel higher rates of growth, and poor countries would converge towards the GDP per capita of the rich countries. The data show clearly that, with all countries as the units of observation, convergence is not observed, at least if all countries are weighted equally. The average long run rate of growth of per capita GDP is about 2 percent for rich countries; the average is about 2 percent for poor countries; and the average for middle income countries is, yes, 2 percent.

But these averages mask large differences across countries, especially among lower income countries, where the variance across the two percent average is greatest. The two low income giants, China and India, grow much faster than the country averages, at just under 10 percent for China and just under 5 percent for India.[16]

Gini coefficients collected by the World Bank, IMF and other organizations show that income inequality has been growing in some countries (U.S., UK, and China), flat in others (India, Japan, and Brazil; the latter flat but at a very high level!) and declining in a few (France and Mexico, albeit only recently). But with individuals as unit of observation, world income distribution has been (slowly) converging for decades. Debate exists over the extent and methodology (Bhalla 2002, Chen and Ravallion 2010, Pinkovskiy and Sala-i-Martin 2009), but the qualitative consensus is solidifying.

Figure 23

Examples of Rapid Growth in Per Capita GDP, Followed by Slowdowns

	Year of Break Point	Growth Rate, Prior 7 Years	Growth Rate, Next 7 Years	Difference	GDP Per Capita at Break Point
Austria	1961	6.4%	3.5%	-2.9%	10,293
Chile	1997	6.6%	2.3%	-4.3%	13,726
Greece	1973	7.5%	1.3%	-6.2%	15,480
Hong Kong	1991	5.5%	1.3%	-4.2%	27,273
Ireland	2000	8.3%	4.0%	-4.3%	31,389
Israel	1974	7.6%	0.1%	-7.5%	14,736
Japan	1970	9.5%	2.9%	-6.6%	13,586
Japan	1991	4.3%	0.3%	-4.0%	27,184
Korea	1991	8.7%	2.6%	-6.1%	12,987
Portugal	1975	8.2%	1.4%	-6.8%	10,004
Singapore	1996	6.3%	0.9%	-5.4%	29,369
United States	1998	3.9%	1.4%	-2.5%	19,496

Source: Eichengreen, Park and Shin (2011)

Is China's rapid, near double digit growth sustainable going forward? This is a hotly debated question. Eichengreen, Park and Shin (2011) have categorized a number of countries that have experienced periods of high growth, but noted that these have generally been followed by long run declines. Figure 23 presents a selection of their data. Our paper does not directly address this

[16] The outlier with a 15 percent growth rate, labeled GNQ, is the small country of Equatorial Guinea, which has recently developed an oil industry. The area of the circles around each country's label is proportional to the country's population.

question, but of course it has a direct bearing on the future of China's housing market. The recent World Bank/Development Research Center report on China to 2030 provides one road map for a pivot from export led growth to an economy driven by domestic consumption, and from an economy that, on the margin, is driven by manufacturing, to one that also delivers world class services.

Overview of China's Housing Markets and Policies

As we wrote successive drafts of this paper, public frustration in China regarding skyrocketing housing costs grew. [17] In response, the Chinese government started a massive public housing program. In 2011, the government started the construction of 10 million units and vowed to build 36 million affordable housing units until 2015. In 2012, the government allocated more than 20,000 hectares of land for low-income housing, according to the Ministry of Land and Resources. Understanding China's regulatory environment requires some context. The following sections review housing policies and housing market finance in China.

History of the real estate market in China

In the centrally planned-economic system, in place from 1949 to 1978, private housing developers were nearly non-existent in China. The state implemented a public housing allocation system, under which the government or the work unit (*danwei*) takes the responsibility of construction, allocation, management and maintenance of properties. Housing was viewed as welfare good to be delivered through central planning system, rather than a commodity, and an important part of the system of in-kind compensation sometimes referral to as the "iron rice bowl". Workers enjoyed various levels of housing according to their official ranking, seniority, working experience and so on. Under the original system, the entire population suffered from a short supply of housing. In 1978, the per capita area of housing for urban residents in China was only 6.7 square meters. The first national urban housing survey conducted in 1985 included 26 million households. It revealed that over 28 percent of households experienced serious housing problems: 870 thousands were classified as homeless (no home after marriage, living in non-housing buildings or living with relatives); over 3 million lived in very crowded conditions with the whole family in one room or two families in one room; another 3.5 million had less than 4 square meters average floor space per person (State Statistics Bureau, 1989).

To meet the dire needs of Chinese residents for housing, the government launched a series of housing reforms step by step since the 1980s.The most important step was announced in *Notice of Further Deepening Housing System Reform and Speeding up Housing Construction* (No 23 Document) (State Council, 1998), which ended the direct public housing distribution by all work units. Under the new regime, approximate 70 percent urban households were expected to buy Economical Comfortable Housing (ECH) (*jingji shiyong fang*) which would be developed with public financial support. Fifteen percent of low-income families could apply to rent Low-Rent

[17] For example, see Esther Fung, "Rising House Prices in China Spark Concern," Wall Street Journal, August 18 2013, http://online.wsj.com/news/articles/SB10001424127887324747104579020081653354284; Simon Rabinovitch, "China: A Place to Call Home—Beijing's programme to build 36m affordable homes is failing to cool the red-hot property market." Financial Times, October 20, 1013. http://www.ft.com/cms/s/0/5d050ce4-37d6-11e3-a493-00144feab7de.html#axzz2ot3G5fYU

Housing (LRH) (*lianzu fang*) which together with ECH formed a new social housing system. The fifteen percent highest income urban households were encouraged to obtain high standard commercial housing through the market.

Logan, Fang and Zhang (2009) present evidence that in pre-reform China, individuals of higher socioeconomic and political status had privileged access to good quality, low cost housing. China was not the only socialist country to allocation housing in this way. Daniel (1985) is an early and representative study in this case of Hungary. Logan, Bian and Bian (1999) showed that housing was also allocated partially to senior officials and managers through a continuous process of bargaining for larger and better housing quality. Income, education and party membership also had positive effect on the size and quality of housing. Those with good social status benefited in two ways: first, they obtained better housing and more subsidies under the old welfare system, which enabled them to sell a good property at a good price after the reform; secondly, they had priority and more money, and easier access to the market housing after the reform.

Despite the remarkable changes due to these reforms, the poor marketability of the old housing stock resulted in a thin resale market. One reason was the partial property rights in privatized work-unit-provided dwelling units. The owner is required to sell their home to their work unit below market price if they would like to liquidate their home equity, or to share resale profit with their work unit. Moreover, resale market institutions are under-developed. Two other major obstacles to consumer demand for commodity housing are high prices relative to average income of urban households, and lack of mortgage lending to individuals (Deng and Fei, 2008). In 2008, the housing price to income ratio in China was above 10, well above international norms (Renaud 1989a). However, the commercial housing market in major cities of China still keeps overheating in recent years due to increasing demand and limited land supply. More and more population moves into cities for the diversity of life, a good education, and better job opportunities. Under the unique household registration (*Hukou*) system, each individual in China is classified as holding rural or urban household status, which embodies a sharp differentiation of rights and privileges. Thus, many rural residents, especially those with better education or some wealth aspire to move to major cities and obtain urban household status, which drives no small part of the demand for housing in urban area. One tradition in China is that parents save over a lifetime for their children's marriage and housing purchase; the one-child policy and other demographic shifts may have slowed population pressure but may also have increased the available resources to at least some young households. Young residents in urban cities then often obtain substantial financial support for their mortgage payment from parents. Housing market demand may be much stronger more in the major cities in China compared to less developed area.

China's Mortgage Market

China's housing finance system revolves around two key institutional features, a mandatory housing saving system called the Housing Provident Fund (HPF), and a mortgage market made by commercial banks.

The HPF systems require employees to contribute a proportion of their income to the fund each month, and employers match the contribution. The fund is deposited in a commercial bank

account. The Housing Provident Fund Management Center in each city manages the fund, under local control. The HPF is a low cost mortgage, but limited to employees. It is usually not sufficient for most families to purchase a house. Deng and Fei (2008) report that most urban home buyers borrow from a commercial bank, with a maximum loan to value ratio 80 percent; the HPF loan is often used to cover the down payment.

China has not developed its secondary mortgage market which could be integrated to capital market. The primary mortgage market are dominated by four state-owned commercial banks: the Industrial and Commercial Bank of China (ICBC), the Bank of China (BOC), the China Construction Bank (CCB), and the Agriculture Bank of China (ABC).18 The first mortgage loans were offered by China Construction Bank in 1986. People's Bank of China (PBoC, the central bank) published the Residential Mortgage Lending Regulations in 1998 which set the framework for China's mortgage market. The mortgage rate is set by PBoC and applies to all borrowers. Any rate adjustment set by the central bank will be applied to all existing mortgage loans starting from the beginning of the following year. Thus, refinance-driven prepayment is rare in China. Since the housing finance system is dominated by state-owned banks, the government could intervene significantly in housing sector. In response to the Asian economic crisis circa 1998, PBoC adjusted down the mortgage interest rate five times. The annual mortgage rate published by PBoC in December 2010 range from 5.8 percent to 6.4 percent, while the inflation is then reported as 4.6 percent (NBS). With limited alternative investment opportunities, mortgage borrowers in China often choose to prepay their mortgage loans when there is an increase in mortgage rate. For instance, the low level of interest rate on bank deposits discourages people from saving. According to a survey conducted by the Chinese Central Bank in 2006, the average mortgage payment accounts for 35 percent of a buyer's income, and more than 35 percent of the buyers paid back their loans ahead of the term. The China Construction Bank successfully issued mortgaged-back securities around 2007, but the secondary mortgage market has not been developed further due to the influence of the global financial crisis.

Recent Policy Initiatives

Note that the data we presented above showed that prices were rising despite government introduced market-cooling measures as far back as April 2010. The campaign intensified in 2011 when the following policies were announced:

- The down payment for first-time buyers' mortgages was increased to 30 percent from 20 percent, while for second homes down payment rose to 60 percent from 50 percent.

- Mortgages for third home purchases were prohibited.

- There were limitations on home purchases in more areas, credit-quota limits and higher benchmark lending rates.

[18] The four banks are all supervised the central bank of China PBoC, and report directly to the State Council of China. In total they account for over 90 percent of the commercial mortgage market share.

- New property taxes were introduced in Shanghai and Chongqing — between 0.4 percent and 0.6 percent in Shanghai, and between 0.5 percent and 1.2 percent on luxury homes and newly purchased high-end homes in Chongqing, plus a special tax on second home purchases by people with no business or employment interest in the city.

- In early-2011, Beijing also banned property purchase to those who have not lived in the city for five years, limited the number of homes a native Beijing family could own to two, and allowed only one home for non-native Beijing families.

- Mortgage discount for first-time homebuyers was eliminated.

- The benchmark interest rate was raised to 6.56 percent in July 2011, the third interest rate hike last year.

While central government housing market policies have evolved over time, real estate market statutes vary across geographic areas in China as well. Local government has a certain degree of freedom on residential real estate policy design and has released a number of temporary or short-term statutes to target local markets' issues, which in turn affect local housing market conditions through both supply and demand channels. For example, from the demand side, high local taxes on second-hand non-primary resident property transactions and cap on properties per household discourage investors' incentive to invest in real estate. From the supply side, restrictions on land use are designed to slow down real estate developments. The effectiveness of such policies is largely an empirical question. In this study, we construct a provincial level regulatory index using a novel dataset on local real estate statutes, which enables us to provide more insights on the above question.

Data and Descriptive Analysis

Our basic dataset is a panel we have assembled for 35 cities comprising quarterly data from 2000 to 2011. In this section we will present selected variables and summary statistics. Our full dataset is available upon request, and will be posted on our website upon completion of the project.

The Basics: Population, Income

Table D1 in appendix D begins with population. City populations for 34 of our 35 cities are from the United Nations *World Urbanization Prospects*. The UN provides city population for years 1995, 2000, 2005, 2007 and 2010; we interpolate our quarterly data assuming constant growth rates between these periods. The 35th city, Haikou, is the capital city of Hainan province; its population was too small to be included in the UN dataset. We obtain the city population of Haikou from the local government website and used the provincial growth rate as a proxy temporarily; we have recently obtained a new, larger dataset from the UN that includes annual data for a larger number of cities, including Haikou. We'll use the new data in our next round of estimation, but it's unlikely that this improved data will change the results qualitatively.

Table D1

Quarterly per capita disposable income data for our 35 cities is from NBS as well. NBS publishes mean values of income in each city, calculated from large household surveys. These survey data are compiled from diaries of income and expenditures kept by sample households. The diaries are kept by a household member year round with assistance from NBS enumerators who visit the household periodically. NBS per capita disposable income includes income from wages, business earnings, interest, and transfer payments, less tax and social insurance contributions. It excludes proceeds from loans or sale of personal items.

Income and housing price data are adjusted for inflation in our analyses. The inflation proxy is the monthly CPI for each province published by NBS. In total there are about 600 "national items" used for calculating the all-China CPI. The list of items is revised annually for representativeness based on purchases reported in the household surveys. The number of items can change from year to year, but rarely by more than 10 in any given year. Prices are collected in 80 counties and 146 cities. We matched each city's house price and income data with its corresponding province.

Other City Characteristics

To study the determinants of the supply elasticity, we obtain a number of other city characteristics, some from NBS, others from UN, World Bank, and other sources. These include the geographic attributes, climate measures, air quality, land usage and water usage for each city in our sample. For cross sectional NBS data, we use 2008 statistics, which are the most recent available to the public on the NBS website as of our data collection effort.

Table D2

The variables in Table D2 of appendix D include the latitude and longitude of each city; dummy variables for whether the city is in a mountainous area, or on the coast; a measure of air quality, per capita water sources; the city's population density; and distance to the ocean.
Next we will discuss four "policy indexes:" one based on city "tiers" from Jones Lang LaSalle, and three constructed by us from NBS survey data. Because measuring the policy environment is so central to our study, we will discuss these policy indexes in some detail.

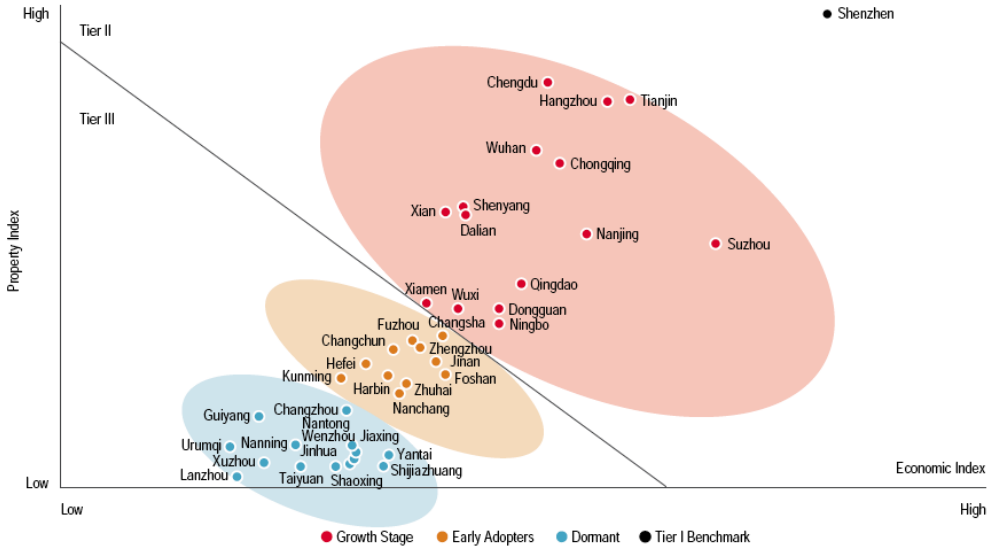
City "Tiers"

Private real estate and economic analysts often refer to Chinese cities as "Tier 1," "Tier 2," "Tier 3", and so on. While widely used, there is no such official categorization, or precise definitions.[19] Several marketing firms and economists issue such lists; generally Tier 1 cities include, at a minimum, Beijing, Shanghai and Guangzhou; usually Shenzhen and sometimes Tianjin are also included. Tier 2 cities are often provincial capitals. Most categorization systems also include Tier 3 and Tier 4 cities, or something along those lines.

[19] See, for example, a recent Wall Street Journal blog entry, What Makes a Tier-2 City in China? Count the Starbucks, at http://blogs.wsj.com/chinarealtime/2014/04/16/what-makes-a-tier-2-city-in-china-count-the-starbucks/ .

Figure 24

Figure10: The Taxonomy Curve of Major Cities in China



Source: Jones Lang LaSalle

The x-axis is the economic index and y-axis is the property index. The two indexes are constructed based on local economic development conditions and property market conditions. Cities are located in the two dimensional space according to their index value. Shenzhen is the bench mark tier I city in this graph. The pink area covers cities in Tier II and orange and blue area covers cities in Tier III.

We use the categorization as provided by Jones Lang LaSalle Greater China (JLL), a well-known real estate service firm. Figure 24 presents a chart of their categorizations, along with two indexes they use to sort cities into the categories. Based on the JLL report, we categorize our cities as follows:

- Leading Group (Tier 1): Beijing, Shanghai, Guangzhou, Shenzen
- Growth Cities (Tier 2): Dalian, Nanjing, Hangzhou, Ningbo, Xiamen, Qingdao, Wuhan, Chengdu, Chongqing, Xi'an, Tianjin, Shenyang
- Early Adopters (Tier 3): Changchun, Harbin, Hefei,, Fuzhou, Nanchang, Jinan, Zhengzhou, Changsha, Haikou, Kunming
- Dormant Group (Tier 4): Shijazhuang, Taiyuan, Hohhot, Guiyang, Lanzhou, Xining, Yinchuan, Urumqi

JLL's tiering system is based on the combined current levels of economic and real estate activity in the main property sectors. They analyzed 275 cities based on a range of demographic, economic, business, infrastructure, technological and labor market factors. The economic index

indicators include the following dimensions of a city: population, nominal GDP, disposable income, FDI, airports, ports, higher education, and quality of business environment. The property index was based on the presence of multinational corporations (retail chains, banks etc), international real estate developers and hotels, and internal/external surveys. The top 100 highest-scoring cities were then positioned on Jones Lang LaSalle's City Evolution Curve (Figure 24) which summarizes their analysis by combining the independent variables into a property market index, and an economic development index, which are mapped on the vertical and horizontal axes, respectively.

JLL forecasts that by 2020, the key Tier 1 cities would account for only 10 percent of China's commercial real estate activity, which serves to highlight the massive opportunities in other cities over the coming decade. In their report titled *China 40: the Rising Urban Stars*, they highlight 40 Tier 2 and Tier 3 cities with, in their opinion, the greatest potential to place them on the radar screen of occupiers, investors and developers. While we will not rely on this ranking exclusively, we believe it is an interesting first cut at how to categorize China's cities.

Our own method of categorizing cities revolves around constructing indexes of the regulatory environment for urban real estate in China, and to this we now turn.

Real Estate Regulatory Indexes

To capture the characteristics of regulatory policy and their impact on housing market, we construct several indexes of real estate regulation, and use them to test the effect of regulatory environments on the residential supply elasticities we estimated in the previous section.

In this section we describe our measures of the regulatory environment for 35 Chinese cities. We start with 38 questions, translated and presented in Appendix I. Eleven of these questions are questions we view as reasonable proxies for real estate regulation, namely:

- Q1_N_Statute='Number of Statutes'
- Q2_Statute_Date='Last Statute Date'
- Q3_Stat_per_Yr_pre_05='Average Statutes per Year Pre 05'
- Q4_Stat_per_Yr_post_05='Average Statutes per Year Post 05'
- Q5_Market_Reg='Statutes on Market Regulating'
- Q6_No_of_Reforms='No. of Housing Reform Statutes'
- Q7_No_of_Price_Regs='No. of Market Price Regulation Statutes'
- Q8_No_Urb_Con_Redevelop='No. of Statutes re. Urban Construction/Redevelopment'
- Q9_No_Home_Assoc_Mgt='No. Statutes Urban Construction Redevelopment'
- Q10_No_Fin_Reg='No. Statutes Finance Regulation'
- Q11_No_LU_Regs='No. Statutes Land Use Regulation'

Two of these (questions 3 and 10) have no variation across our cities, and are dropped from the analysis.

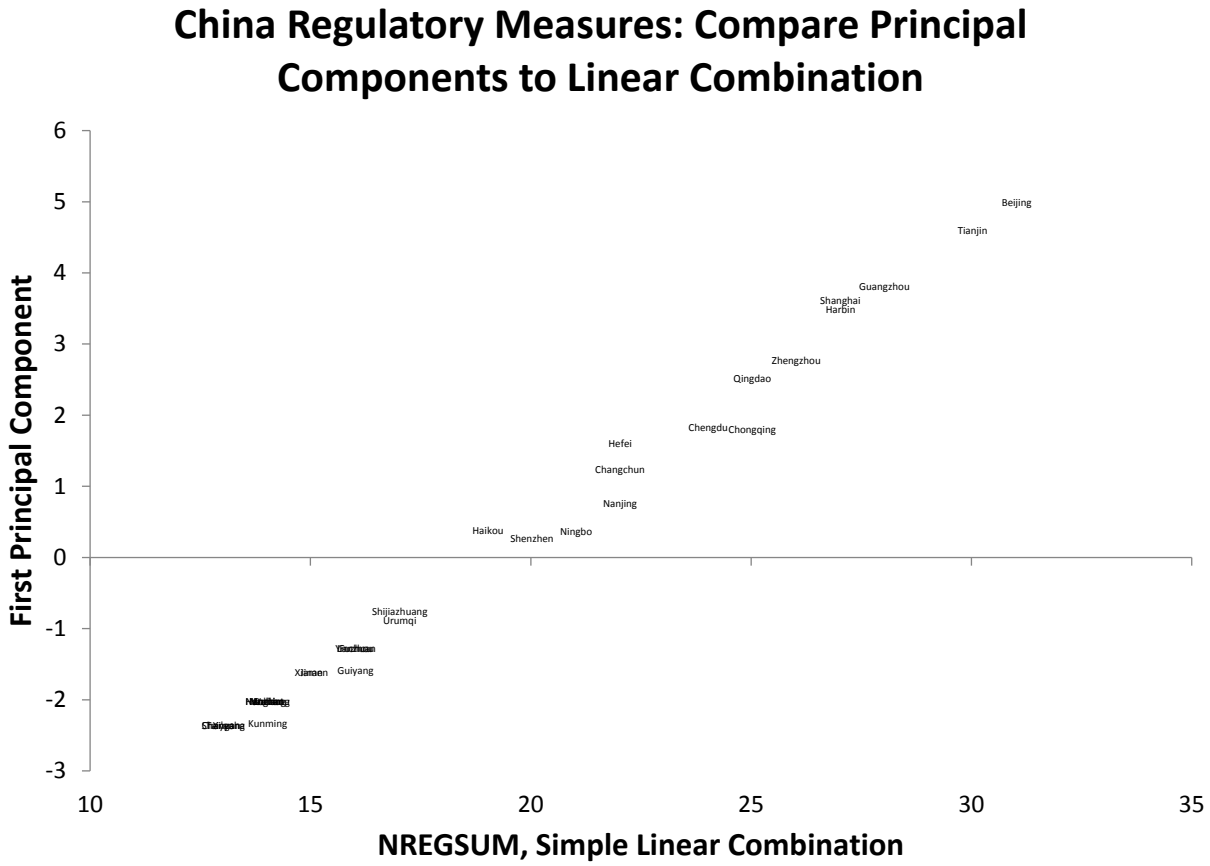
With only 35 cities, and other variables to consider, we need some method of reducing this data into an index. First, following Malpezzi (1996) and Malpezzi and Ball (1993), we construct a

simple linear combination of these nine questions, called NREGSUM. For comparison, we also use principal components to reduce these questions but without imposing the more restrictive additive structure. We extract three linear combinations of the variables for testing. These are denoted CREG1, CREG2 and CREG3, respectively.

Table D3

We also construct ENVIROADD, a measure of environmental-related infrastructure, based on: (1) the number of new sewer systems underway or in planning stages; (2) an indicator for quality and reliability of power supply; (3) an indicator for safe and efficient gas supplies; and (4) whether there is a local statute encouraging the development of more efficient heating systems.

Figure 25



As Figure 25 illustrates, the first principal component extracted from the data is very similar to the simple linear combination.[20] According to these measures, Beijing, Tianjin, Guangzhou and Shanghai are the most stringently regulated cities. Taiyuan, Shenyang, Changsha and Xi'an are the most lightly regulated, according to our measures.

[20] Using very different data, Malpezzi (1996) and Malpezzi and Ball (1993) also found that the simple linear combination and the first principal component of regulatory measures yielded similar results.

Despite the number of questions, clearly our measures are constructed from a reduced information set. There are literally hundreds of individual regulations and possible candidate measures. The maintained hypothesis of this study (as in all studies that construct such indexes) is that there will be some correlation between included and excluded measures, and the measures presented are a latent variable for some unobservable "regulation." *Coefficients of the models below should not be taken literally as the exact partial effects of individual components*.

Another caveat stems from the aggregation necessary to construct such city-level indexes. In fact, most land use and other development regulations are undertaken at a much more local level. But Lenon, Chattopadhay and Heffley (1996) and Brueckner (1998) argue that the regulatory decisions of small governmental units will be partly determined by the decisions of neighboring units; while not, to our knowledge, tested outside of North America, this idea is consistent with theories of spatial aggregation and suggests that a metropolitan level measure, while far from perfect, can be informative.

These data are based on a review of statutes from the 35 representative cities in this database. The answer for each question is based on the terms in each city's statutes. Another characteristic of our indexes (and again, of many other indexes in the literature) is that they rely on laws and regulations as written. Enforcement practices also matter, and they can vary (Kaufmann and Kraay 2008; Alston, Harris and Mueller 2009). On the other hand, this approach may reduce other biases from subjective questions asked of a wide range of respondents, which have created difficulties for some other attempts at policy measurement (Angel and Mayo 1996).

Most answers to the questions are in rating scales. The survey does not include any open ended questions. The sample survey questions, indexes construction methodology and various indexes estimations are reported in the Appendix.

Housing Prices

Of course, another central variable in our analysis is our measure of housing prices. In this paper we use NBS indices of the selling price of residential real estate, a weighted average of the selling price indices of newly built and second-hand residential buildings. Appendix 1 provides additional detail on how NBS collects this variable, and briefly compares it to some alternative measures. The original series is provided as an index number for each city, with 2000Q1 equal to 100; this index allows us to track each city's price over time, but does not provide information on place-to-place differences. Separately, NBS provides us housing sale price level data for a single period. Thus we use 2008 data to fix the place-to-place differences, and the quarterly changes in the index numbers to calculate levels before and after that date, in RMB per square meter. Table D4 presents selections from this data.

Table D4

These housing price data are far from perfect, as Wu, Deng and Liu (2013) have discussed. We make three simple points about data quality.

First, our purpose is not to forecast housing prices exactly, but rather to examine the relative supply responsiveness in markets within China, including how those supply elasticities vary with determinants such as geography and regulatory environment. We would prefer to have high quality constant quality indexes, of course; but as long as there is signal in the NBS indexes—and studies like Wu et al. suggest there is—then we should obtain results that we can rely on at least qualitatively.

Second, we note that no country, developed or emerging, has perfect price indexes. Malpezzi Chun and Green (1999), for example, finds that while hedonic price models are superior to simple median house values, the latter are fairly well correlated with the former.
Third, these data problems in China may well be worse than in the U.S., to date; but we can expect that over time house price data (and other data) to improve.

Descriptive Statistics of Housing Prices by City Type

Before modeling, we present simple time series plots of real house prices, by our version of the Jones Lang LaSalle categorization of cities. Recall from above that Tier I cities comprise of the cities of Beijing, Shanghai, Guangzhou and Shenzhen. Tier II cities correspond to cities in the 'Growth' stage and Tier III correspond to cities in the 'Early Adopter' and 'Dormant' stages (see Figure 24, above). Cities can move between tiers as market circumstances change. For example, Ningbo moved from a Tier III to a Tier II in 2009 to reflect increasing levels of real estate activity.

The China housing market has experienced a dramatic price jump in the past years. Due to low interest rates, prices in Shanghai and Beijing doubled in less than four years, and then doubled again. Most Chinese home buyers expect that today's high prices will climb even higher tomorrow, so they are stretching to pay prices at the edge of their means or beyond.

For many people—especially the young or people moving to the cities from rural areas—the dream of owning a home is more and more difficult to attain. The Xinhua news agency quoted Goldman Sachs as saying that housing price increases had outpaced wage hikes by 30 percent in Shanghai and 80 percent in Beijing in recent years. Our data shows the trend of the property price for the 10 years from 2000Q1 to 2011Q1. We will see that, unsurprisingly, the highest property prices are for the leading cities such as Beijing and Shanghai.

Figure 25 — Tier I: Lead Cities

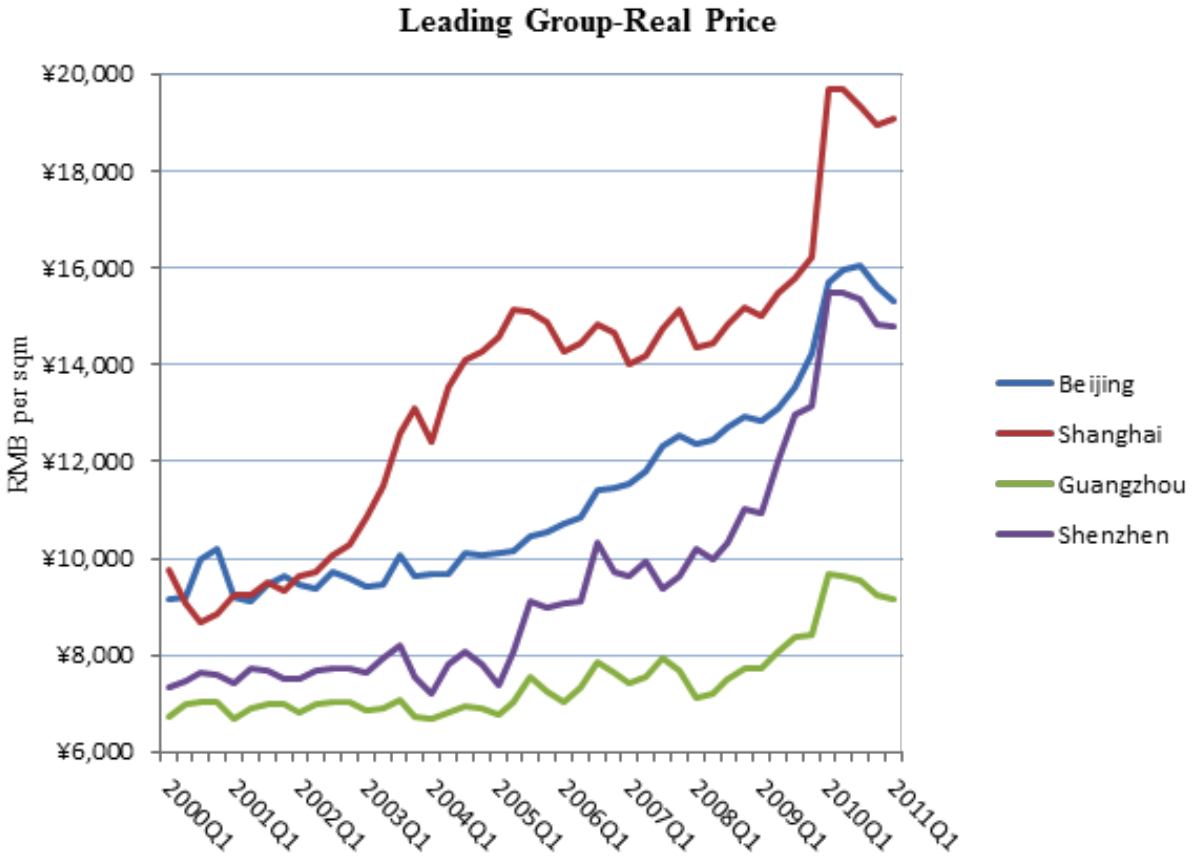


Figure 25 exhibits the house price level over time for the lead cities in China. The Y-axis is housing price per square meters in RMB. What we can see is that all big cities are experiencing price increasing between 2000 and 2011.

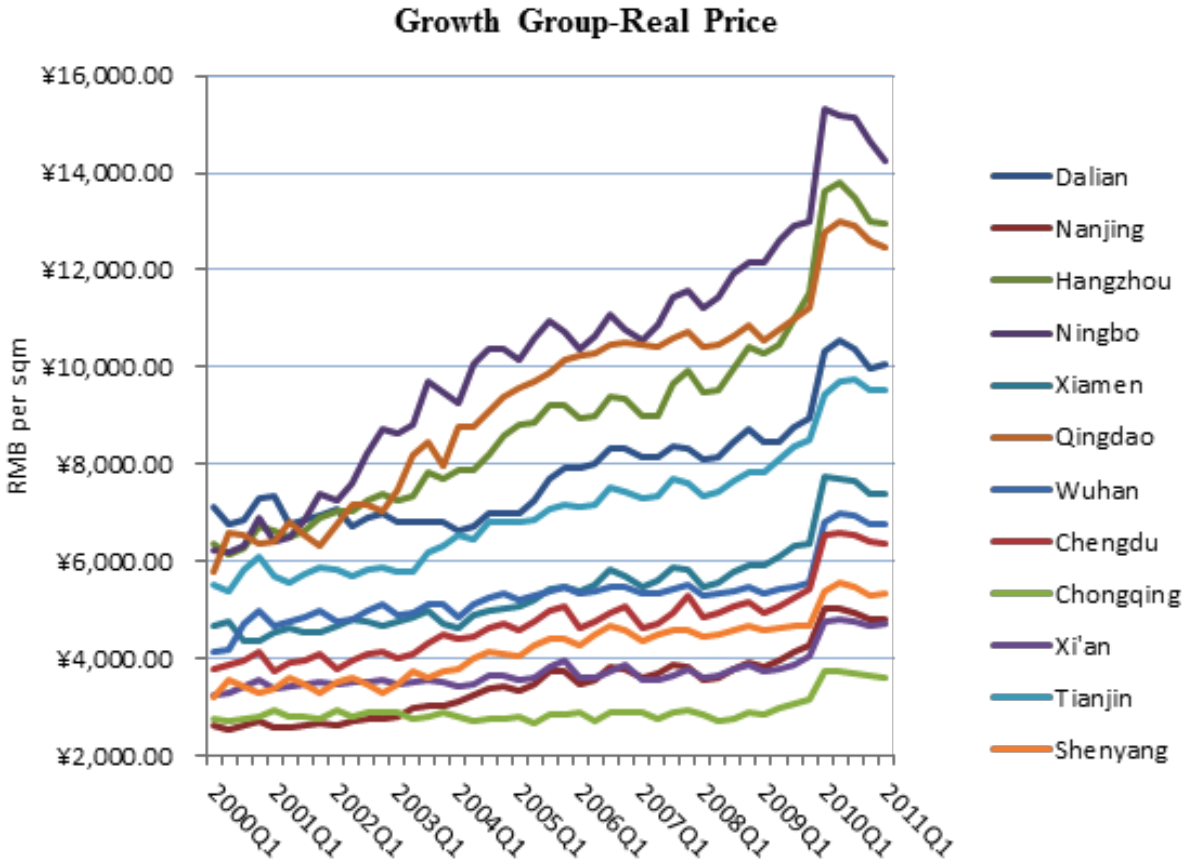
Shanghai is firmly established as China's most international city and attracts both domestic and international investment. Job opportunities and high economic development lead to a significant amount of labor flow into the city and create a high demand for the property in Shanghai both residential and non-residential, which contributes to the leading price level of Shanghai in the whole country. Strong investment demand in Shanghai also contributes to the high price.

Beijing is unique in the sense that it is not only the nation's political, cultural and technological hub, but also the main headquarter location for China's large and expanding corporations. Its real estate market is shaped by the rapid growth of domestic companies and immigrants.

The lead cities all have location advantage and important economic roles in their region. For example, Shanghai is the leading city for the Yangtze River Delta, Shenzhen and Guangzhou for the Pearl River Delta, and Beijing for the Bohai Bay region. Among these cities, Shanghai is characterized by faster growth than other lead cities; it is widely viewed as the most developed city economy, and is particularly attractive to both domestic and international investors.

When we look at the distribution of the prices over time, we can see there is a price drop in 2007 after continuous price increases for 7 years. The drop of price in the middle of 2007 was apparently triggered by the Central Bank's policy release announcing more strict control of the residential mortgage market in September. According to China Banking Regulatory Commission(CBRC) Notice (2007) 359, households must make down payments greater than 40 percent of house value for the second house financing; greater than 30 percent for first house financing above 90 square meters; and greater than 20 percent for first house financing below 90 square meters. These steps had a direct impact on the trading of housing in the late 2007, resulting in an immediate price drop.

Figure 26 — Tier 2: Growth cities



Most of the growth cities (Figure 26) have similar patterns: they experience house price growth from 2000 to 2011. The entrance of international and domestic banks, manufacturing firms, retailers and hotel operators has created strong demand in real estate markets. Many international real estate advisors and consultancy firms are planning to or have already opened offices in these cities.

The cities experienced significant price increases are Tianjin, Hangzhou, Ningbo and Qingdao. As the leading Tier II Tianjin has received enormous attention as a result of the development of its Binhai New Area. FDI in Tianjin has continued to climb and reached USD 5.3billion in 2007, the third highest amount in China behind Shanghai and Suzhou. Besides, it also has efficient

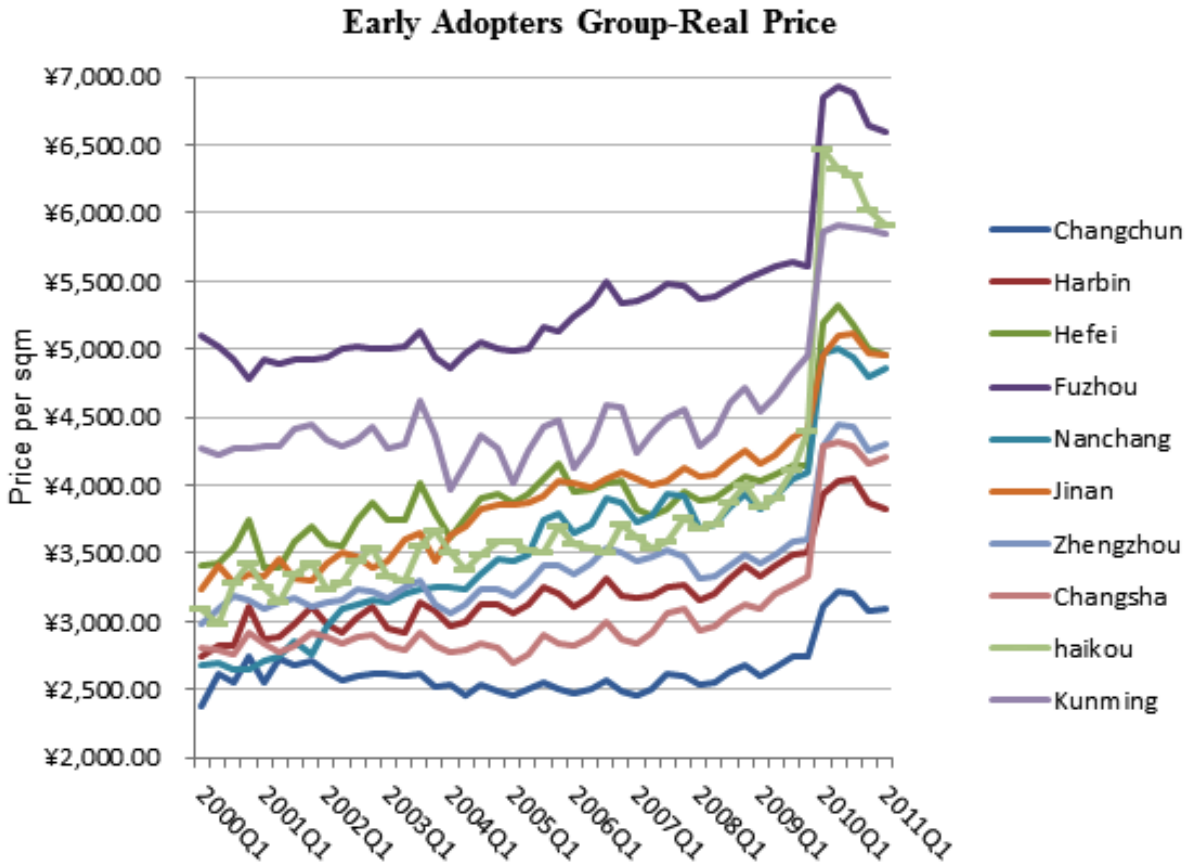
transportation links and good access to skilled labor make them attractive locations for the manufacturing and logistics sectors. Being closely neighboring with Beijing, the property price in Tianjin has increased partly due to the roaring of price in the capital. In the 11th Five Year Plan (2006–2010) by the government, it proposes the aim to reposition Tianjin as the 'economic centre of north China', and accelerate development and openness of new business areas such as Tianjin Binhai New Area. All of these contribute the price increase in Tianjin.

Hangzhou is convenient to Shanghai and famous for its west lake. With amiable weather and beautiful scenery, Hangzhou is known as one of the best places to live in China. It has also been a paradise for property developers and investors in the past few years as property prices have gone through the roof. The price of Hangzhou is largely affected by the high price in Shanghai and especially for its lake-view luxury residential apartments.

Ningbo, China's second largest port, is now connected to Shanghai by the Hangzhou Bay Bridge. The port has been rapidly expanding and maximizing its strategic position near to Shanghai. By 2012, the number of TEUs (standard containers) handled is expected to reach 20 million, which would make the port one of the largest in the world. With development costs approximately 30 percent lower than Shanghai, Ningbo will remain an attractive location for logistics operators for some time. The great location and cost advantage makes it good alternative for investors who wants to invest in Shanghai.

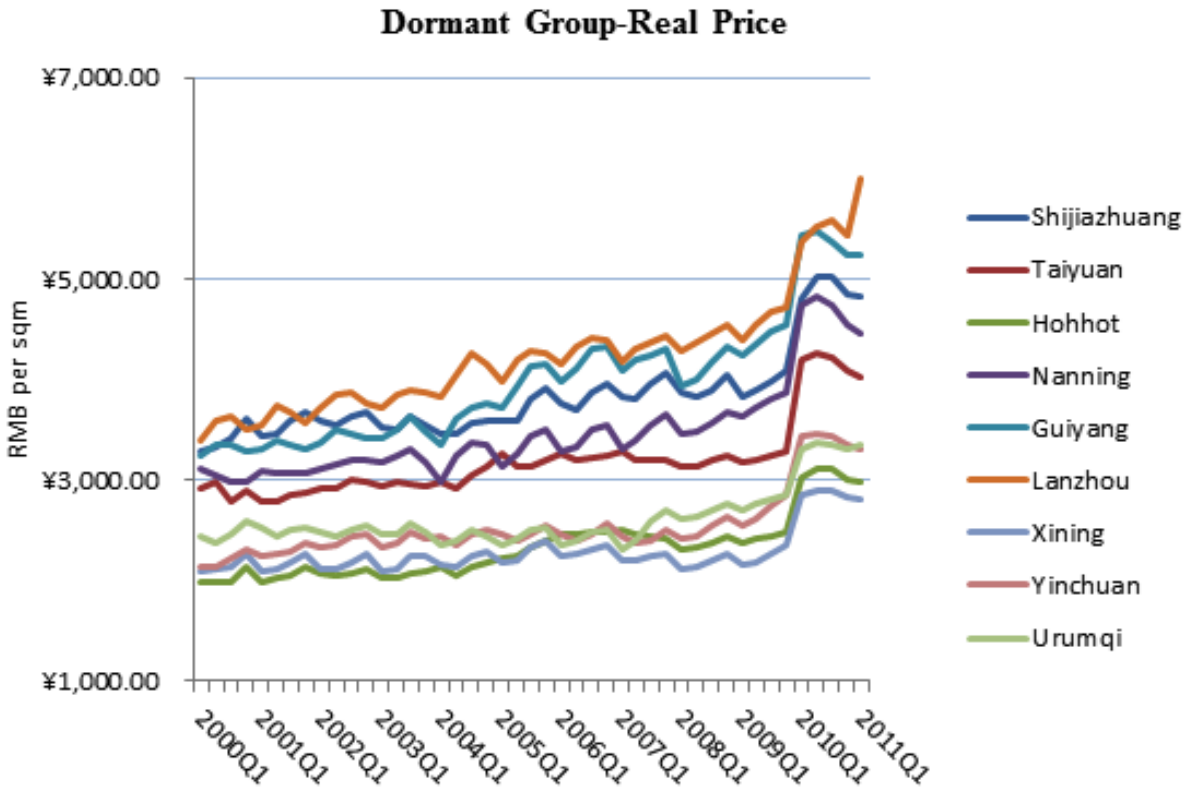
Qingdao possesses significant logistics potential due to strategic location, access to a large population base and their growing roles as port or railway hubs. Besides, the city benefits a lot from its coastal location, which attract a lot of external residential investors. Qingdao's property prices are almost on a par with Guangzhou, but the average income of salaried workers in the city is just half that of the capital of Guangdong Province.

Figure 27 — Tier 3: Early Adopters



For early adopter cities (Figure 27), the house price change is relative stable compared to the previous groups. The reason for those lagged price increase may be that house prices in early adopter cities are more restricted by local low income and lower demand compared lead and growth cities. Since the previous two groups are much more attractive for new residents due to convenient life, more working opportunities, high income, good medical care and education system, the early adopters do not have such great potential demand for house. So the price level is lower and change slowly.

Figure 28 —Tier 4: Dormant cities



Dormant cities (Figure 28) are most central and western cities, such as Yinchuan, Lanzhou, Urumqi and Zhengzhou. These cities are the capital cities for provinces located in central and western China, which are the lower ranked provinces in terms of development. The dormant cities are not as attractive as other groups, both in terms of economic development and natural environment. These cities are featured with less developed local economy and low labor income. The facilities such as hospital, education and entertainment are not comparable to that of other developed region. As a result, the property price is lower compared to the leading groups. However, even the price level is at bottom for the country, Figure 28 still shows a significant increase in the local property price in the past years.

Estimating Supply Elasticities, and Their Determinants: Empirical Framework

Stage 1: Estimating Supply Elasticities

The model we apply was developed in Malpezzi and Mayo (1997). Consider a simple three equation flow model of the housing market:

$$Q_t^D = b_0 + b_1 P_t + b_2 Y_t + b_3 D_t \quad \text{Eq(1)}$$

$$Q_t^S = c_0 + c_1 P_t \quad \text{Eq(2)}$$

$$Q_t{}^D = Q_t{}^S \text{ Eq(3)}$$

where $P_t$is the house price, Y_t is the population, and D_t is the disposable income. $Q_t{}^D$ is the total demand of housing and $Q_t{}^S$ is total supply of housing. For convenience, we use logarithms for all variables.

The reduced system can be solved by equaling supply to demand and solving for the observable variable P_t.

$$b_0 + b_1 P_t + b_2 Y_t + b_3 D_t = c_0 + c_1 P_t \text{ Eq(4)}$$

$$P_t = \frac{b_0 - c_0 + b_2 Y_t + b_3 D_t}{c_1 - b_1} = a_1 + a_2 Y_t + a_3 D_t \text{ Eq(5)}$$

$$c_1 = b_1 + \frac{b_3}{a_3} \text{ Eq(6)}$$

As we discussed above, we can put reasonable bounds on the demand elasticities from cross country studies as well as China-specific studies. That is, we estimate a_2 as part of a reduced form regression; then we parametrically vary demand parameters, based on our literature review, to extract estimates of the supply elasticity c_1.

A Bayesian Interpretation of Negative Coefficients

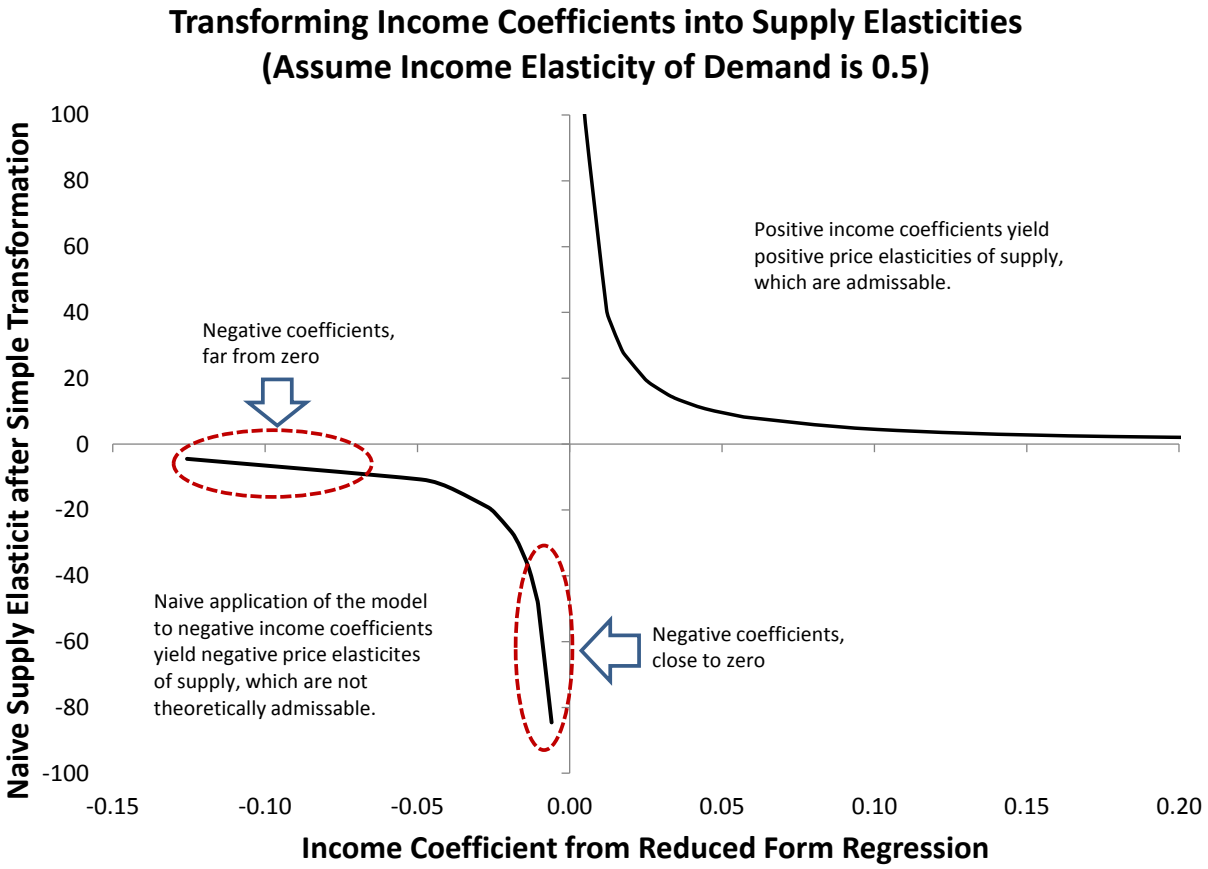
Econ 1-level theory tells us that supply curves should have a nonnegative slope; and that the coefficients of Y should be nonnegative as well. But previous estimates using variations of the model above, such as Follain (1979), Malpezzi and Maclennan (2001), and Wang, Chan and Xu (2012) do sometimes find results that violate these restrictions. We will find some as well, below.

How do we interpret such negative coefficients? We reject the naïve interpretation, that is, that negative coefficients suggest a downward sloping supply curve for housing.

True downward sloping supply curves are rare. Such a result implies th at there are strong decreasing costs throughout the observed range of production. There's no evidence, or any sensible story, about why this would be the case for housing. Economies of scale are not that large, or ubiquitous. Thus we reject the interpretation of a negatively sloping supply curve for China's housing (as we have for other countries).

Malpezzi and Maclennan (2001), following Muth (1960) and Follain (1979), took a simple Bayesian approach. They interpreted a negative coefficient as evidence of a flat (elastic) supply curve.

Figure 29



A possibly better approach is suggested by an unpublished comment Richard Muth made about unexpected coefficients in Follain (1979), namely that a coefficient apparently outside the theoretically permitted range could be consistent with *either* a flat or a vertical supply curve. This is illustrated in Figure 29. We will make use of this insight when we present reduced forms and elasticity estimates, below.

7. Stage 1 Estimates: Supply Elasticities

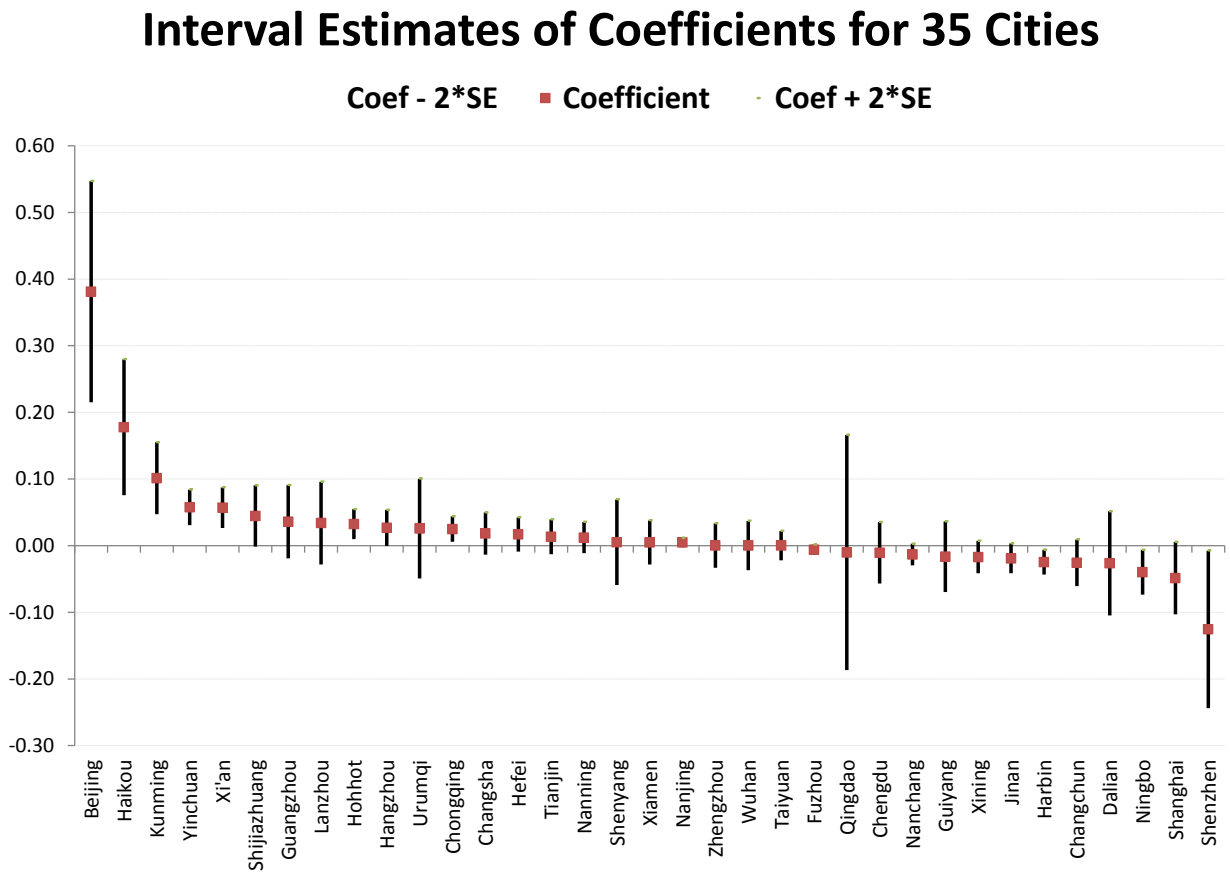
City Reduced Forms

We use our data to estimate the parameters in Eq (5), first at the country level and group level; then we estimate the same equation allowing parameters to vary for each city. All variables are normalized using the corresponding value at first quarter of year 2000 in Beijing as base 100, then logged. The number in bracket is the standard error for the corresponding coefficient. What we can see from Table E1 in Appendix E is that all of our estimates are significant. The explanatory power of the price equations are quite strong.

Table E1

As foreshadowed above, several of our cities exhibit negative coefficients for income, which is a little difficult to reconcile with simple notions of non-negative supply curves. Figure 31 presents an interval estimate of each city's income coefficient, specifically, the point estimate of the coefficient, plus/minus two standard errors. The Figure shows that most of the negative coefficients are not that far from a zero coefficient. Note that 13 of our 35 cities have negative coefficients; but only 3 are more than two standard deviations from zero. (Maybe none, since our standard errors are probably understated, given positive serial correlation.)[21]

Figure 31



[21] Our judgment is that although serial correlation biases our standard errors, the standard fixups for this are based on large sample properties; our individual city samples comprise only a little over a decade of data.

Figure 32

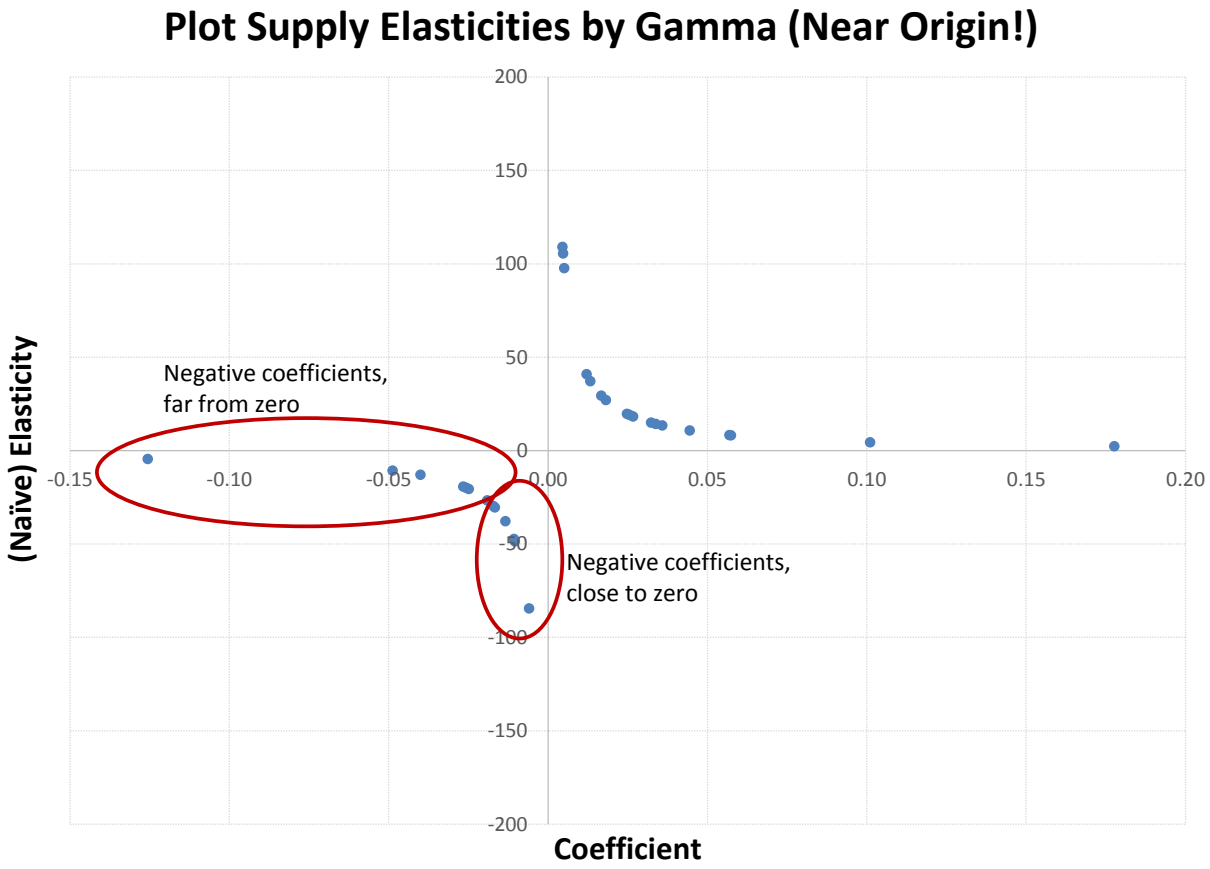


Figure 32 maps (most) of our city estimates on a figure similar to that we laid out in Figure 29. Table 6 presents our estimates of price elasticity of supply, using the model above (specifically Equations 4 and 5) to transform the coefficients from Table E1. We use Figure 32 to allocate (somewhat roughly) non-negative supply elasticities to cities with negative reduced form coefficients. These can be found in the last column of Table E2; allocated responses are in red.

Table E2

There is another, simpler, way of thinking about supply elasticities. In a simple supply-demand framework, if supply is elastic, real prices are flat. We also review the time series plots above to determine which cities are relatively "flat," by visual inspection. Then, our simple Bayesian allocation rules are as follows. Consider Figure 32 above, and the slope of the real price trend.

- If the point estimate is close to zero, and real price trend is relatively flat, we'll assume the market is elastic. Following this rule we set supply elasticity = 50 for Dalian, Changchun, Fuzhou, and Xining.

- If the point estimate is farther from zero, and the real price trend is steep, we'll assume the market is less elastic. We set supply elasticity = 2 for Shanghai, Qingdao, and Shenzen.

- Intermediate cases: set supply elasticity = 10: Harbin, Nanchang, Jinan, Chengdu, and Guiyang.

We also test for whether results are sensitive to these particular allocation rules, both by varying the allocation; and also simply dropping these observations.

8. Stage 2: Determinants of Supply Responsiveness

In this section, we examine the determinants of price elasticity of supply. In addition to the regulatory variables described above, we examine the effects of geography, environmental infrastructure, density, and the level and growth rate of population. Detailed motivation and examples from previous literature can be found in, *inter alia*, Harrison and Rubinfeld (1978), Potepan (1996), Cragg and Kahn (1997), Leggett and Bockstael (2000), Green Malpezzi and Mayo (2005), and Saiz (2010).

Second stage regressions are presented in Table 1. The dependent variable is the logarithm of the estimated supply elasticities in Table 1, specifically the estimates assuming demand elasticities of 0.5 in absolute value, using our simple Bayesian allocation rule. Regulatory and environmental infrastructure variables are discussed in detail above. Geography is proxied by a simple dummy variable for location in a mountainous area. Population, level and growth rate, are from Table D1.

We began with 35 cities, but ended with 34 as Xining's data were incomplete. We collected a number of additional potential determinants of supply, e.g. climate and political variables. But the degrees of freedom available dictated that models be quite parsimonious. As more data becomes available from China, it will be worthwhile to consider a more complete model.

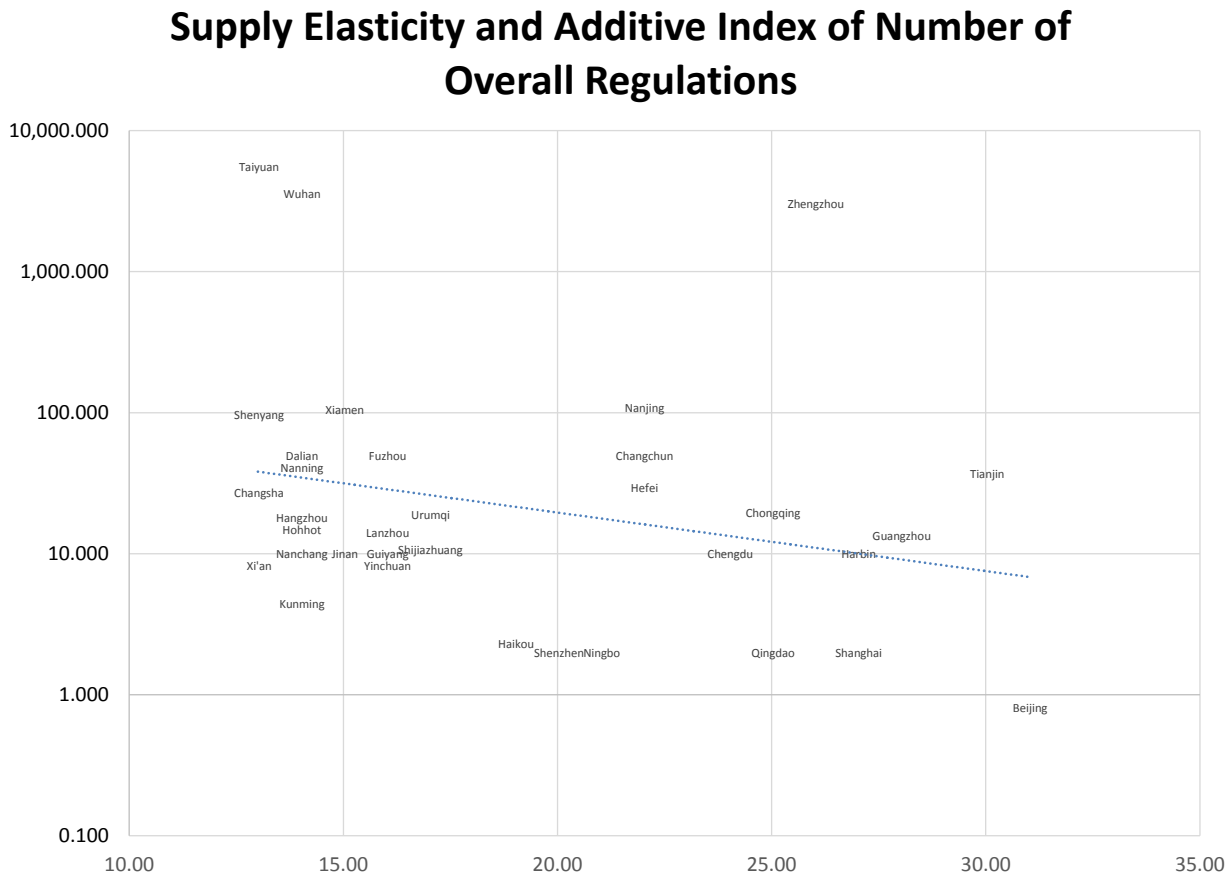
Data limitations have also limited our explorations, so far, of the endogeneity of the regulatory environment. We treat the regulatory environment as exogenous in this paper, as in Malpezzi (1996). Malpezzi Chun and Green (1998) and a number of other papers including Ortalo-Magné and Prat (2010) suggest that when data support it, endogenizing the regulatory environment could be a useful extension.

Table 1

Second State Regressions: Explaining the Elasticity of Housing Supply								
			(1)	(2)	(3)	(4)	(5)	(6)
NREGSUM	Additive Index based on	Coefficient	-0.096		-0.095			-0.106
	number of overall	Standard Error	0.062		0.060			0.075
	regulation	Prob > |t|	0.132		0.128			0.168
		Standardized Coefficient	-0.268		-0.265			-0.296
CREG1	1st Regulatory Principle	Coefficient		-0.227		-0.231	-0.258	
	Component	Standard Error		0.150		0.147	0.181	
		Prob > |t|		0.141		0.127	0.166	
		Standardized Coefficient		-0.262		-0.266	-0.298	
MOUNTAIN	Mountainous Area	Coefficient			-1.182	-1.211	-1.452	-1.415
		Standard Error			0.765	0.765	0.790	0.793
		Prob > |t|			0.132	0.124	0.078	0.086
		Standardized Coefficient			-0.262	-0.268	-0.322	-0.313
ENVIROADD	Index of Environmental	Coefficient					0.437	0.434
	Infrastructure	Standard Error					0.346	0.347
		Prob > |t|					0.218	0.222
		Standardized Coefficient					0.229	0.228
LPPH	Log Persons per Hectare	Coefficient					-0.579	-0.551
		Standard Error					0.641	0.641
		Prob > |t|					0.375	0.398
		Standardized Coefficient					-0.166	-0.158
LAVGPOP	Log Average Population	Coefficient					-0.436	-0.441
	2000 to 2011	Standard Error					0.744	0.744
		Prob > |t|					0.563	0.558
		Standardized Coefficient					-0.124	-0.125
ADPOP00_11	Average Population	Coefficient					-79.552	-79.586
	Growth Rate 2000 to 2011	Standard Error					39.776	39.804
		Prob > |t|					0.056	0.056
		Standardized Coefficient					-0.405	-0.405
Intercept		Coefficient	4.954	3.132	5.260	3.463	10.704	12.627
		Standard Error	1.226	0.349	1.216	0.399	7.237	6.854
		Prob > |t|	0.000	0.000	0.000	0.000	0.151	0.077
Degrees of Freedom			32	32	32	32	32	32
R2			0.07	0.07	0.14	0.14	0.27	0.27
Adjusted R2			0.04	0.04	0.08	0.08	0.10	0.10
Dependent Variable: Log supply elasticity from Eqns. 4-5, assuming price and income demand elasticities are -.5, .5; allocated responses for negative coefficients in reduced forms.								

In the event, Table 1 presents representative results. The first four columns present extremely simple models, examining supply responsiveness as a function of the regulatory environment, with and without our simple geographic measure. Coefficients have the expected negative signs, but the standard errors are large. Figure 34 presents a simple two way plot of our estimated supply elasticity as a function of the simple additive index, as in Model (1) of Table 7.

Figure 34



Models (5) and (6) present "larger" models, incorporating the other variables discussed in the introduction to this section. It's the same story: coefficients have the expected signs (positive for environmental infrastructure, negative for other variables), but generally there are fairly high probabilities that we could observe these coefficient/standard error combinations under the null hypotheses.

We have undertaken a range of sensitivity tests and alternative models not reported in detail here. Among other things, in addition to residual analysis and other regression diagnostics, we have examined other second stage variables including climate, coastal location, and the additional regulatory principal components above. We have also examined results using an alternative dependent variable, where we followed the simpler Malpezzi and Maclennan allocation rule of assuming a positive but near zero price elasticity when reduced form coefficients are negative. We also estimated a set of models using the supply elasticity estimates carefully estimated using a stock-adjustment model by Wang, Chan and Xu. Of course individual estimates changed, but qualitative results were quite robust.

What should we make of our overall result—that second stage coefficients have the expected signs but never reach conventional significance levels? One broad interpretation could be that we have not identified supply, and/or we haven't modeled the determinants very well. Another broad interpretation is that with a relatively small number of observations, our models do not

have large power; and we're limiting ourselves to OLS estimates without large-sample corrections for standard errors and other econometric improvements. Of course these two broad interpretations are not mutually exclusive.

9. Conclusions

Our Findings, and their Limitations

China's housing market has experienced dramatic price increases in the past decade. In this paper, we study the trend of house price for the major cities in China and estimate the price elasticity of supply in China. We find substantial variation in housing supply elasticity estimates from our model, consistent with (but numerically different than) careful previous research by Wang, Chan and Xu (2012). Our regulatory variables, and other proposed determinants of supply responsiveness, generally have the right sign; but coefficients representing the effects of these determinants are not very precisely estimated.

Thus, our results to date can be characterized as largely in accord with expectations as to signs, but weak with respect to their precision. We could not claim to reject null hypotheses in any of the usual formal decision frameworks.

But weak results are to be expected with short data spans of variables that are not well measured. First we discuss some steps toward, and resources for, additional data development; then we discuss some policy implications.

Data Development

Future research will surely improve on these results, as the available data both widens and deepens. NBS is now reporting data for 70 cities, and it is hoped that data quality will improve, too. However, it will take some years to put together a sufficient track record with this expanded data, we can hope that this paper, and many fine related papers recently and presently emerging, will encourage further data development and analysis.

Rents and prices are as close as we get to a "sufficient statistic" for the housing market. But one of the defining characteristics of housing, real estate, land, is extreme heterogeneity in prices.

Simple measures like the NBS data can help, but can be misleading (see also Wu, Gyourko and Deng) and certainly can be much improved. Better measures would be more carefully (and transparently) quality adjusted, e.g. using hedonic methods. An improved set of price measures would be more disaggregated spatially within cities; and could be disaggregated by other submarkets: formal versus informal; by structure type, and quality level. Second moments (standard errors) are also informative. Data on rents, as well as sale prices, and related expenses, e.g. on maintenance and utilities are also important elements of an improved data collection system. Green and Malpezzi (2003) and Bank for International Settlements (2005) are good starting points for the practical details of improved house price measurement; Malpezzi (2005)

provides details and sample questionnaires that can assist in the development of a more complete housing information system.

An important collateral benefit of improved housing price measures, and a stronger housing data system generally, is that it can support the expansion of a property tax system. China's municipal finance system is in need of strengthening (Keohane 2015); and a property tax can be an important element of such reforms (Man 2012; Wong 2013; Ingram 2014).

Our measures of supply conditions—both natural and man-made constraints—can also be much improved. Physical geography is measured using simple dummy variables and distance from coasts, as in a number of preceding studies; but Rose (1989) and especially Saiz (2010) demonstrate how, with additional time and resources, improved measures can be constructed. Our regulatory measures were constructed from surveys already extant, rather than designed for this specific purpose. Improving the signal-to-noise ratio of these measures is a high priority for future research. Quigley and Rosenthal (2005) provide a thorough review of such measures in the U.S., and has the virtue of presenting several actual questionnaires used to collect regulatory information. Of course, these particular questionnaires are only very general models for China or any other country; other sources that can aid in this aspect of data development include Cheshire and Sheppard (2004), Bertaud (2010) and Malpezzi (1999).

Policy Implications

While we have not produced supply elasticities that we regard as definitive, we—and other researchers we surveyed, in China and in other countries—have demonstrated that supply conditions do vary significantly across China's cities, as has been found in other countries. More elastic markets are, ceteris paribus, markets that are performing well. The market meets ncreases in demand with more/better housing. Less elastic markets have more adjustment on the price side, ceteris paribus; and as Wheaton (1999) and Malpezzi and Wachter (2005) note, can lead to more volatile, boom and bust markets.

How can China, or anyone, improve a market's supply elasticity? Among many recent papers on Chinese housing policy, good starting points would be Man (2011), Bertaud (2003, 2010), and Renaud (2009). Lessons from other countries' housing policies, on the supply/regulatory side as well as on other fronts such as subsidy policy, financial policy, taxation and so on, can be gleaned from sources including Angel and Mayo (1996), Buckley and Kalarickal (2005), Malpezzi (1999), and Diop, Malpezzi and Sa-Aadu (forthcoming). Aforementioned papers by Bertaud (2010), Malpezzi (1999) and Quigley and Rosenthal (2005) provide thoughtful reviews of regulatory principles and practices from a range of countries. Of course, regulatory regimes, and changes in the same, cannot simply be adopted wholesale, from one country to the next. "One Size Fits All" can be perilous; and the details of regulation matter. One broad framework that can aid in understanding specific regulatory issues in a particular context is the "incentives model" laid out in Hannah et al. (1989). This model can assist in developing the sort of regulatory triage advocated by Angel and Mayo (1996), in which some regulations are characterized as providing benefits equaling or exceeding the costs imposed; these would be kept in a well-designed system, possibly enhanced and more vigorously enforced. Others are put into a second "bucket," those which have costs larger than their benefits; these should be modified if

not deleted. The third bucket comprises those that are hard to place in the first two, either because costs and benefits are about the same, or (more often) hard to estimate precisely enough to place reliably. Even if the third bucket is significant, targeting regulatory practices in the first two buckets for change can help "elasticize" the market.

Appendix A: Measuring House Prices

Appendix A: Price Data

Our data is from the National Bureau of Statistics of China (NBS). As an agency directly under the State Council, NBS is in charge of statistics and economic accounting in China. In order to reflect changes in housing prices caused by deepening social and economic reform development, NBS established the real estate price survey system in 1997. The real estate price index covers 35 large and medium-sized cities, and is compiled quarterly. After 2005, the scope of real estate price statistics was expanded to 70 large and medium-sized cities in China, whose real estate transactions accounted for more than 70 percent of all transactions in the country. The prices are collected at the municipal district level. The respondents include the real estate administrative departments at all levels of government, such as Housing Administrations, Land Offices, real estate trading centers, real estate enterprises, operating units for real estate, property management enterprises, relevant enterprises and institutions, social organizations and some residents. The key-point survey is used in conjunction with a typical survey. With regard to the method, the survey combined the statements (listed prices) with on-site price collection by a surveyor. The selection of survey units is based on the following principles that should ensure representativeness and reliability of real estate price indices:

1. Representativeness.

The survey units, which are large and powerful, account for a high proportion of the local turnover, and remain active under stable operating conditions, are selected to ensure the reliability and continuity of data. Factors relating to big construction projects are also taken into account when selecting survey units. The index of newly-constructed buildings includes prices for economic and suitable houses, common houses and high-end residential buildings, office buildings, buildings for commercial use etc.

The survey units should be around evenly distributed in the sampled region. Their sales account for more than 70 percent of the total regional sale to ensure the representativeness of the sample. The ratio in Beijing is 81 percent, which is above the NBS required sale percentage.

Properties in different locations, real estate projects at different geographical location should be taken into account when selecting survey units. As there are huge disparities, transaction prices and rents should be diversified by geographical location,

2. Weights in index calculation

The house price index is derived by the method of weighted average. The weighting of one kind of properties depends on the proportion of its sale of the total property sales in the region. For example, the proportion of commercial sales of the total property sales in last year is used as weight of commercial property index in calculating the house price index in current year. The weights are updated annually.

3. Heterogeneity

Houses are highly heterogeneous commodities. The price of a house depends not only on its structural characteristics, but also on its location and neighborhood environment. Thus, the investigation on property price changes should be compared among similar properties.

4. The Calculation of Price Index

With all the sampled information, NBS first calculates the increase of each type price index in a lower category, and then obtain weighted average of lower category index to generate a higher category index. The house sales index is final weighted average of the second sub-level index. The categories are described in the following table:

Table 1: the Categories in Selling Price of Indices of Real Estate

Selling Price Indices of Real Estate			
	Commercial houses 1	residential buildings	economically affordable housing general residential buildings multilayer buildings high-layer buildings other building luxury residential buildings villas high grade apartment
	2	non-residential buildings	office buildings High-grade office buildings General office buildings houses for business and entertainment workshops and storehouses others

	Private owner houses 1	residential buildings	high layer buildings multiplayer buildings other buildings
	2	non-residential buildings	

The following figures show the variation in the components of the commercial index from year 1998 to year 2007, which is from the China Statistical Yearbook (2007). Private owner houses data are not available. From Figure 4, we can see that the price of commercial houses in increasing over time

For the various components of the index, the increasing rate is slightly different.

The price index of residential houses increases faster than that of the non-residential houses. At the end of 2007, the residential price index increases about 55 percent compared to the index in 1998, which is only 30 percent for non-residential index.

For the components of residential houses index, what is interesting is that afford houses index moves up very slow compared to other kinds of properties.

Affordable houses are under strict government control. So the price index trend for economically affordable housing is different from other type. Contrary to affordable houses, index for other kinds of properties increases at a higher rate, driven by market. The general residential buildings and multi-layer buildings feature the highest increase rate because they are in high demand in residential houses. Luxury houses, villas and high grade apartment increase slowly than the two types because the demand for luxury houses is relative small. Thus, the price of other kinds of properties increases much faster to reflect the changing economic and property conditions. For the non-residential side, the price index for houses for business and entertainment keeps increasing over time. However, the price index for offices and others experience drop in a few years after 1998.

Appendix B: Real Estate Statutes Survey Questions

关于城市地产法律法规的问卷回答

Q1: How many statutes does the city have in the database? 数据库中该城市有多少条法律法规？

A: below 30 B: 30-60 C: 60-90 D: above 90

A=1, B=2, C=3, D=4

Q2: When is the latest statute released? 最新的法规何时出台

A: 5 years ago B: 3-5years ago C: 1-2 years ago D: this year

A=1, B=2, C=3, D=4

Q3: What are the average statutes per year before 2005? 2005 年之前的 5 年，平均每年有几条法规。

A: below 2 B: 2-5 C: 5-10 D: above 10

A=1, B=2, C=3, D=4

Q4: What are the average statutes per year since 2005? 2005 年至今，平均每年多少条？

A: below 2 B: 2-5 C: 5-10 D: above 10

A=1, B=2, C=3, D=4

Q5: How many statutes does the city have on market regulating? 关于市场管理的法规有多少条？

A: below 5 B: 5-10 C: 10-20 D: above 20

A=1, B=2, C=3, D=4

Q6: How many statutes does the city have on housing reform? 关于房改政策的法规有多少条？

A: below 5 B: 5-10 C: 10-20 D: above 20

A=1, B=2, C=3, D=4

Q7: How many statutes does the city have on market price regulation? 市场价格的法规有多少条？

A: below 5 B: 5-10 C: 10-20 D: above 20

A=1, B=2, C=3, D=4

Q8: How many statutes does the city have on urban construction and development? 城市建设的法规有多少条？

A: below 5 B: 5-10 C: 10-20 D: above 20

A=1, B=2, C=3, D=4

Q9: How many statutes does the city have on home association management regulation? 关于物业管理的法规有多少条?

A: below 5 B: 5-10 C: 10-20 D: above 20

A=1, B=2, C=3, D=4

Q10: How many statutes does the city have on finance regulation? 金融管理有多少条？

A: below 5 B: 5-10 C: 10-20 D: above 20

A=1, B=2, C=3, D=4

Q11: How many statutes does the city have on land use regulation? 土地管理法规有多少条？

A: below 5 B: 5-10 C: 10-20 D: above 20

A=1, B=2, C=3, D=4

Q12: Which is the city's type? HERE CREATE TWO DUMMY VARIABLES, ONE FOR PROVINCIAL CAPITAL, ONE FOR CG MUNICIPALITY 该城市属于直辖市，省会城市，或者其他。

A: Municipality directly under the Central Government 直辖市

B: Capital City of Province 省会城市

C: None of the above 其他

A=1, B=2, C=3,

Q13: Is the city in the neighboring area of the following cities: Beijing, Shanghai and Shenzhen? 该城市接临北京，上海或者深圳吗？

A: Yes B: No DUMMYd

A:0 B:1

Q14: Is the city an important transportation hub of rail way? 该城市是重要铁路枢纽吗？

A: Yes B: No DUMMY

A:0 B:1

Q15: Is the city an important transportation hub of airplane? 该城市是重要的空中枢纽吗？

A: Yes B: No DUMMY

A:0 B:1

Q16: Is the city an important transportation hub of highway? 该城市是重要的高速枢纽吗？

A: Yes B: No DUMMY

A:0 B:1

Q17: Is there any statute targeting to develop the city as a transportation hub in the next 5 to 10 years? 该城市有没有规划在未来 5-10 年内成为交通枢纽。

A: Yes B: No DUMMY

A:0 B:1

i

Q18: How many high tech garden districts does the city already develop? 该城市已建成多少个高新技术开发区?

A: 0 B: 1-2 C: 3-4 D 5-6 E: unknown

A=1, B=2, C=3, D=4, if E, leave BLANK

Q19: How many high tech garden districts does the city plan to develop in the next 5 to 10 years? 该城市未来 5-10 年计划建设几个高新技术开发区？

A: 0 B: 1-2 C: 3-4 D 5-6 E: unknown

A=1, B=2, C=3, D=4, if E, leave BLANK

Q20: Has there been a new town in the city beside the original city center? 该城市在原有城市中心附近有新城吗/

A: Yes B: No DUMMY

A:0 B:1

Q21: Is there a city plan to develop a new town in the next five to ten years? 该城市计划未来 5-10 年发展新城吗?

A: Yes B: No DUMMY

A:0 B:1

Q22: How many new towns does the city plan to develop in the next 5 to ten years? 未来 5-10 年该城市计划建设多少个新城？

A: 0 B: 0-5 C: 5-10 D above 10 E: unknown

A=1, B=2, C=3, D=4, if E, leave BLANK

Q23: Is there any restrictions on the residential property purchase for non-city residents (residents without Hukou)? 该城市对非户口居民买房有限制吗？

A: Yes B: No DUMMY

A:0 B:1

Q24: How many properties per household are allowed owning? 该城市对居民购房数目有限制吗？

A: 1 B: 2 C: 3 D: no up limit

A=1, B=2, C=3, D=4

Q25: Is there transaction tax for second hand sale of non-primary residential properties? 该城市对二手房交易收税吗？

A: Yes B: No DUMMY

A:0 B:1

Q26: Is there discriminate interest rate for non-primary residential properties financing? 对非自住房的贷款有不同利率吗？

A: Yes B: No DUMMY

A:0 B:1

Q27: Is there any statute about resources allocated to build low-rent housing, affordable housing, price-fixed housing, public rental housing, rebuilding of shanty areas? 有一下方面的法规吗：廉租房，经济实用房，公共租赁房，城中村拆迁？

A: Yes B: No DUMMY

A:0 B:1

Q28: What is the target percentage of low-rent housing, affordable housing, price-fixed housing, public rental housing to total housing built in terms of size? 该城市计划建成廉租房，经济适用房等的比例是多少？

A: 0 B: 0-10% C: 10%-20% D: above 20% E: unknown

A=1, B=2, C=3, D=4, if E, leave BLANK

Q29: What is the target for total population (local residents and non-residents living more than half a year) of the city in 2020 in million? 在 2020 年该城市的目标人口是多少（百万）？

A: 0-3 B: 3-5 C: 5-10 D: 10-15 E: 15-20 F: 20 以上 G: unknown

A=1, B=2, C=3, D=4,E=5,F=6,G=7 if F, leave BLANK

Q30: What is the target percentage of urban population to total population? 该城市计划城市居民占总居民的百分比是多少？

A: 0-50% B: 50%-70% C: 70%-90% D: more than 90% E: unknown

A=1, B=2, C=3, D=4, if E, leave BLANK

Q31: What is the target percentage of central city area population to total population? 该城市中心城市区人口占总人口的目标比例是多少？

A: 0-20% B: 20%-30% C: 30%-40% D: more than 40% E: unknown

A=1, B=2, C=3, D=4, if E, leave BLANK

Q32: What is the target construction land size per capita in square meters in 2020? 2020 年，该城市目标人均建筑用地面积是多少？

A: 0-70 B: 70-90 C: 90-110 D: 110-130 E: unknown

A=1, B=2, C=3, D=4, if E, leave BLANK

Q33: What is the target daily living water quota in urban area in 2020 (liters per capita)? 该城市2020 年目标人均日常用水量是多少？(升)

A: 0-100 B: 100-150 C: 150-200 D: 200 以上 E unknown

A=1, B=2, C=3, D=4, if E, leave BLANK

Q34: How many sewage treatment systems does the city plan to build? 该城市计划修建多少个净水系统工程？

A: 0-20 B: 20-40 C: 40-60 D: above 60 E: unknown

A=1, B=2, C=3, D=4, if E, leave BLANK

Q35: Is there any restrictions on building new fossil-fuel power stations in the central city? 中心城有无新建火力发电厂的限制？

A Yes B: No DUMMY

A:0 B:1

Q36: Is there any statute on development of stable and rich power supply? 该城市有没有关于发展平稳能源供应的计划？

A: Yes B: No DUMMY

A:0 B:1

Q37: Is there any statute on development of efficient and safe pipeline gas supply? 该城市有没有关于发展高校安全天然气供应的计划？

A: Yes B: No DUMMY

A:0 B:1

Q38: Is there any statute on development of environmental friendly heating system? 该城市有没有发展节能环保供热系统的计划？

A: Yes B: No DUMMY

A:0 B:1

Appendix C: Real Estate Regulation Indexes Construction Methodology

NREGSUM='Additive Index based on number of overall regulations'

Q1+Q2+Q3+Q4+Q5+Q6+Q7+Q8+Q9+Q10+Q11

CAPITAL ='Dummy for Provincial Capital'

Q12

CGMUNI='Dummy for municipality directly reporting to Central Government'

Q12

NEARBIG='City is near Beijing, Shanghai, or Shenzen/Guangzhou'

Q13

TRANSADD='Additive Index of Transportation'

Q14+Q15+Q16+Q17

TECHADD='Additive Index for Hi Tech Developments'

Q18+Q19

NEWCENTER='Dummy for second CBD development'

Q20

LIMITOWN='Limits on property ownership'

Q24

AFFORDSTAT='Statute exists mandating affordable housing'

Q27

LANDTARGET= 'Target land per capita'

Q32

ENVIROADD= 'Index of Environmental/Quality of Life Rules'

-Q33+Q34+Q35+Q36+Q37+Q38

Appendix D: 35 Representative Cities Data

Table D1 Population Data

Basic Data for 35 Cities							
Original Rank	City	City Type	Province	Population, 2011Q1 (Thousands)	Annual Growth of Population, 2000 to 2011	Per Capita Income 2011 Q1	Annual Growth in PC Income
1	Beijing	National Central City	Beijing	11,961	1.8%	2,812	10.9%
2	Tianjin	National Central City	Tianjin	7,567	1.1%	2,300	11.3%
3	Shijiazhuang	Prefecture	Hebei	2,702	3.0%	1,526	9.5%
4	Taiyuan	Prefecture	Shanxi	3,170	2.1%	1,513	10.3%
5	Hohhot	Prefecture	Inner Mongolia	1,932	3.0%	1,831	13.0%
6	Shenyang	Sub-provincial	Liaoning	5,008	0.8%	1,715	11.6%
7	Dalian	Sub-provincial	Liaoning	3,393	1.6%	1,715	10.0%
8	Changchun	Sub-provincial	Jilin	3,476	2.2%	1,471	11.1%
9	Harbin	Sub-provincial	Heilongjiang	3,798	0.9%	1,269	9.5%
10	Shanghai	National Central City	Shanghai	16,066	1.8%	3,343	11.0%
11	Nanjing	Sub-provincial	Jiangsu	3,859	1.0%	2,596	11.8%
12	Hangzhou	Sub-provincial	Zhejiang	3,361	3.1%	3,325	12.0%
13	Ningbo	Sub-provincial	Zhejiang	2,152	3.0%	3,325	9.9%
14	Hefei	Prefecture	Anhui	2,277	3.1%	1,619	9.7%
15	Fuzhou	Prefecture	Fujian	2,914	3.0%	2,390	10.5%
16	Xiamen	Sub-provincial	Fujian	2,817	3.3%	2,390	8.3%
17	Nanchang	Prefecture	Jiangxi	2,668	3.5%	1,498	10.0%
18	Jinan	Sub-provincial	Shandong	2,954	1.1%	1,908	8.8%
19	Qingdao	Sub-provincial	Shandong	3,015	1.0%	1,908	9.1%
20	Zhengzhou	Prefecture	Henan	2,773	1.1%	1,558	9.5%
21	Wuhan	Sub-provincial	Hubei	7,644	1.3%	1,710	9.6%
22	Changsha	Prefecture	Hunan	2,912	3.1%	1,783	6.8%
23	Guangzhou	National Central City	Guangdong	9,662	2.5%	2,565	6.6%
24	Shenzhen	Sub-provincial	Guangdong	8,300	2.9%	2,565	1.6%
25	Nanning	Prefecture	Guangxi	2,424	3.0%	1,718	7.7%
26	Haikou	Prefecture	Hainan	2,659	9.5%	1,717	9.1%
27	Chengdu	Sub-provincial	Sichuan	4,315	0.9%	1,685	7.9%
28	Guiyang	Prefecture	Guizhou	4,092	3.1%	1,439	7.8%
29	Kunming	Prefecture	Yunnan	3,152	1.8%	1,583	7.3%
30	Chongqing	National Central City	Chongqing	6,768	1.0%	1,968	11.7%
31	Xi'an	Sub-provincial	Shaanxi	4,236	1.2%	1,627	9.9%
32	Lanzhou	Prefecture	Gansu	2,864	3.0%	1,265	8.6%
33	Xining	Prefecture	Qinghai	1,175	3.0%	1,229	9.1%
34	Yinchuan	Prefecture	Ningxia	1,040	1.2%	1,420	8.8%
35	Urumqi	Prefecture	Xinjiang	2,407	3.1%	1,345	6.5%

Table D2: Other City Characteristics

City Variables for Geography, Location, and Other Characteristics											
		Dummy for Provincial Capital	Dummy for municipality directly reporting to Central Government			Mountain Dummy	Coastal Dummy	Days of air quality above Grade II	Per Capita Local Water Resources	Density (People per Hectare)	Distance to Ocean (Kilometers)
ORIGINAL RANK	CITY	CAPITAL	CGMUNI	LATITUDE	LONGITUDE	MOUNTAIN	COAST	GOOD AIR DAYS	WATER PC	PPH	DIST OCEAN
1	Beijing	0	1	39°54′29″N	116°25′29″E	1	0	285	127	93	223
2	Tianjin	0	1	39°10′N	117°10′E	0	1	307	127	225	52
3	Shijiazhuang	1	0	38.02°N	114.30°E	1	0	318	201	42	209
4	Taiyuan	1	0	37.54°N	112.33°E	0	0	296	251	82	354
5	Hohhot	1	0	40.48°N	111.41°E	1	0	346	1,564	83	722
6	Shenyang	1	0	41.48°N	123.25° E	0	0	328	396	124	123
7	Dalian	0	0	38.55°N	121.36° E	0	1	328	396	101	2
8	Changchun	1	0	43.54°N	125.19°E	0	0	340	1,089	128	342
9	Harbin	1	0	30.3°N	120.2°E	0	1	311	2,587	123	530
10	Shanghai	0	1	31.14°N	121.29°E	0	1	334	218	105	12
11	Nanjing	1	0	32.03°N	118.46°E	0	1	315	520	212	65
12	Hangzhou	1	0	20.02°N	110.20°E	0	0	327	1,808	114	12
13	Ningbo	0	0	29.52°N	121.33°E	0	1	327	1,808	82	10
14	Hefei	1	0	31.52°N	117.17°3E	0	0	321	1,195	88	191
15	Fuzhou	1	0	26.05°N	119.18°E	0	1	353	2,215	115	3
16	Xiamen	0	0	24.27°N	118.06°E	0	1	353	2,215	145	4
17	Nanchang	1	0	28.40°N	115.55° E	0	1	347	2,643	148	332
18	Jinan	1	0	36.40°N	117.00E	0	0	295	302	123	125
19	Qingdao	0	0	36.03°N	116.58°E	0	1	295	302	168	4
20	Zhengzhou	1	0	34.46°N	113.4°E	0	0	322	348	76	363
21	Wuhan	1	0	43.45°N	87.36°E	0	1	301	1,444	132	404
22	Changsha	1	0	28.19°N	112.98°E	0	1	333	2,191	118	536
23	Guangzhou	1	0	23.08°N	113.14°E	0	1	347	1,683	28	2
24	Shenzhen	0	0	22°37′12″N	114°04′12″E	0	1	347	1,683	159	
25	Nanning	1	0	22.8°N	108.3°E	1	1	362	3,069	111	122
26	Haikou	1	0	45.44°N	126.36°E					72	3
27	Chengdu	1	0	30.40°N	104.04°E	1	1	303	2,858	90	1,025
28	Guiyang	1	0	26.35°N	106.42°E	0	0	315	2,398	321	696
29	Kunming	1	0	25°02′11″N	102°42′31″E	1	0	347	3,460	38	773
30	Chongqing	0	1	29.35°N	106.33°E	1	0	365	1,600	254	944
31	Xi'an	1	0	34.17°N	108.57°E	0	0	304	1,106	122	599
32	Lanzhou	1	0	36。04°N	103.51°E	0	0	236	794	29	
33	Xining	1	0	36.38°N	101.48°E	0	0	280	16,114	51	1,204
34	Yinchuan	1	0	38.27°N	106.16°E	1	0	328	136	265	935
35	Urumqi	1	0	30.35°N	114。17°E	1	0	262	3,517	53	2,287

Table D3: Housing and Urban Regulatory Variables

City-Specific Housing and Urban Regulatory Variables							
ORIGINAL RANK	CITY	Jones Lang LaSalle Category* JLLRANK2	Additive Index based on number of overall regulation NREGSUM	Index of Environmental/Quality of Life Rules ENVIROADD	Housing Regulatory Variables: First Principal Component CREG1	Housing Regulatory Variables: Second Principal Component CREG2	Housing Regulatory Variables: Third Principal Component CREG3
1	Beijing	1	31	4	5.00	0.38	-1.22
2	Tianjin	2	30	1	4.60	0.22	-1.23
3	Shijiazhuang	4	17	3	-0.76	-0.40	-0.38
4	Taiyuan	4	13	2	-2.35	-0.34	-0.62
5	Hohhot	4	14	1	-2.02	-0.31	-0.23
6	Shenyang	2	13	2	-2.35	-0.34	-0.62
7	Dalian	2	14	3	-2.02	-0.31	-0.23
8	Changchun	3	22	2	1.24	-2.07	1.60
9	Harbin	3	27	1	3.49	0.19	-1.55
10	Shanghai	1	27	3	3.61	-1.76	0.68
11	Nanjing	2	22	4	0.77	1.89	1.07
12	Hangzhou	2	14	3	-2.02	-0.31	-0.23
13	Ningbo	2	21	2	0.37	1.73	1.07
14	Hefei	3	22	1	1.61	-0.30	-1.86
15	Fuzhou	3	16	3	-1.27	-0.26	0.20
16	Xiamen	2	15	3	-1.61	-0.29	-0.19
17	Nanchang	3	14	4	-2.02	-0.31	-0.23
18	Jinan	3	15	0	-1.61	-0.29	-0.19
19	Qingdao	2	25	1	2.52	-2.03	2.01
20	Zhengzhou	3	26	2	2.77	-1.64	2.01
21	Wuhan	2	14	3	-2.02	-0.31	-0.23
22	Changsha	3	13	3	-2.35	-0.34	-0.62
23	Guangzhou	1	28	1	3.81	0.47	-1.43
24	Shenzhen	1	20	1	0.27	0.03	0.63
25	Nanning	4	14	3	-2.02	-0.31	-0.23
26	Haikou	3	19	4	0.39	-0.11	-1.61
27	Chengdu	2	24	1	1.84	2.44	0.56
28	Guiyang	4	16	2	-1.57	1.67	0.96
29	Kunming	3	14	1	-2.32	1.62	0.53
30	Chongqing	2	25	1	1.81	2.36	1.60
31	Xi'an	2	13	1	-2.35	-0.34	-0.62
32	Lanzhou	4	16	2	-1.27	-0.26	0.20
33	Xining	4		1			
34	Yinchuan	4	16	3	-1.27	-0.26	0.20
35	Urumqi	4	17	2	-0.88	-0.10	0.21
	* Jones Lang LaSalle-based Categories: 1 = Lead; 2 = Growth; 3 = Early Adopters; 4 Dormant						

Table D4: Housing Price Data

Selected Housing Price Data, 35 Cities						
				Average Quarterly Real Price Change	Std Dev of Quarterly Real Price Changes	Coefficient of Variation of Quarterly Real Price Changes
Original Rank	City	Real Price 2000Q1	Real Price 2011Q1	AQD Real Price 00-11	SDQD Real Price 00-11	CVQD Real Price 00-11
1	Beijing	9,154	15,326	0.013	0.019	1.44
2	Tianjin	5,510	9,517	0.014	0.025	1.72
3	Shijiazhuang	3,291	4,824	0.011	0.027	2.51
4	Taiyuan	2,915	4,029	0.009	0.018	1.97
5	Hohhot	1,977	2,987	0.011	0.023	2.01
6	Shenyang	3,176	5,319	0.014	0.030	2.19
7	Dalian	7,138	10,062	0.010	0.034	3.35
8	Changchun	2,376	3,086	0.008	0.027	3.34
9	Harbin	2,749	3,833	0.010	0.028	2.82
10	Shanghai	9,743	19,067	0.017	0.032	1.84
11	Nanjing	2,605	4,796	0.016	0.028	1.75
12	Hangzhou	6,350	12,964	0.019	0.028	1.49
13	Ningbo	6,231	14,239	0.021	0.033	1.54
14	Hefei	3,409	4,957	0.011	0.031	2.94
15	Fuzhou	5,092	6,589	0.008	0.014	1.76
16	Xiamen	4,660	7,380	0.013	0.026	2.05
17	Nanchang	2,673	4,868	0.015	0.025	1.64
18	Jinan	3,232	4,957	0.011	0.021	1.84
19	Qingdao	5,763	12,458	0.020	0.035	1.76
20	Zhengzhou	2,980	4,309	0.010	0.013	1.28
21	Wuhan	4,137	6,746	0.013	0.027	2.04
22	Changsha	2,809	4,214	0.011	0.021	1.86
23	Guangzhou	6,730	9,164	0.009	0.027	2.99
24	Shenzhen	7,343	14,774	0.018	0.042	2.28
25	Nanning	3,118	4,450	0.010	0.026	2.52
26	Haikou	3,096	5,908	0.019	0.064	3.40
27	Chengdu	3,764	6,377	0.014	0.026	1.84
28	Guiyang	3,247	5,232	0.013	0.027	2.12
29	Kunming	4,265	5,855	0.009	0.032	3.45
30	Chongqing	2,757	3,618	0.008	0.019	2.45
31	Xi'an	3,262	4,717	0.011	0.027	2.52
32	Lanzhou	3,400	5,998	0.016	0.031	1.97
33	Xining	2,084	2,811	0.010	0.020	2.09
34	Yinchuan	2,135	3,312	0.012	0.024	1.91
35	Urumqi	2,445	3,354	0.010	0.027	2.83

Appendix E: Supply Elasticities for 35 Cities

Table E1: Reduced Form Regressions Coefficients

Individual City Reduced Form Regressions for Logarithm of Real House Price										
	Log Income				Log Population					
City	Coefficient	Standard Error*	t-Statistic*	Prob > |t|*	Coefficient	Standard Error*	t-Statistic*	Prob > |t|*	Intercept	R^2
Beijing	0.3811	0.0831	4.59	0.0000	0.6314	0.7077	0.89	0.3774	-10.04	0.935
Tianjin	0.0133	0.0130	1.02	0.3141	6.4171	0.2473	25.95	0.0000	-388.35	0.981
Shijiazhuang	0.0445	0.0230	1.93	0.0598	2.2283	0.2816	7.91	0.0000	-12.65	0.946
Taiyuan	0.0001	0.0110	0.01	0.9935	2.6668	0.1514	17.61	0.0000	-37.96	0.971
Hohhot	0.0323	0.0112	2.88	0.0063	1.9803	0.2519	7.86	0.0000	-9.24	0.964
Shenyang	0.0051	0.0321	0.16	0.8746	7.2445	0.9002	8.05	0.0000	-305.66	0.925
Dalian	-0.0266	0.0390	-0.68	0.4987	9.9885	0.7489	13.34	0.0000	-225.46	0.911
Changchun	-0.0258	0.0175	-1.48	0.1477	1.4863	0.2197	6.77	0.0000	-14.36	0.805
Harbin	-0.0249	0.0093	-2.67	0.0108	5.3564	0.2085	25.69	0.0000	-158.67	0.975
Shanghai	-0.0488	0.0271	-1.80	0.0790	4.8154	0.2728	17.65	0.0000	-549.13	0.952
Nanjing	0.0046	0.0035	1.31	0.1963	8.2345	0.6297	13.08	0.0000	-267.07	0.968
Hangzhou	0.0267	0.0135	1.98	0.0539	8.7895	0.2875	30.58	0.0000	-156.57	0.980
Ningbo	-0.0400	0.0168	-2.38	0.0220	18.8347	0.5332	35.32	0.0000	-227.00	0.980
Hefei	0.0167	0.0128	1.31	0.1967	3.0547	0.1839	16.61	0.0000	-16.06	0.959
Fuzhou	-0.0059	0.0037	-1.61	0.1146	3.1697	0.1702	18.62	0.0000	-16.38	0.948
Xiamen	0.0047	0.0165	0.29	0.7763	4.6732	0.2356	19.84	0.0000	-50.08	0.957
Nanchang	-0.0134	0.0081	-1.65	0.1071	3.5075	0.1162	30.19	0.0000	-36.55	0.989
Jinan	-0.0191	0.0111	-1.71	0.0939	8.1348	0.3338	24.37	0.0000	-183.41	0.981
Qingdao	-0.0104	0.0882	-0.12	0.9067	28.8235	3.0614	9.42	0.0000	-728.69	0.943
Zhengzhou	0.0002	0.0166	0.01	0.9921	6.4122	0.4716	13.60	0.0000	-131.80	0.970
Wuhan	0.0001	0.0185	0.01	0.9941	3.2161	0.1740	18.48	0.0000	-172.59	0.976
Changsha	0.0181	0.0158	1.15	0.2582	2.0899	0.1736	12.04	0.0000	-18.34	0.894
Guangzhou	0.0358	0.0275	1.30	0.2002	1.4068	0.1412	9.96	0.0000	-42.44	0.886
Shenzhen	-0.1256	0.0591	-2.13	0.0394	4.3714	0.2857	15.30	0.0000	-186.57	0.844
Nanning	0.0121	0.0117	1.04	0.3062	2.8943	0.1655	17.49	0.0000	-21.44	0.942
Haikou	0.1777	0.0509	3.49	0.0011	1.2246	0.2589	4.73	0.0000	4.54	0.816
Chengdu	-0.0107	0.0230	-0.47	0.6439	9.7305	0.4614	21.09	0.0000	-350.30	0.970
Guiyang	-0.0167	0.0265	-0.63	0.5324	2.5690	0.1825	14.08	0.0000	-44.13	0.958
Kunming	0.1010	0.0270	3.74	0.0006	2.9910	0.3875	7.72	0.0000	-43.57	0.903
Chongqing	0.0248	0.0095	2.61	0.0124	1.3883	0.1537	9.03	0.0000	-59.09	0.913
Xi'an	0.0569	0.0152	3.74	0.0006	2.9809	0.2678	11.13	0.0000	-83.59	0.946
Lanzhou	0.0338	0.0310	1.09	0.2807	3.4793	0.2334	14.91	0.0000	-41.17	0.952
Xining	-0.0171	0.0122	-1.41	0.1662	3.9682	0.2603	15.25	0.0000	-12.30	0.949
Yinchuan	0.0574	0.0133	4.31	0.0001	10.1034	0.8510	11.87	0.0000	-75.82	0.962
Urumqi	0.0256	0.0374	0.68	0.4975	1.7341	0.2887	6.01	0.0000	-8.83	0.749

* Standard errors, t-statistics, and associated probabilities are uncorrected for serial correlation.
Sample sizes are too small to apply methods based on large sample properties.
Given positive autocorrelation, true standard errors are probably larger than these estimates.

Table E2: Alternative Estimates of Supply Elasticities

Alternative Estimates of Supply Elasticities, 35 Cities							
		Price Elasticities of Supply, Varying Assumptions about Demand Elasticities					Price Elasticity of Supply, Allocating Supply Elasticities When First Stage Coefficients are Negative
		Price -0.5	Price -1.0	Price -0.5	Price -1.0		Price and Income Demand
Original Rank	City	Income 0.5	Income 0.5	Income 1.0	Income 1.0		Elasticities Set to -0.5, 0.5
1	Beijing	0.8	0.3	2.1	1.6		0.8
2	Tianjin	37.1	36.6	74.7	74.2		37.1
3	Shijiazhuang	10.7	10.2	22.0	21.5		10.7
4	Taiyuan	5559.4	5558.9	11119.3	11118.8		5559.4
5	Hohhot	15.0	14.5	30.4	29.9		15.0
6	Shenyang	97.7	97.2	195.8	195.3		97.7
7	Dalian	-19.3	-19.8	-38.1	-38.6		50.0
8	Changchun	-19.9	-20.4	-39.3	-39.8		50.0
9	Harbin	-20.6	-21.1	-40.7	-41.2		10.0
10	Shanghai	-10.8	-11.3	-21.0	-21.5		2.0
11	Nanjing	109.1	108.6	218.7	218.2		109.1
12	Hangzhou	18.2	17.7	36.9	36.4		18.2
13	Ningbo	-13.0	-13.5	-25.5	-26.0		2.0
14	Hefei	29.4	28.9	59.2	58.7		29.4
15	Fuzhou	-84.6	-85.1	-168.6	-169.1		50.0
16	Xiamen	105.5	105.0	211.5	211.0		105.5
17	Nanchang	-37.8	-38.3	-75.2	-75.7		10.0
18	Jinan	-26.7	-27.2	-52.9	-53.4		10.0
19	Qingdao	-48.6	-49.1	-96.7	-97.2		2.0
20	Zhengzhou	3029.8	3029.3	6060.2	6059.7		3029.8
21	Wuhan	3600.0	3599.5	7200.5	7200.0		3600.0
22	Changsha	27.1	26.6	54.6	54.1		27.1
23	Guangzhou	13.5	13.0	27.4	26.9		13.5
24	Shenzhen	-4.5	-5.0	-8.5	-9.0		2.0
25	Nanning	40.9	40.4	82.3	81.8		40.9
26	Haikou	2.3	1.8	5.1	4.6		2.3
27	Chengdu	-47.3	-47.8	-94.1	-94.6		10.0
28	Guiyang	-30.5	-31.0	-60.5	-61.0		10.0
29	Kunming	4.5	4.0	9.4	8.9		4.5
30	Chongqing	19.7	19.2	39.8	39.3		19.7
31	Xi'an	8.3	7.8	17.1	16.6		8.3
32	Lanzhou	14.3	13.8	29.1	28.6		14.3
33	Xining	-29.7	-30.2	-58.9	-59.4		50.0
34	Yinchuan	8.2	7.7	16.9	16.4		8.2
35	Urumqi	19.0	18.5	38.6	38.1		19.0

Appendix F: Real Estate Regulatory Indexes for Representative Cities

City	NREGSUM	CAPITAL	CGMUNI	NEARBIG	TRANSADD	TECHADD	NEWCENTPLAN	LIMITOWN	AFFORDSTAT	LANDTARGET	ENVIROADD
Beijing	31	0	1	0	3	2	4	2	1	3	4
Tianjin	30	0	1	0	3	2	4	2	1	4	1
Shijiazhuang	17	1	0	0	2	2		2	1		3
Taiyuan	13	1	0	1	1	2		2	0	3	2
Hohhot	14	1	0	1	2	2		2	1	4	1
Shenyang	13	1	0	1	3	2	3	2	0	3	2
Dalian	14	0	0	1	1	2		2	1	3	7
Changchun	22	1	0	1	1	2		2	1	3	6
Harbin	19	1	0	1	2	2		2	1	3	4
Shanghai	27	0	1	0	3	2	4	2	1		6
Nanjing	22	1	0	0	1	2	3	2	1	3	8
Hangzhou	27	1	0	0	2	2	3	2	1		1
Ningbo	21	0	0	0	2	2		2	0	3	6
Hefei	22	1	0	1	2	2		2	1	3	1
Fuzhou	16	1	0	1	2	2	3	2	1	3	3
Xiamen	15	0	0	1	3	2	2	2	1	4	3
NanChang	14	1	0	1	2	2		2	1		4
Jinan	15	1	0	1	3	2		2	1		0
Qingdao	25	0	0	1	2	2		2	1	3	1
Zhengzhou	26	1	0	1	3	2		2	1	2	2
Wuhan	17	1	0	1	2	2	4	2	1	2	2
Changsha	13	1	0	1	2	2		2	0		3
Guangzhou	28	1	0	0	3	2	3	2	1		1
Shenzhen	20	0	0	0	2	2	2	2	1	2	4
Nanning	14	1	0	1	2	2		2	0	3	7

Haikou	14	1	0	1	2	2		2	1	4	7
Chengdu	24	1	0	1	3	2		2	1	2	1
Guiyang	16	1	0	1	3	2		2	1	3	4
Kunming	14	1	0	1	2	2		2	1	4	1
Xian	13	1	0	1	3	2	2	2	1	3	1
Chongqing	25	0	1	1	2	2		4	1	2	5
Lanzhou	16	1	0	1	2	2		2	1	3	2
Xining	0	1	0	1	2	2	2	2	1		1
Yinchuang	16	1	0	1	1	2		2	1	4	3
Urumqi	14	1	0	1	3	2		2	1	4	3

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