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## Comment

*Erik Hurst, University of Chicago and NBER*

One of the primary goals of this paper is to document house price growth within China at the local level since early in the twenty-first century. The paper shows that for many cities, house price growth outpaced income growth. The paper also discusses potential risks related to Chinese housing markets going forward. Throughout the paper, the authors assume that income growth is a good benchmark for house price growth. In my discussion I will outline the conditions under which income growth is a good benchmark for house price growth. I will then discuss empirically the extent to which house price growth and income growth are linked using data from a large cross section of developed and developing economies.

The models I develop below are relatively standard in the urban literature. The models are based on optimizing households who have preferences over housing, optimizing firms who build housing, and something that makes land special. In these models, land is made special either because it is constrained or because the land offers production or consumption amenities. The production amenities could include factors like the proximity to jobs. The consumption amenities could include factors like climate, a nice view, or the quality of one's neighbors. These amenities, depending on the model, can be either fixed or endogenous.

### **A Model of Housing Prices: Unbounded City, No Amenities, and Fixed Homogeneous Population**

Consider one city with a fixed population of  $N$  identical individuals. Suppose the city can be represented on the real line such that each point on the line,  $i$ , is a different location. Each location can be thought of as

a “neighborhood.”<sup>1</sup> Let  $n(i)$  be the measure of agents who live in neighborhood  $i$  within the city. Let  $h(i)$  be the size of the house chosen by agents living in neighborhood  $i$ . By definition,

$$\int_{-\infty}^{\infty} n(i) di = N.$$

Summing the population across all neighborhoods will equal the total population of the city. For simplicity, the size of each neighborhood is normalized to 1 such that:

$$n(i)h(i) \leq 1.$$

Suppose households maximize their static preferences over nonhousing consumption ( $c$ ), housing consumption ( $h$ ), and which neighborhood to live in subject to a static budget constraint:

$$\begin{aligned} \max_{c,h,i} c(i)^\alpha h(i)^\beta \\ c(i) + R(i) h(i) = Y. \end{aligned}$$

Preferences are assumed to be Cobb-Douglas over nonhousing and housing consumption with  $\alpha > 0$  and  $\beta > 0$ . The flow rental cost of a unit of housing in location  $i$  is defined as  $R(i)$ . The price of nonhousing consumption is normalized to 1. Households are also endowed with labor income  $Y$  that can be used to purchase nonhousing and housing consumption.

On the supply side, there is a continuum of competitive builders who can always build a unit of housing at a constant marginal cost  $\kappa$ . Arbitrage implies a link between flow rental prices and the price of the property,  $P$ , such that:

$$P_t(i) = R_t(i) + \frac{1}{1+r} P_{t+1}(i),$$

where  $r$  is the risk-free discount rate. Profit maximization implies that builders will build a unit of housing in neighborhood  $i$  anytime  $P(i) \geq \kappa$ . This restriction will be relaxed in the next subsection when the city size is assumed to be bounded.

Given the above specification, housing demand functions can be computed for each neighborhood such that:

$$\begin{aligned} h(i) &= \frac{\beta}{\alpha + \beta} \left( \frac{1}{R(i)} \right) Y \text{ or} \\ \frac{R(i) h(i)}{Y} &= \frac{\beta}{\alpha + \beta}. \end{aligned}$$

With the Cobb-Douglas specification, the share of housing expenditures out of income is held fixed either because the price of housing adjusts ( $R(i)$ ) or because the quantity of housing adjusts ( $h(i)$ ).

Spatial equilibrium implies that households have to be indifferent across all locations such that:

$$c(i)^\alpha h(i)^\beta = c(\tilde{i})^\alpha h(\tilde{i})^\beta$$

for all locations  $i$  and  $\tilde{i}$ . If there is nothing special about any neighborhood relative to any other neighborhood, then  $R(i)$  must be constant across all neighborhoods.

Putting all the above together, we can define individual local housing demand curves and a local housing supply curve from this simple model.

$$h(i) = h = \frac{\beta}{\alpha + \beta} \left( \frac{1+r}{r} \right) \left( \frac{1}{P} \right) Y$$

$$P = \kappa.$$

In a world where no neighborhood is more desirable than any other neighborhood and where supply is unbounded, the supply curve for housing is perfectly elastic. In this model, there is no relationship between housing prices and income growth (if construction costs  $\kappa$  remain fixed). Any shock that increases the demand for housing (increasing income, a reduction in interest rates, increased population, etc.) would be mediated by an increase in the supply of housing. In other words, all the action takes place on the quantity margin. This simple model suggests that income growth would be a poor benchmark for house price growth in cities where the supply of housing is elastic. To go further, the simple model implies that house price growth should be zero in the long run, despite rapid income growth.

By assuming that house price growth is tightly linked to income growth, the authors do not have a model of housing prices in the back of their minds where cities can expand by adjusting the supply of housing and/or there are no within-city amenities that households value that are attached to the land within the city.

### **Model of Housing Prices: Bounded City, No Amenities, and Fixed Homogeneous Population**

The reason that house prices did not respond to unexpected income shocks in the above stylized model was that the supply of housing was

unconstrained. Now let us consider a similar model where the city size is constrained. We will formalize the constraint by assuming that neighborhoods within the city must belong to the interval  $[-I, I]$  with the center of the city denoted by  $i = 0$ . Given this, there are only  $2I$  neighborhoods within the city. Suppose that the city size is initially binding such that all land within the city is currently occupied by the  $N$  residents. If this was not the case, we would be back in the model outlined above. Finally, assume that all other aspects of the model stayed the same (households have same preferences, the model is static, the marginal cost of building a house is  $\kappa$ , there are no city-specific production or consumption amenities, etc.). In this modified model, housing prices will still be the same within all neighborhoods within the city. However, the fact that the city is bounded implies that the supply curve for housing is perfectly inelastic. Changes in housing demand will show up as increases in housing prices. The increased housing prices will cause individuals within the city to consume smaller quantities of housing (relative to nonhousing consumption). Formally, simple algebra shows that housing prices within each neighborhood can be expressed as the following:

$$P(i) = P = \left(\frac{N}{2I}\right)\left(\frac{\beta}{\alpha + \beta}\right)\left(\frac{1+r}{r}\right)\gamma.$$

If city sizes are bounded and if the population is fixed, there is a direct link between income growth and housing price growth such that a 1% increase in income will yield a 1% increase in housing prices. In this case, income growth is a good benchmark for housing price growth. Notice, population growth will also cause house prices to grow in this simple model, even if income does not change. Anything that increases the demand for housing within a city (either because existing residents get richer or because of influx of new residents) will be mediated through higher prices when housing supply is inelastic. If both income and population grows, housing price growth can exceed income growth. The extent to which income price growth is a good proxy for housing price growth depends on (a) whether supply is constrained and (b) whether other factors are also changing the demand for housing.

### Discussion of Binding Housing Supply Constraints

While the above models are highly stylized, they are illustrative of the forces necessary to get a tight link between income growth and house

price growth within a city. If city size is bounded such that supply is completely constrained, house price growth within a city can track income growth (or population growth). However, in practice, there are many margins in which the city housing supply can adjust. For example:

1. Cities can expand outward. For the most part, this is like the unconstrained supply model developed above. However, there could be additional costs to expand a city outward relative to developing vacant land within a city. For example, new infrastructure may be needed to build on the fringes of cities (electrical grids, plumbing systems, roads, etc.). The costs of such infrastructure can raise the marginal cost of building within a city boundary and across city boundaries.
2. Cities can build up. Our model assumed that each neighborhood was constrained to be a fixed size. However, in practice, each neighborhood can expand its size by building taller buildings. The marginal cost of doing so may be higher than the marginal cost of building on the fringe of the cities or on vacant land within the city. But, if prices rise sufficiently high, there will be an incentive to build upward.
3. People can move to new or existing cities. Factor mobility is a primary way in which housing prices can be kept in check (Blanchard and Katz 1992). As income increases and the demand for housing grows, households may choose to migrate to cheaper locations.

Factor mobility and the ability to expand housing supply by building upward further breaks the link between local income growth and local house price growth. During the first decade of the twenty-first century, most Chinese cities dramatically expanded the supply of housing. Cities like Beijing expanded outward during the early twenty-first century by building “Ring Roads” that were further away from the city center. Deng, Gyourko, and Wu (2015) document that housing supply dramatically increased within most Chinese cities during the 2004–2014 period. These supply changes help limit the growth of housing prices for a given change in income. Deng et al. (2015) further document that there has been a rapid increase in some Chinese cities in the share of unsold inventory held by developers (out of total housing sales volume). For example, in 2014, developers in Shanghai had inventories accounting for over 200% of annual housing sales volume. These excess inventories, they argue, suggest that housing prices in these cities may fall if demand does not sufficiently increase.

### Model of Housing Prices: Bounded City, Within-City Amenities, and Fixed Homogeneous Population

Supply constraints are not the only way to generate a relationship between property price growth and income growth. Many urban models can generate such a link, even when housing supply is perfectly elastic. However, in these models, there is some amenity within the city that makes some land within the city more desirable than other land within the city. Early iterations of the literature focused on production amenities within the city. In particular, the work of Alonso (1964), Mills (1967), and Muth (1969) all focused on commuting costs as the production amenity. In these models, individuals value living closer to their jobs so as to forego commuting costs. In recent work, Guerrieri, Hartley, and Hurst (2013) and Diamond (2015) emphasize the importance of consumption amenities provided by cities and neighborhoods within cities. For example, Guerrieri et al. (2013) assumes individuals get higher utility from living around richer neighbors given the externalities they generate (better schools, lower crime, more restaurants, etc.).

To illustrate that housing prices are related to income changes even in a world where there are no supply housing constraints, we can make one small adjustment to our base model above. To make our point, I highlight the model with a center city where the jobs are located and transportation costs. In particular, assume the household's budget constraint is now represented as:

$$c(i) + R(i) h(i) - \tau i = Y$$

where  $\tau$  is a per unit transportation cost. Again, we will stick with the normalization that the center city (i.e., jobs) is designated by neighborhood  $i = 0$ . If households live away from the center city, they have to pay  $\tau i$  units in commuting costs. Given the household optimization and the indifference condition needed for spatial equilibrium, the equilibrium housing price in each neighborhood can be expressed as:

$$P(i) = \frac{[Y - \tau i]^{(\alpha+\beta)/\beta}}{[Y - \tau I]^{(\alpha+\beta)/\beta}} \kappa$$

where  $I$  is the boundary of the city. In this case, the boundary is endogenous. No one would want to live at  $I + \epsilon$  if they could live at  $I$  at the same rental price if  $I + \epsilon$  has a higher transportation cost. The transportation cost makes people want to live close to the city center. At  $i = I$ , the competition among builders implies that housing prices are just equal

to the construction cost of housing ( $\kappa$ ). At any  $i < I$ , housing prices are higher than  $\kappa$  because of the amenity of lower commuting costs.

The equilibrium city size is given by:

$$I = Yf(N, \tau, r, \kappa, \alpha, \beta)$$

where  $f(\cdot)$  is a function of the other model variables. The function is messy and as a result I did not write it out fully. However, the key is that it is linear in income. As income increases, the size of the city will expand. As seen from the above equations, an increase in income will shift up housing prices in all neighborhoods. The exact amount housing prices will increase by is a function of the model parameters. However, even in a model with perfectly elastic housing supply, house price growth and income growth will be related. The key is that if households value some part of the city more than others (because of small transportation costs or because of other consumption amenities provided by that neighborhood), income growth and house price growth will be related.

### Discussion of Paper

The paper provides an excellent set of facts documenting housing price dynamics in Chinese cities. However, after reading the paper I find it hard to interpret (a) why prices have risen and (b) whether the prices reflect fundamentals or whether they represent bubble conditions. By benchmarking house price growth against income growth, the authors are implicitly assuming that income growth is the fundamental driving housing price changes and that housing supply is perfectly inelastic.<sup>2</sup> This is akin to the model outlined above. However, as I read the paper, a bunch of questions entered my mind. In particular, is there any evidence that housing demand is outpacing housing supply within Chinese cities? The paper offers no descriptive data on the supply side of the housing market in Chinese cities. If housing supply is constrained, how is it constrained? Are the constraints due to the fact that land is owned by the public sector and they are releasing it slowly? Are the constraints due to the fact that there are migration restrictions or labor market restrictions that prevent workers (or firms) in high-priced cities from moving to lower-priced cities? What will happen to housing prices when these housing supply constraints are relaxed? As discussed in the paper, the local Chinese governments use land sales to raise revenues. Will a reform of the tax system in China cause a property price



collapse because the incentive to hoard land by public officials would be diminished? Is it really income growth that is causing the fundamental increase in housing demand? There is some discussion of property being used as storage device for household saving. If that is true, limited options for other saving channels may be propping up housing demand in China. If there is financial liberalization in China, would that trigger a collapse in the demand for housing in China, which would cause property prices to plummet? Last, how are amenities changing in Chinese cities? Are these amenities the factors that are determining housing price changes? Are the amenities positive (more restaurants, entertainment options, etc.) or negative (more pollution, more congestion)?

As I read the paper, I enjoyed the descriptive facts. However, I am not sure what to make of them given there is no real framework allowing one to evaluate why housing prices are changing. Without such a framework, I am not sure there is a way to tell whether housing prices in China are overvalued, undervalued, or valued just right. This makes many of the claims in the paper—particularly with respect to future house price dynamics—speculative.

### **Cross-Country Relationship between Income Growth and House Price Growth**

Again, the paper asserts that income growth is a good benchmark for house price growth. If that is true, we should be able to see the close relationship between house price growth and income growth within a wide set of countries. To explore this, I used data from the Federal Reserve Bank of Dallas's International House Price Database. The database includes quarterly house price and per capita personal disposable income series for a number of countries. All of the data series begin in the first quarter of 1975. The database includes both real and nominal values where real values are computed using each countries' personal consumption expenditure deflator.<sup>3</sup>

Table 1 shows the cumulative real house price growth and the cumulative real per capita income growth between 1975:Q1 and 2014:Q4 for all countries in the database. Over the 40-year period, is there a systematic relationship between per capita income growth and house price growth for the countries in the Dallas Fed database? The answer is mixed. The countries in table 1 are sorted by their cumulative per capita disposable income growth during the entire period. Countries

**Table 1**

Real House Price Growth and Real Per Capita Disposable Income Growth, 1975Q1–2014Q4

Country	Cumulative Real Per Capita Disposable Income Growth	Cumulative Real House Price Growth	House Price Growth/ Income Growth
South Africa	0.13	0.19	1.46
Netherlands	0.26	0.79	3.04
Spain	0.27	-0.25	-0.93
Belgium	0.32	0.99	3.09
Denmark	0.37	0.48	1.30
Italy	0.37	-0.01	-0.03
New Zealand	0.38	0.80	2.11
Switzerland	0.47	0.34	0.72
France	0.50	0.89	1.78
Canada	0.52	0.91	1.75
Germany	0.52	-0.01	-0.02
Australia	0.53	1.21	2.28
Sweden	0.56	0.59	1.05
Japan	0.60	-0.20	-0.33
United States	0.63	0.46	0.73
Ireland	0.71	1.19	1.68
Finland	0.75	0.66	0.88
United Kingdom	0.76	1.21	1.59
Norway	0.92	0.94	1.02
Israel	0.99	0.94	0.95
Luxembourg	1.09	1.60	1.47
South Korea	1.53	0.13	0.08
Croatia	2.58	0.08	0.03

Note: Data downloaded from Federal Reserve Bank of Dallas's International House Price Database.

like South Korea and Croatia experienced massive per capita income growth, yet housing prices were roughly constant over the entire 40-year period. Both of these countries, however, experienced large housing price cycles during the 40 years with large house price growth followed by large house price declines. Similar patterns are found in Spain, Italy, and Japan. These patterns are consistent with the elastic supply model developed above. Despite rapid income growth, Germany house prices have been falling consistently since the fall of the Berlin Wall.

Conversely, for many countries, disposable income growth and house price growth tracked each other closely. These countries include the Scandinavian countries (Denmark, Sweden, Finland, and Norway),

the United States, Israel, and Switzerland. These patterns could be consistent with either the constrained supply model or the spatial model with within-city urban amenities. For other countries like Canada, Australia, New Zealand, the United Kingdom, Belgium, and France, real house price growth far exceeded disposable income growth.

My reading of the data is that there are very little systematic patterns between house price growth and disposable income growth over long periods of time within countries. Will China—in the long run—resemble South Korea, Japan, or Croatia? Or will China resemble the United Kingdom, Canada, or Luxembourg? These patterns reinforce my main point that without a richer discussion of what is determining housing prices, it is hard to make predictions about whether China's housing price growth is sustainable or not.

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## Endnotes

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1. For ease of exposition, I will only consider steady states. As a result, time subscripts will be suppressed in all subsequent notations.
2. After my initial comments discussing the paper, the authors have now made this assumption explicit in a paragraph in section VI.
3. The data can be downloaded from <http://www.dallasfed.org/institute/houseprice/>.