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BACKWARD-BENDING NEW HOUSING SUPPLY CURVE: EVIDENCE FROM CHINA

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ABSTRACT

This paper tests the existence of a backward-bending housing supply relationship in China, and estimates price elasticities of new housing supply for 35 major Chinese cities. Based on the panel data model of 35 cities, it is found that the response of housing supply to price change is relatively insensitive in China, and the supply elasticities have decreased with the rise in housing price. As a result, the remarkable increase in housing price in China can be at least partly attributed to inelastic housing supply. The results from this paper may inform Chinese government to take effective measures to reduce the large amount of idle land so as to increase the new housing supply.

Keywords: backward-bending housing supply relationship; price elasticies of housing supply; China

INTRODUCTION

Since the abolition of welfare housing allocation in 1998, there has been a considerable price appreciation in China's real estate market, with the annual average growth rate of housing price from 1999 to 2008 reaching as high as 7.3% (China Statistical Yearbook, 2009). As a result, housing affordability in China has become a pressing social and economic issue in recent years. In some large cities, the ratios of property value to annual gross household income have exceeded 10, much larger than those in western countries (Stephen, Lennon, & Winky, 2007).

What has caused the escalation in housing price in China? Existing studies have attempted to answer the question from different perspectives. Chen et al. (2011) found that the growth in urban household income contributed to the increase in housing price in the whole country, and urbanization level and the number of floating population were positively related to housing price in inland provinces. Wang et al. (2011) examined the linkage between urban economic openness and property prices based on the quality of life theory and Balassa-Samuelson (B-S) effects, using panel data of 35 large Chinese cities. Their research demonstrated that urban economic openness accounted for about 15.9% of the housing price appreciation from 1998 to 2006. Wang (2011) developed a theoretical framework to examine how the privatization of housing assets that were previously owned and allocated by the state affected the housing prices in equalization. Her empirical research suggested that housing reform in China have alleviated price distortion, thus allowing households to increase their consumption of housing and leading to a rise in equilibrium housing prices. These studies have paid more attention to the factors causing the increase in demand when explaining the surge of housing price in China. By notable contrast, very few researches have converted emphasis to supply-side factors.

Rising demand leads to rising price under inelastic housing supply. For, example, Vermeulen (2008) found that influenced by government intervention in land and housing markets, Dutch housing supply was almost fully inelastic, and that had contributed significantly to remarkably high level of house price. In July 2011, a report that cited statistics from the Ministry of Land and Resources showed that, by the end of 2010, a total of 11,944 hectares of residential land had been left standing idle in China, amounting to one tenth of the quantity of annual land supply (Xinhua News, July 28th, 2011). Calculated by a floor area ratio of 2 90 square meters per unit, there would be an increase of 2.7 million units of housing if these lands are developed. Given the situation, it would be reasonable to suspect that the response of housing supply to price change might be insensitive in China, and that can be a source of the rapid growth in real estate prices.

Supply curves are generally upwards sloping as suggested by classical microeconomic theory, i.e. the correlation between price and supply is positive. However, some researches have provided the theoretical justification and

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empirical evidence for the feasibility of a backward-bending housing supply curve (Mayo & Sheppard, 1991, 2001; Pryce, 1999), which means housing supply might become negatively related to housing price when housing price rises above a certain level. If the backward-bending supply relation indeed exists, the price elasticities of housing supply can be quite low or even negative when price is quite high, which represents a sluggish response of housing supply. Hence through testing the existence of a backward-bending housing supply relationship, the responsiveness of housing supply can be examined. This paper seeks to test the existence of a backward-bending housing supply relationship in China, and estimate housing supply elasticities for 35 major cities. It is expected that the results can shed new light on the source of the rapid growth in the housing price in China. Section 1 reviews literature on backward-bending housing supply relationship, the estimates of housing supply elasticities, and the impact of land supply on housing supply. Section 2 explains the methodology and the panel data of 35 cities used for estimation. Section 3 presents the empirical results. Section 4 offers concluding comments.

LITERATURE REVIEW

Backward-bending Housing Supply Relationship

Mayo and Sheppard (1991, 2001) first provided the theoretical justification for the backward-bending housing supply curve through the analysis of developers' decision-making process. They suggested that for an individual developer, both the profit from immediate development (π_0) and the value of vacant land (V_0) can be viewed as a monotonically increasing function of the housing price (P), developers won't provide housing unless π_0 is greater than V_0. If the increase in V_0 from the housing price growth is greater than the increase in π_0 (i.e. $\partial V_0 / \partial P > \partial \pi_0 / \partial P$) in the neighborhood of P_0 (where $V_0 = \pi_0$), an individual developer would offer zero supply when price rise above P_0. Figure1 provides the illustration for the situation. When $P < P_0$, an individual would choose to develop the land, when $P = P_0$, he would be indifferent between developing the land and leaving it idle, when $P > P_0$, he would choose to leave it vacant. Thus P_0 can be viewed as a cut-off price, and for each developer, there would be such a cut-off price.

Figure 1 An individual developer's housing supply decision

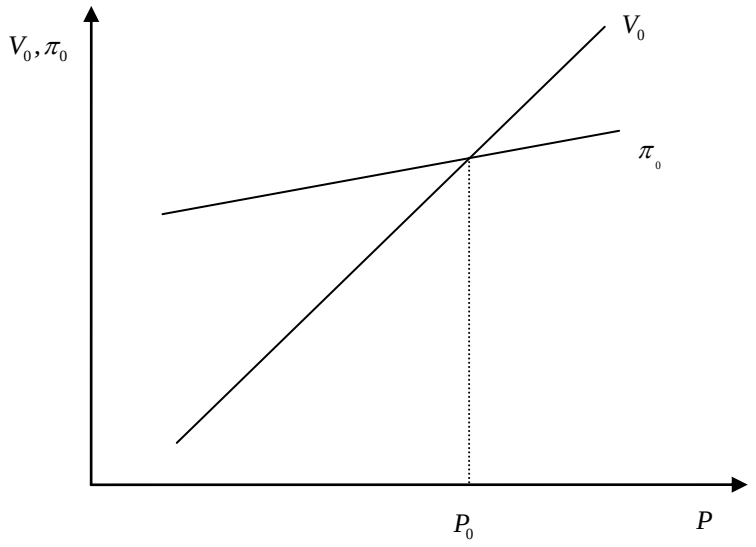
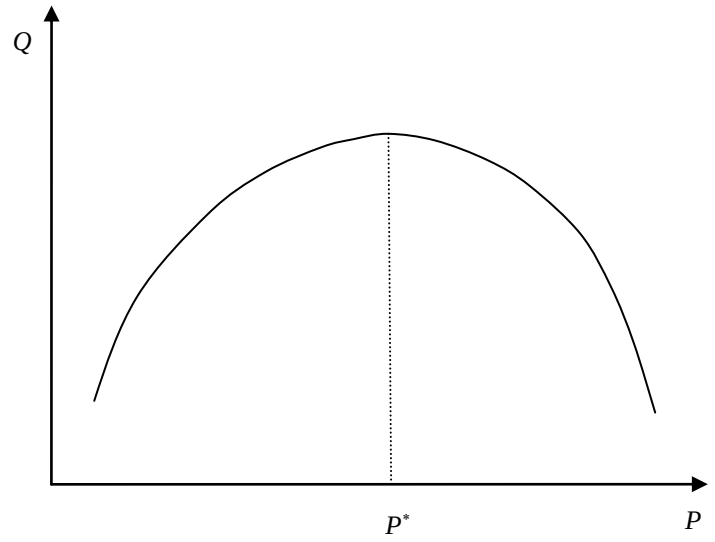


Figure 2 illustrates the situation for the whole house-building industry. Initially, housing supply in the market (Q) is positively related to housing price (P). As the price rises, some developers would choose to reduce their housing output towards zero, and with the further price increase, more and more developers would follow their steps to hold land vacant. Thus it can be observed that when housing price rises to a level higher than P^*, housing supply would become negative related to the price, namely backward-bending housing supply relationship. In this case, the price elasticities of housing supply can be quite low or even negative when price is quite high, so the existence of backward-bend supply relationship can be taken as an evidence of inelastic housing supply.

Another explanation of backward-bending housing supply curve was provided by Pryce (1999). His analysis was based on Evans' point that developers would be likely to hold land vacant if they could foresee that housing price is likely to decrease. Assume that suppliers' expectation about future price is based on past price behavior which has followed a strong cyclical pattern, then in period t, it is conceivable for the developers to expect a decrease in price in period $t + \delta$,

where δ represents the delay between the start and completion of a house structure. Thus the number of starts can be negatively related to current prices during a boom. To test the backward-bending supply relationship, Pryce developed a cross-sectional model using data at English local authority district level, and found that housing supply "bends backwards" during the boom period.

Figure 2 Backward-bending housing supply curve



In different perspective, from the Cobweb Theorem, Ge (2004) and Ge, et al. (2006) developed a generic system for predicting discontinuous changes in housing prices for Hong Kong using cusp catastrophe theory. In her model, vacancies are assumed a proportion of total supply of housing in a stable market system. Since a time lag between the decision to start work and the date of building completion for housing, the lag supply may not meet the increase in demand for housing and leads to a higher price of housing in the short term. Alternatively, if there is a sharp decrease in demand, housing price fall and the lag supply increases because of expectations of supply. Vacant housing may be increased suddenly and supply curve becomes "backward-banding".

The Estimates of Housing Supply Elasticities

Existing studies focus on two basic approaches to estimate the price elasticity of housing supply: the structural approach (where supply is generally expressed as a function of housing price and input prices) and the reduced form approach (which estimates supply elasticity indirectly).

Follain (1979) expressed the quantity of new housing construction as a function of housing price and input prices. The null hypothesis in his study is that housing supply is infinitely elastic. In that case, the long-run equilibrium quantity is determined entirely by demand, and housing price and input prices would not directly affect the quantity of new housing supply. Using aggregate annual data for American housing market, the empirical results showed that there is no significant positive relationship between housing price and quantity supplied, and failed to refute the hypothesis of completely elastic housing supply. Poterba (1984) considered the impact of credit rationing and used an asset market approach to model the housing supply. He regressed the investment supply against real house price, the real price of alternative investment projects, real construction wages and net deposit inflows into savings and loan institutions (as a measure of credit availability). He estimated alternative linear models which produced elasticities raging from 0.5 to 2.3. Topel and Rosen (1988) examined whether the current asset prices are sufficient statistics for housing investment decision. Their model was based on dynamic marginal cost, and the estimated short- and long-run supply elasticities were 1 and 3 respectively. Differing from previous studies, DiPasquale and Wheaton (1994) and Mayer and Somerville (2000) incorporated the land market into theoretical structure. DiPasquale and Wheaton (1994) indicated that new construction only occurs when the current housing stock differs from the long-run equilibrium level (which depends on housing price and input prices). They estimated a stock-adjustment model which includes housing price, lagged housing stock and various input prices as independent variables, and the estimates of price elasticities ranged from 1 to 1.2. Mayer and Somerville (2000) estimated new housing construction as a function of changes in housing prices and costs rather than as a function of the levels of those variables, their study reported a stock elasticity of about 0.08 and a flow elasticity of about 6.

Malpezzi and Maclennan (2001) drew inferences about supply elasticities based on housing demand parameters from the literature. According to a three-equation flow model of the housing market they developed, the price elasticity of housing supply can be expressed as a linear combination of the income elasticity of housing price and the elasticities of demand with respect to housing price and income. They estimated the reduced form equation of housing price to get the income elasticity of housing price first, and then calculated supply elasticities based on the assumption about he elasticities of demand with respect to housing price and income. Given housing's durable nature, construction lags and significant transaction costs, the underling assumption embedded in the flow model that all adjustment takes place in a single year may not be true, hence they also developed a stock adjustment model to estimate income elasticity of housing price and the supply elasticities. According to the flow model, in the prewar United States price elasticities of housing supply were between 4 and 10, postwar they were between 6 and 13. In the prewar UK supply elasticities were between 1 and 4, postwar they were between 0 and 1. Stock adjustment models yielded different elasticities, ranging from 1 to 6 for the United States, and from 0 to 1 for the UK. Harter-Dreiman (2004) also used the results from estimation of the reduced form equation for housing price along with assumptions regarding income and price elasticities of demand to draw inferences regarding the long-run supply elasticities, in spirit related to Malpezzi and Maclennan's. The distinguishing feature of her study is the vector error correction (VEC) approach, which is used to examine the relationship between house price and personal income and estimate a three-equation model of those two variables. Utilizing a panel data set consisting of 76 metropolitan statistical areas in United States from 1980 to 1998, the research reported that supply elasticities were between 1.8 and 3.2.

It is noteworthy that little work on housing supply has been done outside the United States. Given the institutional features affecting housing market outcomes vary a lot from country to country, more efforts on the estimation of supply elasticities in other countries would be necessary.

The Impact of Land Supply on Housing Supply

It is quite common for the governments to exert control over the supply of residential land through land use planning. For example, in many countries, change in land use requires government approval. Furthermore, governments can directly control the flow of new land available for development, which is what happens in Hong Kong and Mainland China. In Hong Kong, government is the sole owner of the territory, who leases land to private developers. In Mainland China, rural land is collectively owned by peasants, while urban land is owned by the state. The municipal governments, as a representative of the state, sell the urban land-use rights to developers for a fixed period through auction, tender, or negotiation. Peng and Wheaton (1994) proposed two theories to explain the correlation between government's land supply and housing supply. The "myopic" theory suggests that land supply should be positively related to housing supply, as an increase in land supply enables developers to get the land they need to complete desired housing production. On the contrary, the "rational" theory argues that housing production mainly responds to variation in housing prices rather than that in land supply, so more restrictive land supply won't alter housing production in the shot run. In the long run, when the market returns to equilibrium, higher housing and land prices encourage the substitution of capital for land and hence raise the density of development. They developed a stock-flow housing model using time series data of 1965 to 1990 for Hong Kong, and found that restrictive land supply led to the rise in housing prices but not lowered housing supply. Zheng (2008) developed a panel data model of housing supply, using provincial data of China, and found that 1-year and 2-year lagged land supply had significant effects on housing supply, 1-year lagged land supply had significant effects on housing price.

METHODOLOGY AND DATA

Based on the provided literature, a model that reflects the relationships between housing supply and housing prices can be developed first. The developed model is then tested by empirical study for the China real estate market. The results from the test then can be discussed.

Compared with the traditional regression model of housing supply, where housing supply is expressed as a function of the level of house price or the change in house price (Follain,1979; Poterba,1984; DiPasquale and Wheaton,1994; Mayer and Somerville, 2000).The existence of backward-bending supply relationship can be tested by including a squared term for price in the model. As mentioned in the section of literature review, government's land supply might have significant effects on housing supply, thus we include land supply as one of the independent variables. Estimation equation takes the following form:

$$Q_{it} = \alpha_0 + \alpha_1 P_{it} + \alpha_2 P_{it}^2 + \alpha_3 LS_{it} + \alpha_4 LS_{it-1} + \alpha_5 LS_{it-2} + \varepsilon_{it} \quad (1)$$

where Q_{it} is the quantity of new housing supply at city i in year t, P is the real house price, LS is the quantity of government's residential land supply, LS_{t-1} and LS_{t-2} are one-year and two-year lagged land supply respectively. α_{0-n} is the coefficients. The price elasticities of housing supply can be calculated as:

$$E_{it} = \partial Q_{it} / \partial P_{it} = \alpha_1 + 2\alpha_2 P_{it} \quad (2)$$

If the backward-bending supply relationship exists, estimation results would show that the supply curve is concave, with a significant negative coefficient on the squared term for housing price. The cut-off price above which housing supply would become negative related to the price can be calculated by making the first-order partial derivative with respect to price equal zero:

$$\partial Q_{it} / \partial P_{it} = \alpha_1 + 2\alpha_2 P_{it} = 0 \quad (3)$$

$$\Rightarrow P_{it} = -\alpha_1 / 2\alpha_2$$

For example, assume α_1 equals 100 and α_2 equals -1, then the estimate of the cut-off price would be 50, which indicates that when housing price reaches a level higher than 50, the correlation between housing price and housing supply would become negative.

Data

Panel data of 35 major Chinese cities from 1999 to 2008 will be utilized in the empirical research. The 35 cities are 4 municipalities directly under the central government (Beijing, Tianjin, Shanghai and Chongqing), 22 capital cities of provinces and autonomous regions, and 5 sub-provincial cities which are not provincial capitals (Dalian, Qingdao, Ningbo, Xiamen, and Shenzhen).

Chain price index and average housing prices for each of the 35 cities can be obtained from China Real Estate Statistics Yearbook (CRESY) and China Statistical Yearbook (CSY). To calculate the real house price, we convert the chain price indexes to fixed-base indexes (normalizing the index to 1 in the chosen base year 1999) first, and then for each city, multiply the index value in each year by the average housing price in 1999. The quantity of new housing supply and government's residential land supply are collected directly from CRESY and CSY respectively. Table 1 presents the variable definition and descriptive statistics for the variables involved.

Table 1: Variable definition and descriptive statistics

Variable	Definition	Source	Mean	Std. Dev.
Q	The quantity of new housing supply	CRESY	604.86	555.58
P	Real house price	Authors' computation	3877.13	2063.46
LS	The quantity of residential land supply	CSY	380.35	362.55

EMPIRICAL RESULTS

Table 2 presents the estimation results for the housing supply model. The value of adjusted R^2 is around 91%, the probability of F-Statistic is *0*, suggesting a reasonable explanatory power of the model. The negative coefficient on the squared term for housing price has a significant t-value, offing a clear evidence of supply curve being concave. The quantity of government's land supply and its lagged value have significant positive effects on housing supply, consistent with the "myopic" theory proposed by Peng and Wheaton. It can be calculated that the cutoff price is 9796.82 yuan, within the sample range of real house price (sample maximum for P_{it} *is* 11648 yuan).

Table 3 reports estimates of city-specific price elasticities of new housing supply in 1999 and 2008. The findings suggest that new supply of housing is relatively inelastic in 35 cities in China. The elasticities range from 0.05 to 0.35 in 1999 and from -.13 to 0.31 in 2008. As mentioned previously, a substantial amount of land being left idle might be one of the major causes of the inelastic housing supply in China. According to the statistics from the Ministry of Land and Resources, 60 percent of the idle land has been left unused due to government-related causes. When the developers acquire the land from the municipal governments, some land have been ready for development (electricity, water supply and paved roads are accessible, the ground has been leveled), whereas some land still have some old buildings left on site. To initiate development programs on theses land, developers have to demolish old houses and relocate the former residents first, which can be difficult and time-consuming and often induce sever delay in housing projects. Governments' planning adjustment can also cause delay in property development. The floor space ratio or building density for the residential land might be changed, sometimes even the residential use can be converted to make way for the municipal construction. Apart from the government-side factors, developers' land hoarding also contributes to the increase in the amount of idle land. Many developers prefer to keep the land undeveloped until its value has risen significantly, then they can choose between developing it and reselling it. For example, a parcel of land only 4

kilometers away from Beijing's CBD was acquired by China Resources Land in 2005, after left vacant for 6 years, the land price per floor area has increased from 5067 yuan/sq^2 to around 20000 yuan/sq^2 (Li, 2011). If the land was resold by the developer, a profit margin of 300% can be obtained.

Table 2: Estimates of new housing supply of 35 major cities in China, 1999-2008

	Dependent variable: new housing supply			
Variable	Coefficients	Std. Error	t-Statistic	Prob.
Constant (C)	-845.7525	73.64980	-11.48343	0.0000
P	0.419304	0.029020	14.44870	0.0000
P^2	-2.14E-05	2.21E-06	-9.677567	0.0000
LS	0.296708	0.048532	6.113658	0.0000
LS_{t-1}	0.137698	0.052727	2.611512	0.0096
LS_{t-2}	0.253735	0.049937	5.081113	0.0000
R^2	0.924441	F-Statistic	75.28999	
Adi.R^2	0.912162	Prob.(F-Statistic)	0.000000	

Table 3: Estimates of city-specific price elasticities of new housing supply

City	E(1999)	E(2008)	City	E(1999)	E(2008)	City	E(1999)	E(2008)
Beijing	0.08	-0.08	Ningbo	0.29	0.13	Nanning	0.31	0.26
Tianjin	0.27	0.18	Hefei	0.31	0.27	Haikou	0.28	0.23
Shijiazhuang	0.34	0.31	Fuzhou	0.25	0.19	Chengdu	0.28	0.21
Taiyuan	0.3	0.26	Xiamen	0.16	0.04	Guiyang	0.33	0.3
Huhehaote	0.35	0.31	Nanchang	0.34	0.28	Kunming	0.29	0.27
Shenyang	0.32	0.25	Jinan	0.3	0.24	Chongqing	0.35	0.31
Dalian	0.25	0.18	Qingdao	0.32	0.21	Xian	0.3	0.26
Changchun	0.31	0.28	Zhengzhou	0.3	0.27	Lanzhou	0.33	0.29
Haerbin	0.31	0.27	Wuhan	0.29	0.22	Xining	0.33	0.3
Shanghai	0.23	0.07	Changsha	0.32	0.28	Yinchuan	0.34	0.31
Nanjing	0.29	0.21	Guangzhou	0.1	0.04	Wulumuqi	0.32	0.29
Hangzhou	0.23	0.07	Shenzhen	0.05	-0.13			

The second finding is that elasticities of all 35 cities have been declined from average 0.27 in 1999 to 0.21 in 2008. This implies that the willingness of providing housing was further declined for the period, and the more and more sluggish response of new housing supply have contributed to the rapid increase in housing price.

Third, Beijing and Shenzhen, among other cities, are shown negative elasticities in the year 2008, -0.08 and -0.13 respectively. Although there was an upward trend in the amounts of new housing start in the two cities in the early 2000s, the quantities have decreased considerably from around 2004 to 2008. In Beijing, the quantity of new housing supply declined from 22.07 million square metres in 2004 to 15.65 million square metres in 2008. In Shenzhen, the quantity went down more notably, from 9.82 million square metres to 4.72 million square metres with an annual decrease rate of 13%. Apart from negative elasticities, near zero easticities are reported for the city of Shanghai and Hangzhou, which also implies rather inelastic housing supply in the two cities.

It is also found that the estimates of supply elasticities in China generally as a whole are much lower than those for US (ranging from 0.5 to 13) and those for UK (ranging from 0 to 4, Table 4). One plausible explanation for this is that rural-urban land conversion is strictly restricted in China, thus the new land available for housing development is very limited, which would adversely affects the responsiveness of the housing supply. Mayo and Sheppard (1996) examined the housing supply in three rapidly growing countries, also found that the countries with more restrictive planning systems had smaller supply elasticities. Apart from Beijing, Shenzhen, Shanghai and Hangzhou, the range of supply elasticities of cities in China are from 0.18-0.35 which are coincided with the literature (Potarba, 1984; Harter-Dreiman, 2004).

Table 4: Estimates of price elasticities of new housing supply for US and UK

Author	Country	Supply elasticities
Poterba (1990)	US	0.5 to 2.3
Topel and Rosen	US	1 (short run), 3 (long run)
DiPasquale and Wheaton	US	1 to 1.2
Mayer and Somerville	US	0.08 (stock elasticity), 6 (flow elasticity)
Malpezzi and Maclennan	US	4 to 10 (prewar), 6 to 13 (after war)
Malpezzi and Maclennan	UK	1 to 4 (prewar), 0 to 1 (after war)
Harter-Dreiman	US	1.8 to 3.2

CONCLUSION

This paper tests the existence of a backward-bending housing supply relationship in China, and estimates price elasticities of new housing supply for 35 major cities. It is found that the response of housing supply to price change is relatively insensitive, and the supply elasticities have decreased with the rise in housing price. In particular, estimates of the supply elasticities for Beijing and Shenzhen are negative, those for Shanghai and Hangzhou are close to 0.

Recently, to curb soaring housing prices, China' s central government has issued a range of policies such as the property-purchasing limitations and regulations on home mortgage loan. However, the policy goals can't be achieved by merely restraining the demand. Governments also need to take effective measures to reduce large amount of idle land so as to increase the supply on housing market. It is essential for the planning authority to avoid unnecessary planning adjustment which can have adverse effects on property development. On the other hand, the policies aiming at regulating developers' land hording should be implemented more strictly.

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