The Impacts of Distance to CDB on Housing Prices in Shanghai: A Hedonic Analysis

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Abstract:

It is widely recognized that location is the primary determining factor of housing price. But to what extent the variation of housing price in Shanghai can be explained by the locational factor has not been empirically examined. In this paper, we examine the power of applying the hedonic method on the statistical analysis of housing price of Shanghai. The data we use covers all new commercial residential housings sold in Shanghai during July 2004 and June 2006. The focus in this paper is to examine the effect of geography distance to city centre on the selling price of residential housing in Shanghai. We also demonstrate the importance of applying quality control on the development of housing price index.

Key Words: Hedonic Analysis, Shanghai Housing Market, Price Gradient, Constant-quality Housing Price Index

1. Introduction:

Despite there is a burgeoning literature on China housing system and real estate market, most existing studies focus mainly on the macro process of housing market formation and housing policy reform (Quan, 2006). There is generally a lack of micro understanding of spatial distribution of housing price, especially how the housing price varies over the urban spatial pattern in Chinese cities. Also very little is know about what are the main determinants of the market value of a particular property. It is probably because detailed information of real estate prices is not generally publicly available in a disaggregated format.

Typically, real estate researchers learn about the spatial distribution of property price through applying hedonic techniques. Although hedonic study of housing price has been a standard analysis of real estate research worldwide, it is still almost an empty area in mainland China.

Two rare expectations are Yang (2001) and Yang & Shen (2006). Both are conducted for housing market in Beijing.

As the biggest city and the leading industrial centre in China, Shanghai's real estate market attracts far more interest than any other. Although Shanghai's 13 million residents represent less than 1% of China's 1.3 billion population and less than 3% of China's total urban population, its market value accounted for a lion's share as high as 22% of the country's whole real estate market value in 2005. Meanwhile, it is the most expensive housing market in China. At the end of 2006, the mean housing price for the whole Shanghai was 7038RMB/m^2 (1 US $ ≈ 8 RMB) while the price level in the city area of Shanghai stood well above 10,000 RMB/m^2. The relatively mature development of real estate market in Shanghai provides an ideal context to study the micro-determining process of housing prices.

In addition to estimate how the spatial distribution of housing prices, another key aim of this paper is to investigate how hedonic price method can be applied on developing a constant-quality housing price index in Shanghai. Right now nearly all housing price indexes in China are developed on mean-price method and do not have explicit quality control. It is straightforward to see that mean-price index is seriously biased in reflecting the true business trend in the housing market. In order to capture the real movement of demand and supply in the housing market, we must use constant-quality housing price index that can isolate the effects due to the over-time variations in location structure of housing supply. Hedonic price method is well known for its robust strengths in this respect and has been widely applied in a number of countries (OECD, 1997; Malpezzi, 2005). Since our data spans from July 2004 to June 2006 and is measured at monthly frequency, it suffices for the need of constructing a housing price index. We then can show how much differences in housing price index can yield with or without quality control.

The rest of this paper is organized as following: section 2 presents a brief of Shanghai housing market; section 3 gives the conceptual and empirical framework of our analysis; section 4 introduces the data sources and econometric model; section 5 contains the empirical results; finally, section 6 provides concluding remarks.

2. Background: Housing market in Shanghai

Residential dwelling was considered as welfare good but not commodity in China in the planned-economy era. Before 1978, most of people in urban China lived under the welfare housing system in which the government produced and allocated nearly free dwellings. However, the single-channel state budgetary funding housing finance system could not be sustained on economic terms. Due to the continued financial deficit, investment on urban residential housing was consistently kept at very low level.

Before the 1978 reform, residential dwelling storage was extremely serious in Shanghai: between 1952 and 1978, housing investment on average accounted for only 5.8% of gross

social investment in Shanghai; the accumulated increase of living space floor per capita over 27 years was a poor 1.2 m^2 (3.4 m^2 in 1952 and 4.5 m^2 in 1978). The acute situation of residential dwelling shortage in Shanghai did not get much improvement even after the economic reform. Between 1979 and 1997, the average annual salary of a worker in Shanghai achieved a three-fold growth (after taking account for inflation) (784 RMB in 1979 vs. 11425 RMB in 1997). But the living space floor per capita increased only from 4.5 m^2 to 9.3 m^2.

The 1998 reform lifted the welfare housing system and paved the largest obstacle for the development of a private real estate market. However, the Shanghai real estate market did not respond swiftly and a real estate boom did not arrive as expected. Instead, the market slumped into stagnancy between 1998 and 1999. The Shanghai city government even had to create a variety of methods to stimulate the home purchasing enthusiasm (Chen and Hao, 2006). The year of 2000 is the turning point. Since 2000, the Shanghai real estate market has shown a strong trend of rebound. Between 2001 and May of 2005, the market can be descried as scorching. The average prices of new commodity residential real estates continuously achieved double-digit growth rate over the previous year. There are people arguing that the fundamental strength of the Shanghai economy, alongside with low interest rates, were driving this phenomenon. However, quite a lot media and researchers attributed property speculation as the major reason for the volatile upswing of real estate prices in Shanghai.

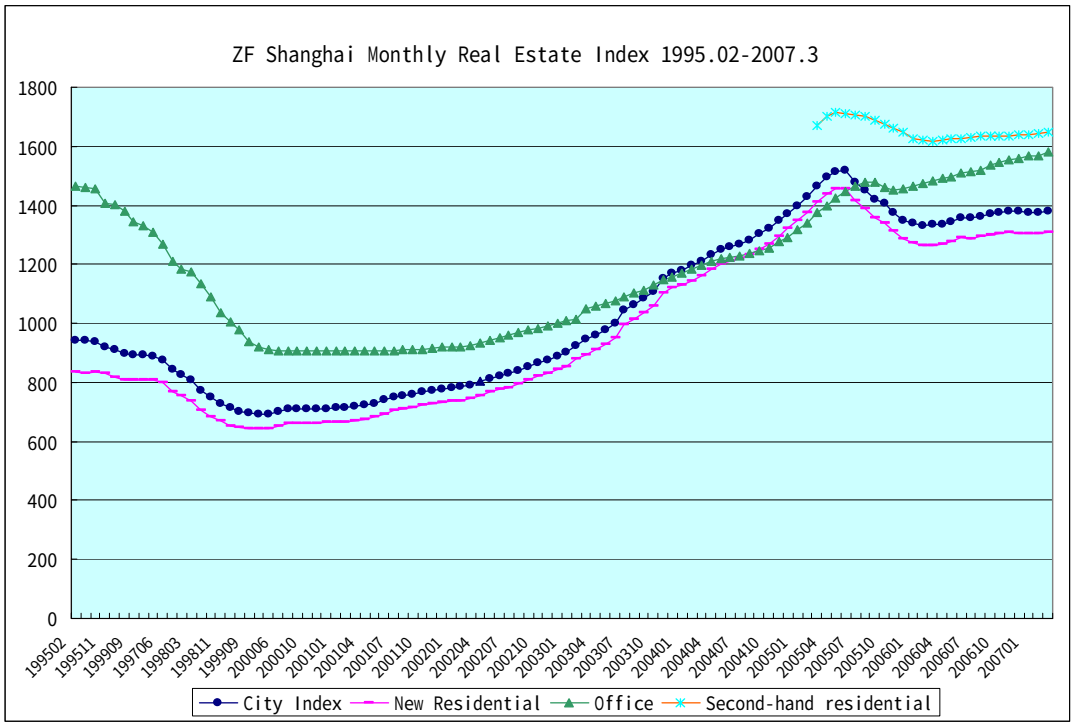
Table 1 The residential real estate market in Shanghai, 1995-2006

Year	Total construction space sold (10,000 m^2)	Growth rate (%)	Total value sold (100 million RMB)	Growth rate (%)	Unit Price (RMB/m^2)	Growth rate (%)
1995	536.31		132.83		2477	
1996	528.56	-1.4	156.90	18.1	2968	19.8
1997	617.02	16.7	178.35	13.7	2891	-2.6
1998	1056.77	71.3	319.76	79.3	3026	4.7
1999	1243.33	17.7	385.64	20.6	3102	2.5
2000	1445.87	16.3	480.97	24.7	3326	7.2
2001	1681.48	16.3	615.17	27.9	3659	10.0
2002	1846.38	9.8	739.89	20.3	4200	14.8
2003	2224.47	20.5	1109.86	50.0	4989	18.8
2004	3233.74	45.4	2064.74	86.0	6385	28.0
2005	2845.69	-12.0	1906.05	-7.7	6698	4.9
2006	2615.49	-8.1	1841.04	-3.4	/	/

Data source: Shanghai Statistical Yearbook, 1996-2006; Shanghai Real Estate Yearbook, 1997-2005.
Note: All the data regarding Shanghai information in this paper are obtained from Shanghai Statistics Yearbook (1996-2006) and Shanghai Real Estate Yearbook (1997-2005) if not noted.

The skyrocketing of real estate prices in Shanghai and also some other major cities in China appeared out of control in early 2005. This imposed severe threat to the financial stability and economic health of China economy. To cool down the apparently over-heated real estate market, the Chinese central government issued a series of new regulations. In spring 2005, the China cabinet decided to increase the interest rate and tighten the rules regarding down payments and real estate transactions. In a bid to crack down real estate speculation, a transaction tax was imposed at the effective rate of more than five percent of the house transaction price for sellers who have owned their properties for less than two years. Meanwhile, the Central Bank twice

raised interest rates on mortgages in 2005. After this series of heavy-hand punch, the Shanghai real estate market was brought to a notable cool-down and the price growth experienced a sharp halt since May 2005. Between May 2005 and April 2006, the real estate market struggled in recession, transaction volumes plummeted and price was on the down trend although the size of drop was small. When the real estate market in Shanghai and some other major cities in China exhibited renewed price vigour in the spring of 2006, the Central Bank responded promptly this time by a new increase in the mortgage rate in April 2006, sending out a strong signal of Chinese government's firm stand to stabilize the market and curb real estate bubble. The movement of housing price in Shanghai has been fairly stable since the middle of 2006.



Note: ZF (ZhongFang) real estate price index is complied by *China Real Estate Price Research College* and computed for each major city in China. Although not quality-adjusted, it is currently well-recognized as a leading indicator of China real estate market.

3. Conceptual and Empirical Framework

In the literature, there are several statistical methods to empirically analyze the housing price, for example, the mean/median price method (possibly combined with stratifying technique), the repeated-sale method, the hedonic price method, and the hybrid method. But the most popular one is the hedonic framework developed since Rosen (1974), which is widely applied not only in academic community but also commercial business (OECD, 1997; Malpezzi, 2005).

In Rosen (1974), housing is treated as differentiated goods in the sense that its market value is dependent on the vector of its characteristics. The theory of hedonic price functions laid down the theoretic foundation for the analysis of differentiated goods and each individual characteristic can be implicitly priced. Commonly, characteristics that important to the market value of housing are

classified into three categories: 1). Structural attributes i.e. building material, floor space, number of bedrooms and bathrooms, inner structure, age of dwelling, floor level, direction, outside appearance; 2). Neighborhood attributes i.e. dwelling maintenance and management service, parking, safety, surrounding parks and leisure facilities, composition of neighbors in terms of ethic, racial, age, educational background; 3). Locational attributes i.e. distance to CBD, travel and shopping convenience, accessibility to subway/underground and public transportation system.

This paper mainly discusses the importance of location attributes on housing prices. Location attributes are widely believed as the most important determents of cross-sectional variations in the housing prices. In many cases the distance to CBD alone account for a very large fraction of variations in housing prices. This is exactly what the classic model of bid-rent curve of housing prices (Alonso, 1964; Mills, 1967; Muth, 1969) has predicted for a monocentric city.

Though the economic theory outlined by Rosen (1974) provides a general framework for the analysis of housing price though hedonic price functions, the theory has not yet provided standard guidelines on empirical issues such as the choice of functional form and the selection of particular housing characteristics to be included in the hedonic price function (Epple, 1987). A long list of function forms have been proposed and tested, including parametric and non-parametric (Meese and Wallce, 1991). However, recent discussions on the identification of hedonic price function show that this issue is still open for further answer (Ivar etc, 2004). Maybe the most exciting breakthrough in hedonic price work during last few decades is the increasing interest and growing application of newly developed spatial econometric techniques (Wihelmsson, 2002). However, as this version of the paper is just a starting point of our research project, we ignore the issue of spatial effects for the moment.

It is common in the literature to consider the following model where the sale prices of housings are related to observable information about their attributes and transaction dates:

$$(1)\ \log \mathrm{V}_{it} = \mathrm{X}_{it}\beta_{it} + \mathrm{D}_{it}\gamma_{it} + \varepsilon_{it}$$

In this formulation, V_{it} is the price of housing i at time t, X_{it} is the observable characteristics of housing i at time t, D_{it} is the vector of time dummy. Correspondingly, β_{it} is the implicit hedonic price parameter of characteristics X_{it} and γ_{it} represents the time intercept coefficient. Linking the γ_{it} in a time series, we may get a hedonic/constant-quality index of housing price over the period under study.

Considering the time period of sample studied in this period is not long, which is only 2 years, we choose to apply a simple formulation of regression (1) where the vector of hedonic price coefficient assumed to be time-invariant. This assumption is quite reasonable since it is not likely that the location effect would change substantially just within 2 year time frame.

$$(2)\ \log \mathrm{V}_{it} = \mathrm{X}_{it}\beta + \mathrm{D}_{it}\gamma_{it} + \varepsilon_{it}$$

4. The Data and Econometric Model

Usually hedonic regressions are run on individual dwelling observations, where the prices of dwellings are linked to their locational and structural characteristics. Unfortunately, we do not have sufficient good-quality data of dwelling prices at this moment.

Nonetheless, the whole Shanghai housing market is administratively divided into 106 residential zones by the authority. Although each zone has a varying size of area, the zone neighborhood is relatively homogenous. The information of zone-level housing price and locational attributes are much easier to collect. As an illustration to show the usefulness of hedonic price method on the analysis of housing prices in Shanghai, we apply our hedonic regression on the zone-level data. Of course such result is really coarse and does not carry very useful policy and business implication. However, it is still of the interest to investigate whether there is a clear pattern of housing price and location attributes from aggregated data, on assumption that the zone neighborhood is fairly homogenous and ignoring the dwelling-level characteristics will not bias the coefficient parameters of zone-level characteristics too much. Meanwhile, as stated in the introduction, another purpose of our study is to develop a constant-quality housing price index. Our data has the potentials to meet this purpose.

The data we use in this paper contains monthly zone-average housing price spanning from July 2004 to June 2006. It also contain the distance to CBD (Shanghai Renmin Square, where the Shanghai municipality office is located) measured at zone-center, whether there is subway within the zone, conditions of public bus connection, and whether there is famous landscape located inside the zone. We use the values of these zone characteristics measured at the same time period of housing prices.

Figure 2: The Spatial Distribution of Zones in Shanghai

Note that the urban area of Shanghai is separated by three major rings outwardly: inner ring, middle ring and outside ring.

Figure 3: Indicating The Three Rings

Table 2 The Distribution of Zones by Ring Separation

Ring Separation	Within inner ring	Between inner and middle ring	Between middle and outside ring	Between outside ring and outskirt	Outskirt
Number of Zones	23	20	19	27	17

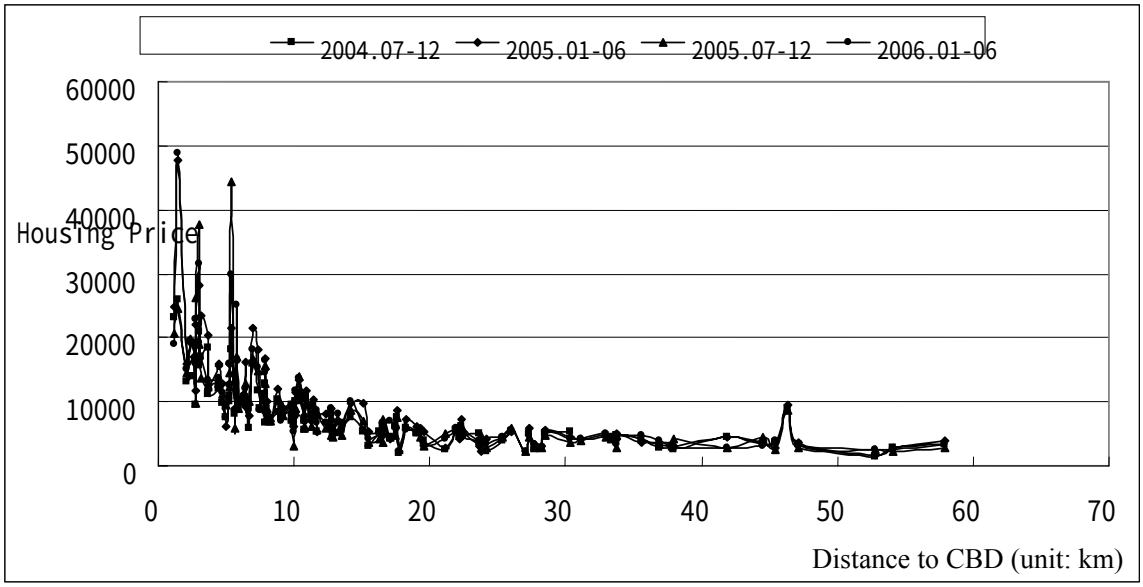
Totally, we have data of housing prices and locational characteristics on 106 zones that are observed for 24 months. Some zones have missing information for a few months. The description of data is found in Table 3.

Table 3 Data Description (N= 2412, Zone =106, T = 24 months)

Variable	Meaning (measured at zone level, monthly)	Mean	Std	Min	Max
lnP	Ln(unit price of apartment, RMB/m^2)	8.87	0.64	6.89	10.98
D	Distance to CBD (kilometers)	16.86	13.19	1.17	57.89
R_ok	Availability with subway	0.23	0.42	0	1
T_good	Good bus connection (more than 2 bus directing to the CBD)	0.32	0.47	0	1
T_good	Bad bus connection (no bus lines directing to the CBD)	0.53	0.50	0	1
S	Famous Scenic View	0.14	0.35	0	1

Before the formal econometric analysis, we can have an intuitive impression about how the zone-level housing price declines as the zone's distance to CBD increases from Figure 3. The price gradient pattern is very obvious. Zone-level housing price clearly drops as the zone is further way from the CBD. Meanwhile, one can find that the declining speed is especially sharp at the first 5 kilometers but slows after that.

Figure 3: The Distance Gradient of Housing Prices in Shanghai



The econometric model used in this paper is based on following equation:

$$\ln P = \beta_0 + \beta_1 D + \beta_2 D^2 + \beta_3 R\_ok + \beta_4 T\_good + \beta_5 T\_bad + \beta_6 S + u_2 \quad (3)$$

where D is the distance to CBD, which is measured at km; D^2 is the square of distance, included in the model as to capture the nonlinear relationship between prices and distance to CBD; the meaning of other variables is explained in Table 2.

Submarket

The primary characteristic of housing is its heterogeneity. Especially due to the spatial immobility of housing, *there are no two identical houses in the world.* House prices are influenced by a variety of land, structural, proximity, neighborhood and regional attributes. For this reason, some researchers argued that, housing market should be regarded as a uniform entity each within a city's urban area; rather, the housing market can be considered as comprised of a set of distinctive submarkets (Goodman & Thibodeau, 2003). In the case of Shanghai housing market, there is a strong indictor of submarket distinction based on the separation of inner and outside ring. Therefore it is of interest to test whether the submarkets exist and if yes, how the key parameters vary across different submarkets.

5. Empirical Results

We run hedonic regressions for the whole city as well as for two assumed submarkets; one is the submarket that contains all the zones within outside ring and another one submarket contains only the zones out of outside ring. The three regression results are reported in Table 4

Table 4 Hedonic Regression Results 1

Variable	All city	Within outside ring	Out of outside ring
D	-0.0527** (-31.78)	-0.0951** (-15.60)	-0.0153** (-4.23)
D^2	0.0005** (20.38	0.0021** (6.51)	0.0000 (0.08)
R_ok	0.2240** (23.08)	0.1966** (15.52)	0.2457** (10.81)
T_good	0.1778** (13.36)	0.1279** (7.70)	-0.0352 (-0.86)
T_bad	-0.0245* (-2.13)	-0.0117 (-0.75)	-0.0905** (-3.55)
S	0.2954** (23.33)	0.2509** (16.14)	0.6789** (7.23)
Constant	9.2593** (386.53	9.4990** (241.82)	8.8319** (152.94)
Wald chi2(4)	14233.86	3243.11	1157.41
Prob>chi2	0.0000	0.0000	0.0000
Log likelihood	-55.9916	-12.1557	-25.5161
Sample Size	2412	1412	1000
Number of groups	106	62	44
Time effect control	Yes	Yes	Yes

Note: figures in parentheses are standard variations of parameter coefficients.
** stands for significance at 1% level, * stands fro 5%.

From Table 4, for the city as a whole, we can say that the zone-level mean housing price on average drops 5% as the zone is one kilometer further away from the CBD, holding others equal. However, the dropping speed is much sharper within the outside ring that outside it. The coefficients of distance to CBD are statistically significant in all regressions.

Meanwhile, we find availability of subway increases housing prices very sharp. Conditions of bus connection also matters. Whether there is scenic view makes differences too. However, we also find the submarkets within and outside of outside ring have substantial quantitative differences in their coefficients of nearly all parameters, although the signs of coefficients are basically same. This finding reminds us that distinctive sub-segments exist in the housing market of Shanghai. Predictions that valid for some certain part of the Shanghai housing market may not hold for other parts of this market.

Further exploration: directional price gradient

Usually the literature assumes there is uniform price gradient pattern at any direction outward from the city center. However, this may not be true in real life. For example, Soderberg and Janssen (2001) examined the real estate market in Stockholm, Sweden and find asymmetric price gradient. People familiar with Shanghai also knows that the north part of urban Shanghai tends to be much richer and flourish than the north part. To formally examine whether and how much the price gradient varies at different directions, we estimate the following regression:

$$\ln P = \theta_0 + \theta_1 \mathrm{D\_east} + \theta_2 \mathrm{D}^2\mathrm{\_east} + \theta_3 \mathrm{D\_north} + \theta_4 \mathrm{D}^2\mathrm{\_north} + \theta_5 \mathrm{D\_south} + \theta_6 \mathrm{D}^2\mathrm{\_south} + \theta_7 R\_ok + \theta_8 T\_good + \theta_9 S + u_3 \quad (4)$$

Table 5 Hedonic Regression Results with directional price gradient

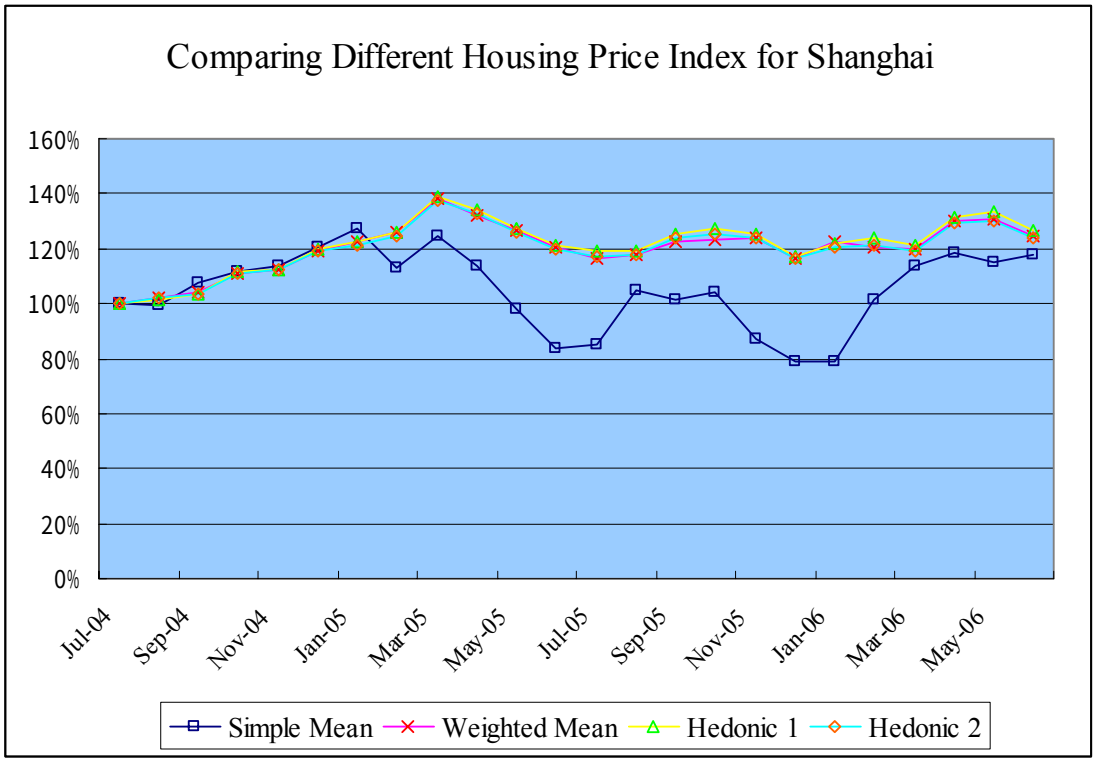
	D	D^2	R_ok	T_good	T_bad	S	Cons
East	-0.0676** (-8.86)	-0.0004 (-0.80)	0.1472** (11.90)	0.1321** (8.42)	0.0350* (1.91)	0.1706** (9.20)	9.4730** (250.93)
North	-0.1139** (-14.25)	0.0031** (5.23)					
South	-0.0232** (-3.10)	-0.0022** (-5.48)					
Wald chi2(9)=4288.58 Prob > chi2 = 0.0000, Number of obs=1412, Number of groups=62							

Note: figures in parentheses are standard variations of parameter coefficients. ** stands for significance at 1% level, * stands fro 5%.

Results presented in Table 5 suggest that the price gradient is flattest in the west direction, almost same flat in the south direction and sharpest in the north direction. This finding adds our knowledge on the spatial distribution of housing prices in Shanghai.

Hedonic price index

We develop four monthly housing indexes for the zone data of July 2004-June 2006. The first one is the simple mean housing price index, where the each month's mean price is obtained by dividing the city-level total sale price by city-level total sale space of that month. The Second one is created when each month's mean price is weighted for zone sale volume. Two hedonic price indexes are constructed: Hedonic 1 is just keeping control of the distance to CBD; Hedonic 2 adds additional controls of all variables included in the main regression model. The four monthly housing indexes are plotted below.



Using the weighted mean price index as the benchmark, we can see that simple mean housing index obviously overstates the market fluctuation and is seriously misleading. However, we did not see any significant disparity between hedonic price indexes and weighted mean price index. It is possible that two year frame is not sufficient to show the full power of hedonic method in constructing housing price index.

Conclusions

How housing prices vary with locational characteristics carry important policy and business implications. This paper provides the first attempt to do a hedonic analysis of housing price in Shanghai. Our results suggest that, for the city as a whole, the zone-level mean housing price on average drops 5% as the zone is one kilometer further away from the CBD, holding others equal. However, the dropping speed is much sharper within the outside ring that outside it. The coefficients of distance to CBD are statistically significant in all regressions.

Meanwhile, we find availability of subway increases the housing value very sharp. Conditions of bus connection also matters. Whether there is scenic view makes differences too. But there are also evidences that distinctive sub-segments exist in the housing market of Shanghai. We also find the price gradient pattern vary substantially at different direction outward from the city center. Finally, we show that hedonic price index can be a good option when constructing housing price index in Shanghai.

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