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學術論著

A Comparison between the Semi-parametric and Parametric CAMA Modeling of Court Auction Residential Housing Market in the Taipei Metropolitan Area*

特徵價格法之參數與半參數電腦輔助大量估價(CAMA)模型之研究－台北地區法拍屋住宅市場之實證分析*

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ABSTRACT

Court auction real estate in the domestic residential housing market has high rate of return, due to the fact that the auction price is always much lower than the market price. However, what is the price difference between the search and auction markets? What are the factors that affect the final bid price of court auction residences? This study will use the comparison between semi-parametric and parametric modelling to find out the relationship between the attributes of court auction residences in the Taipei Metropolitan Area from 2001 to 2003. In addition, this study also adopts the GIS system to find out which spatial factors affect the level of the final bid price on court auction residences. The empirical results show that the parametric approach might bring bigger price gap between the search market and the auction market, but that the use of semi-parametric modelling for measurement and prediction might narrow the gap. Similar results are obtained by adding spatial factors, in which case both semi-parametric and parametric modelling might reduce the gap. Overall, the semi-parametric modelling with or without spatial factors is better than parametric modelling.

Key words: the court auction residential house, semi-parametric and parametric modeling, computer assisted mass assessment (CAMA), bid price

摘　要

因爲大部分法拍屋價格低於市場價格，導致法拍屋有高報酬率，因而吸引投資者進入法拍屋市場。然而，法拍屋與中古屋房價之差異爲何？本文使用台北市2001年至2003年之法拍屋及中古屋資料，分別建立參數與半參數電腦輔助大量估價(CAMA)估價模型，找出影響房價之重要因素，另運用地理資訊系統將空間變數加入模型中，找出影響房價之空間變數。實證結果顯示以參數模型預測法拍屋與中古屋房價之差距較大，而以半參數模型預測法拍屋與中古屋房價之差距較小。另於模型中加入空間變數結果顯示，以參數模型與半參數模型預測法拍屋與中古屋房價之差距亦較小，顯示半參數模型較參數模型佳，且於模型中加入空間變數能更準確預測房價。

關鍵詞：法拍屋、半參數與參數模型、電腦大量估價、拍定價

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1. Introduction

In recent years, many countries have developed Computer Assisted Mass Assessment systems (CAMA) to be a tool for tax-assessment. The systems generally build valuation models, which apply the hedonic price parametric and nonparametric models. Several literature discuss the function forms for hedonic price parametric models, for example, Ridker & Henning(1967) estimated the effects of housing price by the degree of air pollution, Stull(1975), Li & Brown(1980), Thibodeau(1989), Clapp, Giaccotto & Tirtiroglu(1991) made a price index by using the hedonic price model.

In recent years, several studies have proposed the semi-parametric model. Additionally, the parametric model such as the hedonic price model is too restrictive in the problem for identifying function forms and estimating the parameters. It is important to seek for the fitting function forms. Otherwise, the wrong function forms will bring incorrect results. However, the nonparametric regression model and semi-parametric model can improve these drawbacks. There are several literature reviews for semi-parametric model function forms. These include references from researchers such as Pace(1995), Anglin & Genca(1996), Gencay & Yang(1996), Thorsnes(1998), Pavlov(2000), Clapp(2004) and Bin(2004) which proposed that the methods of semi-parametric estimators should combine the merits of parametric and nonparametric estimation. The semi-parametric models might have the function of linear, convex, or concave of curvilinear. And the semi-parametric models might need a few structures which have complicated estimation processes to produce a fitted model.

In our study we did a comparison between the semi-parametric and the parametric modelling to find the relation of the attributes of court auction residences in the Taipei Metropolitan Area from period of 2001 to 2003. In addition, we also adopted the GIS system with spatial factors in the level of final bid price on the court auction residences. The remainder of this paper contains three sections. The first section discusses the literature reviews. The empirical evidence is reported in the second section and the final section concludes this study.

2. Literature Reviews and Methodology

This is divided into three subsections. We first review the literature. In the second subsection, we show how the auction market works. In the concluding subsection, we establish the model frameworks.

2.1 Literature Reviews

There are several literature reviews for semi-parametric model function forms, for example, Pace (1995) showed that the OLS parametric estimators can attain well-specified models in efficiency. Meanwhile, the nonparametric estimators greatly reduce specification error, but at the cost of efficiency. However, the semi-parametric method can act as a compromise between them and obtain better estimators. Anglin & Gencay (1996) and Gencay & Yang (1996) recommended a

Box-Cox model in the specification of hedonic price models. However, the above parametric model involves implicit restrictions and they can be reduced by using a semi-parametric model. Thorsnes (1998) found out that the semi-parametric estimators combined the benefits of the parametric and nonparametric estimations. The semi-parametric models permitted the function to be linear, convex, or concave of curvilinear and sought for the best fitted model. Pavlov (2000) discussed that the nonparametric models can consider the important value of spatial variation. This had been previously ignored in hedonic pricing models. Clapp (2004) derived the local regression model with a semi-parametric approach to estimate a location value surface. They found that the semi-parametric approach can more accurately provide estimates as compared to the parametric approach. Bin (2004) extended the approach of Hastie & Tibshirani (1990) using the additive semi-parametric models with GIS and found it can be useful for measurement and prediction of housing sales prices. We show literature reviews of the semi-parametric approach as in Table 2-1.

2.2 How the Auction Market Works

In the literature review (see Table 2-2), we find that the auction market works on different rules of sales, and in most of the markets the sales rules follow the English auction-open called bid format, which is found in Australia, the U.S.A, and New Zealand. In Taiwan, we generally follow the sales rules of the first-price sealed bid on the auction market. Some of auctions have open called bids in the private sales market (such as the [silver] and [diamond] auction markets in Taiwan), which occupy 2% market share of the total auction market. The Taiwan court auctions are viewed as a way to dispose of distressed properties. Most of the properties in court auctions are related to debtor-creditor, amount due of mortgage or nonperforming loans (NPL) ---mortgage foreclosures, and tax foreclosures. The creditor declares a court auction by the law of enforcing performance in court. The buyers bring secret bids to the auction site inside the court room before the fixed period of date. This is followed by the executing judge openly announcing the highest winning bid. The Taiwan court auction methods are more similar to the first-sealed bid auction where the buyer has claim to the object auctioned by making the highest bid. During the process, buyers do not know the other bids, are not aware of the number of bidders and the bid-prices of other bidders. If in the event when a successful bidder defaults, the court shall call a secondary auction. In the event of an unsuccessful-bid (if it is not a closed auction, or in the case where no bidders reach the base price); the court might have a second, third and subsequent auctions. The bid-times may be a one-shot, two, three or up to eight or more, etc. in order to win the bid and the court can close the auction. Each additional auction will reduce the base price by approximately 20%. The average auction bid times (counts) is three to four times. The winning bidder would pay the full strike-price within seven days of the date notification. Sometimes, the court auction is not efficient in time spent to deal with the properties.

2.3 Establishment of the Model Frameworks

The semi-parametric price function model is adjusted by the hedonic price function to the semi-

Table 2-1. Related Literature Reviews for the Function Forms of the Semi-Parametric Price Model

Authors	Model	Study area	Data	Variables
Bin (2004)	Semi-parametric regression, Hedonic price function	Pitt County of North Carolina form July, 2000 to June, 2002	2,595 observations, Single-family residential homes sold	Price, square footage, number of bed/ bath rooms, age of house, other attributes, geographic locations including Tar River, major roads, streets, business centers, streams and creeks
Clapp (2004)	Local regression model (LRM) Location value surface	Massachusetts from January, 1990 to April, 1999	5,713 observations, Sales prices and dates	Price, square footage, building age, bathrooms, lot size, latitude and longitude
Clapp (2004)	Local regression model	Fairfax County of Washington, D.C. from 1972Q1 to 1991Q2	49,511 sales data	Price, rooms, beds baths, half bath, fireplaces, age, land area, geographic locations, latitude and longitude and dummy
Pavlov (2000)	Semi-parametric multi-dimensional K-nearest-neighbor smoothing	Los Angeles County from April 1 and September 30, in 1997	3,000 observations, real estate transaction data	Sales price, size of living rooms, bedrooms, bathrooms, X, Y coordinates
Thorsnes & McMillen (1998)	Semi-parametric model	Portland, Oregon, metropolitan area from 1980 to 1987	158 undeveloped parcels	Sale price, size of the undeveloped parcels, size of the developed land, distance from Portland CBD or freeway or arterial street
Gencay& Yang (1996)	Semi-parametric model	Windsor in 1990	955 residential houses sold	26 variables of which 19 are dummy
Anglin & Gencay (1996)	Semi-parametric model, Box-Cox model	Windsor and Essex County from July to September, in 1987	546 residential houses sold	Price, Driveway, Recreation room, Finished basement, gas heating, central air, garage, neighborhood dummy variable, lot size, number of bedrooms/ full bathrooms/ stories
Pace (1995)	Semi-parametric model	Memphis, January in 1987	379 single family dwellings sold	Price, age, other area, kitchen area, and lot area

Table 2-2. Literature Review of the Auction Markets Comparisons

Author	Auction System	Real Estate Market Type	Real Estate Type	Evaluation Method
Lusht(1996)	English Auction-Open Called Bid	Australia, The Auction Market Attains Half of the Market Share in the Real Estate Market	Normal Asset, Residential House	Hedonic Price Theory
Dotzour, Moorhead& Winkler(1998)	English Auction-Open Called Bid	New Zealand, The Auction Market Attains Lower Market share	Residential House	Hedonic Price Theory
Mayer(1998)	English Auction-Open Called Bid	U.S.A. The Auction Market Attains Lower Market Share	Normal and NPL Asset Mixed, Residential House	Repeated Sale Method
Marcus(2001)	English Auction-Open Called Bid	U.S.A. The Auction Market Attains Lower Market Share	NPL by HUD Residential House	Hedonic Price Theory
Quan(2002)	English Auction-Open Called Bid	U.S.A	Residential Vacancy Land	Hedonic Price Theory
Lin, Tsai& Chang(1997)	The First-Price Sealed Bid	Taiwan	NPL	Hedonic Price Theory

parametric regressions model. The smoothing methods based on Hastie & Tibshirani (1990) are as follows: 1. Bin Smoothers, 2. Running-Mean and Running-Line Smoothers, 3. Kernel Smoother, 4. Regression Splines, 5. Cubic Smoothing Splines, 6. Locally-Weighted Running-Line Smoothers. The more applied smoothing methods are Kernel Smoother, Cubic Smoothing Splines and Locally-Weighted Running-Line Smoothers; but the most applied method based on the Cubic Smoothing Splines. This study estimate a hedonic price function using the Cubic Smoothing Splines additive semi-parametric models, the model is written as:

$$y=\alpha+\sum_{i=1}^{p}\beta_i X_i+\sum_{j=1}^{k}f_i(Z_j) \quad (1)$$

where $\sum_{i=1}^{p}\beta_i X_i$ is the portion of parametric, $\sum_{j=1}^{k}f_i(Z_j)$ is the portion of Semi-parametric, where $V(\ln P \mid X,Z)=\sigma^2$, an unknown parameter. Note that the usual linear function of Z is replaced with the sum of unspecified functions. The functions $f_j(Z_j)$ that appear in Eq. (1) are estimated using the iterative procedure known as the back-fitting estimator, which reduces multivariate regression to continuous simple regressions. We follow Bin's (2004) detail to estimate the approaches as follows:

(1)backfitting / iteration approach

The backfitting procedure starts with setting initial values for the unknown functions $m_j(Z_j)$ for j=1-6 and then defines the partial residual of j th attribute for the v th iteration as:

$$r_j^{(v)}=\ln P-\tilde{\alpha}-\sum_{i=1}^{p}\tilde{\beta}_i^{(v)}X_i-\sum_{d=1,d\neq j}^{j-1}\tilde{f}_d^{(v)}(Z_d)-\sum_{d=j+1,d\neq j}^{k}\tilde{f}_d^{(v-1)}(Z_d) \quad (2)$$

Where v=1,2⋯ and $\tilde{\alpha}$, $\tilde{\beta}$ and $\tilde{f}_d(Z_d)$ denote the estimated coefficients and estimated function. For the initial values, $\tilde{f}_d^{(0)}(Z_d)$ is defined as the (n×1) vector of zeros. In each end of the iteration the six unknown functions are updated. Iterations are continuous until the sum of squared residuals is changed (the equation as below), which is smaller than a pre-specified measure of tolerance between iterations.

$$\sum_{t=1}^{n}\left(\ln P_t-\tilde{\alpha}-\sum_{i=1}^{p}\tilde{\beta}_i^{(v)}X_{ti}-\sum_{j=1}^{k}\tilde{f}_j^{(v)}(Z_{tj})\right)^2-\sum_{t=1}^{n}\left(\ln P-\tilde{\alpha}-\sum_{i=1}^{p}\tilde{\beta}_i^{(v-1)}X_{ti}-\sum_{j=1}^{k}\tilde{f}_j^{(v-1)}(Z_{tj})\right)^2$$

In the iteration, the $\tilde{f}_j(Z_j)$ functions to be estimated are updated via the local polynomial regression that has the partial residual r_j as the dependent variable and the attribute Z_j as the independent variable for j=1-k. The local polynomial estimator of p-degree for $\tilde{f}_j(Z_j)$ is defined as:

$$\tilde{f}_j(Z_{tj})=e_1'(Z_{tj}'W_{tj}Z_{tj})^{-1}Z_{tj}'W_{tj}r_j \quad \text{..... (3)}$$

where e_1 is a (p+1)×1 vector having the value one in the first entry and zero elsewhere.

$$Z_{tj}=\begin{pmatrix}1 & Z_{tj}-Z_{1j} & \cdots & (Z_{tj}-Z_{1j})^p\\ 1 & Z_{tj}-Z_{2j} & \cdots & (Z_{tj}-Z_{2j})^p\\ \vdots & \vdots & \ddots & \vdots\\ 1 & Z_{tj}-Z_{nj} & \cdots & (Z_{tj}-Z_{nj})^p\end{pmatrix} \quad \text{..... (4)}$$

W_{tj} is an n-dimensional diagonal matrix with elements given by $(1/h_j)K((Z_{tj}-Z_{sj})/h_j)$ for s=1,2,...,n, K is the chosen kernel function, and h_j is a suitably chosen bandwidth.

(2)plug-in approach

Opsomer & Ruppert (1998) proposed an updating plug-in bandwidth selection method, in which a crucial aspect of any non-parametric estimation procedure is the selection of the bandwidths that underlie the calculation of $\tilde{f}_j(Z_j)$. The basic principle behind this plug-in method is the direct estimation of function form by the optimal bandwidths. The bandwidths h_j are chosen to minimize the conditional mean average squared error (MASE):

$$\text{MASE}(h_1,...,h_k|Z_1,...,Z_k)=\frac{1}{n}\sum_{t=1}^{n}E\left[\sum_{j=1}^{k}(\tilde{f}_j(Z_{tj})-\tilde{f}_j(Z_{tj}))|Z_1,...,Z_k\right]^2 \quad \text{..... (5)}$$

Finally, an estimates covariance matrix for each $\tilde{f}_j(Z_j)$ is obtained by $\hat{\sigma}^2R_jR'_j$ where $\hat{\sigma}^2=\frac{1}{n}\sum_{t=1}^{n}\left(\ln P_t-\tilde{\alpha}-\sum_{i=1}^{p}\tilde{\beta}_i^{(v)}X_{ti}-\sum_{j=1}^{k}\tilde{f}_j^{(v)}(Z_{tj})\right)^2$, and $\tilde{f}_j(Z_j)=R_j\ln p$. Then, the lower and upper bounds on the estimates regressions are constructed by using ± 2 times the square root of the diagonal of $\hat{\sigma}^2R_jR'_j$.

After the model be established, the best fitted model will selected by the criteria of RMSE, MAPE, AS-Ratio mean, variance and Hit Ratio which are shown as follows:

(1) Root Mean Squared Errors, RMSE

$RMSE = \sqrt{\sum_{i=1}^{n} e_i^2 / n}$ $\quad e_i = y_i - \hat{y}_i$

The smaller RMSE is the better result is.

(2) Mean Absolute Percentage Errors,

MAPE= $\frac{\sum_{i=1}^{n} |e_t / y_t|}{n} * 100\%$ $(y_t \neq 0)$ $e_i = y_i - \hat{y}_i$;

MAPE not over 5%~15% were better.

(3) Assessment Ratio, AS Ratio, AS Ratio= $\hat{y}$ /y

AS Ratio indicates the fair assessment, with a value closer to 1 as being better. The variance of the AS Ratio not over 15%~25% was better.

(4) Hit Ratio. HitRatio= $\frac{n}{N} * 100\%$; n: the number of hit the range, N: sample size

Hitting Range=y − y(α)≤ $\hat{y}$ ≤y + y(α)

where Y represents the actual value, α are the significant levels : 5%, 10%, 20%, If the forecast value falls in the hitting range defined 1, otherwise defined 0. Adding up the '1' the sum ratio to the total sample defines the Hit Ratio. The higher r=atio defines the small gap between the actual value and the forecast value.

3. The Empirical Analyses

We include five topics in this section. In the first topic we show the empirical study data and their statistics. In the second subsection, we show the important factors affecting the auction housing prices in Taiwan. In the third topic we established the empirical model of the Semi-parametric function forms. In part four we show the predicted results of the semi-parametric modeling. And finally we did a valuation comparison between the semi-parametric and the parametric modeling.

3.1 Data and Descriptive Statistics

There are up to three or four types of auction markets. Occupying the majority of the auction market share is the court auction market and the others are the [gold], [silver], and [diamond] auction markets. The latter only have a 2% market share in the Taiwan real estate market. Most of them deal with the unsuccessful-bid court auction objects which are originally sourced from the NPL bank. The auctioneers, not the court auction, can be the Taiwan Financial Asset Service Corp., entrusted by the Taipei District Court, the bank itself, or the auction agent, entrusted by the Bank. The 16 nationwide courts have executed 17,000 auction property cases in 1992. However this decade has dramatically risen to 306,495 cases (see Figure 3-1). Table3-1-row (9) indicates the court auction change from 1.00% in 1992 to 13.75% in 2003 on the real estate market share in most cases. The successful-bid property cases amount changed from 182 (NT$ a hundred million) in 1992 to 1,872 (NT$ a hundred million) in 2003 and reached a new high in 2004 to around 3000 (NT$ a hundred million).

We found in Table 3-1, that the total court auction property cases for the city of Taipei are as follows. 16% of the Taiwan count auction market share have cases which reached 47,189 in 2002 and

Figure 3-1. 1992-2003 Comparison between the Taiwan Area Court Auction Property Cases and Successful-Bid (Bidden) Property Cases

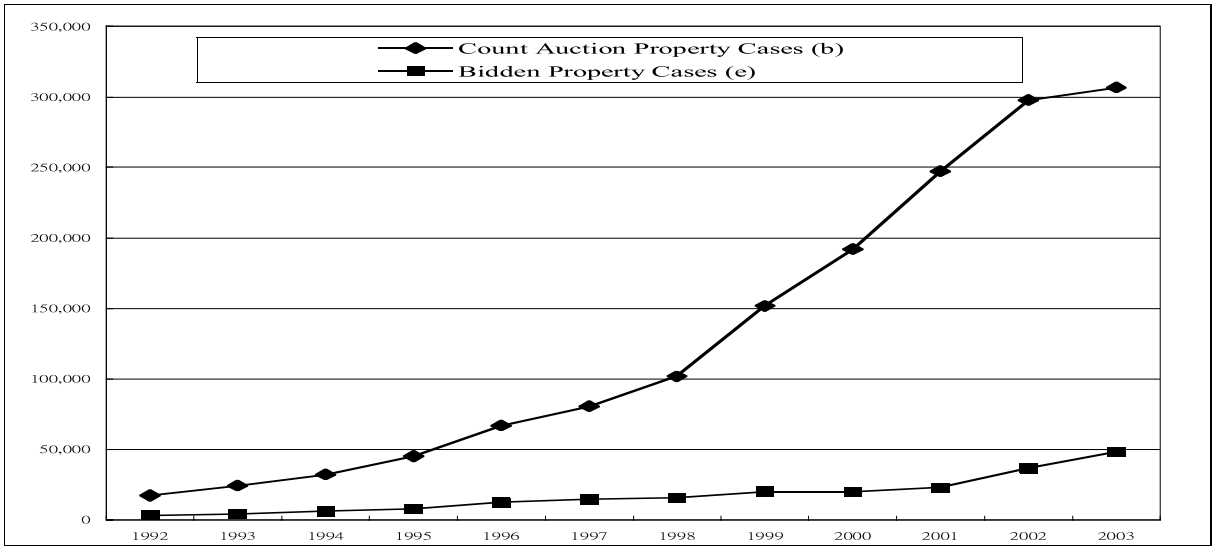

Table 3-1. 1992-2003 Taiwan Area Court Auction Property Cases Statistic Data

(1) Year											
1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
(2) Transaction Property Cases (a) for Taxation Goals											
312,796	371,720	464,480	491,884	508,748	466,568	385,969	385,074	321,165	259,494	320,285	349,789
(3) Court Auction Property Cases (b)											
17,000	24,000	32,000	45,000	66,779	80,388	101,633	151,658	192,009	247,131	297,651	306,495
(5) Successful-Bid Property Cases (c)											
3,059	4,167	5,831	7,608	12,250	14,678	15,367	19,810	19,583	22,800	36,661	48,096
(6) Successful-Bid Property Cases Amount (NT$ Hundred Million)											
182	270	419	534	698	920	838	915	951	820	1,357	1,872
(7) Successful-Bid Property Cases Average Amount Per Case (NT$ Ten Thousand)											
595	648	719	702	570	627	545	462	486	360	370	389
(8) Successful Bidding Rate (c)/(b)											
18.00%	17.40%	18.20%	16.90%	18.30%	18.30%	15.10%	13.10%	10.50%	9.20%	12.32%	15.69%
(9) Percentage of (c)/(a)											
1.00%	1.10%	1.30%	1.50%	2.40%	3.10%	4.00%	5.10%	6.10%	8.80%	11.45%	13.75%

the dollar amount was 32.00% of the market share which amounted to 438.2 (NT$ hundred million).

3.2 Important Factors Affecting Auction Housing Prices in Taiwan

From review of the literature, one discovers that most housing price studies did not include the values that cannot be quantitative (such as timing, location, type, which includes those so-called "quality" variances). Also, are those attributes (such as area, age of the housing, etc.) included in most foreign countries literature really important factors, which affect the auction housing price? Are they as sensible as conceived? The present research will make a review on these model frameworks with certain examples, in order to establish a more suitable model framework as the foundation for an empirical study.

In an attributes analysis of the auction housing price, one should begin from the angle of a user and draw in the following factors (see Table 3-2 and Table 3-3): First, consider the auction attributes, such as bid times auction date, total reserved price (base price), land reserved price, successful-bid total price, handing in over term by term; next finding house internal/ external attribute such as dwelling, building unit characters/neighborhood.

The most important auction market factors were price, which include reservation price, bid price, and the winning-bid price. Indeed, the auction price factors need to be studied. Whether the handing is over term by term or not, the process will affect the winning-bid price. The higher price they will chose the handing over term by term. The more bid-times the lower the reservation bid price as well the winning-bid price. The more the number of bidders, the higher the winning-bid price, but this can not obtained (unobserved in the databank of this study) variable.

The dwelling unit factor refers to the interior condition of a dwelling unit. Generally, one can begin with the proportion of the public facilities, stayed-floor, floor-area, location, management fee, bathroom and toilette, and the number of rooms. As there are different standards for public facilities, locations, and management fees, bathrooms and toilettes, and the number of rooms are all dependents of the dwelling unit's total floor-area. One can simplify these factors to floor-area and stayed-floor.

The building block factor refers to the appearance of the entire building above the construction site, i.e. the "type of building". One can examine this factor from the utilization, age of the building and the number of floors. The neighborhood factor is often connected to the location of the building, which can be divided into a major and minor neighborhood. A major neighborhood refers to the administration district in which a building is located. As the feature of the administration district is different from that of the distance from the CBD, living standards, and the standards of the neighborhood, each has its individual development. For example, the six districts that were only included in the Taipei municipality since 1976 have been developing as residential areas, while the old districts are used as commercial areas. Near neighborhood refers to the convenience of the building to the neighboring public facilities. For example, the price of a building located beside the main road will be higher than one that is located in an alley. Other factors including corner area, and the distance from bus stations, parks, and markets, which are also important attributes relating to accessibility.

In Table 3-4 we found the court auction data from 2001Q1-2003Q4, the total are 3,016 cases. We

Table 3-2. The Court Auction Housing Variable Attributes

Attribute Categories	Attribute Contents	Measurement terms	Variables Coding number
Auction Attribute	Auction Characters	Specific Performance Case ID Number	S5
		The Coding of Auction Court	S2
		Bid-times before auction close	SSNO1
		Auction Date	S29D
		Total Reserved Price	STP
		Land Reserved Price	STPP
		Successful-bid Total Price	SLP
		Handing in Over term by term	Pro=1, Handing in Pro=0, Not Handing in Over
House Internal Attribute	Housing Unit Characters	Building Area	HSIZE
		Land Area	SIZE2
		Total Floor Levels	TOTFLOR
		In-Floor Level	FLOOR
	Building Unit Characters	Building Type	SB : SB1=1, first floor O.W.=0 SB2=1, high rising Buildings O.W.=0 SB3=1, apartments O.W.=0
		Building Construction Structure	STRUC : SC1=1, RC, SRC etc. O.W.= 0 SC2=1, Brick, Iron, Wooden, Soil etc. O.W.=0
		Age	AGE
		Address of Building	ADDR_T
Other Attribute	Dummy	Quarterly Season	Q1=1, 1st season O.W.=0 Q2=1, 2nd season O.W.=0 Q3=1, 3rd Season O.W.=0 Q4=1, 4th season O.W.=0
		Location	LA=1, land high price areas O.W.=0
House External Attribute	Macro Economy Indication	GDP, Salary	GDP, Salary

Note: Location variable defined by the official land present value lot media price, the district lies on the higher lot media price are referred to as the high price area in Taipei city. LA=1, there are half of the 12 districts located in high price areas such as Chung-Chen, Chung-Shen, Shung-Sha Tan-An, Sin-Yi and Sin-Lin district.

Table 3-3. Spatial Factors Description

Variables / Dummy variables	Contents
SDIST/ SCDIST	The Distance from Small Regional Parks/ of a Circle Radius Within 500 Meters, SCDIST=1, O.W. SCDIST=0
BDIST/ BCDIST	The Distance from Big Regional Parks /of a Circle Radius Within 500 Meters, BCDIST=1, O.W. BCDIST=0
STDIST/ SCTDIST	The Distance from Stations of the Mass Rapid Transit System/ of a Circle Radius Within 500 meters, SCTDIST=1, O.W. SCTDIST=0
S_101DIST/ S_101CDIST	The Distance from the Taipei 101 high-rise building or the Shin-Kuang department store in the main Taipei Train Station (Whichever Place is Closer). / of a Circle Radius Within 500 meters (Whichever Place is Closer), S_101CDIS=1, O.W. S_101CDIS=0

Note: We try two data-format types for spatial factors, one is continuous-format distance type, and the other is dummy-format distance type.

Table 3-4. The Empirical Study In/Out Sample Data on the Taipei City Court Auction Houses /Adjusted by Outlier Checking

Year	In Sample Data	Out Sample Data	Outliers for Adjusting
2001	584	65	34
2002	1,019	110	71
2003	1,111	127	65
Added spatial factors			
2001	577	65	33
2002	1,008	108	71
2003	998	114	59

use 90% in-sample data for regression analysis, the 10% out-sample for post forecast. Outliers have been adjusted for the data by Lin (1996) empirical results which shown the DFFITS outlier removal better method. The final data we use in study show as Table 6. After adding spatial factors, the data is also shown in Table 6.

3.3 Semi-parametric/ Parametric Function Forms

Based on the data, we have a limit on the possible data factors. The selected-factors are listed in Table 3-2 and Table 3-3. There are auction variables, house variables, and others. This study chooses two models for each comparison. In the semi-parametric-model the first model is used as a benchmark model, the second model is chosen between the generalized additive model and the spline model to smooth the estimate. In the parametric-model the first model is used as a benchmark model, the second model is chosen by add- or drop-variables in model selection. The empirical model, a benchmark model, is shown as follows:

$$\log(HP_i)=\beta_0+\beta_1(sno_i)+\beta_2(hs_i)+\beta_3(ag_i)+\beta_4(tf_i)+s_1(pro_i)+s_2(la_i)+s_3(f_i)+s_4(sb1_i)+s_5(sb2_i)+$$
$$s_6(sc1_i)+\varepsilon_i \quad (6)$$

where β_0 is intercept, $\beta_1 \sim \beta_4$ are coefficient of parametric, $S_1 \sim S_6$ are coefficient only in the semi-parametric model (or $\beta_5 \sim \beta_{11}$ in the parametric model), and ε_i is error term, we have $\varepsilon_i \sim N(0, \sigma)$.

3.4 The predicted results of the semi-parametric/ parametric modeling

The parametric-models were chosen by three criteria (smaller then one t-value variable drop, max AdjR^2, and min Root MSE). And the semi-parametric-models were chosen by two rules, the rules are the smaller backfitting times and the smaller deviance of the final estimate. The indicators found that for the better models, the criteria are exhibited in Table 3-5. Table 3-6 and Table 3-7 show the better semi- parametric /parametric-models results from the years 2001 to 2003.

We found important factors such as handing over term by term, the bid times, total reservation price, house total size and age all have significance in the winning-bid price model. The positive contributing factors included the handing over term by term (PRO), total reservation price (STP) and house total size (HSIZE). The negative contributing factors are shown as bid times (SSNO1) and age (AGE). The others were vague in the direction for the winning-bid price.

In addition, we added the spatial factors which adopted the GIS system and the distance with the significant landmarks. The signs include the Taipei 101 high-rise building, small and big regional Park, the rapid transit system and Sin-Kua department store in the main Train station.

Table 3-5. The Parametric / Semi-Parametric-model- Chosen Criteria

The Parametric-model-chosen criteria---Adj R^2			
Year	2001	2002	2003
Model 1	0.9360	0.9235	0.9170
Model 2		0.9253	0.9173
The Parametric-model-chosen criteria---Root MSE			
Model 1	0.1140	0.1197	0.1348
Model 2		0.1162	0.1340
The Semi-Parametric-models chosen criteria---Backfitting			
Year	2001	2002	2003
Model 1	6	5	5
Model 2	-	5	5
The Semi-Parametric-models chosen criteria---Deviance of the Final Estimate			
Model 1	1.8796	10.6644	6.2806
Model 2	-	5.4389	6.2293

Table 3-6. Estimate of the Better Fitted Parametric Model (Taking into Consideration the Auction Price Modeling)

Model A Variables	Expected Sign	**Taipei City**		
		2001	2002	2003
Intercept		4.9214**	5.4498**	4.9115**
ssno1	−	-0.0132**		0.004
stp	+	0.0017**	0.0018**	0.0018**
pro	+	0.0217*		
hsize	+	0.0032**	0.0033**	0.0020**
size2	+	0.0016**	0.0012**	0.0022**
Sb1	+	0.0268		0.0317**
Sb2	+	0.0189	0.0165	0.0252**
age	−	-0.0005	-0.0026**	
sc1	+	0.015		0.0677*
totflor	+	0.0018	-0.0030**	
floor	−	-0.0093		-0.001
floor2	+	0.0009		
la	+	0.0255**	0.0346**	0.0462**
gdp	+	0.0001	-0.0001*	0.0001*
Adj R^2		0.936	0.9253	0.9173

Note: * P-value significance level 10%
** P-value significance level 5%

The Table 3-8 and Table 3-9 show the results of the better models with additional factors of spatial from the year 2001 to 2003. We found that the important factors are similar to the results of Table 3-6 and Table 3-7 adding up the distance from the small regional Park. The distance from the small regional Park show a positive contribution on the winning-bid price model.

The best fitted model was selected by the criteria of RMSE, MAPE, AS-Ratio mean, variance and Hit Ratio. The 10% out-sample forecast model final results are shown in Table 3-10. The RMSE, MAPE criteria show the out-sample forecast model results are consistence, the Semi-Parametric Models(with or without the Spatial Factors for Auction Price Modeling; Model D & Model B) come out the smaller RMSE, MAPE. AS Ratio AVG criteria indicate the Parametric Models (Model A & C) are over-valuation price. However, both models show the variance of the AS Ratio are not over 15%~25%. Finally, The higher Hit Ratio of Model B & D defines the small gap between the actual value and the forecast value in the Semi-Parametric Models.

We also set up the search market model by the data from the transaction sales cases from the official transaction sales data banks (see Table 3-11). We found the factors which contributed to the search market price were given by house size (hsize / Builarea), the road width (Road_w) and location (la). The less contributing factors to the search market price were found as house type (Type), house

Table 3-7. Estimate of the Better Fitted Semi-Parametric Model (Taking into Consideration the Auction Price Modeling)

Model B Variables	Expected Sign	Taipei City		
		2001	2002	2003
Intercept		5.1840**	5.1826**	5.1849**
SSNO1	-		0.0098**	
PRO	+	0.0144**		
SB1	+	0.0182**	0.0098	0.0182**
SB2	+	0.0030	0.0183**	0.0097
AGE	-	-0.0012**	-0.0012**	
SC1	+	-0.0028		
LA	+	0.0036	0.0187	0.0136**
TOTFLOOR	+	0.0007	-0.0012**	
FLOOR	-	0.0006		
Linear(SSNO1)	-	0.0059		0.0050*
Linear(STP)	+	0.0019**	0.0019**	0.0019**
Linear(HSIZE)	+	0.0015**	0.0021**	0.0015**
DF				
Spline(SSNO1)	-	3.9361**		3.0000**
Spline(STP)	+	13.2287**	18.5082**	19.2286**
Spline(HSIZE)	+	3.1676**	2.7846**	2.9352**

Note: * P-value significance level 10%
** P-value significance level 5%

age and house stay-floor. In addition, the auction housing characters put in the deepest contributes in housing modeling. Especially the reservation bid price have the extensive effect on auction price. Some of spatial factors did put significant effects on the pricing auction market such as the distance factors from park (SDIST/ BDIST) and the Taipei 101 high-rise building areas (S_101CDIS). The rapid transit system may not be significant in this study, it is a surprise result. We suggest checking the modeling or the GIS system measurement on the distance for further research in the spatial factors side.

3.5 Comparison between the Semi-parametric and Parametric Modeling

We evaluate the housing price respectively by year and by type. In this study we applied the semi-parametric and parametric modeling results. After that, we derived the standard housing price based on 2001 housing characters (see Table 3-12).

The empirical results using parametric modeling for measurement and prediction might bring a big-gap (say max 73%) between the search market and the auction market, and using the semi-parametric approach might bring the price into a small-gap (about 25% to 30%). Similar results were discovered by adding spatial factors, in which both semi-parametric and parametric modeling might result in a small-gap (about 22% to 30%). Overall, the semi-parametric modeling with or without

Table 3-8. Estimate of the Better Fitted Parametric Model (with the Spatial Factors for Auction Price Modeling)

Model C Variables	2001	2002	2003
	PARMS	PARMS	PARMS
Intercept	4.9071**	5.4767**	4.883**
SSNO1	-0.0122*	-0.0001	0.0071
STP	0.0017**	0.0018**	0.0019**
PRO	0.0244**	0.002	0.002
HSIZE	0.0034**	0.0034**	0.0022**
SIZE2	0.0014**	0.0011**	0.0015**
SB1	0.0283	0.015	0.0286
SB2	0.0188	0.0273**	0.0373**
AGE	-0.0008	-0.0021**	0.0004**
SC1	0.0142	0.0553	0.0478
TOTFLOR	0.0013	-0.0042**	-0.0015**
FLOOR	-0.0099	-0.0018	-0.0059
Floor2	0.0009*	0.0002	0.0003
LA	0.0319**	0.035**	0.047**
GDP	0.0001*	-0.0001**	0.0001**
Q1			
SDIST	-0.0001*	-0.0001**	0.0121
BDIST	-0.0001**	0	0.0169*
STDIST	0	0	0.0135
S_101DIS	0	0	0.0375**
MODEL	**m1**	**m1**	**m3**
_P_	19	19	19
EDF	525	918	920
N-1	543	936	938
N-P-1	525	918	920
RMSE	0.1131	0.1198	0.1346
RSQ	0.9393	0.9253	0.9256
Adj-RSQ	0.9372	0.9239	0.9241

Note: * P-value significance level 10%

** P-value significance level 5%

Table 3-9. Estimate of the Better Fitted Semi-Parametric Model (with the Spatial Factors for Auction Price Modeling)

Model D Variables	Expected Sign	Taipei City		
		2001	2002	2003
Intercept	+	5.1748 **	5.1778 **	5.1255 **
SSNO1	-		0.0090 **	
PRO	+	0.0138 **		0.0178 **
SB1	+	0.0198 **	0.0114	0.0216 **
SB2	+	0.0018	0.0182 **	0.0142 *
AGE	-	-0.0014 **	-0.0012 **	
SC1	+	-0.0060		
LA	+	0.0070	0.0201	0.0154 **
TOTFLOOR	+	0.0008	-0.0010 **	
FLOOR	-	0.0008		
SCDIST	+	0.0112 **	0.0102 **	
BCDIST	+	0.0081		0.0097
STCDIST	+	0.0048	0.0114 *	0.0095
S_101CDIS	+	-0.0011		0.0187 **
Linear(SSNO1)	-	0.0068 *		0.0066 **
Linear(STP)	+	0.0019 **	0.0019 **	0.0020 **
Linear(HSIZE)	+	0.0016 **	0.0022 **	0.0015 **
DF				
Spline(SSNO1)	-	3.7202 **		3.0000 **
Spline(STP)	+	13.0747 **	18.4071 **	20.0417 **
Spline(HSIZE)	+	3.1429 **	3.0054 **	2.6782 **

Note: * P-value significance level 10%
** P-value significance level 5%

spatial factors is better than parametric modeling. We can more accurately predict housing prices using the semi-parametric approach.

4. Conclusion

According to the above analyses, the summary of conclusions of our study is as follows:

4.1 Interpreting Statistical Results

In both markets, the auction and search market share common factors such as the house price. The auction-factors include handing over term, the bid times, and the total reservation price. The

Table 3-10. The Out-Sample Criteria for the Estimate of the Better Fitted Model (with/without the Spatial Factors for Auction Price Modeling)

YEAR	2001			2002			2003		
Root MSE (RMSE)									
Model A (in TABLE 3-6)	120.35			156.01			135.34		
Model B (in TABLE 3-7)	41.03			134.08			54.10		
Model C (in TABLE 3-8)	109.77			146.30			184.28		
Model D (in TABLE 3-9)	51.97			74.43			56.88		
MAPE									
Model A (in TABLE 3-6)	10.87%			12.52%			13.27%		
Model B (in TABLE 3-7)	4.62%			7.79%			7.17%		
Model C (in TABLE 3-8)	10.62%			12.24%			14.89%		
Model D (in TABLE 3-9)	5.68%			9.66%			9.77%		
AS Ratio AVG									
Model A (in TABLE 3-6)	1.0086			1.0226			1.0271		
Model B (in TABLE 3-7)	0.9476			0.9756			0.9555		
Model C (in TABLE 3-8)	1.0003			1.1636			1.0484		
Model D (in TABLE 3-9)	0.9984			1.0011			1.0035		
AS Ratio cv (%)									
Model A (in TABLE 3-6)	14.37%			16.88%			16.70%		
Model B (in TABLE 3-7)	23.03%			15.94%			24.24%		
Model C (in TABLE 3-8)	13.98%			14.32%			17.25%		
Model D (in TABLE 3-9)	7.01%			11.90%			12.32%		
Hit Ratio									
	5%	**10%**	**20%**	**5%**	**10%**	**20%**	**5%**	**10%**	**20%**
Model A (in TABLE 3-6)	25.00%	42.00%	89.00%	28.00%	51.00%	86.00%	24.00%	52.00%	77.00%
Model B (in TABLE 3-7)	56.92%	87.69%	95.38%	31.82%	80.00%	98.18%	33.07%	64.57%	92.91%
Model C (in TABLE 3-8)	25.00%	45.00%	91.00%	26.00%	50.00%	88.00%	24.00%	50.00%	75.00%
Model D(in TABLE 3-9)	53.85%	84.62%	99.00%	22.73%	42.73%	78.18%	25.20%	53.54%	81.89%

house character-factors are house total size and age; the more contribute to the search market price factors are given by house size, the road width and location. In additions, some of the spatial factors did put a significant effect on pricing the auction market such as distance from small regional Parks.

Location and house size are the important variables in every submarket as expected. The influence of the stayed-floor at the same time should not be ignored in each market. If one considers location to be the horizontal accessibility (to the CBD) indicator, stayed-floor to be the vertical

Table 3-11. Estimate of the Better Fitted Model (Taking into Consideration the House-Search Market Price Modeling)

Variables	Expected Sign	Taipei City		
		2001	2002	2003
Intercept		5.4429 **	5.4844 **	5.4392 **
ROADW	+	0.0012 *	0.0032 **	
TOTFLOOR	+	0.0059		
LA	+	0.1991 **	0.1979 **	0.1995 **
ZON	+	-0.0242	-0.0253	0.0213
TYP	-	-0.0659 **	-0.1091 **	-0.0411 **
Linear(ROADW)	+			0.0020 **
Linear(BUILAREA)	+	0.0086 **	0.0085 **	0.0087 **
Linear(AGE)	-	-0.0025 **	-0.0030 **	-0.0044 **
Linear(FLOOR)	-	-0.0127 **	-0.0114 **	-0.0055 **

Note: * P-value significance level 10%
** defined P-value significance level 5%

Table 3-12. Court Auction Residential Housing Prices 2001-2003 (in Nominal Prices)

Data	Year	2001	2002	2003
Existing House Market Price (EHMP) (a)	Parametric model	553.11	566.86	557.51
	Semi-parametric model	565.04	565.38	563.6
Auction House Successful-bid Price (AHFBP) (b)	Parametric model	421.30	327.94	478.14
	Semi-parametric model	431.28	445.94	448.17
Auction House Successful-bid Price Added Spatial factor (AHFBP/Spatial) (b)	Parametric model	433.62	450.52	456.96
	Semi-parametric model	433.99	450.48	455.26
Discount ratio(/Premium)	(a-b)/b%			
Non Added Spatial factor	Parametric model – AHFBP vs. EHMP	31.29%	72.85%	16.60%
	Semi-parametric model – AHFBP vs. EHMP	31.01%	26.78%	25.76%
Added Spatial factor	Parametric model – AHFBP/ Spatial vs. EHMP	27.56%	25.82%	22.00%
	Semi-parametric model – AHFBP/ Spatial vs. EHMP	30.20%	25.51%	23.80%

accessibility (to the first floor) indicator, house size (Floor-area) or land size to be the profitability of space, one will realize that the space size of a city is the most influential factor of the real estate price. In general, the greater the floor-area we have, the higher the total price. The coefficients of type-category of each submarket model can reflect the quantitative change from the standard values, which can be applied to real estate price estimation.

4.2 The Results of Forecast Comparison

The RMSE, MAPE criteria show the out-sample forecast model results are consistence, the Semi-Parametric Models(with or without the Spatial Factors for Auction Price Modeling) come out the smaller RMSE, MAPE. AS Ratio AVG criteria indicate the Parametric Models (Model A & C) have over-valuation price. However, both models show the variance of the AS Ratio are not over 15%~25%. Finally, The higher Hit Ratio of Semi-Parametric Models define the small gap between the actual value and the forecast value.

By means of parametric modelling of measurement and prediction might bring a big-gap between the search market and auction market. The use of semi-parametric modelling might bring the small-gap about 25% to 30%. Similar results exposed by adding spatial factors, both semi-parametric and parametric modelling might bring the small-gap to about 22% to 30%. Overall, the semi-parametric modeling with or without spatial factors is better than parametric modeling. We can more accurately predict housing prices in the semi-parametric approach.

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