The Determinants of Value in the Philadelphia Housing Market: A Case Study of the Main Line 1967-1969

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INTRODUCTION

This paper is an empirical study of the housing market for 1967-1969 in the suburban Philadelphia area known as the Main Line.[1] The basic data[2] utilized for this study are 2,143 transactions for residential properties that were listed by the Main Line Board of Realtors' Multiple Listing Service. Our purpose is to examine the economic determinants of housing market value and property tax liability and to explore the functioning of the real estate brokerage market. The analysis of value is based on a theoretical framework whose assumptions are outlined in Section I. Our empirical analysis (Section II) attempts to improve upon previous work by explicitly linking the theoretical underpinnings of market equilibrium to the development of the analysis. The results, while reinforcing some of the empirical findings of earlier studies, do represent a research improvement[3] since the analysis contemporaneously utilizes individual microeconomic property data, takes into account simultaneity bias between the market value and the property tax variables, and develops estimates for the property tax function as well as the market value function.

In brief, we reach the following conclusions. First, the determinants of market value for this housing market are consistent with the currently expounded theories of urban real estate economics. In particular, our research shows that property taxes are capitalized into value (a microeconomic Tiebout hypothesis), and that "accessibility" to the center city is a determinant of market value as are housing attributes (including locational variables) which function as proxies for housing services. Second, the property taxation equation indicates that current local tax assessment policies are inequitable between similarly valued houses (i.e., horizontal inequity) as well as between differently valued houses (i.e., vertical inequity). Finally, in our analysis of the brokerage market (Section III), we discover that discounts on the original asking price and the length of time it takes to sell a property are inter-related, and that brokerage firms appear to affect differentially the length of the listing time.

While we have not pursued the potential applications for our research, it is clear that this type of analysis, if expanded and refined, has potential use in private real estate appraisals, public tax assessment operations, and the regulation of the real estate brokerage industry.

I. MODEL FOR EMPIRICAL IMPLEMENTATION

Our analysis of market value is based upon a spatial location microeconomic framework, as exemplified by the recent works of Alonso (1964) and Muth (1969). According to this theory, in a perfect market the value for each property should be the discounted sum of the expected net value of the flow of housing services generated by the property over time. In other words, each property is an economic capital asset that is valued because it yields a flow of services over its capital life. This conceptualization creates two types of difficulties for our empirical analysis.

First, the quantities of housing services and the prices of housing services as developed in the economic theories of spatial location are not directly observable data. Our empirical analysis, therefore, employs a hedonic index[4] for housing prices that relates market value for each property to the observable, objectively measurable attributes of the housing stock. Obviously, there are many attributes of a house at a given location that generate residential housing services, such as the number and types of rooms, the type of heating system, the topography of the lot of land, the accessibility to employment and shopping, a neighborhood environment, and a diverse collection of public and semi-public goods and services (e.g., police protection, water supply, garbage collection, and schools). It should be clear that objective, observable data do not necessarily represent the full complexity of residential services emanating from a house at a particular location.[5] However, we shall demonstrate that the attribute approach as a surrogate for residential housing services, when appropriately specified, appears to capture a significant portion of the variation in residential housing market values.

The second difficulty encountered in attempting empirical research, one that has not explicitly been recognized in many previous works, deals with the assumptions about property market equilibrium. It is usual in these types of studies to assume that the housing market is in long-run equilibrium. In addition to the assumption of long-run equilibrium, we need to postulate relative adjustment rates for certain supply and demand factors; otherwise our empirical results would yield an inextricable mixture of supply and demand factors that might not be interpretable. We, therefore, hypothesize that for our cross-sectional data base, the changes of the relevant supply factors are relatively inelastic in the short-run as compared to changes in market demand factors. This is quite reasonable because 1) the changes in the quality/quantity supply of local public goods in various communities usually occur slowly over long periods of time and 2) the changes in the supply of the housing stock (i.e., caused by decay--depreciation--or new construction) are usually small relative to the total existing housing stock.

The Market Value Estimator

Urban economic theory suggests that the utility-maximizing consumer chooses his house and its locale after weighing the net stream of housing services, including all costs to him such as operating and maintenance expenditures and local property taxes, among all his relevant housing alternatives. In our disequilibrium context, market value will be a function of housing attributes (the surrogates for housing services), location variables as proxies for accessibility and neighborhood-local services, and property tax liabilities:

$$V_i = f(C_i, l_i, t_i, TX_i, \ldots) \qquad (1)$$

$$i = 1, \ldots, n$$

where

V_i = The market value for the ith house;

C_i = A vector of the value relevant housing attributes (characteristics) of the ith house;

l_i = A vector of the relevant neighborhood location variables, such as the the quality of schools, and so forth for the ith house;

t_i = A vector of the relevant accessibility variables (e.g., distance to work) for the ith house;

TX_i = The tax liability accruing to the owner of the ith house.

The Property Taxation Estimator

Theoretically, property taxes are a linear function of market value.[6] While this precise relationship does not hold in the real world, it is plausible to claim that taxes are nevertheless closely related to value. That is, TX_i is a function of, among other things, V_i. The other variables that affect taxes paid by the ith property owner systematically may be related to attributes of the property (C_i) as well as the fiscal base and structure of the public services provided by the local governments. A proxy for these latter variables are location by taxing authority/servicing area (l_i).

$$TX_i = g\ (V_i, C_i, l_i, \ldots) \qquad i = 1, \ldots, n \tag{2}$$

Formally, equations (1) and (2) represent a two equation simultaneous structural sub-system for the residential property market that can be estimated. That is, given our assumptions about the disequilibrium adjustment mechanisms, the supply equations for public services and the supply equation for changes in the housing stock can be treated as exogenous and, hence, omitted in our cross-sectional study. As we will see, this will permit us to interpret the estimated coefficients in terms of demand factors only. However, assuming proper specification, the estimation of either of the functions (1) or (2) by ordinary least squares will yield statistically inconsistent estimates because of simultaneity bias.[7] As will be discussed below, each equation turns out to be over-identified and, therefore, will be estimated by two-state least squares.[8]

II. THE EMPIRICAL FINDINGS FOR THE MARKET VALUE-TAX MODEL

Market Value Function

The market value function for Main Line properties, as indicated above, is a complex relationship with many types of variables, including several attributes of each property's land and structure, local governmental fiscal arrangements, accessibility considerations, and neighborhood-environmental effects, potentially being important. Our best estimate, using two-stage least squares, of the market value function is (3):

$$\begin{aligned} V = {} & 524 - \underset{(0.09)}{0.31}\, Q - \underset{(0.26)}{2.07}\, AGE - \underset{(9.12)}{78.7}\, \log t + \underset{(3.60)}{92.3}\, BT \\ & + \underset{(5.44)}{115}\, \log LS + \underset{(4.63)}{27.7}\, G + \underset{(6.31)}{40.1}\, [D1968] + \underset{(7.14)}{90.8}\, [D1969] - \underset{(7.00)}{30.1}\, [Dum] \qquad (3) \\ & + \underset{(8.07)}{45.3}\, [Dgmv] - \underset{(5.81)}{15.3}\, [Dtem] \qquad R^2 = .75 \end{aligned}$$

where

Q = (TX/BR) = the property tax bill (in $) divided by the number of bedrooms.

log t = the log of distance, measured from the center of the municipality to center city Philadelphia (i.e., an accessibility index, in miles)

log LS = the log of the lot size (in acres)

G = the number of car-garage spaces

BT = number of bathrooms

AGE = the age of the house (in years)

D1968 = a dummy variable for time: if sale occurred in 1968, D1968 $\equiv$ 1; otherwise D1968 $\equiv$ 0

D1969 = a dummy variable for properties sold in 1969

Dum = a dummy variable for property location: if property is located in Upper Merion, Dum $\equiv$ 1; otherwise $\equiv$ 0

Dtem = a dummy variable for properties located in Tredyffrin, Easttown, or Malvern

Dgmv = a dummy variable for properties located in Gladwyne, Merion or Villanova

V = the market value (in 100$)

The market value function is over-identified because there are six locational dummy variables excluded from the equation. Moreover, as we shall see below, the property taxation function is over-identified, too. Incidentally, this is the precise reason we employed two-stage least squares estimation techniques rather than indirect least squares. Also, in the basic data, there are no "significant" multicollinearity problems.[9]

Interpretation of Value Estimate

The explanatory variables in equation (3) are all significant at the one percent level, and do appear to be consistent with our earlier theoretical exposition.

a) Taxation Capitalization: Tiebout (1956) presented a formal theory involving consumer location in accord with preferences for "local" public goods and services. At the theoretical level, following our equilibrium assumptions and Tiebout, we can envision a system by which a quasi-market solution for public sector activity through changes in market value is determined from the simultaneous solution of equations (1) and (2). In essence, each household will choose among communities, all of which offer varying "baskets" of local public goods and services and tax plans, selecting the locale that offers the "best" services-tax plan according to its preferences. This will affect the relative market values for properties in different communities. Those areas that offer "desirable" public services-tax plans, *ceteris paribus*, will be relatively attractive, and should, through the market mechanism for disequilibrium adjustments have higher property values.

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Dtem in equation (3). It is worth emphasizing that the coefficients of these intercommunity variables in the value equation represent the net tax-services-neighborhood amenities capitalized value. In other words, the market value for a property with a specific set of physical characteristics depends, in part, upon the nature of the bundle of public goods and services received, the local taxes paid, as well as any privately generated neighborhood (locality) externalities.[10]

The variable Q, the ratio of property taxes to the number of bedrooms, can be construed as a measure of the property tax costs per unit of housing services consumed. Also, to some extent, the number of bedrooms is a rough indicator of the number of people residing within a house, and is, therefore, a surrogate for the quantity of certain local public services consumed by the household, especially local public school services. Put differently, *ceteris paribus*, greater property tax bills per bedroom reduce the net value of housing services, *including* certain local public services consumed by the household over time, which should be reflected in a lower market value. This represents, in part, a tax-capitalization hypothesis for our microeconomic property data in terms of *intra* - community property taxes - local services. Returning to equation (3), if this micro-economic intra-community tax-services capitalization exists, controlling for property characteristics and locality, it would be expected that the coefficient of Q would be negative, precisely as it is.

Furthermore, the negative sign for the coefficient of Q implies a negative capitalization of taxes, ceteris paribus. For example, two houses each having four bedrooms and identical in every way except one pays $100 more property tax per year will have a differential sale price of $775. This implies a capitalization rate of about thirteen percent. As you would expect, if idential houses have only two bedrooms, the sale price differential created by a $100 tax difference would be $1550, reflecting a capitalization rate of about seven percent.

b) Accessibility: The theoretical location literature devotes much effort to explaining that accessibility should positively affect value. Our statistical results are consistent with this theoretical notion as well as previous empirical studies.[11] It should be noted that our accessibility index, a simple radial distance measure from Center City to the suburban community center for each property, is consistent with the belief that center city is a significant foci of relevant activities for Main Line dwellers. Therefore, ceteris paribus, households are willing to pay more for housing services on the Main Line that are located closer to Center City. Applying equation (3), given two identical houses, one of which is ten miles closer to center city, the sale price difference attributable to distance will be approximately $7870.

c) Property Characteristics: Four objectively defined attributes of residential properties appear to affect our estimator for market value. The lot size, garage capacity, and the number of bathrooms are, as would be expected on a priori grounds, positively related to market value. The age of a property, on the other hand, has a negative relationship with value. Viewing a house as a capital asset, real depreciation is a function of time, and would be reflected in the form of reduced market values with property age.

d) Other Variables: As has been mentioned earlier, during the 1967-1969 period, housing prices had a significant inflation. Therefore, it is not surprising that dummy variables for time have positive and increasing values over time for the sample data. It has also been suggested that seasonality affects the prices of houses. In other words, there is a value-cycle around the trend that, presumably, peaks in summer periods and troughs during the winter. This hypothesis was explored, and does not appear to have empirical validity. Finally, several other variables do not seem to bear significantly upon the market value of residential property. These variables are the style and construction materials of the house, its heating system, and the broker who originally listed the property. We shall have more to say about the broker variable when we discuss the brokerage market.

Property Taxation Function

The mean price for housing sold during the three year period has increased steadily, with an overall change in values of about 26 percent. Meanwhile, the aggregate "effective" real estate tax rate has changed very little. In fact, statistically the effective average tax rates for the three year period 1967 through 1969 are not different.[12] Therefore, either millage increases and/or upward reassessments for a large segment of the properties in our sample had to occur.[13] (Of course, the former is more likely to have been the dominant factor.)

In Table 1, real estate tax rates have been disaggregated for the three years by properties according to the number of bathrooms. It is apparent that this disaggregated data by year reflects a less stable tax rate, but does suggest a pattern. Namely, the effective tax rates paid by homeowners with two or two and a half bathrooms is higher than the overall average; and large houses (i.e., four or more bathrooms) pay lower effective rates than the average. Approximately speaking, the number of bathrooms correlates with market value (i.e., correlation is +.68), signifying that more expensive housing may be systematically underassessed (i.e., millage rates are the same for everyone in the same taxing jurisdiction).

TABLE 1

Effective Real Estate Tax Rates, by Property Characteristics by Year

	1967				1968				1969			
Number of Bathrooms	Average Value	T.R.[1]	S.D.[2]	N	Average Value	T.R.	S.D.	N	Average Value	T.R.	S.D.	N
1	19.6	1.69	.39	72	21.5	1.79	.26	64	23.9	1.70	.35	43
1.5	24.0	1.73	.31	87	26.4	1.86	.31	73	28.3	1.70	.34	56
2	32.4	1.80	.35	127	35.5	1.82	.36	151	37.4	1.85	.41	132
2.5	37.1	1.83	.37	223	40.3	1.87	.35	297	44.8	1.87	.34	234
3	42.1	1.81	.41	67	48.9	1.72	.45	66	52.1	1.73	.33	58
3.5	47.9	1.66	.41	90	48.6	1.75	.39	93	59.0	1.72	.32	70
4	53.8	1.44	.32	33	67.8	1.50	.32	8	83.9	1.63	.60	17
4.5	65.8	1.61	.41	19	75.9	1.51	.35	24	83.3	1.58	.28	17
5	81.8	1.32	.60	6	88.1	1.68	.63	5	128.8	0.95	.10	2
5.5+	72.4	2.03	.58	9	114.5	1.39	.46	7	98.2	1.84	.54	13
For All Houses	36.6	1.76	.38	713	40.6	1.80	.37	788	46.0	1.79	.37	642

[1] T.R. = Mean tax rate; the ratio of tax bill ($) to sales values ($) multiplied by 100.

[2] S.D. = Standard Deviation of tax rate.

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1.5	24.0	1.73	.31	87	26.4	1.86	.31	73	28.3	1.70	.34	56
2	32.4	1.80	.35	127	35.5	1.82	.36	151	37.4	1.85	.41	132
2.5	37.1	1.83	.37	223	40.3	1.87	.35	297	44.8	1.87	.34	234
3	42.1	1.81	.41	67	48.9	1.72	.45	66	52.1	1.73	.33	58
3.5	47.9	1.66	.41	90	48.6	1.75	.39	93	59.0	1.72	.32	70
4	53.8	1.44	.32	13	67.8	1.50	.32	8	83.9	1.63	.60	17
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The property tax equation, estimated by two-state least squares, is:

$$
\begin{aligned}
TX = & - 27.6 + \underset{(0.15)}{1.57V} - \underset{(0.37)}{1.62\ AGE} - \underset{(1.67)}{11.6\ \text{Log } LS} \\
& + \underset{(1.49)}{9.02\ BT} - \underset{(2.11)}{5.53\ [D1m]} + \underset{(4.30)}{13.5\ [Drad]} - \underset{(2.57)}{10.3\ [Dum]} \qquad (4) \\
& + \underset{(13.3)}{30.9\ [D1969]} \qquad R^2 = .69
\end{aligned}
$$

where the newly introduced variates are

Dlm = a dummy variable for property location: if property is located in Lower Merion, Dlm ≡ 1; otherwise Dlm ≡ 0

Drad = a dummy variable for properties located in Radnor.

As would be expected, market value is positively related to taxes paid. Equation (4), however, supports the contention that, more expensive houses do pay, on average, a lower "effective" real estate tax rate. Land is apparently not assessed in the same way as are improvements. Two properties of equal value in the eyes of the market, would be assessed differently if they occupy different sized plots of land. In particular, homes with large lot sizes receive more favorable tax treatment. Another potential illustration of arbitrary and/or inconsistent tax treatment of homeowners relates to the age of the house. Older houses, on average, have lower tax bills. This may be caused by inefficient reassessment policies and/or a systematic bias for underassessment. (Our data cannot be used to distinguish between the two hypotheses.) Finally, location does affect property taxes. This is consistent with the community public services - taxation program hypothesis in the market disequilibrium context suggested earlier, and the official policies proclaimed by various townships.

Equation (5), using ordinary least squares,[14] estimates the relationship between the ratio of property taxes to market value and types of residential properties. Hypothetically, this ratio should be a constant for all properties within the same taxing jurisdiction. However, the impression created by the property taxation equation (4), that current assessment policies are biased towards undertaxing more expensive, older residential properties, is confirmed in equation (5). Second, locational variables in equation (5) reflect different community taxation policies. Third, improvements as reflected by the variable <u>bathroom</u> are over-assessed relative to land (the lot size variable).

$$\begin{aligned} \text{Ratio} = 3.52 &- \underset{(.03)}{0.42} \log V - \underset{(.01)}{0.06} \log LS + \underset{(.04)}{0.19} \log t + \underset{(.02)}{0.10}\, BT \\ &- \underset{(.001)}{0.60}\, AGE + \underset{(.03)}{0.98}\, [Drad] - \underset{(.05)}{0.24}\, [Dtem] \end{aligned} \qquad (5)$$

where $R^2 = .22$

Ratio = the proportion of property taxes to market value (as a percent) for each property.

It should be clear that equation (5) implies that for any sub-aggregated group of houses in terms of a set of characteristics, there is considerable "horizontal" inequity. This can be deduced from the size of the standard deviation for each average effective tax ratio. In equation (5), the coefficient of determination is only .22 and the standard error of the estimate is .34 percent. That is, while we have identified in equation (5) variables that significantly and systematically affect vertical inequity, it is also clear that horizontal inequity (i.e., the treatment of similarly valued properties differently) is also significant. For example, all properties with market values of $40,000 pay on average approximately $720

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III. THE REAL ESTATE BROKERAGE MARKET

Imperfect information flows between numerous, widely dispersed buyers and sellers is perhaps the chief characteristic of the real estate market "place." Indeed, the brokerage industry functions as this floating market place itself, facilitating transactions through its role as the expeditor of information exchanges. It is, therefore, appropriate to inquire about the length of time it takes to sell properties, and whether there is a difference in the performance of brokerage firms.

Rudiments for a Brokerage Firm Performance Model

Given that the real estate market is imperfect, it is also plausible to believe that the discount (i.e., the ratio of actual sale price to original asking price) and the period of listing (i.e., the number of weeks it takes to sell a property) may be interrelated. For example, if a seller "is willing to wait," he is more likely to receive his asking price; if on the other hand he wishes to sell quickly, he might accept a lower discount to expedite his property's sale. Of course, the effectiveness of the brokerage firm can assist in the sale. In this model, we assume that the broker, *ceteris paribus*, can affect the period of listing, but not the discount ratio directly.[15] Formally, this can be represented as a two-equation simultaneous model, similar to equations (1) and (2) above:

$$DR_i = f(PL_i, C_i, l_i, t_i, V_i, \ldots) \tag{6}$$

$$PL_i = g(DR_i, C_i, l_i, t_i, V_i, BKR_i, \ldots) \tag{7}$$

$$i = 1, \ldots n$$

where

DR_i = the discount for the ith house (ratio of sales price to asking price)

PL_i = the period of listing for the ith house (in weeks)

C_i = a vector of characteristics of the ith house

l_i = a vector of locational variables for the ith house

t_i = an accessibility index for the ith house

V_i = the market value for the ith house

BKR_i = the broker who originally listed the ith house

It is clear that equation (6) is identified and equation (7) is not because of our assumed brokerage behavior effect. Therefore, using two-stage least squares, we can estimate the discount ratio equation (8):

$$\begin{aligned} DR = .911 &+ \underset{(.0001)}{.0003V} - \underset{(.0008)}{.0103\ LS} - \underset{(.00210)}{.00422\ BT} - \underset{(.0001)}{.0007AGE} + \underset{(.00002)}{.00013\ t} \\ &+ \underset{(.00251)}{.00573\ Dtem} + \underset{(.00070)}{.00015\ PL} \qquad R^2 = .15 \end{aligned} \tag{8}$$

Equation (8) uncovers several interesting relationships about the discount ratio function. First, the period of listing affects the discount ratio as we hypothesized. That is, controlling for location, property type, and so forth, the longer you wait to sell the property thecloser the final sale price will be to the original asking price. However, this effect while statistically significant is very small. Second, properties in the Tredyffrin, Easttown, and Malvern areas as well as properties farther from center city have higher discount ratios (i.e., sell closer to the original asking price). Third, while more expensive properties sell at slightly higher discount ratios, physically larger properties in terms of number of bathrooms and lot size

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Equation (8) uncovers several interesting relationships about the discount ratio function. First, the period of listing affects the discount ratio as we hypothesized. That is, controlling for location, property type, and so forth, the longer you wait to sell the property thecloser the final sale price will be to the original asking price. However, this effect while statistically significant is very small. Second, properties in the Tredyffrin, Easttown, and Malvern areas as well as properties farther from center city have higher discount ratios (i.e., sell closer to the original asking price). Third, while more expensive properties sell at slightly higher discount ratios, sell at lower discount ratios. Fourth, the older a property, the lower the expected discount ratio will be.

It is noteworthy to observe that our analysis attempted to use dummy variables for the year of the original listing and the month of the original listing. We discovered, however, that these time dummies do not significantly affect the discount ratio. Therefore, we reject any hypotheses about trend or seasonal differences in the discount ratio. Also, though the coefficients of the estimate are significant at the one percent level, the total fit of the equation is not exceptionally good. In other words, there is a great amount of variation that is not captured by the objective data used in our analysis. (This may be caused by either a misspecified model of brokerage behavior or excluded objective and/or subjective variables. Also, differences in the discount ratio may be explained by variables of a non-economic nature that are excluded from our analysis.) The poor fit, in fact, seems to imply that the structure of the brokerage market does not lead to "arbitrary" variations in pricing and timing for transactions. In particular, the explanatory variables common to the market value equation (3) and the discount rate equation (8) do not appear to have a systematic relationship in the two equations. In this sense, it appears likely that the brokerage market does not affect ultimate market value but facilitates, through expediting of information flows, transactions.

Though we cannot satisfactorily test our hypothesis that the period of listing is affected by the brokerage firm, the following simple (ordinary least squares) regression suggests that our notions may be correct:

$$\underset{}{PL} = 7.8 + \underset{(.037)}{1.11\ LS} + \underset{(.07)}{1.31\ DR} + \underset{(1.68)}{3.49\ DG3} - \underset{(1.24)}{2.41\ DBrA} \qquad R^2 = .08 \qquad (9)$$

where

DG3 = a dummy variable for firms in Group 3, a group consisting of 33 brokerage firms

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Equation (9) indicates that, controlling for the discount ratio and property characteristics (i.e., lot size in this equation), Broker A will expedite sales and Group 3 realtors retard sales. These conclusions, however, should be taken as gossamery and suggestive, rather than definitive.

In summary, it appears that the real estate brokerage market does not affect ultimate market values for properties. The discount ratio and the period of listing are interrelated, and the latter is apparently affected by the choice of broker. Also, the discount ratio for larger properties in terms of land and improvements appears to be systematically lower.

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A FINAL WORD

Our empirical findings provide support for much of the contemporary theory of urban residential location economics. First, in the analysis of the determinants of residential property values, our research shows that property taxes are capitalized into value (a microeconomic Tiebout hypothesis), and that "accessibility" to the center city is a determinant of market value as are housing attributes (including locational variables) which function as proxies for housing services. Second, our examination of local property taxation indicates that local tax assessment policies possess significant vertical and horizontal inequity. Finally, in our study of the real estate brokerage market, we discover that discounts on the original asking price and the length of time it takes to sell a property are inter-related, and that certain brokerage firms appear to affect differentially the length of the listing time.

While we have not pursued the potential applications for our research, it is clear that this type of analysis, if expanded and refined, has potential use in private real estate appraisals, public tax assessment operations, and the regulation of the real estate brokerage industry.

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Footnotes

[*]Assistant Professor of Finance, The Wharton School, University of Pennsylvania. The author wishes to thank the Rodney L. White Center for Financial Research at the University of Pennsylvania for its financial support. He, also, wishes to thank Professors Noel Edelson and Lawrence Jones for their very helpful comments, Professor Herb Grubel, who originally prepared the basic data, for making it available for this study, and Moshe Cohen for his computational assistance. Also, Professor Grubel's mimeographed notes, entitled "Determinants of House Prices on the Philadelphia Mainline," have been of immense help. Finally, an anonymous referee made several extremely helpful comments, which significantly improved this paper. Of course, the author is responsible for any remaining errors.

[1]The main line communities considered in this analysis are the six suburban townships stretching west from the boundary of the city of Philadelphia along the tracks of the Penn-Central Railroad: Lower Merion (including Narberth), Radnor, Upper Merion, Easttown, Tredyffrin, and Malvern. In many of our statistical manipulations the last three townships were, for convenience, treated as one unit. However, for many of the "excluded" variables in the two stage least squares analysis finer geographic variables used in this study were for 1) Lower Merion Township, the following separable areas: Ardmore, Bala-Cynwyd, Bryn Mawr, Gladwyne, Wynnewood (including Penn Wynne, Overbrook Hills, Green Hill Farms), Haverford, Merion, Penn Valley, Rosemont and Narberth. 2) Radnor Township, the following separable areas: Radnor, St. Davids and Ithan, Villanova and Wayne. 3) Tredyffrin, Easttown, and Malvern Townships, the following separable areas: Berwyn, Devon, Malvern, Paoli and Daylesford, Strafford and Colonial Village, and Valley Forge. 4) Upper Merion Township, the following separable areas: Gulph Mills and King of Prussia.

[2]The basic data for the study were generated by the Main Line Board of Realtors Multiple Listing Services, and provided through Mr. Edmund Bossone. After the elimination of about fifteen percent of the properties for which information was incomplete, the number of observations used in the study was 2,143. There appears to have been no systematic bias in the characteristics of houses for which information was incomplete. However, the data do not include sales of property that were unlisted and sold privately; and there is no ready way in which the bias resulting from this omission can be measured. In a strict sense, therefore, the study is concerned only with the determination of values for houses sold through members of the Mainline Board of Realtors during the years 1967-1969.

The sixteen basic variables available in the data were: 1) Style of house, 2) type of construction, 3) type of heating, 4) number of garages, 5) number of bedrooms, 6) number of bathrooms, 7) age of house, 8) location of house, 9) market value of house, 10) property taxes per year, 11) length of time listed with realtor service, 12) date of sale, 13) original asking price, 14) lot size, 15) brokerage firm handling original listing, and 16) distance to center city.

[3]See Ball (1973) for a recent survey of empirical work. Our analysis is a research improvement in many ways, even above some of the most sophisticated works such as Oates (1969) and Edel and Sclar (1973). In these particular studies median value for census tract data was used as the dependent variable. This variable is utilized as an implicit proxy in predicting "average behavior" for each community without any theoretical justification. Our analysis based on micro-data, is obviously superior. In addition, there is reason to believe that even if median value was an appropriate variate for analysis that the census self-assessment approach yields unreliable value data. Again, actual market value data is superior.

[4]See Griliches (1961) who has done extensive empirical work with hedonic indexes for automobiles; also, see Dhyrmes (1967). For the theoretical justification for the hedonic approach see Lancaster (1966).

[5]Kain and Quigley (1970) try to distinguish between quality and quantity. For example, two identical houses (i.e., same number of rooms, and so forth) in the same neighborhood are objectively the same; however, they may differ in qualitative terms such as the condition of fixtures, plumbing, etc. If our choice of observable, objective data does not (implicitly or explicitly) incorporate this type of information, our model's effectiveness will be reduced.

[6]Pennsylvania law requires that property assessments for all properties within a taxing jurisdiction be a pre-specified uniform proportion of the fair market value of the property. This is interpreted by the courts to mean that a property assessment is an equal proportion (perhaps not the pre-specified proportion) of market value for all properties within the same taxing jurisdiction. In theory, the uniform tax rate for the jurisdictional area is then applied to each property's assessment to determine its tax liability. Hypothetically, the tax liability for each property under this system would be an equi-proportion of its property value. For too many reasons to be explained here, this is not the way the system works in fact. It should, also, be noted that we estimate the tax function as a linear function of value, even though the log value variable yields a slightly superior overall fit; we do this because we wish to examine if the "statute" requirement for Pennsylvania is being fulfilled (i.e., taxes are a linear function of value with a zero intercept).

[7]See Johnston (1972), chapters 12, 13.

[8]A necessary condition for exact-identification is that the number of exogenous variables excluded from the equation equal the number of endogenous variables included less one; over-identification requires that the exogenous, excluded variables be greater than the endogenous, included variables less one. Indirect Least Square can be used to estimate only exactly-identified equations; while Two Stage Least Square can be used for over-identified as well as exactly-identified equations.

[9]Though "significant" multicollinearity is, in the final analysis, a matter of judgment, Johnston (1972), pp. 159-168, outlines the effects of and several statistical tests for "significant" multicollinearity. Another problem that may exist within our data, though we disregard it in our analysis, is that of heteroscedastic disturbances in the market value and property tax functions. If, for example, market value disturbances are generated as a "percentage" of the true market value, certainly a plausible disturbance process, the market value model will be heteroscedastic. See Johnston (1972), pp. 214-221.

[10]Unfortunately, these analytically separable effects between local taxes, local services, and neighborhood amenity-externalities at the inter-community level can not be adequately segregated empirically in our analysis. While we do have property tax data, we do not have adequate measures for public services provided. For example, if higher taxing communities _also_ provide higher levels of public services, the simple inclusion of the tax variable in our regression for market value would pick up the services effect, too (i.e., the value of the resulting tax variable coefficient would be a mixture of the two effects.) Even if we wish to consider a public service variable, the choice of an appropriate measure for the level of local public services is not clear. A dollar measure of, say, expenditure per capita on local schools is not necessarily a good indicator of the quality/quantity of schooling provided in a community. Finally, the market value of the "neighborhood effect" would require much more refined data in terms of the sub-localities than we had available.

In addition, given that our property data is basically cross-sectional and that in the short-run it has been assumed that both the housing stock within each locale and the provision of local services by each community are relatively inelastic, it is plausible that, at least in part, the coefficients of the locational variables in equation (3) reflect the relative _short-run_ scarcities of housing in communities that provide "desired" local services. In the long-run, there will be supply responses that will increase the housing stock within locales that provide "desired" local public services and/or increase the supply of "desired" local public services provided in the other communities. If, for example, the "desired" local public service could be provided at a constant and equal long-run marginal cost in all communities (and residential property taxes are utilized as the sole form of local public service finance), in the long-run the Tiebout effect would lead to the expansion of the "desired" public service in the other communities (or an increased stock of housing in the original community) such that the market value of properties, _ceteris paribus_, in different communities, some of which provide and some of which do not provide the "desired" local public service, would not differ. Of course, to the extent that there exist _long-run_ differences between communities in terms of either non-residential tax bases, non-residential tax collection policies, inter-governmental grants, or intrinsic long-run costs in supplying public services, differences in market values for properties, _ceteris paribus_, located in different communities offering varied bundles of public services could persist in the long-run. In terms of equation (3), this would imply that the coefficients of the locational variables could be non-zero even in the long run.

[11]Brigham (1964), Kain (1964), Muth (1969) and Oates (1969), among others, find that accessibility (appropriately defined) is an important explanatory variable of property market value.

[12]The tax rates for 1967 through 1969 are 1.76, 1.80, and 1.79, respectively, and are found to be statistically indistinguishable at the 95 percent level (i.e., the null hypothesis is $R_i = R_j$ and we cannot reject it) by applying the following formula:

$$K\alpha = t\alpha \frac{\sqrt{n_i \; SD_i^{\,2} + n_j \; SD_j^{\,2}}}{\sqrt{\frac{n_i n_j}{n_i + n_j} (n_i + n_j - 2)}}$$

If $|R_i - R_j| > K\alpha$ reject null hypothesis where

$t\alpha$ = the value for the t-statistic for n_i+n_j-2 degrees of freedom and confidence level α.

R_i = tax rate in i^{th} year

SD_i = standard deviation of R_i in year i

n_i = number of transaction in year i

[13]This could, also, happen if there were a substantial shift over time in the mix of properties that sold from communities with different tax rates. However, this possibility turns out not to be true because the mixture of properties by communities is relatively constant for the three years.

[14]We have used ordinary least squares instead of two stage least squares to estimate equation (5), though there is probably some simultaneity bias between ratio and value, because we do not have the appropriate excluded variables (i.e., pre-determined excluded variables). For example, we would like to have data about when properties were last reassessed, who was the actual assessor, and the institutional-organizational make-up of the local Board of Assessment.

[15]This is not precisely true. The broker probably influences many prospective sellers on the appropriate original asking price. However, many sellers do have an initial asking price in mind before they list; also, the willingness to accept a discount, once an asking price has been established, is ultimately in the jurisdiction of the seller. On the other hand, the effort and effectiveness of the broker should influence the time it takes to sell a property.

An additional reason for omitting the broker from the discount ratio equation is that since the brokerage variables did not significantly affect the market value function estimated above, it is unlikely that a particular broker affects the discount ratio. If he did, those brokers affecting the discount ratio positively, *ceteris paribus*, should be expected to affect the market value function in a positive way, too.

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