PRICING AND EMINENT DOMAIN TAKINGS:

A CASE STUDY OF RESIDENTIAL PROPERTY

IN LAS VEGAS, NEVADA

by

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ABSTRACT

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in Las Vegas, Nevada

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This case study tests whether compensation for eminent domain takings equals estimated market prices for residential property located near McCarran Airport in Clark County Nevada. The hedonic model provides evidence that takings compensation was often less than estimated market price, a discount was paid to owners of smaller homes, and a premium was paid to owners of larger homes. Although data constraints, estimation issues and lack of previous studies hamper broad conclusions, the robust data set, consistency of model specification results, and the explanatory power of economic thought is evident in these results. The results are somewhat surprising in that McCarran International Airport is very much an integral aspect of Las Vegas. It is recommended that hedonic analysis be considered as a component of estimating fair market value. Further research will hopefully expand this preliminary effort and eventually improve understanding and executing the responsibilities of eminent domain.

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CHAPTER 1

INTRODUCTION

Eminent domain grants government the right to take private property within its boundaries without the owner's consent provided the taking is for a public use and just compensation is paid. The conditions of public use and just compensation raise numerous legal, political, historical, and moral issues. For example, in the United States just compensation legally requires payment of fair market value, but without the benefit of information from market-style negotiation. Still, in the final analysis, the overriding principle is that the public interest takes precedent over private interest.

But what is fair market value? One might reasonably infer that fair market value in an eminent domain taking calls for government payment equal to price determined in a competitive market, that is, meeting the efficiency requirements of Pareto optimality. I found no study, however, that has quantified how eminent domain prices compare with market prices, though one can identify scenarios in which the government might pay discounts (takings payments less than market value) or premiums (takings payment greater than market value). For example, following Breton (1974), a government exploiting its monopolist position could discriminate in its payment for takings. One might expect a discount when the government uses market power adversely to the interests of the property owner and a premium when government responds to influential political power from the property owner. Thus, economic or political influences could account for a discount or premium paid for eminent domain takings.

The Pareto optimality postulate for welfare maximization limits social choice to the Pareto efficient frontier. This normative measurement offers little comfort for positive assessment, however. The lack of a social welfare function gives rise to contested issues and little agreement. Again, I found no study that evaluates whether takings' compensation is consistent among homeowners of the same or different levels of economic well-being, that is, horizontal and vertical equity in takings. If the size of a home implies wealth, one measure of well-being, a significant difference between compensation for takings and market prices for homes of different size may suggest vertical inequality, and variability between takings compensation and market prices for a given size of home may suggest horizontal inequality.

To address the efficiency and equity issues for eminent domain takings, I estimate an hedonic model that can be used to quantify the differences between the estimated market prices and compensations for takings. I investigate the size, sign, and statistical significance of these differences. My first hypothesis is that governments do provide just compensation, that is, government does not systematically take advantage of people or is manipulated by special interest property owners by paying takings compensation (fair market value) that differs from estimated market value. I also model the price difference between takings and market prices with home size, thereby empirically investigating whether government takings' compensation is neutral on the issue of horizontal and vertical equity, as measured by home size, my second hypothesis.

The data analyzed is from the Clark County Assessor's Office and McCarran International Airport. The large number of takings in and around McCarran Airport during the 1990s offers a robust set of observations to test these two hypotheses. House sale price is regressed against five interval and seven dummy variables of housing characteristics, two location dummy variables, three year of sale dummy variables, a takings dummy variable, and the three interaction variables--takings and size of home, outlier and living space, and outliers and takings. I compare alternative hedonic model specifications and identify strengths and weaknesses. In addition, measurement errors, critical estimation issues, and sample sets incorporating outlier adjustments are addressed. After analyzing the models, conclusions regarding the hypotheses follow.

Findings suggest that compensation prices paid for takings in the McCarran Airport environs during the mid-1990s differ from estimated market prices; takings were at a discount for smaller homes and a premium for larger homes; and residuals-to-home size for takings exceed the residuals-to-home size for market sales. As such, the findings point to inefficiency and inequity.

CHAPTER 2

LITERATURE REVIEW

This literature review draws from several fields of study. Welfare economics provides a theoretical framework to transform general questions on eminent domain into testable hypotheses. Previous studies of housing prices and hedonic indexes provide important guidance on specification of market price equations. Equally important, the legal environment of eminent domain ties together taking procedures, normative welfare economics and my hypotheses, shedding light on the equity and efficiency of this case study of eminent domain takings.

Eminent Domain May Be Welfare Improving

Given that a property is often transferred from the private to the public sector by eminent domain, welfare improvement is an important issue. Munger (2000) and Takayama (1993) provide much of the information reviewed here. Many economists have contributed ideas relevant to my eminent domain study, including Pareto, Pigou, Coase, Kaldor, and Hicks with each having a given preference as to whether government activity might or might not be Pareto improving. Most notably, Pareto developed the efficiency and equity postulates of welfare economics that are among the few that have held up to general agreement. The contribution of Pigou and Coase focuses on the efficacy of public and private actions to meet efficiency conditions. Pigou identified externality conditions violating Pareto efficiency criteria that suggested government solutions, whereas Coase demonstrated conditions whereby voluntary negotiations without transactions cost yield Pareto efficiency conditions. Still, meeting efficiency criteria may fall far short of a desired equitable outcome. Kaldor and Hicks recognized that voluntary exchanges between individuals could improve overall well-being. Kaldor's compensation principle, trading partners find themselves better off when winners compensate losers, underlies Pareto improvement action of eminent domain activity.

The Pareto efficiency criterion calls for choosing the static state that is superior to the others and thereby maximizing the efficiency gain to society, but with no explicit requirement to compensate individuals that may suffer a loss, nor requiring individuals to participate in any exchange not advantageous to that individual. In short, benefits accrue to whomever they accrue, but unanimity of decision is needed. Under its weak form, not all individuals end up being better off, some will only be indifferent. As such, everyone may not willingly participate in a Pareto improving activity. A holdout could easily forestall activity, thereby precluding the social gain. Thus, one could argue that government intervention in the form of eminent domain may be Pareto improving.

The Coase (1960) postulate is that when transaction costs are zero, an efficient use of resources may result from private bargaining, regardless of the legal assignment of property rights. When transaction costs are too high and prevent bargaining, however, the efficient use of resources will depend on how property rights are assigned. Without eminent domain, acquisition of private property would cause government to satisfy holdouts seeking to capture the project's added social value, perhaps even being Pareto deteriorating. Alternatively, the holdout could be unwilling to bargain, a situation of infinite transaction costs. Thus, Coase's analytical insight focuses on efficiency conditions, ignoring the equity issues of individual gains and losses.

Still, the Kaldor compensation approach comes closest to giving a normative rationale for eminent domain takings. It does not require unanimity and it allows, through gainers compensating losers, movement toward a Pareto improving outcome. The normative findings of welfare economics point to how eminent domain may improve efficiency and equity. Mueller (1974) notes there may be "some slippage between the lips of voters and the flow of outputs from the government cup." The positive theory of public choice raises questions regarding government takings behavior. Empirical analysis offers evidence for evaluating eminent domain impacts.

Hedonic Pricing is Useful for the Housing Market

Hedonic pricing is still developing, but considerable agreement exists on its application to housing. Rosen (1974) in his path breaking article and more recently Palmquist (1991) provide the key literature cited here. The hedonic model is a revealed preference method that extracts the implicit marginal value of homogeneous characteristics (such as a bathroom) of a heterogeneous product (such as a residential home). The price of a home (P) is explained by a vector of characteristics (z) such that $P = P(z)$. Simply put, the estimated price of a home is the summation of an implied price of its characteristics generated from an array of data on actual home transactions.

The two most troubling issues addressed in the hedonic literature are:

1) simultaneity, and
2) proper specification and estimation of attribute prices consistent with economic theory.

A major problem with housing is that quantity and price of each component are chosen simultaneously. This precludes identifying a shift versus movement along supply and demand relationships. The essence of the problem lies in the fact that existing data sets typically do not provide enough information to describe supply, demand, and marginal prices reliably. Diamond and Smith (1985) also argue that simultaneity results from price relations between characteristics. They recommend multiple time period data as one solution, an approach adopted here.

The second concern in developing an appropriate model is pooling of cross-section and time series data, which challenges the assumption of constant intercept and slope. Omitted observations may lead to changing cross-section and time series intercepts, error terms may be correlated over time and cross-section units, and heteroscedasticity or serial correlation can occur. Though numerous models have been developed to address panel data sets, see Woodridge (2000), I follow Pindyck's (1991) recommendation, separating year of sale into annual dummy variables as separate intercepts. In other words, although this data set could be analyzed as a panel data set, I analyze it as cross-sectional and time series data. I believe this approach to be a reliable one given the sporadic nature of home sales.

Estimating Hedonic Housing Equations

Grether and Mieszkowski (1974) developed models that included living space, number of bathrooms, number of rooms, lot size, and age as variables, specifying age as quadratic. Linneman (1980) developed models that did not include any lot characteristics or interaction variables, using living space, number of bathrooms, number of non bathrooms, age, and a number of dummy variables to account for quality characteristics and neighborhood. Studemund (2001) states that specifications of housing price equations are a matter of choice and experience, but his favorites based on theoretical grounds include living space, neighborhood, age, age squared, lot size and a dummy for air conditioning.

Fair Market Value is a Legal Construct

The legal requirements of eminent domain add vital insight. Eminent domain is a subset of government restrictions on private property, in which the injured party receives "just compensation" based on "fair market value" if government takes a property. In the United States, the legal basis of eminent domain evolved from England common law. Eminent domain is defined by US and state constitutions and statutes, and is supplemented by administrative rules and judicial opinions.

There is no national land acquisition policy, rather a montage of institutional rules recognized by local jurisdictions defines eminent domain procedures. In essence, the government may take private property within its boundaries for public use, but valuations paid for just compensation may vary in accord with local rules. Faced with diversity, judiciary interpretation ultimately arbitrates.

Eminent domain takings differ from regulatory takings in that regulatory takings use government police powers such as nuisance laws, zoning regulations, and similar restrictions on private property. Although regulatory takings are sometimes challenged under eminent domain law, they remain different. Regulatory takings are not addressed directly in this paper. Rather, this paper focuses on eminent domain condemnations that use government's constitutional power to redistribute land ownership to the public sector from the private sector in exchange for payment based on the legal concept of fair market value.

Eminent domain uses market appraisals to establish fair market value, but this value is not necessarily the same value established in competitive markets. Once a public project defines the land to be acquired, an appraiser applies market data to a specific property, and expresses an opinion in writing of the fair market value at a point in time. As stated by the American Right of Way Association(1972), a recognized professional association of appraisers, "Fair market value is a reflection of opinion and has no scientific validity beyond the care and skill applied by the appraiser in gathering, organizing, and analyzing the information. The data are drawn from numerous sources that have varying degrees of reliability and applicability for the present valuation. The market accuracy of the evaluation depends on the degree of detail and objectivity in the appraiser's analysis of all available market data".

In an effort to bring consistency to valuations, the American Right of Way Association and many jurisdictions have established professional requirements that appraisers must meet and methodologies they must follow. Typically, appraisers use the comparative sales, cost, and income methods. If more than one method is used that creates different results, the appraiser extracts, and hopefully justifies, a statement of final value estimate. This statement of value incorporates nuances of nonmarket valuations involving appraisal concepts and institutional rules.

This statement of value is typically what is offered to the property owner, who may accept it, contest it based on the same institutional constraints, or simply refuse the offer. The government entity can attempt to conclude negotiations, or begin judicial condemnation proceedings. The government may obtain occupancy while proceedings continue. Sellers typically receive lengthy advance notice of a taking, and they may have had input to the appraisal. Negotiations between the government and the landowners begin with the government offer. If these negotiations fail, the government's legal staff files suit to take the property. Negotiations may continue during litigation. If necessary, a judge or jury may ultimately set fair market value and the proceedings end. An appeal process is available, but seldom used.

Obviously, the essential element of the process is establishing fair market value. Fair market value is defined in Black's Law Dictionary as the "amount at which property would exchange hands between a willing buyer and a willing seller, neither being under any compulsion to buy or sell and both having reasonable knowledge of the relevant facts. The price is in cash, or its equivalent, that the property would have brought at the time of taking, considering its highest and most profitable use, if then offered for sale in the open market, in competition with other similar properties at or near the location of the property taken, with a reasonable time allowed to find a purchaser." It is important to note that just compensation may be less than full compensation. Full compensation includes monopoly pricing and any holdout value.

The legal process of eminent domain takings uses expert opinion in developing estimates as a basis for negotiations. The buyer and seller have an opportunity for negotiation, which substitutes for a market transaction. If negotiations fail, the court provides a safety net for the reasonable transfer of property from the private to the public sector. In making the offer for a taking, government self-interest and the application of appraisal procedures may result in an outcome that is not one of fair market value.

Summary

This literature review shows that the analysis of eminent domain takings rests on normative principles of welfare economics, the positive analysis of public choice, and the econometric analysis of housing prices using hedonic analysis, and the institutional legal framework. The literature provides reasons for takings compensation to differ from expected market prices and suggests that expected market prices can be modeled with an hedonic equation.

CHAPTER 3

MODEL SPECIFICATION AND HYPOTHESES

My goal is to test whether compensation for eminent domain takings equals estimated market price, using an hedonic model, and investigate whether the difference between takings compensation and estimated market price varies with home size. Price, the dependent variable under study, and the property characteristics used as explanatory variables, are presented in Table 1.

The General Model and Hypotheses

The general hedonic pricing model can be summarized as:

$$\text{Price} = f\,(\text{takings indicator, location, year of sale, house characteristics, outlier indicator}) \qquad (3\text{-}1)$$

The takings indicator equals one for a takings and zero for a market sale. A positive takings regression coefficient implies a premium, a negative value implies a discount, and a value close to zero implies market price equals takings price. Location and year of sale are also dummy variables, house characteristics is a vector of interval and dummy variables, and the outlier indicator captures the effects of possible mismeasurement. The interaction variables of the explanatory variables provide additional information. For example, if Takings*Living Space is negative, larger homes receive less; if positive,

Table 1: Description of Variables

Variable	Description
Price	Sales price of a home; market of by eminent domain
PSF	Sales price per square foot
Takings	Takings=1 for eminent domain. Takings=0 for a market sale
Takings*Living Space	Takings X living space (0 for market sales)
Living Space	living space of a home
Living Space Sqd	square of living space
Total Rooms	rooms in a home, including baths
Baths	Full baths+1/2 X half-baths
Other Space	Patio + carport + storage + converted; minimum of 1
Age	Sale year–effective year finished; minimum of 1
Age Squared	Square of age
Upgrade	Homes where effective year > construction year
Intercom	Home with an intercom
Fireplace	Home with 1 or more fireplaces
Pool	Home with a pool of any size
Jacuzzi	Home with a Jacuzzi
Septic	Home with a septic tank rather than sewer, may also be proxy for a large lot
No Garage	Garage space = 0
One Car Garage	Garage space up to 300 square feet
Two Car Garage	Garage space up to 600 square feet
>Two Car Garage	Garage space > 600 square feet
Location 162-25,26,27	North 3 square miles of study area
Location 162-35,36	Center 3 square miles of study area
Location 177-1,2,3,4	Southern 4 square miles of study area
1993	Sale occurred in 1993
1994	Sale occurred in 1994
1995	Sale occurred in 1995
1996	Sale occurred in 1996
Outlier	Defined by Hadi method on psf
Takings*Outlier	Eminent domain outliers
Outlier*Living Space	Outlier X living space

larger homes receive more, other things being equal. The primary null hypotheses, tested at the 10 %(*), 5 %(**), and 1 %(***) level of significance is that there is no statistically significant differences between:

1) market price and compensation for eminent domain takings after accounting for housing and other characteristics, and

2) takings and market valuations according to home size.

Predictions of Theory

Theory provides a prediction of the sign (positive or negative) of coefficients for some, but not all, variables composing the general model. The coefficients of Takings and Takings*Living Space may be positive, zero, or negative. Similarly, the location variable is relative to an arbitrary reference location, and no coefficient sign is predicted. The coefficients of living space and other space are expected to be positive. Coefficients of total rooms and baths are also expected to be positive, but an interaction with living space may produce a negative value. Age is expected to have a negative coefficient. The coefficients of the quadratic transformations of living space and age may be positive or negative. The coefficients of year are expected to be positive, reflecting housing market inflation. Bundling annual sales as a dummy variable, and this study's relatively short time period, may weaken the explanatory power of these variables. The coefficients for intercom, fireplace, pool, Jacuzzi, septic, and garage are expected to be positive. Outlier coefficients and interactions of outlier may be positive or negative. Upgrade is positive if modifications increase value and negative if modifications decrease value.

CHAPTER 4

THE DATA

The analysis of this data set compares housing prices for market sales and eminent domain takings in Clark County using data from McCarran Airport and the Clark County Assessor's Office. The study area, presented in Figure 1, is bounded by Tropicana Avenue, Las Vegas Boulevard, Pecos Road and Warm Springs Avenue.

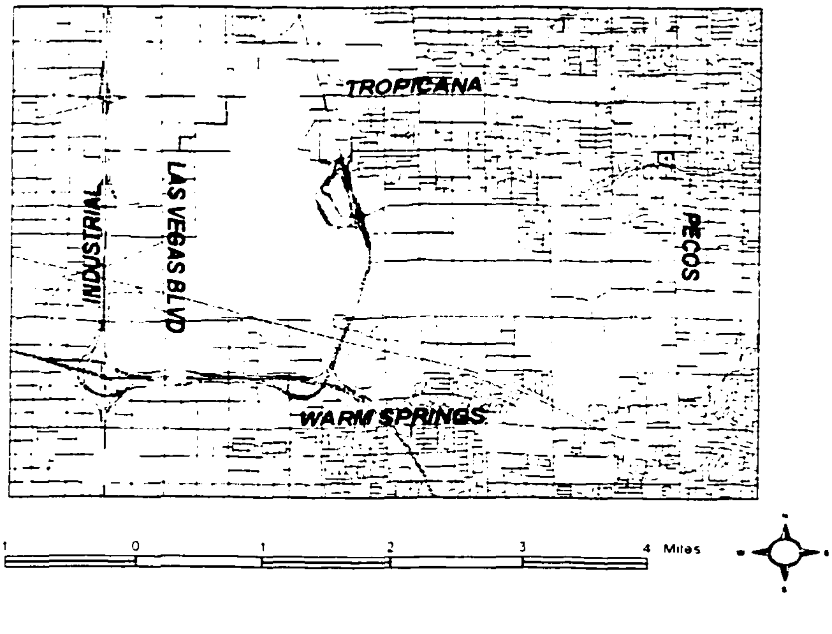

Figure 1. Study Area

Data Description

From the nine fiscal years (1994-2002) of assessor data and twelve years (1990-2001) of takings data, four years of sales were selected for analysis. Data availability, the number of takings, and a representative mix of takings and market transactions were criteria used in the selection of the years to study. The nine sections (each one square mile) were combined to create three location variables.

A breakdown of sales by location and year of sale is provided in Table 2 and Table 3, showing 115 takings and 2,134 market sales. In addition to the time and location variables, price is regressed against five housing characteristics using interval scales, seven dummy variables of housing characteristics, a takings dummy differential, and an interaction variable of takings differential and size of home.

Table 2: Number and Percentage of Market Sales and Takings for the McCarran Airport Study Area by Year; 1990-2001

Year	Total Sales	Market Sales	Takings	Percent Takings
1990	78	1	77	99%
1991	67	0	67	100%
1992	63	0	63	100%
1993	96	50	46	48%
1994	889	853	36	4%
1995	627	608	19	3%
1996	637	623	14	2%
1997	499	497	2	<1%
1998	567	555	12	2%
1999	651	646	5	1%
2000	509	506	3	1%
2001	299	229	0	0%

Table 3: Number and Percentage of Market Sales and Takings for the McCarran Airport Study Area by Location and Year: 1993-96

Section	Market Sales	Takings	Percent Takings
162-25	750	0	0%
162-26	461	1	<1%
162-27	177	0	0%
162-35	1	71	>99%
162-36	51	36	41%
177-01	66	0	0%
177-02	569	3	<1%
177-03	43	3	7%
177-04	6	1	17%

Possible Outliers and Adjustments Taken

The descriptive statistics of the key housing characteristics variables of the combined data set (market sales and takings) are presented in Table 4. A cursory examination of these summaries offers credible evidence that some outliers may be present, which I believe to be primarily measurement errors. A price per square foot of $4.44 as shown in Table 4 as a minimum value is not possible under normal conditions. Construction costs during this period in Las Vegas began at around $40 per square foot. To be sure, price can be less than this due to depreciation, functional obsolescence,

Table 4: Descriptive Statistics of Key Variables for the Combined Data Set (2,249 observations) Before Adjusting for Outliers

Variable	Mean	Std. Dev.	Min.	Max.
Price	115550	115320	7000	3700000
Living Space	1505	823	462	12405
Total Rooms	5.33	1.70	3	18
Baths	2.16	.70	1	9
Other Space	271	426	1	4297
Age	10.55	10.50	1	59
Price psf	75.65	23.71	4.44	489.46

Table 5: Descriptive Statistics of Key Variables for the Takings Data Set (110 observations) After Adjusting for 5 Outliers

Variable	Mean	Std. Dev.	Min.	Max.
Price	150082	96470	65000	465000
Living Space	1873	876	972	4668
Total Rooms	6.08	1.26	4	12
Baths	2.16	.57	1	4
Other Space	549	535	1	2956
Age	24.12	8.99	2	45
Price psf	76.79	17.57	25.65	126.24

Table 6: Descriptive Statistics of Key Variables for the Market Data Set (2,095 observations) After Adjusting for 39 Outliers

Variable	Mean	Std. Dev.	Min.	Max.
Price	107293	59937	15000	945970
Living Space	1470	763	462	11278
Total Rooms	5.29	1.70	3	18
Baths	2.16	.69	1	9
Other Space	247	396	1	4297
Age	9.67	9.96	1	59
Price psf	73.44	12.78	19.06	128.86

personal crises or distressed property; nevertheless, one would be hard pressed to accept as reasonable a price per square foot (psf) in Las Vegas under $20 per square foot. Rather than eliminate these observations perceived to be questionable, however, I performed a Hadi (1992) multivariate outlier test on price per square foot of living space. This criteria appears appropriate as this test resulted in more believable descriptive statistics, presented in Tables 4, 5 and 6. Whereas $4.44 psf is assuredly not reasonable, the range of $19.06 psf to $128.86, on the other hand, is a reasonable range of expected values. Summary statistics for the combined, takings, and market data sets are provided in Tables 7. The variable Outlier, a dummy variable equal to one for the 5 eminent domain outliers and the 39 market outliers, identified these outlying observations.

Table 7: Mean Values of Combined, Market, and Takings Data Sets Before and After Excluding Outliers

Variable	Com-bined Before	Com-bined After	Market Before	Market After	Takings Before	Takings After
Price	115550	109428	107293	113242	158374	150082
Takings	0.051	.050	0	0	1	11.76
Takings*Living Space	97.01	93.43	0	0	1897	1873
Living Space	1505	1491	1897	1484	1897	1873
Total Rooms	5.33	5.32	5.29	5.29	6.09	6.089
Baths	2.16	2.16	2.16	2.16	2.15	2.164
Other Space	271	263	248	254	592	549
Age	10.18	10.39	9.67	9.82	23.93	24.12
Upgrade	.044	.043	.033	.035	.21	.23
Intercom	0.039	.036	.032	.034	.13	.12
Fireplace	0.65	0.65	.66	.65	.61	.59
Pool	0.16	0.16	.15	.15	.24	.24
Jacuzzi	0.054	.053	.054	.055	.035	.027
Septic	0.027	.024	.020	.023	.11	.11
No Garage	0.41	.41	.41	.41	.45	. 46
One Car Garage	0.030	.027	.028	.031	.017	.018
Two Car Garage	0.48	.48	.49	.49	.37	.36
>Two Car Garage	0.083	.079	.078	.079	.17	.16
Location 162-25,26,27	0.62	.62	.65	.65	.0087	0
Location 162-35,36	0.071	.068	..023	.025	.93	.94
Location 177-1,2,3,4	0.31	.31	.324	.324	.061	.064
1993	0.043	.043	.024	.023	.40	.40
1994	0.40	.40	.40	.34	.31	.33
1995	0.28	.28	.284	.285	.17	.16
1996	0.28	.28	.294	.285	.12	.11
observations	2249	2249	2095+39	2134	115	110+5

Variable Specifications

Identifying outliers is but one of many steps used to become familiar with the data and thereby reduce the chance of unseemly errors in the analysis. In an effort to further improve my estimation, Living Space Squared and Age Squared are generated independent variables. Living space is often the most critical characteristic in determining price of housing. As such, adding a transformation of living space may significantly improve estimation. Age squared is another unique variable, included as recommended by Grether and Mieszkowski (1974).

Additional variables are added or generated to assist in the analysis. Takings is the dummy variable identifying prices determined through eminent domain, the primary thesis variable. This Takings indicator is 1 for eminent domain properties, otherwise it equals 0. If the coefficient of Takings is positive, a premium is implied, and if negative, a discount is implied. Takings*Living Space is a generated variable identifying living space of a takings property, the second thesis variable. Takings*Outlier identifies the five takings that were identified as outliers by the Hadi procedure. Outlier*Living Space identifies Living Space of all 44 outliers. This method allows retention of the outliers in the data set, but isolates their influence.

The location variables combine several sections (square miles) of land in an important way. Casinos, airport noise, heavy traffic, and an increased urban intensity impact this area of Las Vegas. These impacts are generally felt in an east-west rather than north-south direction. The casinos are predominantly north of this area. Auto traffic in this area is principally in an east-west direction. Aircraft landings are predominantly from the east and takeoffs to the west. In all, the impacts tend to be intense in an east-west, linear fashion. Therefore, by geographically combining the observations linearly in an east-west manner, these various impacts may be accounted for.

The year of sale variable is inherently imperfect. As a dummy variable, it lumps an entire year's sales in one class, a potential grouping problem. This makes a sale in any month of the same year equal, which probably does not reflect a monthly inflation some might anticipate. This is another case where hedonic analysis must be done in an imperfect world.

How This Data Set Was Created

As previously discussed, this data combines takings and market sale data. The procedure of developing the takings data set was as follows:

1) The McCarran Airport data set contained 688 takings, and identified each parcel number, sale price, and closing date.

2) Parcel numbers were matched with assessor data files to generate the characteristics of that parcel.

3) The parcels with positive values for "bedroom," "living space," and "construction year" were kept, thereby eliminating undeveloped land, commercial, and other non-residential property.

The procedure of developing the market data set was similar. The Clark County Assessor's office provided data on 4,636 sales that were reduced to 4,502 residential market sales in the surrounding area between 1993 through 2001, as follows:

1) Nine fiscal years (1994-2002) of data were obtained from the Clark County Assessor. Each year had two files of characteristics, which were combined by matching parcel

numbers. Seventeen parcels were eliminated because a parcel number had one sale price associated with two sets of property characteristics.

2) Since the data set contained every assessor parcel, only those recording an "arms length" transaction were kept (sales type R), and subsequently only those parcels registering a positive number in the fields "bedroom", "living space" and "construction year "were kept. Seven observations were deleted because the assessor archived files had no entry for a critical field such as "sales price". In addition, 334 observations were deleted at 7000 Paradise Road because all 334 were listed at $2 million each, sold in November of 1996, obviously not an accurate sales price for a residential unit at that location.

3) The assessor's market data sets for each year were then combined, yielding approximately 17,000 observations. This data set, however, had many duplicates of actual sales, so duplicates were deleted. For instance, if a house sold twice in the 9 year period, the property would be in each fiscal year data sets, but only twice in the final data set. The assessor file of market sales and the eminent domain file were then combined, adding a field "takings", where market data value was 0 and taking value set at 1, for use as a dummy variable.

4) Values of living space and age were used to generate transformations living space squared and age squared. Age and Other Space were given minimum values of 1, so log transformations could be generated.

Summary

This study uses a data set that enables a comparison of eminent domain takings compensation with estimated market prices. The outlier adjustments taken improve analysis while keeping the data set intact. The model and variables are specified to allow evaluation of alternative functional form, testing for assumption violations, and corrective actions, if warranted.

CHAPTER 5

RESULTS

This analysis of eminent domain takings rests on economic principles, follows available guidance on model specification, and uses a robust data set. The combining of two data sets, the specification of the location variables, the potential for omitted variables, and the lack of prior studies suggest a larger than usual review of alternative model specification is appropriate. My evaluations include goodness of fit, overall fit, multicollinearity, heteroscedasticity, and other analyses to extract as much reliable information as can be reasonably accomplished.

Alternative Functional Forms

The literature of hedonic equations for urban housing prices fails to establish a specific functional form or the exact explanatory variables to include in an analysis. Though the evidence provides guidance, I use popular functional forms, an often used first step, and add three power transformations suggested by a Box-Cox analysis. In all, eight ordinary least squares model specifications (OLS) are developed. The models are referred to as log or linear, but are not in the strictest sense. That is, right hand side variables may not all be linear because of transformations of a dependent variable, but the equations are linear in terms of the parameters. This exception noted, the model specifications to be estimated are:

1) Linear-Linear using sales price as the dependent variable.

2) Linear-Linear (PSF) using sales price per square foot as dependent variable.

3) Log-Linear,

4) Linear-Log,

5) Log-Log,

6) A Theta-Lambda functional form model, a Linear-Linear model using RHS-LHS (right hand side-left hand side) Box-Cox parameters to transform the dependent and independent numeric variables,

7) A Theta functional form model, a Linear-Linear model using RHS (right hand side only) Box-Cox parameters to transform independent numeric variables, and

8) A Lambda functional form model, a Linear-Linear model using LHS (left hand side only) Box-Cox parameter to transform the dependent variable.

All the specifications include both age squared and living space squared. Estimating the Linear-Log and Log-Log forms result in living space and age being dropped as independent variables, however, as including them would create near redundant variables with their respective squared terms. Models 6, 7 and 8 are OLS models that include transformed variables from a maximum likelihood estimated (MLE) Box-Cox regression.

These Box-Cox exponents for all three models are presented in Table 8. As shown by the chi-square statistics, transforming both the RHS-LHS indicate significant exponents, the Box-Cox coefficients differ significantly from a linear, inverse, or logarithmic values of 1, -1 or 0. Transforming the LHS draws a similar analysis, as does transforming the RHS only. The RHS only transformation does support inclusion of the quadratic forms of age and living space, as indicated in the previously cited literature.

Table 8: Regression Results of the Three MLE Box-Cox Model Specifications used to Generate the Theta/Lambda, Theta and Lambda Models and Tests of Significance for These Functional Forms.

Variable	Transformations of both side w/ separate parameters	Transformations of left hand side only	Transformations of right hand side only
Lambda (RHS) Chi2	**0.7408366** 9.12***		**2.38379** 36.20***
Theta (LHS) Chi2	**0.0946368** 5.44***	**0.1219783** 7.69***	
LRchi2	3545***	3531***	5024***
Chi2 Theta&/or lambda= -1 = 0 = 1	 3675*** 31*** 3392***	 3927*** 58*** 3378***	 3304*** 2635*** 752***

Coefficients are output from Stata 7. Statistical Significance is *10%;**5%;***1%.

The Theta-Lambda coefficients from Table 8 were used to transform the specified variables for models 6, 7 and 8. For example, the Theta-Lambda (model 6, linear-linear) model using RHS-LHS Box-Cox parameters was accomplished by power transformation of 0.7408366 for price, and a power a transformation of 0.0946368 for age, age squared, total rooms, baths, other space, takings*living space, outlier*living space, living space, and living space squared. Dummy variables were not transformed.

Evaluation Criteria

The eight models, presented in Table 9, were compared by several statistical criteria, including R-squared (goodness of fit), F-statistic (overall fit), Ramsey Reset (Regression specification error test, sometimes referred to as a test for omitted variables, but useful for testing functional form), VIF (variance inflation factor test for harmful multicollinearity), and Cook-Weisberg (constant variance). These criteria are used in conjunction with economic analysis and findings from the empirical literature on housing prices. The findings of Table 9 suggest that some models are weaker than others, though most models show striking similarity as to signs and significance of explanatory variables. The F-statistics are significant at the one per cent level in all cases. The Linear- Linear PSF and the Linear-Log specifications, however, have smaller R-squared values (.541 and .654) when compared with the other models. A comparison of R-squared and quasi R-squared values suggests the relative superiority of the Linear-Linear and the Lambda model specifications, though the differences between model results is surely minimal and other issues need greater consideration before a more definitive conclusion can be made. The Lambda specification suggests incorporating age and living space squared has credence. The Log-Linear specification also has appeal, as its heteroscedasticity and omitted variable diagnostics are slightly better than the Linear-Linear specification. The Linear-Linear PSF and Linear-Log have weaker R-squared than the other models but the findings are generally consistent with economic theory. The Linear-Log and Log-Log indicate multicollinearity is still present, even after dropping variables of interest: still, the remaining coefficients have the anticipated signs. The MLE specifications are all good. In general, these findings are in general agreement with expectations.

Table 9: Regression Results and Diagnostic Statistics of Eight OLS Model Specifications

Variable	Linear-Linear	Linear-Linear PSF	Log-Linear	Linear-Log	Log-Log	Theta-Lambda	Theta Model	Lambda Model
Takings	-60989 4.49***	-24.45 4.96***	-.152 2.36***	-320786 2.42***	-1.16 2.83***	-.070 3.10***	-.092 3.10***	-25593 3.38***
Takings* Living Space	25.17 4.64***	.0088 4.49***	6.16e-5 2.39***	41578 2.37***	.15 2.82***	2.25e-4 3.31***	3.86e-5 3.05***	1.50e-4 4.11***
Living Space	26.28 4.49***	-.018 9.73***	.00045 18.98***	Dropped	Dropped	.0013 3.91***	2.27e-4 19.36***	5.00e-4 26.1***
Living Space Sqd	.0036 8.88***	1.46e-6 9.91***	-2.48e-8 12.81***	63976 12.06***	.39 23.70***	-5.59e-7 7.85***	1.14e-8 11.98***	-9.1e-14 25.4***
Total Rooms	-4604 3.76***	-.54 1.23	.0045 .77	-48386 4.20***	-.0073 .21	-6.64e-4 .19	3.71e-4 .13	-226 9.58***
Baths	9776 3.91***	.48 .53	.022 1.87**	3332 .38	-.056 2.09**	.0086 1.51	.12 2.02**	1420 8.67***
Other Space	15.71 4.40***	.00476 3.76***	6.29e-5 3.70***	-1195 .95	.00164 .42	1.37e-4 3.91***	3.57e-5 4.28***	3.66e-4 6.98***
Age	-1765 5.49***	-1.300 11.16***	-.0152 9.95***	Dropped	Dropped	-.0107 8.63***	-.00733 9.78***	-2.339 1.80
Age sqd	53.78 5.46***	.0388 10.85***	4.13e-4 8.82***	-180 .24	-.0143 6.28***	6.51e-4 6.88***	1.98e-4 8.60***	6.98e-4 3.91***
Upgrade	-11847 2.18**	-11.16 5.66***	-.743 2.87***	-6591 .85	-.036 1.51	-.0216 3.01***	-.0396 3.12***	-9432 2.08**
Intercom	39148 6.84***	11.93 5.71***	.0729 2.66***	67258 7.72***	.117 4.37***	.0274 3.62***	.0470 3.50***	33736 6.87***
Fireplace	13657 5.35***	3.47 3.75***	.0830 6.84***	-944 .24	.0367 3.03***	.0201 5.91***	.0405 6.80***	15263 7.27***
Pool	13922 3.92***	6.51 5.06***	.116 6.88***	15694 2.91***	.1086 6.54***	.0307 6.58***	.0577 6.96***	13215 4.43***
Jacuzzi	14509 2.82***	3.54 1.89	.0335 1.37	10495 1.34	.041 1.70	.0128 1.89	.0216 1.80	18457 4.20***
Septic	43624 5.90***	10.17 3.79***	.0816 2.32**	45147 4.17***	.190 5.70***	.0373 3.89***	.0535 3.10***	19052 2.91***
Outlier	-17708 3.41***	97.99 24.26***	.485 9.15***	-3.70e6 29.55***	1.388 3.60***	.146 7.74***	.242 9.30***	102922 15.4***
Outlier* Living Space	198.25 50.25***	.00352 2.46***	4.93e-5 2.63***	535592 31.86***	-.103 1.99**	1.62e-4 2.78***	4.79e-5 5.21***	6.5e-4 64.5***
Takings* Outlier	-1.89e5 8.51***	-53.516 6.61***	-.0776 .73	-338773 9.92***	-.081 .77	-.0419 1.43	-.0767 1.47	-77629 4.10***

Coefficients are output from Stata 7. Statistical Significance is *10%;**5%;***1%. t-statistics are absolute values. VIF is average of all variables. t-statistical significance indicated as a 2-tailed test.

Table 9: Continued

Variable	Linear-Linear	Linear-Linear PSF	Log-Linear	Linear-Log	Log-Log	Theta-Lambda	Theta Model	Lambda Model
One Car Garage	12125 1.99**	2.41 1.09	-.0287 .99	17847 1.71**	-.0424 1.32	-.00371 .46	-.0100 .70	-11559 2.32**
Two Car Garage	22953 5.90***	13.30 13.32***	.232 17.7***	1337 .30	.170 12.5***	.0595 16.1***	.112 17.5***	25445 11.5***
>Two Car Garage	17129 3.41***	14.02 7.70***	.203 8.49***	12124 1.61	.163 7.02***	.0534 8.07***	.0992 8.47***	25213 6.18***
Location 162-35.36	37780 6.02***	18.40 8.08***	.197 6.61***	25677 2.67***	.158 5.33***	.0555 6.68***	.102 6.94***	40037 7.55***
Location 177-1,2,3,4	-5903 2.08**	1.085 1.05	.0106 .79	4312 1.02	.0294 2.26**	.00557 1.50	.00412 .62	-4426 1.85
1994	-6150 1.16	-2.52 1.31	-.0349 1.39	-5910 .73	-.0371 1.49	-.0106 1.53	-.0177 1.44	-4487 1.00
1995	-2148 .39	-.926 .47	-.0184 .71	-487 .06	-.0171 .67	-.00519 .72	-.00854 .67	-1213 .26
1996	1754 .32	2.55 1.28	.0240 .92	-344 .04	.0262 1.02	.00724 1.00	.0124 .97	2748 .59
Constant	41956 6.29***	89.75 336***	10.67 336***	-739432 12.14***	5.85 31.2***	2.664 234***	3.66 235***	59737 13.0***
R-squared	.8523	.541	.796	.654	.77	.811	.813	.894
Quasi-R2			.722			.756	.798	
F-statistic	493	101	333	175	369	368	372	717
Ramsey Reset (F)	472	217	89	1344	58	87	89	161
Cook Weisberg chi2	32868	14921	1043	104942	1509	1786	1808	15498
VIF (overall)	5	5	5	49	49	6	5	5

Coefficients are output from Stata 7. Statistical Significance is *10%;**5%;***1%. t-statistics are absolute values. VIF is average of all variables. . t-statistical significance indicated as a 2-tailed test.

Table 10: Summary Analysis of Variables Influence on Price at 5% Significance Level

Variable	Null Hypothesis Alt. Hypothesis	No. of Models H_0 Accepted	No. of Models H_a Accepted	Conclusions
Takings	=0; not=0	0	8	Takings occur at a discount
Takings* Living Space	=0; not=0	0	8	Vertical inequity; larger homes receive more compensation than smaller homes
Living Space	=0; >0	0 of 6	6 of 6	As expected excluding psf model
Living Space sqd	=0; not=0	0	8	Price and Living Space have a nonlinear relationship; sign of coefficient inconsistent; 3 negative and 5 positive
Total Rooms	=0; not=0	6	2	May be interacting with Living Space
Baths	=0; not=0	6	2	Generally as expected
Other Space	=0; >0	3	5	As expected
Age	=0; <0	0	6 of 6	As expected
Age sqd	=0; not=0	1	7	Price and age have a nonlinear relationship
Constant	=0; >0	1	7	Generally as expected; Linear-Log Model had neg. coefficient
Upgrade	=0; not=0	2	6	Assessor definition may be illogical
Intercom	=0; >0	0	8	As expected
Fireplace	=0; >0	1	7	As expected
Pool	=0; >0	0	8	As expected
Jacuzzi	=0; >0	3	5	As expected
Septic	=0; >0	0	8	As expected
One Car Garage	=0; >0	6	2	Weakly as expected
Two Car Garage	=0; >0	1	7	As expected
>Two Car Garage	=0; >0	1	7	As Expected
Location 162-35,36	=0; not=0	0	8	Better area than nearer strip
Location 177-1,2,3,4	=0; not=0	6	2	Inconclusive; weak influence
1994	=0; >0	8	0	Not an influential variable
1995	=0; >0	8	0	Not an influential variable
1996	=0; >0	8	0	Not an influential variable
Outlier	=0; >0	1	7	Outliers are important
Outlier* Living Space	=0; >0	0	8	Outliers*Living Space is important
Takings* Outlier	=0; >0	5	3	5 outlier takings have lower price, all else equal

The t-statistics are absolute values, tested at 5%, in accord with their respective one-tail or two-tail criteria.

Omitted Variables

The omitted variable problem is an inherent condition of housing data, including this data set. Many variables are available for potential selection as explanatory variables, but the fundamental assumption that house characteristics are homogenous stretches reality. The type of flooring, cabinets, counter tops and other variables are seldom accounted for in the available data. There is also no direct means of accounting for tastes, level of maintenance, and other matters that can influence price. For instance, flooring can be linoleum or marble, old or new, but data almost never accurately distinguishes uniqueness. It can be argued that larger, newer homes with intercoms, pools and Jacuzzis, characteristics described in this database, are more likely to have a higher price per square foot, but such amenity variables may capture only some undescribed uniqueness. In all these specifications, the results from the Ramsey Reset test suggests possible omitted variables, leaving open the issue of best functional form. Omitted independent variables or heteroscedasticity (Kennedy) can bias the coefficient estimates of the included independent variables. First, unless the mean of an omitted variable is zero, the constant will be biased. Second, only if an omitted variable is orthogonal to included variables will there be no bias introduced into those coefficients. Third, the explanatory power of the model suffers by not including an important variable. The results in Table 9 and 10 have coefficient signs as predicted and the fits are reasonably good. Undescribed uniqueness aside, these preliminary results appear adequate in that the results are consistent across a number of functional form specifications, signs of coefficients are consistent with what is expected and coefficients are statistically significant, results that are usually achieved when no omitted variables problems exist.

Multicollinearity

The VIF (variance inflation factor) test for harmful multicollinearity is good when the right hand side of the equation is a linear, but poor if a log. Multicollinearity appears to be an issue in the Linear-Log and Log-Log specifications. The overall VIF exceeds 49, well beyond the value deemed acceptable. Variables were dropped for estimation because of high collinearity. Still multicollinearity does not bias coefficient estimates. Rather, it increases standard errors and reduces t-statistics. Not surprisingly, the rooms, other space, and the interaction variable of Takings*Outlier were statistically insignificant. All in all, however, the models have good t-statistics across a wide array of explanatory variables.

Dropping a variable is one corrective action. The numeric variables total rooms and baths are not typically statistically significant in any of these models, but no strong theoretical argument can be made for dropping them. Other authors have also found total rooms and baths to be weak explanatory variables, so this problem is somewhat common. Several dummy variables were not always statistically significant, particularly year of sale and location, but these have a theoretical value suggesting their inclusion. It is relevant to note, however, that although the VIF test provides an acceptable average value, living space has the highest variable VIF in all functional forms. The VIF test indicates serious multicollinearity when the specification uses the log of RHS variables, and the variables associated with living space and age. These variables, however, are theoretically critical and are included in the analysis, except where these variables are dropped by the statistical software.

Heteroscedasticity

As Mankiw (1990) states "Heteroscedasticity has never been a reason to throw out an otherwise good model," and as Gujarati (1995) adds, "But it should not be ignored either." A critical assumption of OLS estimation is constant variance of independent variables, or homoscedasticity. Non-constant variance, or heteroscedasticity, does not create bias nor harm consistency properties of OLS estimators, but these estimators no longer are of minimum variance, and thus are not as efficient, and can result in misleading t-tests and F-tests. The Cook-Weisberg general statistic indicates possible heteroscedasticity, statistically significant at the 1% level in all cases. Having identified the presence of heteroscedasticity still leaves open the question of how best to address the problem. Furthermore, heteroscedastic error terms may also arise with a less than adequate specification of functional form or omitted variables. Thus, non-constant error terms may occur within the context of other modeling issues, further confounding the analysis. Regression modeling must balance all these issues.

Heteroscedasticity is an efficiency concern, not one of bias or consistency. Since the true variance is unknown, weighted least squares is not a feasible remediation. An alternative that is available, White's method, is used to test the Linear-Linear, Log Linear, and Theta models. In these cases, White's method produces heteroscedasticity-corrected standard errors larger than OLS standard errors and therefore smaller t-statistic values, but identical coefficients as with OLS estimates. As Table 11 shows, Takings and Takings* Living Space remain significant in all models. Living Space and Living

Space Squared are also significant except in the Linear-Linear model. It is difficult to conclude whether heteroscedasticity, omitted variables, or both cause these diagnostic results, but the issue of undescribed uniqueness likely contributes to the problem. The White adjustment indicates that despite potential heteroscedasticity, all three models provide a reasonable specification.

Findings on Model Variables

It appears that despite the potential issues of omitted variables, heteroscedasticity, and multicollinearity, the eight OLS model specifications of Table 9 do provide information from which conclusions may be drawn. Table 10 combines all the specifications, providing a summary score card of how each variable fares. A major finding is that the accept/reject decision is generally consistent across functional forms, coefficients follow the anticipated signs, and conclusions are supported with statistical findings. It is apparent from this analysis that more than one functional form could be used for further analysis. The Linear-Linear Model has special appeal, however, as it is straightforward to understand and interpret, has generally favorable statistics that are as good as the other models in terms of diagnostic evaluation results, and most importantly, the findings generally agree with what is anticipated from economic theory. This Linear-Linear specification is, therefore, the basis of further tests, interpretations, and conclusions. This is supported by ancillary reporting of the Log-Linear and Theta models to evaluate consistency across functional form.

Table 11: Selected Variables of Takings and Living Space, Coefficients and t-values Before and After Correction: White's Heteroscedasticity-corrected Standard Error Method to Remediate Nonconstant Variance.

Model	Linear-Linear		Log-Linear		Theta-Linear	
Variable	Before	After	Before	After	Before	After
Takings	-60989 4.49***	-60989 2.61***	-.15 2.36***	-.15 2.03**	-.092 3.10***	-.092 2.31**
Takings*Living Space	25.17 4.64***	25.17 2.73***	6.16e-4 2.39***	6.16e-4 2.14**	3.86e-5 3.05***	3.86e-5 2.50***
Living Space	26.28 4.49***	26.28 1.15	.00045 18.98***	.00045 7.89***	2.27e-4 19.36***	2.27e-4 7.16***
Living Space Squared	.0036 8.88***	.0036 1.16	-2.48e-8 12.81***	-2.48e-8 4.10***	-1.14e-8 2.16**	-1.14e-8 3.28***

Coefficients are output from Stata 7. Statistical Significance is *10%;**5%;***1%. t-statistics are absolute values.

Vertical Inequity is Suggested

Figures 2 and 3 demonstrate the important concept of vertical inequity between the estimated market price and Takings compensation, suggested by the Linear-Linear and other model specifications. The Linear-Linear model specification indicates eminent domain takings include an initial discount that diminishes with size of home, becoming a premium with large homes. There are many characteristics of a home, and not all homes have all characteristics or equal number of characteristics, but all else equal, my analysis indicates a diminishing discount as home size increases and a premium with large homes. Figure 3 reflects the 88 takings at a discount (77%) on homes of less than 2,411 square feet of living space, suggesting most takings were at a discount. The Log-Linear and Theta-Linear specifications predict similar results to the Linear-Linear model; however, these two models suggest decidedly more moderate vertical inequity. Moreover, it is relevant to note that in the range of living space for most homes, the

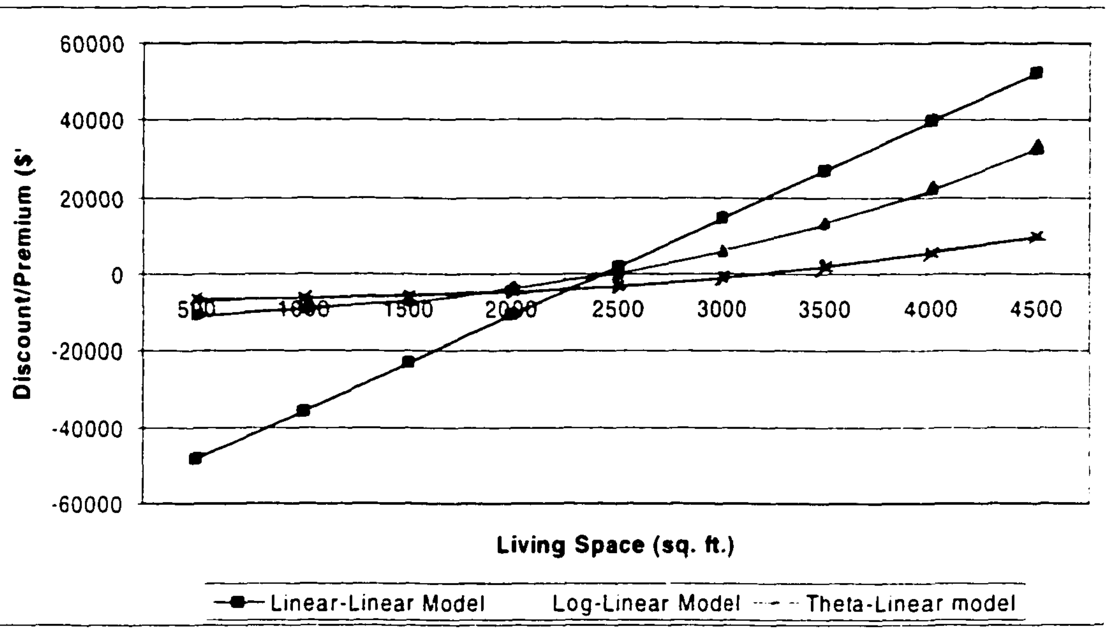

Figure 2: Predicted Small Home Takings Discount and Large Home Takings Premium

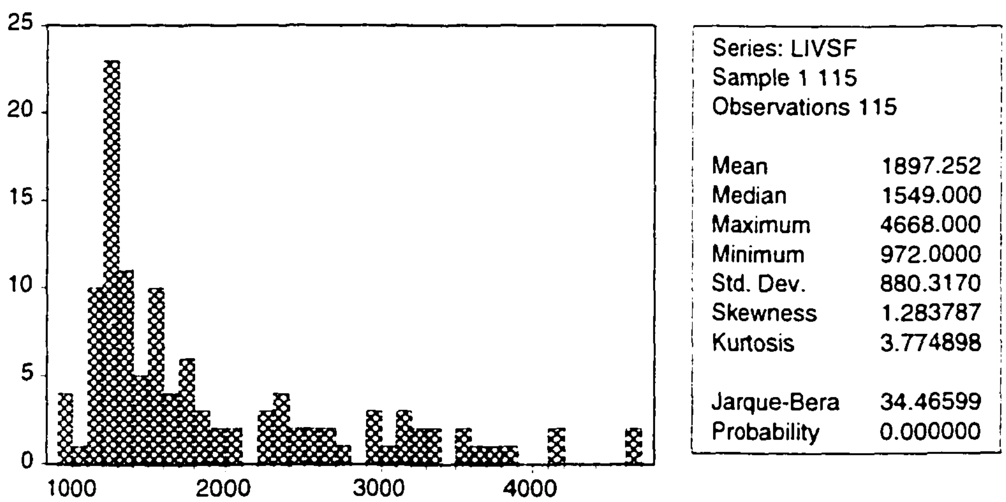

Figure 3: Frequency Distribution of Living Space for Takings

discount or premium is less dramatic than at the extremes. Yet, vertical inequity is demonstrated in all three cases.

Elasticity

It is evident that the relationship of Takings, Takings*Living Space and Price (as indicated by a discount or premium) is an important one. The price elasticity of demand for Takings*Living Space can add insight into the relationship between size of home and takings compensation. Because this elasticity is not constant, I compare price elasticity of demand for living space where living space is 1,254 square feet (the first quartile, an implied discount), and at 2,384 square feet (the third quartile, an implied premium), for the Linear-Linear Model, presented in Table 12. These estimates are for eminent domain takings, and thus approximate the elasticity living space of 1,254square feet and 2,384square feet, points on the line presented in Figure 2. The price elasticity of demand for living space in both cases is elastic, and is greater for the smaller home. Elasticity decreases with size of home, expected with a positively sloped line. In other words, Takings*Living Space of a smaller home is more price sensitive than of a larger home.

Table 12: Price Elasticity for Living Space Estimated for Takings Properties at the First and Third Quartile for Living Space

Variable	First Quartile	Third Quartile
Living Space	1254	2384
Estimated Price	51081	80780
Elasticity	1.55	1.29

Values for Living Space are the inversion of Stata output providing %change in y for a %change in x.

Horizontal Inequity is Suggested

Another analysis is for horizontal inequity. Whereas vertical equity was proxied by the takings difference and Takings*Living Space, horizontal inequity is, at least in part, measured by the residuals, or unexplained error of the regression. The theory of hedonic analysis would imply that, all else being equal, one should expect two homes with the exact same features sold at the same time should receive the same price. The reality of the market, however, is that, with different buyers and different sellers this is actually unlikely. It is likely, however, that the forces of supply and demand would keep prices within a relatively small range. Eminent domain, on the other hand, rests on an inherent equity principle that government treats all equally, and sellers get an equivalent deal. As a rough test for horizontal equity, I normalize the residuals to living space, and test if takings differ from the estimated market price. The hypothesis is:

$$\frac{\text{(Takings Residuals)}}{\text{Living Space}} - \frac{\text{(Market Residuals)}}{\text{Living Space}} = 0$$

For this two-tailed test, the results are presented in Table 13.

The t-statistic is significant at the 5% level so the null hypothesis is rejected. The residuals (unexplained error) of the Linear-Linear model, normalized to living space, (residuals/living space) for takings, are larger than the same measure for the market

Table 13: Horizontal Inequity: Means Test of Takings and Market data

Group	Observations	Mean	Std. Dev
Market	2134	75.358	17.548
Takings	115	79.892	20.862
Combined	2249	75.590	17.756
t-statistic	2.287**		

transactions. This can imply that these takings, for a given size of home, vary in price more than the market. From this one could infer that, relative to the market, some horizontal inequity existed in this sample of eminent domain takings.

Alternatively, it could also merely show that the model reflects market prices better than takings prices; or that the market process, the takings process, or both are inefficient. Case and Schiller (1989) present sound arguments for housing market inefficiency, including random factors affecting price. These include not only transaction costs, carrying costs and taxes, but also noise in price due to imperfections in the market for housing. These imperfections can include the random behavior such as arrival of interested purchasers and real estate agent behavior, such that sale price is not identical to market price. As my discussion of the process of eminent domain indicates, there are a number of potential inefficiencies that might preclude duplication of takings compensation for near identical properties. Nevertheless, with the market as a benchmark, this evidence suggests greater inequity, inefficiency, or both in the takings process.

Chow Test for Differences Across Takings and Market Data Sets

In addition to providing insight into the overall fit of the model, the F-statistic using Chow's approach enables testing whether or not the regression coefficients of the market and takings data sets differ significantly.

The null hypothesis for comparison is that the two regression coefficients are equivalent. The appropriate F-statistic is:

$[(RSS_{combined}-RSS_{market}-RSS_{takings})/(23+1)]/[(RSS_{market}+RSS_{takings})/(2134+115-2(23)-2)]$

$=[(4.60-4.09-0.11)/24]/[(4.09+0.11)/(2201)] = [.0167/.00191] = 8.75$

$F_{critical}(23.2201) = 1.85$

Therefore. the null hypothesis is rejected: the two data sets do not have equivalent coefficients. A close inspection of the data in Table 14 exposes an even clearer insight. Note that the Takings price regression has three significant explanatory variables: living space. upgrade and pool. On the other hand. the Market price regression has many significant explanatory variables. One can infer from this that the market pricing mechanism is much more complex than may be used determining fair market value in eminent domain takings. This has potential policy implications in that hedonic pricing might be a powerful addition to the takings process of estimating fair market value. and may improve equity among sellers.

As a final point to add to this perspective. I calculated the two data sets' diagnostics tests (Ramsey Reset. VIF. and Cook-Weisberg). As Table 15 suggests. it is apparent there is a potential for different price generation processes between the data sets.

Table 14: Combined, Market and Takings Regressions and Statistics for Chow Test

Variable	Combined Data Set 2249 observations		Market Data Set 2134 observations		Takings Data Set 115 observations	
	Linear	Log-Linear	Linear	Log-linear	Linear	Log-Linear
R-sq'd	.852	.796	.850	.79	.910	.904
RSS	4.60e12	100	4.26e12	95	1.11e11	3.36
ESS	2.53e13	388	2.42e13	349	1.12e12	31.65
TSS	2.99e13	487	2.84e13	443	1.23e12	35.01
Living Space	30.21 5.92***	.00045 18.98***	22.49 4.56***	.000436 17.79***	100 3.58***	.000868 5.44***
Living Space Sqd	.0036 8.88***	-2.48e-8 12.81***	.00373 9.14***	-2.37e-8 12.14***	-.004 .76	-8.77e-8 3.12***
Total Rooms	-4604 3.76***	.0045 .77	-4389 3.50***	.00481 .80	3510 .81	.016 .67
Baths	9776 3.91***	.022 1.87**	11574 4.55***	.0291 2.39***	-12992 1.25	-.074 1.29
Other Space	15.71 4.40***	6.29e-5 3.70***	17.32 4.52***	6.95e-5 3.79***	-3.71 .41	7.33e-6 .15
Age	-1765 5.49***	-.0152 9.95***	-1889 5.82***	-.016 10.22***	-1850 .80	-.015 1.19
Age sqd	53.78 5.46***	4.13e-4 8.82***	56.51 5.60***	.0004318.9 1***	28.68 .58	-.000210 .76
Up-grade	-11847 2.18**	-.743 2.87***	-10936 1.79*	-.064 2.20**	-25605 2.37**	.164 2.75***
Inter-com	39148 6.84***	.0729 2.66***	25914 3.97***	.0333 1.06	10258 .74	.010 .013
Fire-place	13657 5.35***	.0830 6.84***	14110 5.42***	.0845 6.77***	7083 .71	.072 1.50
Pool	13922 3.92***	.116 6.88***	14646 3.95	.117 6.56***	23871 2.59***	.139 2.73***
Jacuz-zi	14509 2.82***	.0335 1.37	15612 2.98***	.0036 1.46	27186 1.29	.059 .51
Septic	43624 5.90***	.0816 2.32**	68600 7.96***	.149 3.61***	-5452 .38	.00589 .08
Outlier	-17708 3.41***	.485 9.15***	-191249 17.21***	4.60 8.63***	70831 .91	.856 1.98**
Outlier* Living Space	198.3 50.3***	4.93e-5 2.63***	204 51.49***	5.92e-5 3.12***	17.14 .16	-.000159 1.07
Constant	41956 6.29***	10.67 336***	34678 4.64***	10.63 297***	7422 .10	10.84 26.68***
One Car Garage	12125 1.99**	-.0287 .99	14577 2.37**	-.024 .82	-30410 1.07	-.128 .81

Table 14: Continued

Variable	Combined Data Set 2249 observations		Market Data Set 2134 observations		Takings Data Set 115 observations	
	Linear	Log-Linear	Linear	Log-linear	Linear	Log-Linear
Two Car Garage	22953 5.90***	-.0287 .99	25166 8.84***	.248 18.21***	3114 .33	.017 .33
>Two Car Garage	17129 3.41***	.232 17.7***	15654 3.03***	.208 8.42***	37817 1.88*	.148 1.33
Location 162-35.36	37780 6.02***	.203 8.49***	44528 6.71***	.217 6.82***	-3507 .06	-.079 .25
Location 177-1.2.3.4	-5903 2.08**	.197 6.61***	-7788 2.71***	-4.58e-5 0.00	7911 .13	-.073 .22
1994	-6150 1.16	.0106 .79	1098 .17	.00963 .31	-2552 .30	-.022 .48
1995	-2148 .39	-.0184 .71	4382 .67	.0242 .77	-13706 .99	-.064 .83
1996	1754 .32	.0240 .92	9171 1.40	.071 2.27**	-4252 .26	-.064 .89

Coefficients are output from Stata 7. Statistical Significance is *10%:**5%:***1%. t-statistics are absolute values.

Table 15: Diagnostic Tests from the Market and Takings Data Sets Regressions

Test	Market Linear	Market Log-Linear	Takings Linear	Takings Log-Linear
R-squared	.85	.77	.91	.89
F-test	545	327	42	35
Ramsey Reset Test	479	114	4.2	5.2
Cook-Weisberg Chi2	35831	1256	17.21	3.0

Omitted Variables, Potential Bias,

And Unknown Factors

It is possible that the model specifications have an inherent bias, if, for instance, eminent domain takings are not random events, similar to self-selection, or if the Takings coefficient is systematically related to unobserved factors. To test if this is the case, I use the treatment effect model as discussed by Wooldridge (2000) and Greene (2000). The Takings coefficient controls for its uniqueness in the model, but may be measuring some unknown variable as well. Houses selected for taking by the government are not completely random events, so it is uncertain whether the takings indicator is measuring additional information that introduces bias. In this case study, most takings occur in a selected project area, so location may introduce systematic bias. No new homes were taken, so age may introduce systematic bias. No other variables has a definitive theoretical basis for inclusion in the treatment. The treatment model uses the same price equation as (3-1) with Takings as the treated variable, based on location and age. The specifications tested are the Linear-Linear, the Log-Linear, and the Theta-Linear (MLE), the three specifications with favorable properties and diagnostics.

Price = f (takings indicator, location indicator, year of sale,

house characteristics, outlier effects)

Takings =f (location indicator, age) (5-1)

The treatment model Null hypothesis is:

The error terms of the price equation are uncorrelated to the error terms of the Takings treatment equation. As shown in Table 16, in all three models, the coefficients of the

Takings equations are statistically significant, and the likelihood ratio test indicates the error terms are not correlated. It is important to remember this analysis of eminent domain takings begins with economic principles, and is followed by econometric analyses. The combining of two distinct data sets into a single specification increases the potential for issues to arise and may suggest tempered conclusions, but these results are consistent across functional form.

Table 16: Linear-Linear Model Regression with Treatment of Takings as Function of Selected Independent Variables

Variable	Model					
	Linear-Linear		Log-Linear		Theta-Linear	
	Price	Treatment	Price	Treatment	Price	Treatment
Takings	-61040 4.35***		-.18 2.49**		-.100 2.91***	
Takings* Living Space	25.16 4.64***		.000057 2.21**		.000037 2.94***	
Living Space	26.28 5.26***		.00045 19.10***		.00023 19.48***	
Living Space Squared	.0036 8.94***		-2.47e-08 12.87***		-1.14e-8 12.05***	
Age	-1766 5.52***	.053 6.95***	-.015 10.06***	.054 6.96***	-.0074 9.86***	.053 6.96***
Age Squared	53.79 5.47***		.00042 8.89***		.00020 8.61***	
Location 162-35,36	37823 5.39***	3.70 10.67***	.22 5.28***	3.71 10.54***	.109 5.81***	3.71 10.58***
Location 177-1,2,3,4	-5901 2.09**	1.38 3.69***	.011 .86	1.38 3.65***	.0044 .66	1.38 3.66***
Constant	41956 6.33***	-4.32 11.2***	10.67 339***	-4.34 11.06***	3.66 237	-4.33 11.10***
Rho		.00094		.119		.0696
Sigma		44309		.211		.10
lambda		41.5		.025		.0072
Likelihood Ratio chi2 (rho=0) Prob>chi2		.0 .99		.75 0.39		.41 .52

LR tests of independent equations (rho=0) by Chi(2). Theta-Linear uses price^0.1219783

CHAPTER 6

CONCLUSIONS

Takings of homes in the McCarran Airport study area were not paid the expected market value, other things equal. I found a discount paid to owners of smaller homes, and a premium paid to owners of larger homes, suggesting vertical inequity. In all the specifications tested, the Takings dummy variable coefficient is negative and typically significant, implying a discount. In all the specifications, the Takings*Living Space variable coefficient is positive and typically significant, implying vertical inequality. Horizontal inequity was also evident, as reflected in the variance of residuals. The market and takings data sets fail the Chow test and evaluating the data sets separately provide credence to the possibility of differing mechanisms determining price.

The results are somewhat surprising in that McCarran International Airport is very much an integral aspect of Las Vegas. It is the primary access point for 36 million visitors per year, an engine that drives the local economy. It is governed by Clark County, a body of locally elected officials. It has worked closely with other local agencies to help solve area transportation and flood control issues, and has a reputation of trying to be a good neighbor. It has access to Federal funding, so all money is not generated locally. One might expect if any government body had a policy to pay a premium for takings; it would be a well-funded, local agency like McCarran Airport.

This limited data analysis indicates takings compensation premiums were not generally paid, and begs the question of what may be occurring with non-local agencies, poorly funded agencies, and private companies provided with the power of eminent domain. Further research will hopefully expand this case study. Takings compensation in other jurisdictions may be different than in Clark County, Nevada. For example a slower growing regional economy with a less transient population might produce different outcomes. Undescribed uniqueness of housing characteristics further constrains analysis of eminent domain takings. Additional study and review of public policy alternatives is warranted before one can conclude that compensation in eminent domain takings approximates estimated market price.

It is, however, quite conceivable that incorporating hedonic analysis into the determination of eminent domain takings compensation might better approximate market price, if market price is the criterion for fair market value and thus just compensation.

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