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Property tax shifting under imperfect competition: Theory and application

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PROPERTY TAX SHIFTING UNDER IMPERFECT COMPETITION: THEORY AND
APPLICATION

BY

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DISSERTATION

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in

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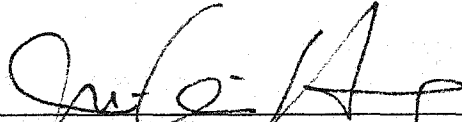
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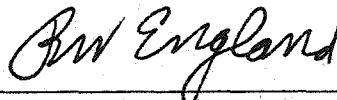
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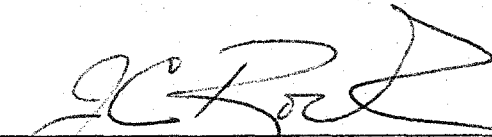
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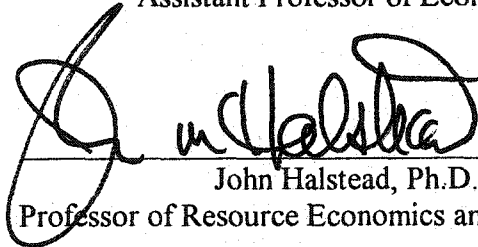
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ABSTRACT

PROPERTY TAX SHIFTING UNDER IMPERFECT COMPETITION: THEORY
AND APPLICATION

by

Mustafa Oktem

University of New Hampshire, December, 2001

The objectives of this dissertation are to examine, using hedonic methods, whether site-specific environmental amenities can become sources of market power for property management firms that control them and the extent to which such market power, if present, affects property tax shifting from property owners to property renters. The specific market examined in this dissertation is the vacation rentals market. The key participants in this market are the property owners, the renters and a few property management firms that manage the rental units in return for a fixed percentage commission paid by the owner each time the unit is rented out. In this dissertation, a proposition is derived by theoretically extending hedonic methods to accommodate both market structure and the local public sector. This proposition is then used to empirically examine the role of environmental amenities in creating firm-specific market power and assess the extent to which such market power facilitates property tax shifting. The results of this dissertation indicate that most of the market power exercised by the property management firms is derived from the environmental amenity, namely the lake, and a firm's ability to shift property taxes may be greatly affected by the magnitude of market power it possesses.

CHAPTER I

INTRODUCTION

The hedonic technique is the most commonly used method for examining the relationship between the price of a composite good and its attributes. Prior to the sixties, the hedonic technique lacked theoretical foundations. Rosen (1971) remedied this problem by developing a theoretical basis for using hedonic methods.

The hedonic technique has been used to analyze a variety of composite goods, one of them being the residential housing market. Residential housing market applications of the hedonic technique can be divided into two categories, based on what these applications have tried to achieved:

The first category entails applications that involve retrieving the marginal price of housing attributes. Some of these applications are primarily concerned with disclosing tenure choice and preferences with regard to housing attributes. Others try to measure the value that residents place on environmental amenities such as clean air (Cobb, 1977; Figueroa et al., 1996; Harrison and Rubinfeld, 1978; Lansford and Jones, 1995; Palmquist, 1982.) Finally, a number of these applications try to assess the impact of

natural disasters such as earthquakes or changes in national socio-economic conditions on the sales price of houses (Beron et al., 1997; Galster and Williams, 1994; Grass, 1992).

The second category is comprised of studies that examine the relationship between property taxation and property values. Changes in the property tax rate should be reflected in property values, because the property tax rate is based on the assessed value of properties. This renders the residential housing market a good candidate for examining the impact of property tax changes. The literature examining the relationship between property taxation and property values can be divided into two groups. The first group is comprised of studies that examine the impact of property tax differentials on house values. More specifically, these studies try to measure the degree to which property taxes are capitalized into the price of the house once differences in public service quality are controlled for (Wicks, Little and Beck 1968; Oates 1969; Smith 1970; Heinberg and Oates 1973; Pollakowski 1973; Church 1974; Edelstein 1974; Wales and Wiens 1974; McDougall 1976; Rosen and Fullerton 1977; King 1977; Chinloy 1978; Reinhard 1981; Richardson and Thalheimer 1981; Ihlanfeldt and Jackson 1982; Rosen 1982; Cushing 1984; Yinger, Bloom, Borsch-Supan and Ladd 1988). The second group entails studies that examine the relationship between property taxation and the rental price of housing. These studies try to assess the degree to which property taxes are shifted from property owners to property renters (Orr, 1968; Heinberg and Oates, 1970; Hyman and Pasour, 1973; Dusansky, Melvin and Karatjas, 1981). In spite of the plethora of studies that have examined the relationship between property taxation and the rental/sales price of housing, there still is no consensus on the magnitude of the relationship. In the context of the owner-occupied housing market, there is no consensus on the property tax capitalization

rate; the estimated tax capitalization rates range from zero percent (no property tax capitalization) to one hundred and fifteen percent (over-capitalization of the property tax). In the context of the rental housing market, there is no consensus on the extent to which property taxes are shifted from property owners to renters.

One potential problem with both categories of studies is the following: Rosen's results are derived under the assumption of competitive markets. However, in reality, the markets for composite goods can be less competitive, because product differentiation creates market power. Hence, in order for the hedonic method to derive unbiased results when used to analyze less competitive markets, the price-cost markup must be included as a regressor in the hedonic regression.

There are some applications of the hedonic approach to less competitive markets such as automobiles (Murray and Sarantis, 1999; Bajic 1988; Bajic 1993). These applications do not address the issues that arise from applying hedonic methods to less competitive markets. The empirical results in these applications are potentially biased because price-cost markups are omitted from the regression equation.

Feenstra (1995) is the only study that provides some theoretical foundations for extending hedonic methods to encompass imperfect competition. Feenstra (1995) derives expressions for the profit-maximizing and social welfare-maximizing choice of attributes given oligopoly competition.

There are also a number of studies that examine composite goods under less competitive conditions, without using hedonic methods. Some of these studies examine the welfare and efficiency effects of composite product taxation under less competitive market structures (Anderson, Palma and Kreider 2001A; Anderson, Palma and Kreider

2001B). Other studies are primarily concerned with the separation of marginal prices into a price-cost markup and a marginal cost component: Feenstra and Levinsohn (1995) devise a model of oligopoly pricing in which products are multi-dimensionally differentiated and apply it to the 1987 US automobile industry. The model allows for different types of market conduct; it measures the price-cost markups resulting from Bertrand equilibrium, Cournot equilibrium and other mixed cases. Goldberg (1996) investigates car dealer price discrimination. Goldberg estimates the price-cost markups involved in car purchases under price discrimination. Taylor and Smith (2000) use a series of statistical procedures to retrieve the marginal cost of the rental price of vacation rental properties to assess whether environmental amenities can become sources of market power in the vacation rentals market.

In the context of the literature, in the broadest sense, this dissertation establishes a formal link between hedonic methods, imperfect competition and property taxation. Past studies that have used hedonic methods to analyze the relationship between property taxation and the sales/rental price of properties have assumed highly competitive housing markets. However, not all housing markets are highly competitive. In this dissertation, the competitive markets assumption is relaxed.

The objectives of this dissertation are to examine, using hedonic methods, (1) whether site-specific environmental amenities, such as a lake, can become sources of market power for firms that control them and (2) the extent to which such market power, if present, affects the relationship between property taxation and the rental price of housing. To achieve these objectives theoretically, hedonic methods are extended to accommodate both market structure and the local public sector. In the empirical part, the

magnitude of property tax shifting that is achieved by property management firms under the current less competitive market structure and the magnitude that would prevail under perfectly competitive conditions, are computed. The key task, in the empirical section, is retrieving the marginal cost of the property attributes.

The specific market, examined in this dissertation, is the vacation rentals market of the New Hampshire Lakes Region. The key participants in this market are the property owners, the renters and a few property management firms that manage the rental units in return for a fixed percentage of commission paid by the owner each time the unit is rented out. The market operates as follows: The firm must decide on whether the expected profits that accrue from managing a rental unit exceed the opportunity cost. The firm's decision on whether to manage the rental unit or not is based on the rental unit's attributes and the unit's expected rental price. If the firm contemplates that the rental unit is marketable at a profitable rental price, then a contract is signed between the property owner and the firm. The contract renders the firm responsible for managing and marketing the rental unit. In return for this service, the firm receives a commission from the owner each week the unit is rented out.

New Hampshire is an ideal state to study property taxation, because of its unique tax code. New Hampshire's income and sales tax is confined to an income tax on dividends and interest and a sales tax on meals and rooms respectively (Connor, England, Kenyon and Shapiro, 1999,1). The absence of a broad sales and income tax renders property taxes the prime source of state government finance. Furthermore, each locality has its own property tax rate based on the average property value within the locality, hence there is considerable variation in the property tax rate.

The findings of this dissertation indicate that most of the market power exercised by these firms is derived from the environmental amenity, namely the lake. More specifically, the attributes that command very high premiums above their marginal cost are those variables that are inherently linked to the lake, or are variables that allow the renter to better enjoy the amenities provided by the presence of the lake. The most important conclusion that can be drawn from this analysis is that financial incentives exist for firms to conserve site-specific environmental amenities such as a lake, the ocean etc.

Concerning property tax shifting, this dissertation discloses some interesting findings: First, the rate at which the firms pass on the property tax from their clients, the owners, to the renters is significantly high, and in some cases greater than 100%. This implies that, in these specific cases, the firm is able to pass more than the owner's property tax liability onto the renter. The demand for vacation rentals in the New Hampshire Lakes Region is primarily made up of out-of-state visitors, mostly from Southern New England states. If the majority of the property owners are New Hampshire residents, then this result may imply that tax exporting is taking place. On the other hand, if the majority of the property owners are non-residents, then this result may suggest that tax redistribution among non-residents is present rather than tax exporting. Second, a significant portion of the property tax shifting achieved by Firm 1 and Firm 2 is due to the presence of imperfect competition. The contribution of market structure to Firm 3's ability to shift property taxes is small. A general conclusion that can be drawn from this finding is the following: In a less competitive rental housing market, depending on the degree of the market power exercised by the firm, the structure of the market may

significantly augment the firm's ability to shift property taxes from property owners to property renters. This result can be further interpreted as indicating that, in certain cases, the simplifying assumption of competitive housing markets that all past studies have appealed to may not be valid.

CHAPTER II

LITERATURE REVIEW

The literature review is organized into four main sections:

The first section, Section 2.1, reviews hedonic methods. This section is subdivided into two parts. In Part 2.1.1, I discuss hedonic methods under perfect competition. First, the theoretical underpinnings of hedonic methods under perfect competition are provided. Then, the residential housing market applications of the hedonic technique are presented. In Part 2.1.2, I discuss the studies that extend hedonic methods to accommodate less competitive market structures.

The second section, Section 2.2, reviews the literature examining indirect taxation of composite products under imperfect competition. This literature is very recent and consists of only a few papers.

The third section, Section 2.3, reviews the literature examining the relationship between local fiscal differentials and property values. This section is subdivided into two parts. In Part 2.3.1, a comprehensive review of the property tax capitalization literature is provided. In Part 2.3.2, the literature examining the relationship between property taxation and the rental price of property is presented.

In the fourth section, Section 2.4, a discussion of the contribution of this dissertation, in the context of the literature, is provided.

2.1. The Hedonic Method

2.1.1. Hedonic Price Analysis: The Case of Competitive Markets

2.1.1.1. Hedonic Price Theory. The theoretical foundations of hedonic price theory can be traced back to Lancaster (1966) and Rosen (1974).

Lancaster (1966) develops a model of consumer behavior where utility is derived from the characteristics of a good, as opposed to the good itself. He demonstrates that his model embodies much more explanatory and predictive power than the conventional model that is built upon the premise that individuals derive utility from consuming the good itself.

Rosen (1974) provides a theoretical justification for the use of the hedonic price technique as a means of disclosing the marginal price of a composite good's attributes, under competitive conditions. In his analysis, the consumer/demand side of the market is accounted for via a bid function. The bid function represents the willingness to pay of the consumer for a product with a given vector of attributes, and a given level of income and utility. The supply side is captured via offer curves. An offer curve represents the reservation price of the supplier for a good with a given vector of attributes and a given level of profits. The hedonic price schedule is determined by the interaction of the two sides; it is a locus of tangency points between the bid and offer curves; each point represents an equilibrium point. Hence, the hedonic price function represents the locus of equilibrium points where a consumer's willingness to pay is equal to the seller's reservation price, holding all other attributes, income, utility and profits constant. In Cobb's (1977, 215) words, the hedonic price function is a "joint envelope representing

the equilibrium solution set to independent decisions made by consumers and producers of attributes.” Therefore, the derivative of the hedonic price equation with respect to a given attribute, for example attribute z_1 , is equal to the marginal bid function with respect to z_1 which in turn is equal to the marginal offer function with respect to z_1 . This implies that the derivative of the hedonic price equation with respect to attribute z_1 represents the marginal/implicit price of z_1 at market equilibrium (Osborne, 1996, 56-57 and Rosen, 1974, 38-54).

Rosen’s theory requires two assumptions:

First, the market for the composite good achieves equilibrium. Second, there are many varieties of the composite good; enough so that the price function and the bid and offer curves can be assumed continuous (Palmquist, 1991).

A more structured presentation of Rosen’s theory is provided below:

Let us assume that a composite good is made up of three attributes, namely a, b and c. Then, the price of the composite good is a function of the following attributes and can be represented as follows:

$$P = P(a, b, c) \tag{2.1}$$

Hence a utility-maximizing agent’s maximization problem is:

Max $U = U(a, b, c, n)$ subject to $Y = P_n n + P(a, b, c)$, where n is the numeraire commodity with a price, P_n , equal to one, P is the price of the composite good, and Y is income. Assuming utility-maximizing behavior with a, b, c and n as choice variables and an interior solution to the utility-maximization problem, and assuming that preferences are weakly separable in the composite good in question and its attributes, then the

representative agent's marginal willingness to pay for attribute a is equal to the marginal price of attribute a.

The aforementioned utility-maximization problem can be specified using bid functions. Let $H = H(a, b, c, \bar{u}, y; \alpha)$ be the locus of consumer type α 's bids with attributes a, b and c and income level y for a specified level of utility.

Now the utility-maximizing agent's maximization problem is expressed as:

$$\text{Max } H = H(a, b, c, \bar{u}, y; \alpha) \text{ subject to } u(y-H; \alpha) = \bar{u}, \quad (2.2)$$

Solving for the utility-maximization problem in its new specification yields the same results as before, namely that the representative agent's marginal price for attribute a is equal to his marginal bid with respect to attribute a.

The seller's side of the market assumes that each firm chooses the type of good to produce and its quantity, x. Then the firm's profit is represented by the following equation:

$$\Pi = x \cdot P(a, b, c) - C(x, a, b, c; t), \quad (2.3)$$

where $C(\cdot)$ represents the cost function and t is the vector denoting the index of factor prices and technology. Assuming profit-maximizing behavior (via choice variables x, a, b and c) and an interior solution to the profit-maximization problem, then the representative firm will optimize with respect to attribute a by setting the marginal price of attribute a equal to the marginal cost of attribute a. Analogous to the consumer side of the market, if firm preferences are to be represented by offer curves, then the profit-maximizing quantity of attribute a is achieved at the point where the marginal offer function with respect to attribute a is equal to the marginal cost of attribute a.

Combining the consumer side of the market with the supplier side, in equilibrium, the marginal price of attribute a is equal to the marginal offer and marginal bid functions with respect to attribute a .

2.1.1.2. Applications of the Hedonic Technique to the Residential Housing Market. There are a plethora of studies that have applied hedonic methods to the residential housing markets.

Most of these studies have attempted to quantify the value that consumers place on environmental amenities such as clean air, and their willingness to pay for a reduction in environmental disamenities such as pollution, highway noise etc. The sheer volume of these studies renders it impossible to review each one individually. Hence, in this section, only the general review articles that address the important issues, with specific mention of the more influential papers, are considered.

The first of these articles is Smith and Huang (1995). Smith and Huang (1995) conduct a meta-analysis of hedonic property models for purposes of assessing the efficacy of hedonic models in valuing clean air. They provide a statistical summary of marginal willingness to pay estimates for pollution reduction, hereafter MWTP, for hedonic studies published between 1967 and 1988. Their methodology involves correlating the MWTP obtained from each hedonic model to its structural attributes. These structural attributes include real per capita income, the conditions of local housing markets, air pollution and other important features. The results of the study indicate that there is a consistent correlation between the marginal value placed on reducing air pollution in a given study and the level of air pollution in the city, the average income of

its population and other considerations that pertain to the implementation of the hedonic study (Smith and Huang, 1995, 209-215).

The second general review article is Palmquist (2000). Palmquist (2000) provides a comprehensive review of the important issues involved in using hedonic methods to measure willingness-to-pay for improvements in environmental quality and the papers that address these issues. The most important of these issues and the accompanying papers that address these issues are briefly discussed below:

One problem common to all hedonic studies is the correct identification of the extent of the market. Since the hedonic price schedule represents the locus of equilibrium points within a market, all observations that are used to estimate a hedonic equation must come from a single market. If the hedonic price equation is correctly specified in terms of functional form and there are no omitted variables, a simple F-test is sufficient to separate a geographic location into separate markets. However, since this is very rarely the case, using F-tests is not methodologically sound. Palmquist discusses the problems that arise from treating several markets as one single market (Palmquist, 2000, 26-27).

Another important problem is the correct specification of the functional form. In the past, linear, semi-log and log-linear functional forms have been used. Halvorsen and Pollakowski (1981) recommend the use of the quadratic Box-Cox functional form due to its considerable flexibility. However, Cropper et al. (1988) find that the quadratic Box-Cox functional form performs well when all relevant attributes are included in the hedonic equation. They also find that, in the presence of omitted attributes, simpler functional forms perform better than the quadratic Box-Cox functional form (Palmquist, 2000, 28-29).

Another econometric issue addressed by Palmquist (2000) is multicollinearity. Atkinson and Crocker (1987) and Graves et al. (1988) examine the problems that arise from the presence of multicollinearity. Atkinson and Crocker (1987) conclude that multicollinearity contributes significantly to coefficient instability. Graves et al. (1988) find that the coefficient of their visibility variable is significantly sensitive to the inclusion of various combinations of some “not-so-relevant variables”, while their pollution measure is unaffected (Palmquist, 2000, 34).

Another important challenge faced by researchers is identifying the appropriate unit or measure of the attribute. The ideal measure of an attribute is one that is consistent with the way agents perceive the attribute. This issue is more relevant to environmental attributes (Palmquist, 2000, 33). Murdoch and Thayer (1988) test the hypothesis that the correct specification of the hedonic price function should employ mean levels of environmental quality. The test is a mean specification test that involves two types of regressions: The first includes probabilities of various levels of environmental quality as explanatory variables. The second is the restricted version; the mean environmental quality variable is the only measure of environmental quality. Specification error tests indicate that the restricted version gives rise to biased estimates (Murdoch and Thayer, 1988, 143-146).

Finally, there is no consensus on the length of time that is required for property values to fully absorb the impact of an environmental change. Palmquist notes that information availability and expectations are the key factors that determine the length of time. He reviews the empirical work of Kohlhase (1991), Kiel and McCain (1995) and

Dale, Murdoch, Thayer and Waddell (1999) to shed further light to this issue (Palmquist, 2000, 41-42).

Residential housing market applications of the hedonic method are not limited to studies that measure environmental quality and willingness-to-pay for improvements in environmental quality. The hedonic approach has been employed to examine other interesting questions concerning residential housing. The more recent of these applications are provided below:

Grass (1992) investigates the question of whether public investment in heavy rail transit systems increases residential property values. His dataset encompasses several neighborhoods in the Washington D.C area. The study reveals a robust positive relationship between investment in transit systems and property values (Grass, 1992, 139-146).

Galster and Williams (1994) investigate the impact of dwellings of the mentally disabled on property values between 1989 and 1992. Their hedonic price equation is comprised of neighborhood attributes, housing attributes and a set of variables denoting proximity to mentally disabled homes. The results of their study indicate that proximity to mentally disabled dwellings has a significant negative impact on property values (Galster and Williams, 1994, 467-475).

Lansford and Jones (1995) utilize the hedonic price approach to measure the recreational and aesthetic (RA) value of a lake in the Highland Lakes Region of Texas. Their dataset includes the property sales that occurred between January 1988 and December 1990. These are their most significant findings: Distance to the lake, scenic view and waterfront location all have statistically significant coefficients. Waterfront

properties possess a premium price. Water access properties also possess a premium price, however this premium rapidly declines as the distance between the property and the water increases.

Beron, Murdoch, Thayer and Vijverberg (1997) investigate the impact of the 1989 Loma Prieta earthquake on residential housing prices in the San Francisco Bay area. Their hedonic regression includes community attributes, housing quality attributes, earthquake hazard measures and geological measures. Their empirical results indicate that house prices fell after the earthquake. The conclusion that Beron et al. (1991) draw from this finding is that consumers had ex-ante overestimated the earthquake hazard. In the light of this finding, Beron et al. (1991) suggest that a greater allocation of resources should be devoted to earthquake risk communication (Beron, Murdoch, Thayer, Vijverberg, 1997, 101-113).

2.1.2. Hedonic Price Analysis: The Case of Imperfect Competition

One of the key assumptions of hedonic price theory is that the market reaches equilibrium. Hence, one issue that needs to be addressed in order for hedonic price theory to encompass imperfect competition is whether a Nash equilibrium exists within an imperfectly competitive market where firms produce composite goods.

Feenstra (1995) develops a model whereby each firm chooses attributes and prices simultaneously, while treating the prices and attributes of other firms as fixed. Such a formulation allows for firms to be treated as Cournot competitors. In Feenstra's model, the price of the composite good does not depend on the amount consumed of the

composite good, but rather on the amount consumed of the attributes that make up the composite good. Firms are able to produce multiple varieties of each good. Feenstra (1995) first considers the case where each variety is produced by one firm. Feenstra (1995) shows that a Nash equilibrium exists when the profit maximization problem is re-specified to hold utility constant. The Nash equilibrium level of price and attributes are computed for the case where each variety is produced by one firm.¹ Using this result an expression is derived which can be construed as follows: The marginal cost and marginal value of an attribute differ from one another by a level that is proportional to the price-cost markup of the product and the elasticity of substitution between the product's quality-adjusted price and the attribute. The model is extended by allowing for product competition in a given variety. In this case, competition in prices yields the well known Bertrand result, namely price and marginal cost equality. Feenstra (1995) also computes the socially optimal level of attributes.

Another important question examined in Feenstra (1995) is how a change in attributes and prices affects aggregate utility. To this end, exact hedonic price indexes are developed. A hedonic price index is exact if it is equal to the ratio of two expenditure functions in two periods at a constant quality adjusted price (but changing prices and attributes). The exact hedonic price indexes provide bounds on the expenditure necessary to maintain a given level of utility when prices and attributes are changing.

Finally, Feenstra (1995) investigates the possibility of estimating the marginal price of attributes, using a hedonic price regression, under imperfect competition. He shows that if marginal costs are semi-log in attributes, quality-adjusted prices along with

¹ This is the case that is applicable to my case study. In my model, each rental property is managed by only one firm and no two properties are identical.

the utility functions take on a special form, whereby each is homogeneous to degree one, the coefficients of the hedonic regression represent the marginal price of the attribute relative to the cost of the product.

Taylor and Smith (2000) use Feenstra's results to examine whether site-specific environmental amenities can become sources of market power through product differentiation. They propose a methodology for recovering the marginal cost of housing attributes, in an imperfectly competitive housing market, from the hedonic price regression. Their application involves firms that manage vacation rentals in the North Carolina Outer Banks coastline. Their dataset encompasses several thousand beach rentals rented out by four firms. First, firm-specific hedonic rent functions are estimated. Second, firm-specific residual demand models are constructed for purposes of disclosing the market power exercised by each firm. Finally, marginal cost estimates for site-specific environmental amenities are recovered. Taylor and Smith's results indicate that site-specific amenities can become sources of market power for real estate rental firms.

The most important shortcoming of Feenstra (1995) and Smith and Taylor (2000) is the absence of any formal treatment of the local public sector. Neither paper gives any consideration to issues pertaining to taxation and local public service quality. Feenstra's theoretical model does not account for the local public sector. Smith and Taylor do not include the property tax rate and public service quality variables as regressors in their hedonic rent regressions.

2.2. Taxation Under Imperfect Competition

The literature examining taxation under perfect competition and monopoly is well developed. However, in the past decade, there has been a growing interest in understanding the effects of taxation under market structures other than perfect competition and monopoly. This interest has been stimulated by the realization that most market structures fall between these two polar cases.

Earlier studies examining taxation under imperfect competition have analyzed Cournot competition with a homogenous product (Stern 1987; Besley 1989; Delipalla and Keen 1992; Skeath and Trandel 1994; Hamilton 1999). One shortcoming of Cournot competition is that firms are modeled as competing in quantities, not prices. However, in reality, firms almost always compete in prices (Tirole, 1988, 224). Also, firms that compete in imperfectly competitive markets almost always produce composite products. In the light of these facts, more recent studies have modeled firms as Bertrand competitors producing a composite good (Anderson, Palma and Kreider 2001A; Anderson, Palma and Kreider 2001B). As a result, the literature examining taxation under imperfect competition is divided into two categories. The first encompasses the studies that model firms as Cournot competitors producing a homogenous product. The second accounts for the more recent studies that model firms as Bertrand competitors producing a composite product.

2.2.1. Taxation Under Imperfect Competition: Homogenous Product Taxation Under Cournot Competition

Stern (1987) is one of the first papers to examine the effects of taxation of a homogenous product under market structures outside of the two polar cases of perfect competition and monopoly. Stern compares, within a Cournot framework, the impact of introducing an excise tax into an oligopoly market and a monopolistically competitive market. His analysis assumes that the number of firms is fixed. He shows that the price increase effect of the tax will be higher in the case of monopolistic competition if and only if the tax reduces profits for the given number of firms. He demonstrates that if the elasticity of demand is sufficiently low, the excise tax may give rise to higher profits for the firms.

Besley (1989) extends the work of Stern (1987) by examining homogenous product taxation under imperfect competition, when firms are free to enter and exit the industry. Hence, Besley (1989) relaxes Stern's fixed number of firms assumption. Given a homogenous product and a fixed number of firms, the imposition of a small tax in an oligopoly market always leads to welfare reduction. Using a Cournot model, Besley (1989) shows that, with entry, such a tax may be welfare increasing (Besley, 1987, 359-367).

Delipalla and Keen (1992) extend the literature by devising a framework that allows welfare comparisons of different taxes for a homogenous product under imperfect competition. Specifically, they compare the welfare effects of a unit and ad valorem tax.

They show that, for a homogenous product under Cournot oligopoly, a shift from a unit to an ad valorem tax, holding government revenue constant, is always welfare increasing.

Skeath and Trandel (1994) build upon the work of Delipalla and Keen (1992) by providing a Pareto comparison of an ad valorem and unit tax for a homogenous product under monopoly. Delipalla and Keen (1992)'s criterion for comparing the two forms of taxation is welfare-maximization. Skeath and Trandel (1994) extend the work of Delipalla and Keen (1992) by adopting a Pareto criterion. They show that for any unit tax imposed on a monopoly that produces a homogenous product, there exists an ad valorem tax that is Pareto superior (produces larger profits, tax revenue and consumer surplus). The only shortcoming of this result is that it applies only to a monopoly. Skeath and Trandel try to generalize this result to all Cournot-Nash oligopolies. They demonstrate that their result may extend to Cournot-Nash oligopoly only if the tax is sufficiently large. They show that this critical tax level is affected by the market demand curve and the number of firms present in the market.

The results of Delipalla and Keen (1992) and Skeath and Trandel (1994) can only be used in the context of the unit and ad valorem tax. Hamilton (1999) tries to generalize the theoretical results derived by Delipalla and Keen (1992) and Skeath and Trandel (1994) to a wider range of tax instruments. He considers two market structures, the Generalized Cournot model and the Free Entry Oligopoly. Both are homogeneous product oligopoly markets, where firms compete in quantities. The only distinction between the two is that the latter allows for free entry and exit into the industry. For each of the two market structures, he derives the necessary and sufficient conditions for tax

overshifting to take place. Furthermore, he develops a set of criteria that allows for welfare comparisons. His results are applicable to a broad range of tax instruments.

2.2.2. Taxation Under Imperfect Competition: Composite Product Taxation Under Bertrand Competition

Anderson, Palma and Kreider (2001A) examine the welfare consequences of ad valorem and unit excise taxes in an oligopoly industry characterized by differentiated products and Bertrand competition. Anderson, Palma and Kreider demonstrate that both the unit tax and the ad valorem tax may be overshifted, with the unit tax more likely to be overshifted than the ad valorem tax. They also show that, under certain demand curvature conditions, both a unit tax and an ad valorem tax will give rise to an increase in firm profits and thereby lead to an increase in the number of firms in the long-run. Finally, Anderson, Palma and Kreider show that the imposition of a unit tax or an ad valorem tax gives rise to an increase in the long-run equilibrium consumer price.

Anderson, Palma and Kreider (2001B) compare and contrast the relative efficiency of a unit and ad valorem tax for differentiated products under imperfect competition. Anderson, Palma and Kreider demonstrate the welfare superiority of the ad valorem tax, in the short-run, in imperfectly competitive markets characterized by product differentiation and Bertrand competition. They also show that the ad valorem tax is welfare superior in the long-run as long as marginal costs are constant and equal across firms. Overall, their analysis demonstrates that the welfare superiority of the ad valorem tax is strongly contingent on the assumptions of symmetric costs and a fixed number of

firms. They demonstrate that if aggregate demand is highly inelastic and firm costs are asymmetric, then the unit tax may be more efficient than the ad valorem tax.

2.3. The Impact of Local Fiscal Differentials on Property Values

The literature examining the relationship between fiscal variables and property values can be divided into two broad categories. The first category is comprised of studies that examine the impact of fiscal differentials on house values. More specifically, these studies try to measure the degree to which property taxes are capitalized into the price of the house once differences in public service quality are controlled for. The second category entails studies that try to assess the relationship between fiscal differentials and the rental price of housing. These studies are primarily concerned with measuring the extent to which property taxes are shifted from property owners to property renters once public service quality is controlled for. This section of the literature review will closely examine both categories of studies.

2.3.1. Category 1: Capitalization of Property Taxes into Property Values

The literature on property tax capitalization is vast. However, before presenting the theory and empirical findings concerning property tax capitalization, it is important to discuss what is meant by this term and its relevance to public economics and public policy. Property tax capitalization refers to the incorporation of the present value of the expected future stream of tax liabilities into the value of property. Full capitalization occurs when, after controlling for housing attributes, neighborhood attributes and public services, the difference in property values is exactly equal to the variation in the present value of the future stream of tax liabilities. An enhanced understanding of property tax

capitalization is important for the following reasons: First, the magnitude of property tax capitalization may provide information concerning the tax burden shouldered by the property owner. Second, a high degree of property tax capitalization may imply that residential and business location decisions are substantially influenced by fiscal differentials. Awareness of the relationship between local fiscal differentials and location decisions will help policy-makers devise local public policies that better fit the needs of the community (Cushing, 1984, 1). Third, the magnitude of property tax capitalization may also significantly impact the real estate market by influencing purchase and sale decisions. In the absence of property tax capitalization, a property owner may be able to evade the financial cost associated with a rise in property taxes by selling his/her property. However, if full capitalization exists, the property owner is unable to evade this financial cost, because the tax increase leads to an equivalent decline in the value of the property (Bloom, Ladd and Yinger, 1983, 145).

Numerous studies have empirically examined whether better local public services and lower taxes give rise to higher house values, as the theory suggests. These studies have taken either one of two approaches, namely the amenities approach or the tax capitalization approach:

The amenities approach is specified as follows:

$$P_j = \alpha + \sum \beta Z_{ij} + \gamma T_j, \quad (2.4)$$

where P_j is the price of the j th property, Z_i is the vector of structural and location-specific housing attributes as well as local public services. T_j is the property tax rate.

Assuming that the tax rate does not change over time, full capitalization of the tax rate

implies that $\gamma = \{P[1 - (1+r)^{-n}]\}/r$. This approach assumes that the tax rate is simply another housing attribute that affects the price of the house.

Inherent in tax capitalization approach is the notion that tax rates affect property values in a manner that is different than housing and location-specific attributes. The tax capitalization approach, assuming an infinite time horizon, is specified as follows:

$$P = S/(r - g + \delta + m + t), \quad (2.5)$$

where P is the property's value, S represents the annual value of housing services, r is the discount rate, g represents the annual real market-wide appreciation rate of houses, δ denotes the depreciation rate, m is the maintenance cost and t is the property tax cost of owning the house. $(r - g + \delta + m)$ represents the net of property tax user cost of housing.

The estimating equation used in the tax capitalization approach is:

$$P_j = S_j/(\sigma + \beta t_j), \quad (2.6)$$

where j is the j th house, P is the value of the house, σ is the net of property tax user cost of housing and t is the taxation cost of owning the house. Full capitalization, in this specification, implies that β is equal to 1.

Following Bloom, Ladd and Yinger (1983), I divide the empirical property tax capitalization literature into three categories, namely studies based on aggregate data, studies based on cross-sectional micro data and studies based on data representing tax changes.

2.3.1.1. Studies Based on Aggregate Data. Studies that fall into this category use the amenities approach to examine whether a relationship exists between inter-jurisdictional differences in average property taxes and average house values, once all house value determinants (including public services) are controlled for. The majority of these studies find tax capitalization to be between forty percent and ninety percent, with the exception of Heinberg and Oates (1970), Pollakowski (1973), McDougall (1976) and Cushing (1984). Heinberg and Oates (1970), McDougall (1976) and Cushing (1984), based on their results, conclude that property taxes are fully capitalized into house values, while Pollakowski (1973) finds no evidence of tax capitalization.

Studies based on aggregate data test the hypothesis of capitalization by regressing median house values against property taxes, some average measure of public services, structural attributes, neighborhood attributes and accessibility to employment (Bloom, Ladd and Yinger, 1983).

Oates (1969) is the first and seminal paper that investigates capitalization using aggregate data. All of the other studies that belong to this category are extensions of Oates (1969). Oates studied fifty-three municipalities located in the New York metropolitan area. He regressed the median value of owner-occupied houses on the median number of rooms per house, the percentage of houses constructed since 1950, median family income, the distance in miles from Manhattan, the annual expenditure per pupil in public schools, the effective property tax rate (nominal tax rate times the assessment ratio) and the percentage of low income families in the community with an income of less than \$3000 per year. According to his regression results, there exists a positive and statistically significant relationship between house values and public

services, and a negative and statistically significant relationship between house values and the effective property tax rate. Using a discount rate of five percent, Oates finds that “approximately two thirds” of the effective property tax is capitalized into the value of a house. He also finds that the positive impact of increased school expenditures on property values is approximately offset by the decrease in property values resulting from the increase in property taxes (to finance the additional school expenditures). His findings, in general, support the view that property taxes are capitalized into property values (Oates, 1969, 959-969).

Pollakowski (1973) raises a number of econometric concerns over Oates’s (1969) model. First, he discusses the omitted variable bias that arises from the role that Oates (1969) assigns to his education expenditure variable. This variable is the sole public service variable, and hence represents a general proxy for local public services. Second, Pollakowski (1973) is critical of Oates (1969)’s median family income variable. Pollakowski (1973) notes that this variable is not a determinant of house value, since the value of a house depends on the demand of all of the potential demanders, and not only on the demand of the current owner. Third, Pollakowski (1973) raises the reader’s attention to the erroneous use of 2SLS by Oates (1969). He points out that the pre-determined variables need to be correlated with the tax variable and the public service variable, but not the error term. He argues that Oates’s pre-determined variables do not meet these requirements. Pollakowski (1973) re-estimates Oates’s model, using Oates’s data, after remedying some of these problems. His results completely refute the capitalization hypothesis; he finds no evidence of capitalization (Pollakowski, 1973, 994-1001). In response to Pollakowski’s criticisms concerning omitted variable bias, Oates

(1973) adds non-school expenditures per capita into his regression equation. The inclusion of this variable raises the tax capitalization figure from sixty-six percent to ninety percent (Oates, 1973, 1004-1008).

McDougall (1976) and Rosen and Fullerton (1977) extend Oates's (1969) empirical model by considering non-expenditure measures of public services. The underlying argument in both papers is that expenditures represent inputs for local public services; including the output in lieu of the input is a more direct and fruitful way of measuring the influence of local public services on house values. Proxies for park and recreation services, fire protection services, school services and police services are included in McDougall's (1976) specification, while Rosen and Fullerton (1977) use student achievement test scores as their only measure of local public services.

McDougall's results indicate that property taxes are fully capitalized into house values and that individuals are responsive to the availability of environmental amenities (McDougall, 1976, 436-441). According to Rosen and Fullerton's results, eighty-eight percent of the tax differential is capitalized in house values (Rosen and Fullerton, 1977, 433-440).

King (1977) re-estimates Oates's (1969) regression equation using Oates's data. The only difference in King's specification is that Oates's (1969) town-specific effective tax rate is replaced by a town-specific estimate of the property tax payment for the median value dwelling. King argues that a tax variable specified as a percentage is problematic, because any decline in a house's value in response to a tax change will be independent of the value of that house. Hence, King's motivation for re-specifying the tax variable stems from his conviction that the tax burden is what is capitalized into the

value of a house, not the tax rate. Assuming a five percent discount rate and a forty-year horizon, as did Oates (1969), King finds capitalization to be approximately forty percent. This figure is significantly less than that of Oates (1969) (King, 1977, 425-431).

Reinhard (1981) finds two flaws in King's (1977) model. First, he notes that King's specification accounts for the capitalization of only one year's tax payment. Second, he claims that King's use of the R-squared level as the maximum likelihood criterion leads to a downward bias in capitalization rates. Using Oates's (1969) data, Reinhard re-estimates King's regression equation after making the following changes: First, he adjusts King's regression model such that it tests the hypothesis of the capitalization of the present value of future stream of tax payments and not the tax payment of one year. Second, he uses the F-statistic as his maximum likelihood criterion, instead of the R-squared statistic. Using a discount rate of 3.6 percent and an infinite time horizon, Reinhard computes property tax capitalization to be 100 percent (Reinhard, 1981, 1251-1260).

Cushing (1984) takes a different approach and measures the extent of capitalization by using a unique dataset. His dataset encompasses properties that are at the border of two jurisdictions throughout the Detroit, Michigan SMSA for the year 1970. This dataset, by default, controls for public services and inter-jurisdictional externalities. According to Cushing's results, property taxes are fully capitalized into property values (Cushing, 1984, 317-326).

2.3.1.2. Methodological Problems Concerning Studies Based on Aggregate Data.

The problems that arise when using aggregate data are fourfold:

Simultaneity bias is one very important problem concerning aggregate data studies. Theory tells us that tax rates have a negative impact on house values, *ceteris paribus*. However, on average if house values are high, then a lower property tax rate is required to finance a given level of public services. Most authors have recognized the simultaneity problem, and have tried to remedy it through the use of two-stage least squares. However, the appropriate use of two-stage least squares requires instrumental variables that are uncorrelated with the error term, but highly correlated with the tax variable. Unfortunately, most of the past studies have employed instrumental variables that do not meet this criterion (Martinez-Vazquez and Ihlanfeldt, 1987, 127-140).

The second problem concerns the bias that arises due to omitted explanatory variables. In order for the coefficients of the regression equation to be unbiased, all determinants of the value of a house need to be included as explanatory variables in the regression equation. This is very difficult to do, since there are many factors that determine the value of a house. Omitted variable bias is likely to arise due to difficulties and controversies surrounding the measurement of public services. Exclusion of an important public service variable leads to spurious correlation between the component of the error term related to the omitted variable and the tax variable, which in turn leads to biased results (Palmon and Smith, 1998a, 1100-1101).

Third, in order to compute capitalization rates using both the tax capitalization and amenities approach, one needs to select a discount rate and time horizon. The estimated capitalization rate is extremely sensitive to the discount rate and time horizon

used, because the present value of the total future tax burden is calculated based on a selected discount rate and the expected length of occupation of the property. Since there is no consensus on what the discount rate should be, authors have used a variety of discount rates. This has contributed greatly to the dispersion in the estimated capitalization rates (Bloom, Ladd and Yinger, 1983, 152-153). Do and Sirmans (1994) derive a discount rate empirically by using a unique dataset in which taxes are expected to be fully capitalized into house values. Assuming a one hundred percent capitalization rate, they work backwards to compute the discount rate. They estimate a discount rate equal to four percent (Do and Sirmans, 1994, 341-347).

The fourth problem is related to the specification of the tax variable. Each specification of the tax variable has its own set of idiosyncratic problems. Prior to King (1977), most of the aggregate data studies employed the effective tax rate as their tax variable. The effective tax rate is the nominal tax rate multiplied by the assessment ratio. The assessment ratio is the ratio of the assessed value of property to its true market value. King (1977) argues that aggregate data studies that use this specification are potentially flawed, because its use implies that any reduction in the value of a house due to a tax change is independent of the value of the house. To remedy this problem, King (1977) uses tax payments instead of the tax rate (King, 1977, 425-428). However, the use of tax payments introduces other problems: First, the use of tax payments does not rid the model of simultaneity bias. Tax payments equal the nominal tax rate multiplied by the assessed value of each house. However, the assessed value is a function of the market value. Hence, the causality between tax payments and market value goes both ways, leading to simultaneity bias. Second, both the tax payment and effective tax rate

specification are susceptible to measurement error resulting from differing municipality-specific assessment practices (Bloom, Ladd and Yinger, 1983, 152).

2.3.1.3. Studies Based on Cross-Sectional Micro Data. Cross-sectional micro data studies generally examine the impact of both intra-jurisdictional and inter-jurisdictional tax differentials on house values. Most of the studies that fall into this category have employed the amenities approach, however there are some that have used the tax capitalization approach. Cross-sectional micro data studies find a high degree of both intra-jurisdictional and inter-jurisdictional tax capitalization (between forty and ninety percent), with the exception of Wales and Weins (1974) (Bloom, Ladd and Yinger, 1983, 154).

Edelstein (1974) uses the amenities approach to conduct an empirical investigation of the determinants of property value in the suburban Philadelphia area known as the Main Line for the years 1967-1969. He regresses the value of a house on structural housing attributes, neighborhood attributes, an accessibility variable and a tax variable. His tax variable is the ratio of the tax payment of the house to the number of bedrooms. Hence, his specification of taxation measures the tax paid per bedroom. Edelstein (1974) finds a high degree of tax capitalization (Edelstein, 1974, 319-327).

Wales and Wiens (1974) examine intra-jurisdictional tax capitalization within the municipality of Surrey in Vancouver in 1972 and find absolutely no evidence of tax capitalization. By limiting the scope of their study to one municipality, they evade the problems associated with variations in assessment practices. Also, another advantage of having only one municipality is that public services need not be considered in the

regression equation, since public services are the same for all properties. The most important contribution of Wales and Weins is their attempt to separate the bias resulting from spurious correlation from the coefficient of the tax variable, the effective tax rate, and thereby produce a true measure of tax capitalization (Wales and Weins, 1974, 329-333). However Bloom, Ladd and Yinger (1983) point out an important flaw in Wales and Weins (1974). They demonstrate that Wales and Wiens's procedure is correct if there is no capitalization. However, in the presence of capitalization, they show that their procedure is circular and does not accurately separate the bias from the coefficient of the tax variable (Bloom, Ladd and Yinger, 1983, 155-156).

Church (1974) estimates a simultaneous equations model to assess the extent of tax capitalization using the tax capitalization approach. His sample consists of single-family residential property sales that took place in five of the neighborhoods of Martinez, California between 1967 and 1970. His simultaneous equations model is made up of two equations. The first equation regresses the house value against a number of structural, neighborhood, public service, other location-specific attributes and the effective tax rate. The second equation is the effective tax rate regressed on the price of the house. Hence, this specification assumes that the effective tax rate is a linear function of the house price. The error term, in this equation, represents the variation in the effective tax rate due to assessment error. The assessment error is the deviation of the assessed value of property from its true market value. Church's results indicate that overcapitalization of the property tax takes place. Church attributes this partly to differing assessment practices (Church, 1974, 113-122).

Chinloy (1978) uses data from London, Ontario, to assess the extent of tax capitalization. He uses a two-stage approach: First, he regresses the effective tax rate against a number of household attributes such as gross income, number of household members and deductions from income tax return. Then he regresses the value of the house against the estimated tax rate from the previous regression model along with a number of structural housing attributes. Chinloy finds a significant level of tax capitalization, but once he factors in the impact of the Canadian tax credit, he concludes that tax capitalization is zero percent (Chinloy, 1978, 740-750).

Richardson and Thalheimer (1981) use the amenities approach and a unique dataset to test the hypothesis of tax capitalization. Their sample is comprised of sales of single-family residences in Fayette County, Kentucky, that took place between January 1973 and July 1974. The sample is exclusively made up of houses that have access to the same local public services, have market values that are almost identical to their assessed value and vary significantly in terms of taxes. Hence, their dataset is ideally-suited for testing the hypothesis of property tax capitalization. Richardson and Thalheimer regress the price of the house against a number of structural and neighborhood attributes as well as a nominal tax rate. They use two specifications for function form, the first is a linear specification and the other is a semi-log one. Using a discount rate of eight percent, and a time horizon of ten years, the linear and semi-log specifications yield a tax capitalization rate of sixty percent and seventy percent respectively (Richardson and Thalheimer, 1981, 674-687).

Ihlanfeldt and Jackson (1982) use a methodology for testing intra-jurisdictional tax capitalization that allows for the assessment error to be decomposed into two

components, namely the systematic assessment error component and the random assessment error component. Their data are confined to single-family properties located within the central city of Saint Louis between 1976 and 1977. They estimate two versions of a hedonic price regression, one where the tax rate is included as an independent variable and one where it is not. Then, they regress the difference in the estimated house values obtained from the aforementioned regressions against the systematic and random assessment error. The systematic and random assessment errors are calculated as follows: First, the mean of the effective tax rate is computed. This is the tax rate that would prevail in a world of "perfect assessment", where no assessment error is made. The difference between the actual taxes paid and the mean of the effective tax rate represents the assessment error. The assessment error is regressed on the predicted market value of property to obtain the systematic and random components of the assessment error. Overall, this exercise yields estimates of the intra-jurisdictional capitalization of assessment error. Ihlanfeldt and Jackson find that property tax assessment errors that are unrelated to the value of the house are capitalized into the value of the house at a high rate. They argue that this may contribute significantly to the large dispersion in the estimated capitalization rates throughout the literature (Ihlanfeldt and Jackson, 1982, 417-425).

Palmon and Smith (1998a) present an empirical analysis of tax capitalization, which addresses a very important econometric problem that has plagued past studies. This problem stems from spurious correlation between the error term and omitted public service variables and gives rise to biased coefficients. Palmon and Smith (1998a) are able to evade this problem through their use of a unique dataset which consists of large

variations in taxes, but no variation in public services. The dataset is made up of 449 owner-occupied properties sold in Harris County, Houston, in 1989. Using the tax capitalization approach and a discount rate of three percent, they find property tax capitalization to be sixty-two percent (Palmon and Smith, 1998, 1099-1111).

Palmon and Smith (1998b), using the same dataset used in Palmon and Smith (1998a), construct an empirical tax capitalization model that mitigates the following two econometric problems: The first is the spurious correlation between the error term and omitted public service variables that gives rise to biased coefficients. The second concerns the user cost of housing capital. Since the user cost of housing capital is not directly observable, past studies have had to use ad-hoc methods to determine the user cost of housing capital. This has contributed greatly to the large variation in the estimated capitalization rates. The authors evade the first problem by utilizing a dataset with large variations in taxes, but no variation in public services. The second problem is resolved by empirically estimating the discount rate through the use of both rental price and property value data. Palmon and Smith's (1998b) results indicate that taxes are fully capitalized into property prices (Palmon and Smith, 1998b, 299-315).

Bartolome and Rosenthal (1999) criticize past studies for their failure to appropriately account for the federal income tax code. Bartolome and Rosenthal claim that past studies implicitly assume "that all families itemize, that families save in assets for which interest is taxed on receipt, and that real interest income (as opposed to nominal income) is taxed." Bartolome and Rosenthal assert, based on recent research, that most homeowners do not itemize and that savings for retirement is done via investing in tax-deferred assets. Furthermore, they note that nominal income is taxed, not real income.

They use the amenities approach to estimate a model that corrects for the aforementioned errors. Their sample is made up of owner-occupied properties, located in various parts of the US, in the years 1985 and 1989. Their estimated tax capitalization rate is forty percent, which is equal to the rate found in Yinger et al., (1988). After pointing out that their results are consistent with that of past studies, they conclude that the specification errors that result from inadequate and erroneous representation of the federal income tax code offset one another (Bartolome and Rosenthal, 1999, 85-93).

2.3.1.4. Methodological Problems Concerning Studies Based on Cross-Sectional Micro Data. Studies based on cross-sectional micro data have several strengths relative to those that are based on aggregate data. First, most of these studies include a very large number of explanatory variables, mostly housing and neighborhood attributes. This mitigates the problems related to omitted variable bias. Second, cross-sectional micro data can be used to analyze both intra-jurisdictional tax as well as inter-jurisdictional tax capitalization (aggregate data studies can only be used to examine the extent of inter-jurisdictional tax capitalization). Third, in the case of intra-jurisdictional tax capitalization studies, the level and quality of public services are constant (since the sample is confined to a single municipality). As a result, the problem of omission of public service variables is avoided (Bloom, Ladd and Yinger, 1983, 153-154).

In spite of the aforementioned advantages, cross-sectional micro data studies face the same econometric problems that have plagued aggregate data studies. Omitted variable bias, although much less severe, is likely to be present. Like aggregate data studies, the findings of cross-sectional micro data studies are driven by the choice of

discount rate and time horizon. Furthermore, problems concerning the appropriate specification of the tax variable are still present:

Studies that use tax payments as their proxy for taxation give rise to biased coefficients and also a positively signed tax payment coefficient (theoretically, the coefficient should be negative). This is a direct result of the tax payment variable acting as a proxy for omitted variables such as expenditures on local public services (Martinez-Vasquez and Ihlanfeldt, 1987, 131-132).

The use of the effective tax rate (tax payment divided by the market value of the house) in lieu of tax payments brings with it its own problems. This specification gives rise to endogeneity bias, because the market value of the house appears on both sides of the regression equation (Martinez-Vazquez and Ihlanfeldt, 1987, 133-134). Some studies have attempted to resolve this problem via the use of 2SLS (Church 1974; Chinloy 1978). Wales and Weins (1974), on the other hand, have tried to decompose the tax rate coefficient into two components, namely the bias and the true tax rate coefficient. I have presented Bloom, Ladd and Yinger's (1983) critique of this approach in the previous section. To sum up, the use of the effective tax rate as the tax variable produces endogeneity bias. Even though researchers are aware of this problem, none of the remedies presented thus far have been fully satisfactory.

Finally, both the tax payment and effective tax rate specifications are potentially plagued by measurement error resulting from systematic (resulting from structural and neighborhood attributes) and random assessment differences. Ihlanfeldt and Jackson (1982) address the problem of assessment error.

2.3.1.5. Studies Based on Tax Change Data. Studies that fall into this category try to measure the tax capitalization rate by observing the change in house values in response to institutional changes in property taxes. Full property tax capitalization implies that the reduction in property values is exactly equal to the increase in the present value of the future stream of tax payments. Hence, examining the change in property prices due to a change in the tax rate is a useful approach to measuring the extent of property tax capitalization. A change in the effective tax rate can be due either to a change in the nominal tax rate or a change in the assessment ratio. Generally, nominal tax rates do not change frequently. However, reassessment of properties occurs quite often. Hence, most of the studies that fall into this category try to assess the rate of capitalization by examining changes in property values resulting from reassessment of property.

Wicks, Little and Beck (1968) try to measure the extent of tax capitalization by measuring the response of house values to property tax changes resulting from a general reassessment of property in Missoula County, Montana, during 1965. They compare the change in tax payment resulting from the reassessment to the difference between the market price of the house and the estimated would-be price had there not been a reassessment. Wicks, Little and Beck (1968) find that the average capitalization ratio is nineteen to one, meaning that a dollar increase in property taxes leads to a nineteen dollar decrease in the value of a house (Wicks, Little and Beck, 1968, 263-265).

Smith (1970) uses data from San Francisco to measure the impact of property tax changes, due to a reassessment that took place between 1966 and 1968, on house values. He finds an average capitalization ratio of fourteen and a half (Bloom, Ladd and Yinger, 1983, 157-158).

Rosen (1982) tries to measure the magnitude of inter-jurisdictional tax capitalization by examining the impact of California's Proposition Thirteen on house values in counties that fall in the San Francisco Bay area jurisdictions. Proposition Thirteen is a statewide property tax limitation initiative that took effect in 1978. Rosen regresses the change in the mean house price resulting from Proposition Thirteen against the change in the property tax bill of the mean house, and a number of property and location-specific attributes. Rosen's results approximate the inter-jurisdictional tax capitalization rate to be seven percent (Rosen, 1982, 191-200).

Bloom, Borsch-Supan, Ladd and Yinger (1988) also try to measure tax capitalization by examining the relationship between changes in house prices and changes in property taxes resulting from reassessments that occurred between 1967 and 1974. Their data consist of houses sold more than once throughout a period of ten years (Five years before and five years after reassessment) in seven Boston municipalities. In using 2SLS to mitigate simultaneity bias, Bloom, Borsch-Supan, Ladd and Yinger employ a theoretically derived first stage regression to identify instrumental variables, in order to minimize the possibility of choosing instrumental variables that are correlated with the error term. Furthermore, the discount rate is an estimable parameter in Bloom, Borsch-Supan, Ladd and Yinger's empirical model; this eliminates the need to choose a discount rate. Bloom, Borsch-Supan, Ladd and Yinger's estimates of the capitalization rate range from forty percent to ninety percent (Bloom, Ladd and Yinger, 1983, 159-160; Bloom, Borsch-Supan, Ladd and Yinger, 1988, 74-75).

2.3.1.6. Methodological Problems Concerning Studies Based on Tax Change

Data. These studies utilize a first-difference approach. This approach mitigates the problems associated with omitted variables, spurious correlation and measurement error which are present in studies that fall into the other two categories. However, these studies have problems of their own. The first problem lies in identifying the property price that would have prevailed had there not been the institutional change that altered property taxes. Various approaches have been taken to eliminate this problem, however each approach is ad-hoc. Second, all of these studies implicitly assume that public services are not affected by institutional tax changes. This may not necessarily be the case (Martinez-Vasquez and Ihlanfeldt, 1987, 130).

2.3.2. Category 2: Property Taxes, the Rental Price of Property and Property Tax Shifting

There are a number of studies that examine the extent to which property tax differentials lead to rent differentials (Orr, 1968; Heinberg and Oates, 1970; Hyman and Pasour, 1973; Dusansky, Melvin and Karatjas, 1981). This exercise provides important insights into the extent to which property taxes are shifted from property owners to renters. This exercise is important for several reasons: First, an awareness of the extent of property tax shifting implies an awareness of the tax burden shouldered by the property owner and renter. An enhanced understanding of property tax incidence will help policy-makers devise policies that better meet their objectives. Second, changes in the relative magnitudes of property tax shifting and property tax capitalization may

impact the real estate market. If the extent of property tax shifting and property tax capitalization is high, then renting the property may be the best means to avoid an increase in the property tax bill for the owner. On the other hand, if the magnitude of property tax shifting and property tax capitalization is low, then the best way to avoid the financial costs associated with increased property taxes is to sell the property.

2.3.2.1. Studies that Examine Property Tax Shifting. Orr (1968) constructs an empirical model to test the hypothesis that differential property taxes are shifted from owners to renters. Orr's data consists of properties that fall within 31 tax jurisdictions in the Boston Metropolitan Area in the year 1959. Orr begins his analysis by noting that the incidence of property taxation depends on the price elasticity of the supply of rental housing and the price elasticity of the demand for rental housing. He argues that the elasticity of demand is much more elastic relative to the supply, hence the incidence of property taxes are borne, by and large, to owners. To buttress his proposition that demand is more elastic than supply, Orr makes the following argument: American urban areas are made up of many small jurisdictions that offer households a great choice of locations with similar public services and attributes. Orr's point is that the availability of many close substitutes renders a more elastic demand. To test his proposition, Orr regresses the median gross rent per room on the tax rate and a number of structural and public service variables such as an index of the conditions of housing units in the taxing jurisdiction, an education proxy etc. He argues that his empirical model is robust, but the effective tax variable is statistically insignificant and adds very little to the explanatory

power of his model. Based on this observation, he rejects the hypothesis of complete or substantial tax shifting from owners to renters (Orr, 1968, 253-262).

Heinberg and Oates (1970) re-estimate Orr's (1968) model using Orr's data after making some changes. They argue that Orr's model is plagued by simultaneity bias. Furthermore, they claim that the rent variable (median gross rent divided by the median number of rooms) and some of the explanatory variables in Orr's study relate to the entire housing stock as opposed to the rental housing stock. To remedy the first problem they re-estimate the model using 2SLS. To remedy the second problem they limit their sample to the twenty-four jurisdictions that consist of rental data only and also re-specify the rent variable. Their new rent variable is the ratio of the median rental price to median number of rooms in rental units. The first modification gives rise to results that are very similar to Orr's. However, the second modification substantially reduces the explanatory power of the model. Then, Heinberg and Oates re-estimate the model using sales data instead of rental data, and find evidence of substantial capitalization of taxes into property values. Based on these results, they conclude that property taxes on owner-occupied houses are capitalized and that Orr's methodology is not appropriate for making inferences on property tax incidence (Heinberg and Oates, 1970, 92-98).

Hyman and Pasour (1973) empirically test the hypothesis that property tax differentials give rise to rent differentials using data very similar to Orr (1968). Their data encompasses one hundred and fifteen municipalities across North Carolina for the year 1970. They estimate the model using OLS. Their statistically significant tax coefficient indicates that a ten cent tax differential among municipalities leads to a nine dollar differential in the annual median rent per dwelling. For a rental unit valued at fifteen

thousand dollars, they compute a sixty percent shift in the property tax from owners to renters. Based on this finding, they conclude that a significant portion of the property tax is shifted from owners to renters (Hyman and Pasour, 1973, 303-306).

Dusansky, Ingber and Karatjas (1981) devise an econometric model that jointly tests for property tax capitalization and property tax shifting from owners to renters. Their dataset is made up of properties, in the year 1970, that belong to 62 school districts in Suffolk County, New York. A five-equation system which represents a general equilibrium model of the rental and owner-occupied housing markets is simultaneously estimated. Using a time horizon of twenty years, the authors find tax capitalization and tax shifting, from owners to renters, to be sixty-eight and seventy percent respectively (Dusansky, Ingber and Karatjas, 1981, 241-253).

Carroll and Yinger (1994) examine the question of whether the property tax is a benefit tax in the context of rental housing. A benefit tax is a tax in which the individuals who bear the tax burden are fully compensated via improvements in the quality and/or quantity of public services that they have access to. Carroll and Yinger consider the case in which renters are mobile (prior studies assume that renters are not fully mobile). They devise a model that examines the impact of differential property taxes on rents in a world where renters are mobile and renters consider the level of public services in deciding where to live. Their empirical model consists of estimating two simultaneous equations, namely a hedonic rent equation and a public service quality equation. Their empirical results indicate that a dollar's increase in property taxes gives rise to an improvement in public services that is much less than a dollar. Hence, Carroll and Yinger conclude that

the property tax is not a benefit tax, in the context of rental housing (Carroll and Yinger, 1994, 295-311).

2.3.2.2. Methodological Problems Concerning Studies that Examine Property Tax Shifting. Most of the econometric problems present in cross-sectional micro data studies are also present in the studies that examine the relationship between property taxation and the rental price of property.

As in the previously discussed groups of studies, omitted variable bias and the adequate representation of the public sector are common problems. Representing the public sector with one general public service variable potentially gives rise to omitted variable bias, whereas representing it with too many variables may create multicollinearity.

Doubts concerning the appropriate specification of the tax variable are also prevalent, as in the case of cross-section micro studies. Furthermore, measurement error arising from assessment error also contributes to the differing property tax shifting rates reported in the literature. These issues are discussed in detail in Section 2.3.1.4.

Finally, endogeneity bias, a problem common to both aggregate data and cross-sectional micro data studies, is not present in studies that examine the relationship between property taxation and the rental price of property. This is due to the fact that the dependent variable in these studies is the rental price of property rather than the market value.

2.4. The Contribution of this Dissertation in the Context of the Literature

There are a plethora of studies that utilize hedonic methods to empirically examine (1) the willingness to pay of consumers for site-specific property attributes (2) the relationship between property taxation and the sales/rental price of properties. A detailed presentation of these studies is provided in the previous sections. The studies that examine the relationship between property taxation and the sales/rental price of properties implicitly assume highly competitive housing markets. This is a required assumption since Rosen's theoretical results are derived under this assumption.

There is very little work done in the area of linking hedonic methods to market structure. Feenstra (1995) is the only study that provides some theoretical foundations for extending the hedonic method to encompass imperfect competition. Also, there are a number of applications that specifically address the separation of marginal prices into a price-cost markup and a marginal cost component. Feenstra and Levinsohn (1995) devise a model of oligopoly pricing in which products are multi-dimensionally differentiated and apply it to the 1987 US automobile industry. Goldberg (1996) estimates the price-cost markups involved in car purchases under price discrimination. Taylor and Smith (2000) recover the marginal cost of property attributes for purposes of assessing whether environmental amenities can become sources of market power in the vacation rentals market. Although these papers contribute greatly to the literature on product differentiation under imperfect competition, they do not account for the role of the public sector. The scope of these papers does not extend to account for the effects of taxation.

However, there are more recent studies that try to disclose the effects of taxation of composite goods in imperfectly competitive markets. Anderson, Palma and Kreider (2001A) examine the welfare consequences of ad valorem and unit excise taxes in an oligopolistic industry characterized by differentiated products and Bertrand competition. Anderson, Palma and Kreider (2001B) compare and contrast the relative efficiency of a unit and ad valorem tax for differentiated products under imperfect competition. However, none of these studies use hedonic methods to examine these issues; their unit of analysis is the composite product, not the composite product's attributes.

In the context of the literature, in the broadest sense, this dissertation establishes a formal link between hedonic methods, imperfect competition and property taxation. Past studies that use hedonic methods to analyze the relationship between property taxation and the sales/rental price of properties have assumed highly competitive housing markets. However, not all housing markets are highly competitive. In this dissertation, the highly competitive markets assumption is relaxed.

The objectives of this dissertation are to examine, using hedonic methods, (1) whether site-specific environmental amenities, such as a lake, can become a source of market power for firms that control them and (2) the extent to which such market power, if present, affects the relationship between property taxation and the rental price of housing. To achieve these objectives theoretically, hedonic methods are extended to accommodate both market structure and the local public sector. In the empirical part, for each property management firm, the rate of property tax shifting under the current less competitive market structure is computed. Then, the magnitude of property tax shifting that would be achieved by these firms under perfectly competitive conditions is

computed. The key task, in the empirical section, is retrieving the marginal cost of each housing attribute from its marginal price.

CHAPTER III

THEORETICAL MODEL

The purpose of this section is to theoretically extend hedonic methods to encompass both market structure and the local public sector. Feenstra (1995) develops a hedonic price framework that accommodates market structure. In this chapter, his work is extended by incorporating local fiscal variables into the theoretical model. The local fiscal variables are treated as property attributes. An equilibrium condition for the profit-maximizing level of attributes is derived. The equilibrium condition is substituted into the hedonic regression to derive an expression for the coefficient of all attributes.

In my case study, the composite goods are vacation rentals. The sections that follow in this chapter are developed in correspondence with the application. Nonetheless, the model applies generally to composite products with non-competitive market structures.

3.1. The Structural Assumptions of the Model

The structural assumptions of the theoretical model are as follows:

- 1) There are a sufficient number of municipalities (each with a different tax rate) to render the tax rate a continuous variable.
- 2) Renters are aware of the potential for property tax shifting from owners to renters (it is conjectured that a higher tax rate will result in a higher rental price). Hence, holding all other housing attributes constant, renters will derive a higher level of utility from a rental property with a lower tax rate.
- 3) Owners do not use these vacation rental units as their primary residence. Therefore, they are perfectly mobile in the sense that they can sell their property and purchase another property, in the same municipality or a different one, with negligible transaction costs.
- 4) Each rental property is managed by only one firm.
- 5) The financial incentives of the property management firms are perfectly aligned with the joint incentives of their clients, the owners, such that there are no conflicts of interest. The content of this assumption may be better elucidated with the following analogy: If the clients of a particular firm were to form a “coalition of owners” to manage their properties, it would make no difference whether the profits of this coalition or the firm are maximized; both would yield identical results. Hence each management firm may be thought of as a coalition of owners.

The first three assumptions allow for the tax rate to be treated as a choice variable, in both the renter’s utility function and the property owner’s cost function. Hence, like

any other attribute, the tax rate enters into the model through the rental price function and the cost function. The fifth assumption eliminates the potential for a principle-agent problem. In accordance with the fifth assumption, the management firms will be thought of as coalitions of owners, when modeling firm behavior.

3.2. Consumer's Expected Demand

In modeling the demand for vacation rentals, a random utility model is used. In property value applications of random utility models, each consumer makes a discrete choice between i properties. The consumer knows all of the attributes of the property and also his/her preferences. However, the exact specification of the true utility function is not known to the researcher, hence the perceived utility derived from house i is measured with error, $\varepsilon = (\varepsilon_1, \dots, \varepsilon_N)$. The random error terms are distributed across properties according to the joint distribution function $F(\varepsilon)$. Each consumer selects the property that maximizes his/her level of utility. Hence, the joint distribution function $F(\varepsilon)$ measures the probability that the utility of renting unit i yields the highest utility relative to any other unit. The functional form of $F(\varepsilon)$ and the distributional assumptions concerning ε determine the functional form of the expected demand functions (Palmquist, 2000, 52-54).

The first step in deriving consumer's expected demand is choosing the functional form for the observed/perceived utility function. Earlier studies have used a linear specification for the utility function. In this specification, the random term, the attributes, price and income all enter linearly, hence this specification is commonly referred to as the Linear Random Utility Model. The appeal of this model stems from its ease of estimation. However, because the attributes and income enter linearly, the marginal utility of the attributes and income are constant (Palmquist, 2000, 52-53). In my theoretical model, a more general utility function, previously used by Swan (1970) and Fisher and Shell (1972), is used which allows for a non-constant marginal utility of

attributes and income. The utility function for a representative consumer (renter) used in my theoretical model, in indirect form, is:

$$v_{it} = \ln \phi_0(y) - B - \ln \phi_{it}(p_{it}, z_{it}, \Gamma_{it}) + \varepsilon_{it} \quad (3.1)$$

where z = the vector of K attributes of the rental unit, Γ = the tax rate, p = the rental price, y = income, $i = i^{\text{th}}$ rental unit and t = time measured in weeks. In this specification, a representative individual derives utility, in week t , from consuming a numeraire commodity, B (whose price is equal to 1) and renting vacation rental unit i . $q = \phi_i(p_{it}, z_{it}, \Gamma_{it})$ is interpreted as a quality adjusted rental price and is the inverse of $p_{it} = \pi_i(q_{it}, z_{it}, \Gamma_{it})$. Hence, $\pi_{it}(q_{it}, z_{it}, \Gamma_{it}) = \phi_{it}^{-1}(p_{it}, z_{it}, \Gamma_{it})$. Also it is assumed that the partial derivative of ϕ with respect to z is greater than zero and $\partial \phi_{it} / \partial p_{it} > 0$.

Given the aforementioned specification of utility, the probability, according to the distribution $F(\varepsilon) = F(\varepsilon_1, \dots, \varepsilon_N)$, that rental unit i is chosen is:

$$Pr_{it} = \text{Prob} \left[v_{it} = \max_{j=1, \dots, N} v_{jt} \right] \quad (3.2)$$

Let $x_{it} = 1$ if rental unit i is chosen and $x_{it} = 0$ if not. Then, the expected demand for rental unit i , in week t , is:

$$E(x_{it} | Pr_{it}) = \sum Pr_{it} x_{it} = Pr_{it} + (1 - Pr_{it}) * 0 = Pr_{it} \quad (3.3)$$

The expected market demand of the i^{th} unit at time t , X_{it} , is simply the expected demand for rental unit i , Pr_{it} , multiplied by the number of individuals in the market, M :

$$X_{it} = MPr_{it} \quad (3.4)$$

Equation (3.4) states that the aggregate demand for rental unit i in week t is equal to the demand of a representative consumer multiplied by the number of individuals.

Since vacation rental properties are composite products, aggregation over consumers is an issue that needs to be addressed. More specifically, the relationship between the aggregate utility over all individuals and the expected market demand needs to be established. To achieve this, a theorem due to McFadden (1978, 1983) is used. McFadden (1978, 1983) shows that under a broad family of distribution functions, $F(\epsilon)$, there exists an aggregate indirect utility function V (over all individuals) such that $X_{it} = -(\partial V / \partial p_{it}) / (\partial V / \partial y)$.² This implies that the aggregate demand in equation (3.4) can be obtained from a utilitarian social welfare function, V .

² Feenstra (1995)'s presentation of the theorem is provided in Appendix 8.1.

3.3. The Coalition of Owners' Profit-Maximizing Choice of Attributes and Tax Rate

The analysis concerning the behavior of each Coalition of Owners entails the following assumptions:

- 1) Any Coalition of Owners chooses rental price, p_{it} , and attributes, z_{it} , for the i^{th} rental unit simultaneously, while considering the price and quantity of other coalitions as fixed. The subscript, t , represents time, in weeks.
- 2) Per unit costs, $c_{it}(z_{it}, \Gamma_{it})$, that accrue from managing the i^{th} rental unit in week t depend on the i^{th} rental unit's attributes in week t and the tax rate for the i^{th} rental unit, Γ_{it} in week t (the tax rate varies on an annual basis).

The following equation represents a Coalition of Owners' annual profit maximization problem³:

$$\text{Max}_{p_{it}, z_{it}, \Gamma_{it}} \sum_t \sum_i [p_{it} - c_{it}(z_{it}, \Gamma_{it})] X_{it} \quad (3.5)$$

where X_{it} is the expected market demand for rental unit i at time t as presented in equation (3.4).

³ Typically, in the vacation rentals market the firm that manages a rental property charges a percentage of the rent as commission. The commission can be incorporated into the model as a scaling factor of P_{it} . As it turns out, the analytical results are not affected by the commission when the commission rate is assumed constant across i and t -as is the standard practice in the vacation rental market. Hence, in the analytical model, the commission rate is omitted. P_{it} may be thought of as the after-commission rental price.

X_{it} can be further presented as follows:

$$X_{it} = -(\partial V/\partial p_{it})/(\partial V/\partial Y) \quad (3.5a)$$

$$= -(\partial \emptyset_{it}/\partial p_{it}) [(\partial V/\partial \emptyset_{it})/(\partial V/\partial Y)] \quad (3.5b)$$

$$= -(\partial \pi_{it}/\partial q_{it})^{-1} [(\partial V/\partial \emptyset_{it})/(\partial V/\partial Y)] \quad (3.5c)$$

Equation (3.5a) follows from McFadden (1978,1983). Simple manipulation of equation (3.5a) yields equation (3.5b). Recognizing that the rental price is the inverse function of the quality adjusted rental price, equation (3.5b) can be expressed as equation (3.5c).⁴

Assume a Nash equilibrium at $(p^*_{it}, z^*_{it}, \Gamma^*_{it})$, where p^*_{it} denotes the Nash equilibrium value for the rental price, z^*_{it} denotes the Nash equilibrium value of attributes, Γ^*_{it} denotes the Nash equilibrium value of the tax rate and $q^*_{it} = \emptyset_{it}(p^*_{it}, z^*_{it}, \Gamma^*_{it})$ is the Nash equilibrium value of the quality adjusted rental price. Then, consider alternative choices of $(p_{it}, z_{it}, \Gamma_{it})$ satisfying $p_{it} = \pi_{it}(q^*_{it}, z_{it}, \Gamma_{it})$. For such choices of $(p_{it}, z_{it}, \Gamma_{it})$ (holding q^*_{it} constant), arguments of V are unaffected, hence X_{it} changes only due to $(d\pi_{it}/dq_{it})^{-1}$. Thus, the condensed profit maximization problem becomes⁵:

$$\text{Max}_{z_{it}, \Gamma_{it} > 0} [\pi_{it}(q^*_{it}, z_{it}, \Gamma_{it}) - c_{it}(z_{it}, \Gamma_{it})](\partial \pi_{it}(q^*_{it}, z_{it}, \Gamma_{it})/\partial q_{it})^{-1} \quad (3.6)$$

Hence, in this specification, p_{it} is endogenized to hold q^*_{it} constant.

⁴ In the forthcoming sections and chapters, the rental price and the quality adjusted rental price may be referred to as the price and the quality adjusted price for simplicity.

⁵ Profits are assumed to be quasi-concave in the firm's own prices and attributes to ensure that an interior maximum exists. See Appendix 8.3 for a more detailed discussion of the required conditions for an equilibrium to exist.

The analytical model is structured such that the tax rate is a choice variable that contributes to product differentiation. Hence, in this model, the tax rate is treated as a property attribute. Thus, equation (3.6) can be further simplified by letting λ_{it} denote the vector of all property attributes for the i^{th} rental property, including the tax rate:

$$\lambda_{it} = \lambda_{it}(z_{it}, \Gamma_{it}) \quad (3.7)$$

Substituting equation (3.7) into equation (3.6):

$$\begin{aligned} \text{Max}_{\lambda_{it} > 0} & [\pi_{it}(q^*_{it}, \lambda_{it}) - c_{it}(\lambda_{it})](\partial\pi_{it}(q^*_{it}, \lambda_{it})/\partial q_{it})^{-1} \end{aligned} \quad (3.8)$$

Taking the FOC with respect to the k^{th} attribute and setting it equal to zero yields:

$$\begin{aligned} & [\partial\pi_{it}(q^*_{it}, \lambda_{it})/\partial\lambda_{ikt} - \partial c_{it}(\lambda_{it})/\partial\lambda_{ikt}] (\partial\pi_{it}(q^*_{it}, \lambda_{ikt})/\partial q_{it})^{-1} \\ & - [\pi_{it}(q^*_{it}, \lambda_{it}) - c_{it}(\lambda_{it})](\partial\pi_{it}(q^*_{it}, \lambda_{it})/\partial q_{it})^{-2} [\partial^2\pi_{it}(q^*_{it}, \lambda_{it})/\partial q_{it}\partial\lambda_{ikt}] = 0 \end{aligned} \quad (3.9)$$

Isolating $\partial c_{it}(\lambda_{it})/\partial\lambda_{ikt}$ and dividing through by $(\partial\pi_{it}(q^*_{it}, \lambda_{it})/\partial q_{it})^{-1}$ yields :

$$\begin{aligned} \partial c_{it}(\lambda^*_{it})/\partial\lambda_{ikt} &= \partial\pi_{it}(q^*_{it}, \lambda^*_{it})/\partial\lambda_{ikt} - [\pi_{it}(q^*_{it}, \lambda^*_{it}) - c_{it}(\lambda^*_{it})] \\ & (\partial\pi_{it}(q^*_{it}, \lambda^*_{it})/\partial q_{it})^{-1} [\partial^2\pi_{it}(q^*_{it}, \lambda^*_{it})/\partial q_{it}\partial\lambda_{ikt}] \end{aligned} \quad (3.10)$$

Setting $p^* = \pi_{it}(q^*_{it}, \lambda^*_{it})$ and then dividing and multiplying by p^* :

$$\begin{aligned} \partial c_{it}(\lambda^*_{it})/\partial\lambda_{ikt} &= \partial\pi_{it}(q^*_{it}, \lambda^*_{it})/\partial\lambda_{ikt} - ([p^* - c_{it}(\lambda^*_{it})]/p^*) \\ & (\partial\pi_{it}(q^*_{it}, \lambda^*_{it})/\partial q_{it})^{-1} [\partial^2\pi_{it}(q^*_{it}, \lambda^*_{it})/\partial q_{it}\partial\lambda_{ikt}] p^* \end{aligned} \quad (3.11)$$

Dividing and multiplying by $\partial\pi_{it}(q^*_{it}, \lambda^*_{ikt})/\partial\lambda_{ikt}$:

$$\begin{aligned} \partial c_{it}(\lambda^*_{it})/\partial\lambda_{ikt} &= \partial\pi_{it}(q^*_{it}, \lambda^*_{ikt})/\partial\lambda_{ikt} - (\partial\pi_{it}(q^*_{it}, \lambda^*_{ikt})/\partial\lambda_{ikt}) ([p^* - c_{it}(\lambda^*_{it})]/p^*) \\ &\quad (\partial\pi_{it}(q^*_{it}, \lambda^*_{ikt})/\partial q_{it})^{-1} (\partial\pi_{it}(q^*_{it}, \lambda^*_{ikt})/\partial\lambda_{ikt})^{-1} \\ &\quad [\partial^2\pi_{it}(q^*_{it}, \lambda^*_{ikt})/\partial q_{it}\partial\lambda_{ikt}] p^* \end{aligned} \quad (3.12)$$

Rearranging the terms yields the equilibrium condition for the k^{th} attribute:

$$\partial c_{it}(\lambda^*_{it})/\partial\lambda_{ikt} = \partial\pi_{it}(q^*_{it}, \lambda^*_{ikt})/\partial\lambda_{ikt} [1 - ([p^* - c_{it}(\lambda^*_{it})]/p^*) (1/\sigma^*_{ikt})] \quad (3.13)$$

where $\sigma^*_{ikt} = (\partial\pi_{it}/\partial q_{it})(\partial\pi_{it}/\partial\lambda_{ikt})/p^*_{it} (\partial^2\pi_{it}/\partial q_{it}\partial\lambda_{ikt})$, evaluated at $(q^*_{it}, \lambda^*_{ikt})$

represents the elasticity of substitution between q_{it} and λ_{ikt} in the function $\pi_{it}(q^*_{it}, \lambda_{it})$, when π_{it} is homogenous to degree 1. Equation (3.13) may be interpreted as follows: The marginal cost of the k^{th} attribute of property i at week t depends on the marginal price of the k^{th} attribute, the price-cost markup of property i , and the elasticity of substitution between q_{it} and λ_{ikt} in the function $\pi_{it}(q^*_{it}, \lambda_{it})$, when π_{it} is homogenous to degree 1. When the k^{th} attribute is the tax rate, Γ_{it} , equation (3.13) may be interpreted as follows: The marginal cost of the tax rate, Γ_{it} , depends on the marginal price of Γ_{it} , the price-cost markup for property i , and the elasticity of substitution between q_{it} and Γ_{it} in the function $\pi_{it}(q^*_{it}, \lambda_{it})$, when π_{it} is homogenous to degree 1.

The equilibrium condition demonstrates that under imperfect competition the marginal price of an attribute is not equal to its marginal cost. The marginal price of an attribute is greater than its marginal cost by a margin that depends on the price-cost markup of the property and the elasticity of substitution between the attribute and the property's quality adjusted price, in the price function, π , when π is homogeneous to

degree 1. The marginal price of an attribute is equal to its marginal cost, as in the competitive case, when the elasticity of substitution term, σ , is equal to infinity. A σ equal to infinity implies that the attribute in question and the quality adjusted price of the property are perfect substitutes.

3.4. The Equilibrium Condition in the Context of the Hedonic Rent Regression

Assume that marginal costs are semi-log in attributes, $c_{it}(\lambda_{it}) = Ae^{\sum \beta_k \lambda_{ikt} + v_{it}}$. Then:

$$\ln c_{it} = \alpha_t + \sum_{k=1}^K \beta'_{kt} \lambda_{ikt} + v_{it} \quad (3.14)$$

where α and β' are parameters and

$$\partial \ln c_{it} / \partial \ln \lambda_{ikt} = (\partial \ln c_{it} / \partial \lambda_{ikt}) (1/c_{it}) = \beta_{kt} \quad (3.15)$$

Adding $\ln(p_{it})$ and subtracting $\ln(c_{it})$ from both sides of (3.14) yields:

$$\ln p_{it} = \alpha_t + \sum_{k=1}^K \beta'_{kt} \lambda_{ikt} + (\ln p_{it} - \ln c_{it}) + v_{it} \quad (3.16)$$

Suppose that p_{it}/c_{it} is constant across i . Using a first order Taylor series expansion at $p_{it}/c_{it} = 1$, $(\ln p_{it} - \ln c_{it}) \approx p_{it}/c_{it} - 1$. Replacing $(\ln p_{it} - \ln c_{it})$ with $p_{it}/c_{it} - 1$:

$$\ln p_{it} = \alpha_t + \sum_{k=1}^K \beta'_{kt} \lambda_{ikt} + (p_{it}/c_{it} - 1) + v_{it} \quad (3.17)$$

Substituting the equilibrium condition, (3.13), and (3.15) into (3.17):

$$\begin{aligned} \ln p_{it} = & \alpha_t + \sum_{k=1}^K \{ (1/c_{it}) \partial \pi_{it} / \partial \lambda_{ikt} [1 - ((p_{it} - c_{it})/p_{it})(1/\sigma_{ikt})] \} \lambda_{ikt} \\ & + (p_{it}/c_{it} - 1) + v_{it} \end{aligned} \quad (3.18)$$

Letting $\gamma_{ikt} = \partial \ln \pi_{it} / \partial \lambda_{ikt} = (\partial \ln \pi_{it} / \partial \lambda_{ikt})(1/\pi_{it})$ and regrouping the terms:

$$\ln p_{it} = \alpha_t + \sum_{k=1}^K (p_{it}/c_{it}) \gamma'_{ikt} \lambda_{ikt} + (p_{it}/c_{it} - 1) \left[1 - \sum_{k=1}^K (\gamma_{ikt} \lambda_{ikt} / \sigma_{ikt}) \right] + v_{it} \quad (3.19)$$

Feenstra (1995) demonstrates that the term, $(p_{it}/c_{it} - 1) \left[1 - \sum_{k=1}^K (\gamma_{ikt} \lambda_{ikt} / \sigma_{ikt}) \right]$, disappears if the quality adjusted price, $q_{it} = \mathcal{O}_{it}(p_{it}, \lambda_{it})$, is of the form:

$$\mathcal{O}_{it}(p_{it}, \lambda_{it}) = \psi_{it} \left[\{p_{it} - g_{it}(\lambda_{it})\} / h_{it}(\lambda_{it}) \right] \quad (3.20)$$

where $\psi_{it} > 0$, $\psi'_{it} > 0$, $h_{it} > 0$, $\partial g_{it} / \partial \lambda_{it} > 0$ and h_{it} is homogeneous to degree 1.⁶ In this formulation, the function g is equal to the value that individuals place on the observed attributes in terms of the numeraire. The function h is a proxy for durability.

If the aforementioned condition is met, the hedonic price equation becomes:

$$\ln p_{it} = \alpha_t + \sum_{k=1}^K (p_{it}/c_{it}) \gamma'_{ikt} \lambda_{ikt} + v_{it} \quad (3.21)$$

According to equation (3.21), the coefficient of the k^{th} property attribute (the marginal price of the k^{th} property attribute), is equal to the marginal cost of the k^{th} property attribute expressed in elasticity form, $\partial \ln p_{it}(q_{it}, z_{it}) / \partial \lambda_{ikt} = \gamma'_{ikt}$, multiplied by the price-cost ratio, (p_{it}/c_{it}) . In the case where $\lambda_{kt} = \Gamma_{it}$, equation (3.21) is interpreted as follows: The coefficient of Γ_{it} , the property tax rate, is equal to the marginal cost of the property tax expressed in elasticity form, multiplied by the price-cost ratio, (p_{it}/c_{it}) .

Using the results derived in equation (3.21), and the fact that, in a non-competitive setting, a firm's cost-price ratio is equal to $(1+R)$ where R is the inverse

⁶ Feenstra (1995)'s presentation of this result is provided in Appendix 8.2.

residual demand elasticity of the firm (Taylor and Smith, 2000), the following proposition is derived:

PROPOSITION: Given semi-log marginal costs in attributes, constant markups over rental units, rational behavior on behalf of firms, quality adjusted prices specified as in equation (3.20) and the presence of a Nash equilibria, then marginal cost of any non-tax attribute can be recovered by multiplying the marginal price of the attribute by $(1+R)$ where R is the inverse residual demand elasticity of the firm. The marginal cost of the tax variable can also be recovered by multiplying the coefficient of the tax attribute in equation (3.21) by $(1+R)$.

The functional form of the quality adjusted price, as expressed in equation (3.20), needs to be explored a little further. If the durability proxy, h , is approximately equal to 1, then the quality adjusted price becomes a linear function of the price and the value that individuals place on the observed attributes in terms of the numeraire. On the other hand if g_i is equal to 0, this means that the value that individuals place on the observed attributes in terms of the numeraire is equal to 0. If this is the case, then the quality adjusted price is simply the ratio of price and durability (Feenstra, 1995, 637-638). In this specific case, the price function, p , is weakly separable in its arguments, namely the durability proxy and the quality adjusted price.

In the empirical section of this dissertation, the aforementioned proposition is used to retrieve the marginal cost of the attributes.

CHAPTER IV.

EMPIRICAL IMPLEMENTATION

4.1. Overview of the Issues

The purpose of this dissertation is to examine (1) whether site-specific environmental amenities, such as a lake, can become a source of market power for firms that control them and (2) the extent to which such market power, if present, affects the relationship between property taxation and the rental price of housing. In a market characterized by a high degree of competition, a basic hedonic price function would adequately describe the relationship between the price of a house and its corresponding attributes. However, the vacation rentals market is characterized by imperfect competition. As seen in Section 3.4, the hedonic price function describes a relationship between the price and housing attributes exaggerated by the price-cost ratio. Hence, the use of conventional hedonic methods for purposes of estimating the marginal cost of housing attributes can be misleading. The conventional hedonic price regression does not provide any means to separate the marginal cost of attributes from the price-cost ratio. Consequently, the key challenge is to retrieve the marginal cost of each attribute from its coefficient, in the hedonic regression.

Taylor and Smith (2000) propose to estimate the price-cost markup for each firm by estimating the so-called firm-specific residual demand model. The price-cost markup

is then employed to retrieve the marginal cost of each attribute from its estimated marginal prices in the hedonic regressions. In the empirical section of this dissertation, the framework of Taylor and Smith (2000) is used to estimate the price-cost markup and retrieve the marginal cost of housing attributes, including the tax rate⁷. The estimation procedure includes estimating hedonic price regressions, constructing quality adjusted price and quality adjusted quantity indices, estimating residual demand models, recovering the marginal cost of attributes and computing the rate of property tax shifting under perfect and imperfect competition. The remainder of this chapter describes the specific steps involved in the estimation procedure.

⁷ It is important to remind the reader that, under perfect competition, the marginal price of an attribute is equal to its marginal cost.

4.2. Hedonic Rent Functions

In order to derive market power measures for each firm, firm-specific hedonic rent functions are estimated for each year.

The hedonic rent functions are composed of attributes/variables that belong to one of seven categories, namely price variables, season variables, variables that account for property size, variables that account for housing quality, lake related variables, local government appropriation variables and the property tax rate. The price variables denote the rental price of each property for each season of each year. The season variables are dummy variables that denote the season in which the property is rented out. There is very little within-season variation in the occupancy rate across properties. However a substantial amount of seasonal variation is observed. To account for this, season dummies are used. The housing size category consists of variables that convey the size of the rental unit. Examples of such attributes include the maximum occupancy number and the number of bathrooms. The housing quality category consists of variables that measure quality such as whether the rental unit is classified as a contemporary unit, whether it has a fireplace etc. The environmental amenity-related variables capture the impact that the environmental amenity, namely the lake, has on the rental price of the rental unit. Examples include whether the unit is waterfront or not, whether it has a view of the lake or not. The local government appropriation variables are used as control variables for measuring the impact of the property tax on the rental price. These variables include the town-specific appropriations for highways and streets, appropriations for police services etc. The final category is made up of one variable, namely the full value property tax per

\$1000 of equalized property value.

Three criteria are used in selecting the variables to be included in the final specification of each hedonic rent function: The first is theoretical. Real estate rental agents were consulted and past hedonic studies involving the vacation rentals market were scrutinized for purposes of determining which attributes are more valued by customers. The second criterion is statistical significance. The final specification of each hedonic rent regression includes all variables that are theoretically important. These variables are almost always statistically significant. However, there are a number of variables that are theoretically important, but not statistically significant. These variables are also included in the final specifications in order to eliminate omitted variable bias. The last criterion is multicollinearity. A substantial effort is made to eliminate the potential for multicollinearity.

One of the biggest challenges facing the researcher is adequately representing the public sector in the hedonic equation. Some papers have chosen to control for public services with one general public service variable, while others have chosen to include several more specific public service variables. Each approach has its own problems. Representing the public sector with one general variable may give rise to omitted variable bias. On the other hand, using several more specific variables may plague the hedonic regression with multicollinearity. In this dissertation, the second approach is used. The choice of public service variables to be included in each hedonic regression is greatly influenced by efforts to minimize multicollinearity.

The public service variables and the property tax rate are lagged by a year in each hedonic regression. The property tax rate for any given year is determined and made

public the following year. Hence, firms make pricing decisions based on the previous year's tax rate.

The structure of the hedonic rent functions is as follows:

$$\ln(\text{Rental price}) = F(\text{dummy variables indicating season, housing size attributes, housing quality attributes, lake related variables, local public appropriation variables, the property tax rate}) \quad (4.1)$$

Choosing the appropriate functional form for the hedonic rent equation is very important, since different specifications for the hedonic rent equation embody different implications concerning the relationship between property taxation and the rental price of property. The two specifications commonly used in the literature are the linear and semi-log specifications. A linear specification implies that the extent of property tax shifting is independent of the rental price of the property. This, clearly, is a very strong implication. On the other hand, a semi-log specification implies that the extent of property tax shifting depends on the rental price of property. Furthermore, as seen in Section 3.4, under the semi-log specification, the coefficient of the tax variable can be viewed as the marginal cost of the tax augmented by the price-cost ratio. To render the empirical model consistent with the theoretical model, the semi-log specification is used.

4.3. The Quality Adjusted Rent and the Quality Adjusted Quantity Indexes

The estimates of the hedonic rent regressions are used along with weekly occupancy data to construct the following quality adjusted rent index:

$$\ln P_t = \sum [(P_{tk} R_{tk}) / TR_t] \ln P^*_{tk} \quad (4.2)$$

where t denotes the week, k denotes the rental unit, R_{tk} is equal to 1 if house k is occupied in week t , and zero otherwise. P_{tk} is the posted rental price of house k in week t , P^*_{tk} is the predicted rental price of house k at week t .

The posted rental price represents the ex-ante pricing strategy of the firm. Combining these prices with the ex-post reaction of consumers (the occupancy rates), in a Stone price index-like formulation, yields an effective rent index that adequately captures the market performance of the firm.

A quality adjusted quantity index is constructed by dividing total revenue in each week by the quality adjusted rent index.

4.4. The Residual Demand Model

The residual demand technique is an econometric technique for measuring market power that is especially well suited for industries characterized by a high degree of product differentiation. Prior to the advent of the residual demand technique, any statistical attempt to measure market power, in industries with substantial product differentiation, required the estimation of cross-price elasticities of demand. Generally estimating cross-price elasticities is difficult and the data requirements are substantial. The residual demand method allows for measurement of market power without the need to estimate cross-price elasticities (Baker and Bresnahan, 1988, 283-286).

The residual demand function is a semi-reduced form of a general supply and demand system for all differentiated products in a given market. It provides a relationship between the price and quantity of a firm, once the supply responses of all other firms have been taken into account. In other words, it identifies the “residual” demand facing the firm, once other firms’ supply responses have been accounted for. If there is no significant correlation between price and quantity once the supply responses of all other firms have been controlled for, then the slope of the residual demand curve facing the firm is zero, which implies that the firm has no market power. On the other hand, a negative and statistically significant correlation coefficient indicates that the firm is able to exercise market power (Baker and Bresnahan, 1988, 283-285).

Following Baker and Bresnahan (1988), let P_1 be the price index of Firm 1, the firm of interest, Q_1 its own quantity, Q the vector of quantities for other firms’ products,

Y the set of exogenous demand variables and α^1 the parameters measuring own-price demand elasticity, the income elasticity etc. for the market.

Then Firm 1's inverse demand function is:

$$P_1 = P^1(Q_1, Q, Y; \alpha^1) \quad (4.3)$$

Firm 1's supply response is given by:

$$P_1 - MC^1(Q_1, W_1, W; \beta^1) = \mu^1(Q_1, Q, Y; \alpha^1), \quad (4.4)$$

where the marginal cost, MC, depends on firm-specific costs, W_1 , industry-wide costs, W , and supply parameters, β^1 .

The inverse demand and supply curve for any other firm, Firm i , where i is not equal to 1, is:

$$P_i = P^i(Q_i, Q, Y; \alpha^i) \quad (4.5)$$

$$P_i - MC^i(Q_i, W_i, W; \beta^i) = \mu^i(Q_i, Q, Y; \alpha^i) \quad (4.6)$$

Simultaneously solving equations (4.5) and (4.6), for Q yields:

$$Q = Q^i(Q_1, Y, W, W^i; \alpha^i, \beta^i), \quad (4.7)$$

where the superscript i denotes equilibrium level in the markets when all firms except for Firm 1 have been accounted for.

Substituting equation (4.7) into equation (4.3) yields Firm 1's residual demand:

$$P_1 = R^1(Q_1, Y, W, W^i; \alpha, \beta^i), \quad (4.8)$$

where α measures the joint impact of all firms' demand parameters including those of Firm 1.

The observable variables in the residual demand function are own quantity, the demand variables, industry-wide costs, and firm costs for all firms except Firm 1. These variables are functions of the structural parameters, α and β^i , hence the impact of these unobservable structural parameters are captured through the observable variables. Equation (4.8) is specified in the double-log functional form, which implies that the coefficient of $\ln Q$, denoted as R , is the inverse residual demand elasticity. An inverse residual demand elasticity that is significantly less than 0 indicates the presence of market power.

4.5. Recovering the Marginal Cost of Attributes

In the theoretical part of the dissertation a proposition is derived:

PROPOSITION: Given semi-log marginal costs in attributes, constant markups over rental units, rational behavior on behalf of firms, quality adjusted prices specified as in equation (3.20) and the presence of a Nash equilibria, then the marginal cost of any non-tax attribute can be recovered by multiplying the marginal price of the attribute by $(1+R)$ where R is the inverse residual demand elasticity of the firm. Also, the marginal cost of the tax variable can also be recovered by multiplying the coefficient of the tax attribute in equation (3.21) by $(1+R)$.

Using this proposition, the marginal cost of each housing attribute, including the tax rate, is retrieved. Then, the attributes that command the highest premium above their marginal cost are identified. The attributes that command the highest premium above their marginal cost are expected to be the variables that are inherently linked to the lake or allow the renter to better enjoy the amenities provided by the presence of the lake. If this is so, then these results will reinforce Taylor and Smith's (2000) finding that financial incentives exist for firms to conserve site-specific environmental amenities such as a lake, the ocean etc.

4.6. Computing the Magnitude of Property Tax Shifting

The marginal price and marginal cost of the property tax rate variable are used to compute the magnitude of property tax shifting, for the case of imperfect and perfectly competitive rental housing markets, respectively. The objective of the empirical exercise is to assess the impact of varying levels of firm-specific market power on the relationship between property taxation and the rental price of property.

The analysis concerning property tax shifting entails several assumptions: First, a 10 cent tax increase is assumed. In other words, the property tax shifting consequences of a 10 cent increase in the property tax rate are being analyzed. Second, the rates of property tax shifting that are computed are firm-specific average property tax shifting rates. Third, rates of property tax shifting are computed using different values for the discount rate and the property tax capitalization rate. In order to account for the effect of property tax capitalization on the market value of the property, the tax rate is required. Given that each firm operates in more than one tax jurisdiction, the median tax rate is used. The tax rates are specified as the equalized-assessed property tax rate, hence differences in assessment ratios are accounted for. Fourth, maintenance costs for each property are assumed to be negligible and hence not accounted for. However, it is important to note that maintenance costs and the rate of property tax shifting are positively related. In other words, accounting for maintenance costs would have led to higher rates of property tax shifting.

Now I will present the specific steps involved in computing the rates of property tax shifting, for the case of imperfect and perfect competition:

Consider the following hedonic regression:

$$\ln P_i = \alpha_1 + \sum \beta_1 Z_i + \gamma_1 t_i \quad (4.9)$$

where $\ln P_i$ is the logarithm of the rental price of the i th property, P_i is the rental price of the i th property, Z_i is the vector of structural and location-specific housing attributes as well as local public services and t_i is the effective tax per 1000 dollars of equalized-assessed property value.

Assume $\gamma_1 = 0.02$. This is the marginal price of the tax rate, expressed in elasticity form. A 10 cent tax differential leads to a 0.2 percent increase in the rental price of housing. Let us also assume that the median rental price for the hypothetical firm in the year of interest is \$750. Then the increase in the median rental price due to the 10 cent increase in the property tax rate is $(\$750)(0.002) = \1.5 .

Assuming that this firm operates for 16 weeks, and its average occupancy rate for these 16 weeks is 50%, then the 10 cent tax differential leads to a \$12 annual difference in rent.

The next task is to determine the market value of the median rental unit. Given that the hypothetical firm operates for 16 weeks with an average occupancy rate of 50%, then the median rental unit generates $750 * 8 = \$6,000$ per year. Assuming a discount rate of 3 percent, full property tax capitalization and a median tax rate of 2 percent, then the market value of the median rental unit is $(6,000)/(0.03 + 0.02) = \$120,000$.

Given a market value equal to \$120,000, then a 10 cent tax differential leads to a \$12 annual difference in the tax bill for the owner, \$12 of which is passed onto the renter.

Hence, the average property tax shifting for this hypothetical firm, under imperfectly competitive conditions, is equal to 100%. A simplified formula that can be used to compute the average rate of property tax shifting is:

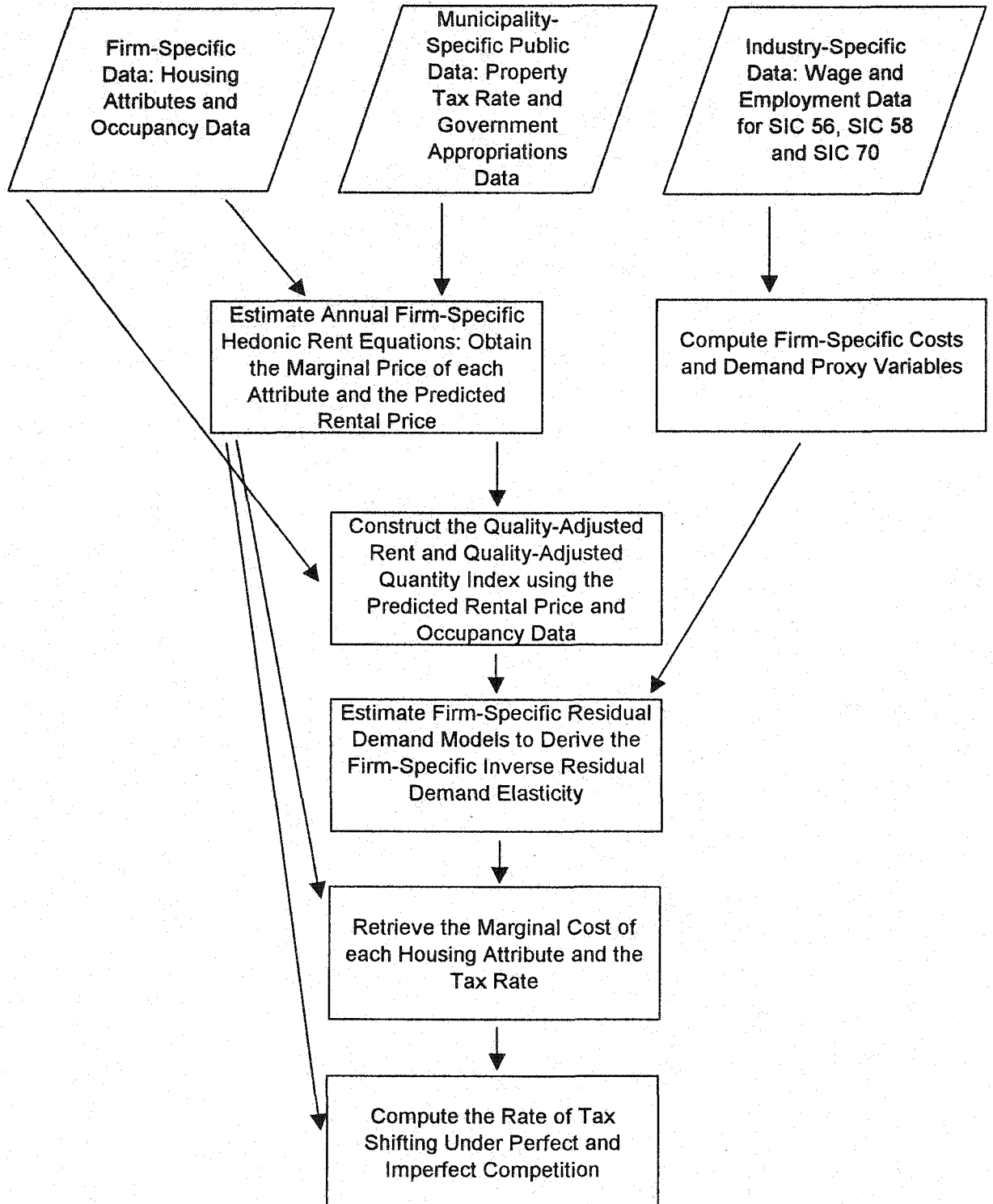
$$\text{Average Rate of Tax Shifting} = (\gamma_1)(\text{discount rate} + \text{portion of the tax rate that is capitalized})(1000) \quad (4.10)$$

Now, let us assume that, for this firm, the coefficient of the quality adjusted quantity index in the firm's residual demand model (the inverse residual demand elasticity, R) is -0.25 . Hence, this firm's price-cost markup is 25%. Multiplying the coefficient of the tax rate in the hedonic regression, 0.02, by $(1+R)$ yields 0.015. This is the marginal cost of the tax rate, expressed in elasticity form. Using this figure, in lieu of the marginal price, and repeating the aforementioned steps yields this hypothetical firm's average rate of property tax shifting under perfectly competitive conditions (price-cost markup = 0). The simplified formula is:

$$\text{Rate of Tax Shifting} = (0.015)(\text{discount rate} + \text{portion of the tax rate that is capitalized})(1000) \quad (4.11)$$

In summary, the estimation procedure can be described as a flow chart in Figure 4.1.

FIGURE 4.1: Flow Chart Describing the Empirical Implementation



CHAPTER V

CASE STUDY AND DATA

In this chapter, a case study of the vacation rentals market in the New Hampshire Lakes Region is presented. The chapter begins with a description of some of the important features of the New Hampshire Lakes Region and the vacation rentals market. Then, evidence that indicates that the vacation rentals market is imperfectly competitive is presented. In the latter parts of this chapter, the data used in the case study and the data collection process are discussed.

5.1. The New Hampshire Lakes Region

The Lakes Region is a geographically distinct area in central New Hampshire that covers a total of 42 towns.⁸ This area consists of 273 lakes and ponds surrounded by beaches, inns, resorts, lakefront and lake-access cottages, shopping and dining establishments. The largest of these lakes is Lake Winnepesaukee. It is surrounded by 3 mountains, covers 72 square miles, has 183 miles of shoreline and contains 274 islands (NH Visitors Guide, 53). Other large lakes include Squam Lake and Newfound Lake, which consist of shorelines of 61 miles and 22 miles respectively (Squam Lake Chamber of Commerce web-site and Newfound Lake Region Pamphlet).

The New Hampshire Lakes Region attracts a large number of tourists each year. In the year 2000, close to 4 million visitor trips (total person days) were made to the New Hampshire Lakes Region by visitors and 180.43 million dollars were spent on hotel rooms and meals by visitors (Travel Barometers, The Institute of New Hampshire Studies, 1-13). The area is not in proximity to a ski area, however the presence of the lakes allow for a wide variety of activities including swimming, boating, sailing, canoeing, kayaking, fishing and water-skiing. For individuals who enjoy nature and wildlife, there are many hiking trails and campgrounds. The New Hampshire Lakes Region is home to a great variety of animals and birds, which include the ruffed grouse, snowshoe hare and migratory waterfowl (The Official NH Visitors Guide, 46). Also, the Squam Lakes Natural Science Center, a 200 acre nature center with live native wildlife, consists of nature trails, interactive exhibits and live animal programs. The New

⁸ A map of the area is presented in Figure 5.1.

Hampshire Lakes Region consists of a number of historic sites, the most notable being the Wright Museum in which films, artifacts, military equipment and vehicles from World War II are exhibited (Where To! Lakes Region of New Hampshire, 16-17).

5.2. The New Hampshire Lakes Region Vacation Rentals Market

The specific market that my theoretical model will be applied to is the vacation rentals market of the NH Lakes Region. The participants of this market are the property owners, the property management firms and the property renters. Property owners sign a contract with a property management firm. Under this contract, the property management firm is responsible for renting out the property to renters and also managing the day-to-day needs of the property. In return for this service, the management firm receives a commission from the property owner.

One important task, at hand, is to define the vacation rentals market of the New Hampshire Lakes Region. Based on this definition, the boundaries of the market must be established. An ideal definition of a market must account for substitution possibilities in both production and consumption. On the production side, two products that are very different in composition may nevertheless belong to the same market if firms are able to switch from producing one product to the other with minimal opportunity cost. On the consumption side, two products that are considered “close” substitutes by consumers should also be treated as products that belong to the market. One potential problem is measuring the degree of substitutability. In other words what criteria should be used to determine whether products are close substitutes or not? One possibility is to consider the cross price elasticity of demand. If the cross price elasticity between two products is high, then these two products should be grouped together when defining the relevant market. However, cross price elasticities vary in different price ranges (Scherer and Ross, 1990, 215).

The previous paragraph describes some of the difficulties involved in defining a market. Given these difficulties, how should the boundaries for the vacation rentals market be set? In order to adequately address this question, both supply-side and demand-side substitution possibilities must be explored. Concerning the supply-side, the vacation rentals industry is characterized by asset specificity. In other words, establishing a vacation rentals firm involves a lot of specific investment. For example, it requires rental agents who are very familiar with the business and the customer base. As a result, in this industry, supply-side substitution possibilities are very limited, if any. Concerning the demand-side, the closest substitute to a vacation rental unit in proximity to a lake is a vacation rental unit in proximity to an ocean. Are these two types of properties close enough substitutes, in the eyes of a potential renter, such that it is appropriate to treat them as products competing in the same market? In this dissertation, these two types of properties are considered different properties, because the site-specific environmental amenities for each type of property are sufficiently different to render these properties non-substitutes, or at best, weak substitutes. But, what about lakefront and lake-access properties in locations that are close to but not within the boundaries of the New Hampshire Lakes Region, such as lakefront and lake-access properties in Maine? Should these properties be grouped together with the properties located in the New Hampshire Lakes Region when defining the relevant market? Providing a definitive answer to this question is very difficult. However, the rental agents interviewed by the author have argued that the New Hampshire Lakes Region, as a geographic region, offers so much in terms of outdoor attractions, including nature and wildlife, and other local attractions that it has gained a reputation throughout New England as being a distinct or “unique”

recreational area. In this spirit, I argue that an adequate definition of the vacation rentals market should include all firms that rent lakefront and lake-access properties in the geographic location known as the New Hampshire Lakes Region. This geographic location encompasses all of the towns that are in proximity to Lake Winnepesaukee and the surrounding smaller lakes, and Newfound Lake.

Given the aforementioned market definition, the vacations rentals market of the NH Lakes Region is led by six firms. The first two firms, hereafter referred to as Firm 1 and Firm 2, are the largest firms with an inventory of approximately eighty to one hundred rental units in any given year. Firm 3 and Firm 4 are the medium-sized firms with between fifty to sixty rental units in any given year. Finally, Firm 5 and Firm 6 represent the smaller-sized firms; these two firms manage approximately forty rental units each year.

There are a number of firms that rent out less than forty rental units per year. These firms are generally not considered part of the industry for the following reasons: First, and foremost, these firms are primarily in the real estate sales business. They manage very few rental properties, some as few as three. They do not have a separate rentals division; the rental units are managed by the real estate sales division. Furthermore, the prime business focus of some of these firms is long-term rentals and in some cases emergency housing rentals (if there is a hospital in the city).

Information obtained from rental agents indicates that there is market segmentation within the New Hampshire Lakes Region vacation rentals market. Discussions with rental agents who work for the six firms and a close examination of the records of the three firms for which detailed data was available (Firm 1, Firm 2 and Firm

3) reveal that firms which operate in the Newfound Lake area do not manage properties near Lake Winnepesaukee or the smaller lakes surrounding it, and vice versa. Hence, the market is divided up into two segments: The first is the Newfound Lake area, which encompasses the towns of Bristol, Alexandria, Bridgewater and Hebron. The second is the Winnepesaukee Lake and surrounding area. This segment encompasses the towns of Alton, Tilton, Moultonborough, Center Harbor, Meredith, Laconia, Gilford, Alton, Wolfeboro, Tuftonborough, Sandwich, Belmont, Gilmanton and Ossipee. Firm 3 and Firm 5 operate in the Newfound Lake area, while Firm 1, Firm 2, Firm 4 and Firm 6 operate in the Winnepesaukee Lake and surrounding area. Each firm's competitors are only those firms that operate in the same market segment.

The firms in the New Hampshire Lakes Region vacation rentals market can be classified into three categories, namely large-sized firms, medium-sized firms and smaller-sized firms. A complete set of data was available for Firm 1, Firm 2 and Firm 3, hence my sample is limited to these three firms. As a result, my sample consists of two larger-sized firm and one medium-sized firm. Since the purpose of the empirical model, in more general terms, is to examine firm pricing behavior in the presence of imperfect competition and property taxation, I would have liked to have had a representative of each firm size in my sample. However, including a smaller-sized firm is not feasible for the following reason: In the empirical model, I employ hedonic methods to determine the contribution of each housing attribute to the rental price of housing. Smaller-sized firms manage no more than forty rental units per year. Hence, a hedonic regression for a smaller-sized firm would have no more than forty observations; forty observations are not sufficient to consistently estimate the parameters of the hedonic regression. However, it is

important to note that even though hedonic regressions (and residual demand models) are not estimated for these smaller firms, their supply response is accounted for in the residual demand models of the larger firms (Firm 1, Firm 2 and Firm 3), since the costs of these firms are included as regressors in the residual demand models.

5.3. Evidence of Imperfect Competition in the Vacation Rentals Market

There is considerable evidence indicating that the vacation rentals market is an imperfectly competitive market. First, there is theoretical evidence. Experimental studies have demonstrated that posted price markets give rise to supra-competitive price levels (Davis and Holt, 1993). The vacation rentals market is a posted price market. A posted price market is one in which suppliers quote a price at the beginning of a sales period and demanders shop for and choose the best offer. Second, there is empirical evidence. Taylor and Smith (2000) find that the demand faced by vacation rental management firms is imperfectly elastic. Third, the NH Lakes Region vacation rentals market is controlled by very few firms. These firms are very similar in structure. Each firm, with the exception of one, is composed of a rentals and sales division. The structural similarities among firms and their sparse numbers may facilitate anti-competitive behavior such as parallel pricing and/or tacit collusion. Fourth, there is market segmentation. This issue is discussed in the previous section.

5.4. Property Taxation in the State of New Hampshire

New Hampshire is an ideal state to study local fiscal policy, because of its unique tax code. Government expenditure, in New Hampshire, is financed primarily by three types of taxes, namely an income tax, a sales tax and a property tax. The income tax is levied only on dividends and interest. The sales tax, on the other hand, is levied only on meals and rooms (Shapiro, England, Kenyon and Connor, 1999,1). The absence of a broad-based sales and income tax renders property taxes the prime source of local government revenue.

In the state of New Hampshire, property taxes vary by municipality. Each municipality determines its property tax rate, based on appropriations, incoming revenues and the assessed value of property. Each municipality annually holds county delegation meetings and city council meetings. During these meetings, elected representatives vote on appropriations that are necessary to fund the public services administered in the municipality. Also, a complete revaluation of property within the municipality is conducted to determine the municipality's "local assessed property value." The purpose of this revaluation is to ensure that the assessed value reflects the "true" or "market" value of property and that each property owner's tax burden is consistent with the value of his/her property. A revaluation is not conducted each year. The revaluation establishes "base year" property values. In the years that follow (years in which a revaluation is not conducted), the assessors examine the changes that take place since the base year, such as new construction and additions to the property, to determine the assessed value of property (Arnold, 1999, 1-4).

The equation for determining the property tax rate is:

$$\text{Property Tax Rate} = [(VA - IR)/LAPV] * 1000 \quad (5.1)$$

Tax Rate

where VA denotes voted appropriations, IR denotes incoming revenue and LAPV represents the local assessed property value. The tax rate is expressed per one thousand dollars of valuation (Arnold, 1999, 1-4).

Municipalities do not conduct revaluations in the same year. Hence, generally, the assessed value of property will be closer to its market value for municipalities that recently conducted their revaluation relative to those whose last revaluation dates back a few years. This discrepancy arising from differences in revaluation years along with idiosyncratic differences in assessment practices render comparison of property taxes among municipalities very difficult. The Department of Revenue Administration conducts an equalization process, annually, to adjust for these differences. This new “equalized” tax rate allows for comparison across municipalities. To derive the equalized property tax rate, the Department of Revenue Administration undertakes a meticulous investigation of property sales within each municipality. These sales are compared to the assessed property value to derive an “assessment ratio.” For instance, an assessment ratio equal to 85 percent implies that the municipality assessed property at approximately 85 percent of its full/market value.

Once the assessment ratio is derived, the “property tax per 1000 dollars of equalized-assessed property value” is computed as follows:

$$\text{Equalized Property} = [(VA - IR)/LAPV*AS]* 1000 \quad (5.2)$$

Tax Rate

where VA, IR, LAPV are defined as before and AS is the assessment ratio

(Arnold, 1999, 1-4).

5.5. Firm-Specific Data

A complete set of firm-specific data is available for the years 2000 and 1999 for Firm 1 and the years 2000, 1999 and 1998 for Firm 2 and Firm 3. Hence, a total of 8 hedonic rent functions are estimated. All firm-specific data are collected directly from the firm's rental records. The firm-specific data can be divided into two groups, namely housing attributes and firm costs:

A complete list of all housing attributes used in my empirical model and their definitions are provided in Tables 5.1, 5.2, 5.3 and 5.4. The definitions are based on the definitions used by realtors. Basic descriptive statistics for all of these variables are provided in Tables 5.5, 5.6, 5.7, 5.8, 5.9, 5.10 and 5.11. The housing attributes that are considered in my empirical model can be divided into seven categories, namely, the rental price, season variables, variables that account for property size, variables that account for housing quality, lake related variables, local government appropriation variables and the property tax rate. The rental price is the price paid by renters for renting the property for a week. It is important to note that actual property values for rental units are unavailable. Hence, property tax shifting rates are computed using market values that are obtained by summing up the present value of the future stream of rental payments. Dummy variables are used in order to account for the highly seasonal nature of the vacation rentals market. A typical year is made up of three seasons, namely pre season, peak season and post season. Only one firm, namely Firm 1, has a peak, post and pre season for all years. Firm 2 does not distinguish among seasons. Almost all of its inventory is rented out during peak season. Any rental arrangements made marginally

before or after the peak season are subject to peak season prices. Firm 3 also rents out most of its inventory during peak season. However, in 1999 and 1998, Firm 3 rented out a few properties during post season, hence a peak season dummy variable is included in the 1999 and 1998 hedonic rent equations of Firm 3. Any property that is rented out in more than one season is considered a separate property for each of those seasons and hence is accounted for as a separate rental unit in the hedonic model. Maximum occupancy number and the number of bathrooms make up the housing size variables. The housing quality category consists of variables that measure quality such as whether the rental unit is classified as a contemporary unit, whether it has a fireplace etc. The environmental amenity-related variables capture the impact that the environmental amenity, namely the lake, has on the rental price of the property. Examples include whether the property is waterfront or not, whether it has a view of the lake or not etc. The local government appropriation variables are used as control variables for measuring the impact of the property tax rate on the rental price. Examples of these variables are the town-specific appropriations per capita for highways and streets and the appropriations per capita for police services. The final category, the property tax rate, is the tax bill, in dollars, per one thousand dollars of equalized property value.

Each firm's costs are made up of two components, namely costs associated with cleaning the rental unit each time the unit is vacated and rental agent costs. Rental agents work on a commission basis. Hence, for each firm, the sum of all commission payments made to rental agents make up the rental agent costs. The administrative assistants work for both the rentals and sales department of each firm, and are on the sales department's payroll.

After each rental unit is vacated, the unit is cleaned up by a cleaning team whose members work for hourly wages. The total cost associated with hiring this team is referred to as "cleaning costs." Cleaning costs do not accrue to the firm. These costs are either deducted from the payments received by the owner, or there is a mandatory cleaning fee charged to each renter on top of the rental price. Hence, these costs are passed onto either the owner or renter. Thus, the only costs incurred by the firm are rental agent fees.

For each of the firms that provided detailed occupancy records, very precise weekly total revenue figures are computed. The firm-specific average occupancy rates by season and year are provided in Table 5.12. Using the confidential annual personal income figure of a rental agent (this rental agent is the only rental agent working for the firm in question), I am able to compute the percentage (of the weekly rental price) that each rental agent receives as commission once the unit is rented out. It is simply the firm's annual total revenue divided by the rental agent's personal annual income. It is approximately equal to a third for all firms. Hence dividing the firm's weekly total revenues by three, yields the weekly rental agent costs for each of these firms.

For the firms for which occupancy information is not available, rudimentary cost figures are computed using the following methodology: I call up each of these firms and ask the rental agents to provide me with the average number of units rented out in a typical week for each month of each year (generally the numbers do not vary from year to year). Basically, I am trying to obtain a monthly capacity utilization rate. Then, I compute the mean rental price for each firm for each year. Using the mean rental prices and the capacity utilization figures, I compute weekly total revenue. By dividing the weekly total

revenue by three (rental agent costs make up a third of total revenue), I obtain the weekly rental agent costs for each of these firms. For each of these firms, costs vary on a monthly basis, while for the other group of firms, costs vary on a weekly basis.

5.6. Industry-Specific Data and Demand Proxy Variables

The industry-specific data used in my empirical model is a wage index for real estate brokers, agents and managers (SIC two-digit code 56) in New Hampshire. The wage index is constructed as follows: I divide the total quarterly wages for SIC Code 56, by the number of weeks in each quarter (13) to obtain weekly wages. The wage index is obtained by dividing weekly wages by weekly employment. The New Hampshire quarterly wage and employment data for SIC Code 56 are obtained from the State of New Hampshire Department of Employment Security. The wage index varies on a monthly basis, hence for each week of a given month, the wage index is the same.

Finally, the demand proxy variables are two wage indexes, one for eating and drinking establishments (SIC two-digit code 58) and the other for hotel and other lodging places (SIC two-digit code 70), and dummy variables identifying national holidays. The methodology used in constructing these wage indexes is identical to that of the wage index for real estate brokers, agents and managers (SIC two-digit code 56). The raw data are obtained from the State of New Hampshire Department of Employment Security.

FIGURE 5.1: Map of the New Hampshire Lakes Region



TABLE 5.1: Variable Names and Definitions: Rental Price and Seasonal Dummy

Variables

Variable Name	Definition
PRI00	The rental price of the property in the year 2000.
PRI99	The rental price of the property in the year 1999.
PRI98	The rental price of the property in the year 1998.
PEAK00	Dummy variable equal to one if the property was available for rent in the peak season of 2000 (between July 1 st and September 2 nd), zero otherwise.
PEAK99	Dummy variable equal to one if the property was available for rent in the peak season of 1999 (between June 26 th and August 28 th), zero otherwise.
PEAK98	Dummy variable equal to one if the property was available for rent in the peak season of 1998 (between June 27 th and September 5 th), zero otherwise.
PRE00/POST00	Dummy variable equal to one if the property was available for rent in the pre/post season of 2000 (pre season 2000 begins May 13 th and ends July 1 st ; post season 2000 begins September 2 nd and ends October 16 th), zero otherwise.
PRE99/POST99	Dummy variable equal to one if the property was available for rent in the pre/post season of 1999 (pre season 1999 begins May 15 th and ends June 26 th ; post season 1999 begins August 28 th and ends October 16 th), zero otherwise.
PRE98/POST98	Dummy variable equal to one if the property was available for rent in the pre/post season of 1998 (pre season 1998 begins May 16 th and ends June 27 th ; post season 1998 begins September 5 th and ends October 17 th), zero otherwise.

TABLE 5.2: Variable Names and Definitions: Property Size and Property Quality

Variable Name	Definition
MAXOCC	The maximum number of individuals that the property can accommodate.
BATHS	The number of bathrooms.
FPLACE	Dummy variable equal to one if a fireplace is available, zero otherwise.
GRLAWN	Dummy variable equal to one if the property possesses a grassy lawn, zero otherwise.
CONTEM	Dummy variable equal to one if the property is characterized as “contemporary”, zero otherwise.

TABLE 5.3: Variable Names and Definitions: Lake Related Variables

Variable Name	Definition
WFRONT	Dummy variable equal to one if the property is waterfront, zero otherwise.
LVIEW	Dummy variable equal to one if the property has a view of the lake, zero otherwise.
ISLAND	Dummy variable equal to one if the property is on an island, zero otherwise.
SD	Secchi disc measure of water clarity, in feet.
DOCK	Dummy variable equal to one if a dock is available, zero otherwise.
DECK	Dummy variable equal to one if a deck is available, zero otherwise.
SPORCH	Dummy variable equal to one if a screen porch is available, zero otherwise.
BOCAN	Dummy variable equal to one if a boat/canoe is available, zero otherwise.
RAFT	Dummy variable equal to one if a raft is available, zero otherwise.

TABLE 5.4: Variable Names and Definitions: Local Government Appropriations and the Property Tax Rate

Variable Name	Definition
FIRE99/98/97	Local government appropriations, per capita, devoted to the Fire and Safety Department in the year 1999/1998/1997 in US dollars.
AMB99/98/97	Local government appropriations, per capita, devoted to ambulance services in the year 1999/1998/1997 in US dollars.
HSTR99/98/97	Local government appropriations, per capita, devoted to maintaining and constructing highways and streets in the year 1999/1998/1997 in US dollars.
POL99/98/97	Local government appropriations, per capita, devoted to police services in the year 1999/1998/1997 in US dollars.
TAX99/98/97	Full value property tax per one thousand dollars of equalized property value in the year 1999/1998/1997.

TABLE 5.5: Basic Descriptive Statistics for Firm 1's Year 2000 Variables

YEAR	VARIABLES	MEAN	MEDIAN	STD. DEV.	MIN.	MAX.
2000	PRI00	1122.82	987.50	661.15	400.00	3725.00
	PEAK00	0.41	0	0.49	0	1.00
	POST00	0.30	0	0.46	0	1.00
	MAXOCC	7.49	7.00	2.93	2.00	18.00
	BATHS	1.90	2.00	0.86	1.00	4.00
	WFRONT	0.56	1.00	0.50	0	1.00
	LVIEW	0.35	0	0.48	0	1.00
	ISLAND	0.0266	0	0.1611	0	1.00
	SD	5.22	5.00	1.12	4.00	9.52
	DOCK	0.60	1.00	0.49	0	1.00
	FPLACE	0.48	0	0.50	0	1.00
	RAFT	0.04	0	0.20	0	2.00
	GRLAWN	0.10	0	0.30	0	1.00
	CONTEM	0.07	0	0.25	0	1.00
	BOCAN	0.08	0	0.35	0	1.00
	TAX99	15.36	12.90	3.76	12.90	27.10
	HSTR99	214.56	215.54	86.42	60.69	430.39
	AMB99	32.89	36.34	17.30	0	65.17
	FIRE99	72.71	70.99	14.67	27.45	105.69

TABLE 5.6: Basic Descriptive Statistics for Firm 1's Year 1999 Variables

YEAR	VARIABLES	MEAN	MEDIAN	STD. DEV.	MIN.	MAX.
1 9 9 9	PRI99	938.47	900	435.26	400.00	3000.00
	PEAK99	0.40	0	0.49	0	1.00
	POST99	0.30	0	0.46	0	1.00
	MAXOCC	7.21	7.00	1.96	4.00	18.00
	BATHS	1.61	1.50	1.60	0.75	4.00
	WFRONT	0.58	1.00	0.50	0	1.00
	LVIEW	0.36	0	0.48	0	1.00
	DOCK	0.58	1.00	0.49	0	1.00
	DECK	0.77	1.00	0.42	0	1.00
	SPORCH	0.45	0	0.51	0	1.00
	CONTEM	0.03	0	0.16	0	1.00
	BOCAN	0.07	0	0.28	0	2.00
	TAX98	13.96	9.28	7.11	9.28	32.64
	HSTR98	207.97	225.12	53.05	52.17	279.96
POL98	126.84	126.15	12.26	84.15	146.13	
AMB98	30.70	35.82	12.83	0	38.46	

TABLE 5.7: Basic Descriptive Statistics for Firm 2's Variables

YEAR	VARIABLES	MEAN	MEDIAN	STD. DEV.	MIN.	MAX.
2000	PRI00	1259.89	1250.00	563.88	275.00	3000.00
	MAXOCC	6.37	6.00	1.67	3.00	13.00
	BATHS	1.56	1.00	0.71	0	4.00
	WFRONT	0.61	1.00	0.49	0	1.00
	SD	5.91	5.74	0.86	5.00	9.52
	DECK	0.49	0	0.50	0	1.00
	TAX99	14.28	12.91	2.59	12.91	21.04
	FIRE99	67.94	71.00	13.82	5.90	105.70
1999	HSTR99	229.64	215.54	90.97	41.66	457.86
	PRI99	1214.86	1237.50	482.55	525.00	2575.00
	MAXOCC	6.54	6.00	1.41	4.00	10.00
	BATHS	1.60	1.25	0.74	0	4.00
	WFRONT	0.62	1.00	0.49	0	2.00
	SD	6.61	6.69	0.55	5.14	7.27
	DECK	0.53	1.00	0.50	0	1.00
	TAX98	11.77	9.28	5.03	9.28	26.03
	HSTR98	131.23	127.12	38.68	42.61	245.40
1998	POL98	80.44	71.24	25.37	23.88	142.92
	FIRE98	41.40	39.18	14.15	13.14	100.12
	PRI98	1153.68	1112.50	458.95	525.00	2500.00
	MAXOCC	6.32	6.00	1.32	4.00	10.00
	BATHS	1.52	1.00	0.74	0	4.00
	WFRONT	0.63	1.00	0.49	0	1.00
	FPLACE	0.39	0	0.55	0	2.00
	DECK	0.59	1.00	0.50	0	1.00
	TAX97	11.51	9.30	4.54	9.30	26.70
1998	POL97	100.12	122.74	9.57	85.27	136.70
	FIRE97	61.89	65.45	12.32	33.74	93.67

TABLE 5.8: Basic Descriptive Statistics for Firm 3's Variables

YEAR	VARIABLES	MEAN	MEDIAN	STD. DEV.	MIN.	MAX.
2000	PRI00	864.41	900.00	178.30	375.00	1300.00
	MAXOCC	5.88	6.00	1.45	4.00	12.00
	BATHS	1.57	1.50	0.68	0.75	3.00
	WFRONT	0.53	1.00	0.50	0	1.00
	LVIEW	0.25	0	0.44	0	1.00
	TAX99	16.93	20.32	4.70	10.28	20.40
	FIRE99	27.50	30.81	15.40	7.93	61.31
	POL99	89.21	65.17	55.11	37.06	164.76
1999	PRI99	826.04	862.50	172.36	475.00	1300
	PEAK99	0.90	1.00	0.31	0	1.00
	MAXOCC	5.96	6.00	1.44	4.00	12.00
	BATHS	1.62	1.50	0.66	0.75	3.00
	WFRONT	0.58	1.00	0.50	0	1.00
	LVIEW	0.27	0	0.45	0	1.00
	TAX98	22.65	25.11	6.17	7.72	26.04
	AMB98	33.65	5.42	34.38	0	73.89
	POL98	83.36	61.15	46.53	37.59	136.94
1998	PRI98	785.80	775.00	157.32	350.00	1200.00
	PEAK98	0.86	1.00	0.35	0	1.00
	MAXOCC	5.93	6.00	1.11	4.00	8.00
	BATHS	1.59	1.50	0.69	0.75	3.00
	WFRONT	0.68	1.00	0.47	0	1.00
	LVIEW	0.25	0	0.44	0	1.00
	SPORCH	0.66	1.00	0.48	0	1.00
	DOCK	0.36	0	0.49	0	1.00
	TAX97	24.08	26.16	7.91	7.36	29.15
	HSTR97	119.39	144.93	64.96	29.92	175.71

TABLE 5.9: Basic Descriptive Statistics: Weekly Wage and Weekly Cost Indexes used in Firm 1's Residual Demand Model

VARIABLES	MEAN	MEDIAN	STD. DEV.	MIN.	MAX.
WAGE INDEX FOR SIC CODE 58	228.43	231.85	15.09	202.95	252.91
COST INDEX FOR THE INDUSTRY	563.60	565.39	34.19	504.21	603.30
COST INDEX FOR FIRM 1'S COMPETITORS	1061.96	648.88	1019.69	0	2853.05

TABLE 5.10: Basic Descriptive Statistics: Weekly Wage and Weekly Cost Indexes used in Firm 2's Residual Demand Model

VARIABLES	MEAN	MEDIAN	STD. DEV.	MIN.	MAX.
WAGE INDEX FOR SIC CODE 70	289.47	291.50	44.28	224.82	370.55
COST INDEX FOR THE INDUSTRY	543.54	545.86	44.85	466.97	603.30
COST INDEX FOR FIRM 2'S COMPETITORS	1966.73	2557.83	1030.13	130.00	3338.93

TABLE 5.11: Basic Descriptive Statistics: Weekly Wage and Weekly Cost Indexes used in Firm 3's Residual Demand Model

VARIABLES	MEAN	MEDIAN	STD. DEV.	MIN.	MAX.
WAGE INDEX FOR SIC CODE 70	289.62	293.89	42.50	224.82	370.55
COST INDEX FOR THE INDUSTRY	540.68	545.86	42.87	466.97	603.30
COST INDEX FOR FIRM 3'S COMPETITORS	1182.15	1643.00	620.23	333.00	1825.00

TABLE 5.12: Occupancy Rates by Year and Season

YEAR	SEASON	FIRM 1	FIRM 2	FIRM 3
2 0 0 0	PRE SEASON	21.67%	11.80%	5.39%
	PEAK SEASON	55.74%	53.20%	61.70%
	POST SEASON	14.78%	5.39%	9.80%
	ANNUAL	34.07%	32.00%	42.30%
1 9 9 9	PRE SEASON	17.61%	5.26%	13.30%
	PEAK SEASON	58.20%	57.50%	62.60%
	POST SEASON	19.02%	15.80%	9.80%
	ANNUAL	37.05%	48.90%	41.00%
1 9 9 8	PRE SEASON	-	15.40%	6.19%
	PEAK SEASON	-	61.80%	63.63%
	POST SEASON	-	24.00%	11.36%
	ANNUAL	-	57.00%	43.38%

CHAPTER VI

EMPIRICAL RESULTS

6.1. The Hedonic Regression Results

The estimation results of the hedonic rent equations are presented in Table 6.1, Table 6.2 and Table 6.3. All eight hedonic rent regressions are statistically robust. The R-squared statistic for each of these regressions is very high. Given the semi-log functional form, the coefficients represent the percentage change in rent resulting from a one unit change in the explanatory variable. The coefficients for most of the attributes are statistically significant. Multicollinearity tests are conducted for each hedonic rent regression. The tests indicate the presence of low to moderate levels of multicollinearity.

The hedonic rent results for the year 2000 are presented in Table 6.1. For Firm 1, the attributes that have the largest coefficient are PEAK, CONTEM, DOCK, LVIEW, RAFT, WFRONT and BOCAN. The weekly rental price of a rental unit rented out in peak season is thirty-one percent greater than an identical unit that is not rented out in peak season. Also, the weekly rental price of a house that is categorized as contemporary is almost twenty-two percent greater than an identical one that is not. Concerning the attributes DOCK and LVIEW, the rental price of a unit that possesses either one of these attributes is approximately twenty-two percent greater than an identical one that does not. The price of a rental unit that possesses either a raft or a boat/canoe or is waterfront is

approximately nineteen percent greater than an identical one that does/is not. Concerning the hedonic rent results for Firm 2, the coefficients of the WFRONT and DECK variables are very high. The rental price of a property that is categorized as waterfront is almost thirty-six percent greater than an identical one that is not, while one that possesses a deck is almost twenty-nine percent greater than one that is not. For Firm 3, the attributes that have very large coefficients are the two lake related variables, namely WFRONT and LVIEW.

The hedonic rent results for the year 1999 are presented in Table 6.2. For Firm 1, the attributes that command the highest premiums are PEAK and CONTEM. Other attributes that possess large coefficients are WFRONT, BOCAN, DOCK and BATHS. For Firm 2, the attribute whose presence leads to the largest percentage increase in rental price is WFRONT. Also, the coefficient of DECK is very large. The rental price of a unit with a deck is twenty-two percent greater than an identical property without one. As before, the variables with the largest coefficients, for Firm 3, are WFRONT and LVIEW. In 1999, Firm 3 had both a peak and a post season, hence the PEAK dummy variable is included in the hedonic rent regression. The coefficient of this variable is equal to 0.25, indicating that, the rental price of a property rented out during peak season is twenty-five percent greater than an identical one that is not.

The hedonic rent results for the year 1998 are presented in Table 6.3. The results are similar to those of 1999 and 2000. However, concerning Table 6.3, two points are worth noting: First, for Firm 2, the coefficient of DECK is very large, larger than that of some key attributes such as WFRONT and BATHS. Second, for Firm 3, the variable BATHS, is not statistically significant. Both of these results are quite surprising.

In general, the variables that contribute greatest, in percentage terms, to the rental price are the variables that are inherently linked to the lake (WFRONT, LVIEW, DOCK, DECK, SPORCH, BOCAN and RAFT) and the variable that differentiates between a luxury and non-luxury property, namely CONTEM. In spite of SD being a lake related variable, its coefficient is small relative to the coefficients of the other lake related variables.

Some of the public service variables are insignificant and incorrectly signed. However, these variables are control variables, and not variables that are being examined.

Finally, the coefficient of the property tax variable is relatively constant across firms and years. It varies between 0.0117 and 0.0171. Hence, a dollar increase in the tax bill per 1000 dollars of equalized property value gives rise to a percentage increase in the weekly rental price that ranges from 1.2 to 1.7 percent.

6.2. The Residual Demand Model Estimation Results

The weekly rent and quantity indexes, along with the demand, industry cost and firm-specific cost variables are utilized to estimate a residual demand model. A residual demand model is estimated for each of the three firms, using two years of data for Firm 1 and three years of data for Firm 2 and Firm 3. The observations for each of the firms are weekly measures. For Firm 1, the observations encompass three seasons for two years, while for Firm 2 and Firm 3, the observations include three seasons and three years, however, for these firms, the pre and post season is very short.

There were no significant disruptions to tourism in the New Hampshire Lakes Region throughout the years 1998, 1999 and 2000. Furthermore, to the knowledge of the numerous rental agents interviewed by the author, neither the vacation rentals market nor the businesses themselves have experienced any disruption or significant change in the aforementioned years. Hence, it is assumed that the demand faced by each of these firms is stable over the studied years. As a result, I expect the market power exercised by these firms to be relatively stable over these years.

The equation below represents the residual demand model:

$$\ln P_{it} = F(\ln Q_{it}, \ln Y_t, \ln W_t, \ln W_{-it}, \varepsilon_{it}) \quad (6.1)$$

where F is linear function. P_{it} and Q_{it} denote the quality adjusted rent and quantity indexes for Firm i , respectively. Y_t represents the group of demand proxy variables. The demand proxy variables used in my model are two wage indexes, one for eating and drinking establishments (SIC two-digit code 58) and the other for hotel and other lodging places (SIC two-digit code 70), and dummy variables identifying national holidays. It is

expected that the coefficient of the SIC code 58 wage index be negatively correlated with rental price, since vacation rental homes and eating and drinking establishments are complementary goods. It is also expected that the coefficient of the second wage index be positively correlated with rental price, since vacation rental homes and hotels/lodging places are substitutes. W_t is the group of variables that account for industry-wide influences on costs in week t . Industry-wide influences on costs are captured by a wage index for New Hampshire real estate brokers, agents and managers (SIC two-digit code 56). The methodology used in constructing all of the aforementioned wage indexes is outlined in Chapter Five. W_{-it} is the firm-specific costs of all firms except Firm i . It is the weighted average of the costs of all of Firm i 's competitors, the weight being the market share of each competitor. ε_{it} is the error term.

Since the residual demand equation is of double log functional form, all parameters are elasticities. The parameter for quantity represents the inverse price elasticity of demand for the firm; a negative and statistically significant coefficient indicates that the firm is able to exercise market power.

Tests for autocorrelation indicate that the residual demand models for Firm 1 and Firm 2 are plagued by first order autocorrelation, while that of Firm 3 is plagued by second order autocorrelation. Also, the residual demand model is a semi-reduced demand-supply model, hence the quality adjusted quantity index, Q , is endogenous. A method proposed by Fair (1970) is used to estimate the residual demand models in the presence of simultaneity bias and autocorrelation. The methodology gives rise to consistent results.

The steps involved are as follows:

- 1) Regress Q_t against a set of instrumental variables that are uncorrelated with the error term to obtain predicted Q_t (Q_t^*). These variables should include Y_t , W_t , W_{-it} and the appropriate lagged values of Q_t , Y_t , W_t , W_{-it} . For example, if the residual demand model follows an autoregressive process of order two, then the lagged values that need to be included are Q_{t-2} , Y_{t-2} , W_{t-2} , W_{-it-2} .
- 2) Estimate a second stage regression in which P_t is regressed on Q_t^* , Y_t , W_t , W_{-it} . However, before estimating the second stage regression, transform the data for purposes of correcting for autocorrelation. Again, if the model follows an autoregressive process of order two, then all exogenous variables, included in the second stage estimation, must be transformed as follows:

$$P_t^* = P_t - \rho P_{t-2} \quad (6.2)$$

$$Q_t^{**} = Q_t^* - \rho Q_{t-2} \quad (6.3)$$

The residual demand model is now written as follows:

$$\ln P_t^* = \ln Q_t^{**} + \ln Y_t^* + \ln W_t^* + \ln W_{-it}^* \quad (6.4)$$

Fair (1970)'s methodology is used to estimate each residual demand model. Once the estimation is complete, each model is tested for heteroskedasticity. The results of the tests indicate that the residual demand model for Firm 2 is heteroskedastic. The corrected standard errors are used to re-compute the t-statistic of each of the coefficients in Firm 2's residual demand model.

Past studies that use the residual demand technique report estimation results that vary significantly across firms (Baker and Bresnahan, 1988; Taylor and Smith, 2000).

With the exception of the demand proxy variables (and of course the variable

representing quantity which is always negative due to the law of demand), there seems to be no consistency in the signs of the coefficients of identical variables across firms. Furthermore, there seems to be considerable variation in the size of the coefficients of identical variables across firms. These results suggest that firms may respond differently to changes in industry and firm-specific costs, and that their response to changes in demand may be different in magnitude.

The results of the firm-specific residual demand models are provided in Table 6.4. All of the demand proxy variables are correctly signed with the exception of the Holidays variable for Firm 3's residual demand model. This variable is included in the final specification, because of its theoretical significance. Generally, a price-cost markup equal to or greater than twenty percent is considered strong evidence of anticompetitive pricing (Taylor and Smith, 2000). Firm 1, Firm 2 and Firm 3's estimated markups are 26.05%, 31.61% and 6.17% respectively.

6.3. The Marginal Price and Marginal Cost of Attributes

The marginal price of each attribute is the coefficient of the attribute multiplied by the median rental price. The marginal cost estimates are recovered by multiplying the marginal price by $(1+R)$ where R is the inverse residual demand elasticity of the firm. Note that the marginal cost estimates for the categorical variables are not exactly the “marginal” cost estimates, because these variables are not continuous. The marginal cost estimate for a categorical variable, such as WFRONT, represents the dollar change in the rental price resulting from the presence of the categorical variable. In other words, it represents the difference in the rental price of two properties that are identical in all respects, except in one the categorical variable is present, in the other it is not.

In general the attributes that derive product-differentiating market power for the firms are the property size attributes (MAXOCC and BATHS), the attribute that distinguishes between a luxury and non-luxury property, namely CONTEM, and the attributes that are linked to the environmental amenity, namely the lake (WFRONT, LVIEW, DOCK, DECK, RAFT, SPORCH and BOCAN).

Tables 6.5, 6.6 and 6.7 provide the marginal cost and the marginal price estimates of the aforementioned groups of attributes. For Firm 1, the difference between the marginal price and marginal cost for BATHS, WFRONT, LVIEW, CONTEM, DOCK and BOCAN is very high, indicating that Firm 1 derives a substantial portion of its market power from these attributes. On the other hand, Firm 2’s primary source of market power is WFRONT and DECK, while much of Firm 3’s market power is derived from both WFRONT and LVIEW.

The aforementioned findings clearly indicate that much of the market power exercised by the firms is derived from the environmental amenity, namely the lake. More specifically, the attributes that command very high premiums above their marginal cost are those variables that are inherently linked to the lake (WFRONT and LVIEW), or allow the renter to better enjoy the amenities provided by the presence of the lake (BOCAN, RAFT, SPORCH, DOCK, DECK). The important conclusion that can be drawn from this analysis is that financial incentives exist for firms to conserve site-specific environmental amenities such as a lake, the ocean etc.

6.4. Property Tax Shifting Under Imperfect and Perfect Competition

In this section, the rates of property tax shifting for the case of perfect and imperfect competition are computed. The occupancy rates, provided in Table 5.12, are used to compute the magnitudes of property tax shifting. The methodology used is outlined in Chapter IV. Also, the computational details involved in calculating the rates of property tax shifting for Firm 1 in the year 2000 for the case of imperfect and perfect competition are presented in Appendix 8.4 and Appendix 8.5 respectively.

The tax shifting results are presented in Tables 6.8, 6.9, 6.10, 6.11, 6.12, 6.13, 6.14 and 6.15. Each table is designed to provide statistics concerning the annual property tax shifting rate for a given firm in a given year. Each table is composed of two rows. The first row displays the property tax shifting rate under imperfect competition, while the second row displays the property tax shifting rate under perfect competition (price-cost markup =0). The property tax shifting rates are very sensitive to the discount rate. The discount rates used in the literature range from three percent to eight percent. Hence, the rates of property tax shifting are computed using three different discount rates, namely three percent, five percent and eight percent. Also, the rates of tax shifting are sensitive to the property tax capitalization rate. In the literature, almost all of the tax capitalization rates reported fall between zero percent and one hundred percent. As a result, rates of tax shifting are computed using three different values for the property tax capitalization rate, namely zero percent, fifty percent and one hundred percent. For simplicity, property maintenance costs are assumed to be zero. The relationship between the computed rates

of property tax shifting, the discount rate and the property tax capitalization rate is illustrated in Figures 6.1, 6.2, 6.3, 6.4, 6.5 and 6.6.

Examining the tables, it is clear to see that the extent of property tax shifting achieved by all three firms is quite high, and in some cases greater than one hundred percent. A rate greater than one hundred percent implies that the firm is able to pass more than the owner's tax liability onto the renter. A significant portion of the property tax shifting achieved by Firm 1 and Firm 2 is due to the presence of imperfect competition. However, the contribution of market structure to Firm 3's ability to shift taxes is very small; in all three years, the difference in the property tax shifting rates for Firm 3 under perfect and imperfect competition is very small.

TABLE 6.1: Hedonic Rent Results for the Year 2000

Variable	FIRM1	FIRM2	FIRM3
INTERCEPT	5.33078 (54.00)**	5.4737 (20.96)**	5.84904 (45.88)**
PEAK00	0.30908 (10.24)**	-	-
POST00	0.00383 (0.12)	-	-
MAXOCC	0.07391 (12.52)**	0.06715 (4.78)**	0.05738 (3.95)**
BATHS	0.17821 (8.39)**	0.12236 (3.85)**	0.08129 (2.36)**
FPLACE	0.07671 (2.73)**	-	-
GRLAWN	0.13915 (3.12)**	-	-
CONTEM	0.22369 (3.92)**	-	-
DOCK	0.21801 (5.54)**	-	-
DECK	-	0.28614 (5.33)**	-
RAFT	0.19271 (2.79)**	-	-
SPORCH	-	-	-
BOCAN	0.19010 (4.90)**	-	-
WFRONT	0.19762 (5.50)**	0.35859 (6.49)**	0.19376 (5.26)**
LVIEW	0.21455 (7.03)**	-	0.13800 (3.20)**
ISLAND	0.14599 (1.76)	-	-
SD	-	0.04591 (1.31)	-
AMB99	0.01147 (3.31)**	-	-
FIRE99	-	0.00167 (1.06)	0.00458 (2.27)**
HSTR99	-0.00207 (-3.31)**	0.00014544 (0.57)	-
POL99	-	-	-0.00052481 (-0.89)
TAX99	0.01260 (2.09)*	0.01511 (1.73)*	0.01225 (1.86)*
R ²	0.8327	0.8336	0.7477
N	301	94	51

- The dependent variable is lnPRI00.

- Numbers in parenthesis are t-statistics. T-statistics denoted by “***” are significant at a five percent significance level. T-statistics denoted by “*” are significant at a ten percent significance level.

TABLE 6.2: Hedonic Rent Results for the Year 1999

Variable	FIRM1	FIRM2	FIRM3
INTERCEPT	5.35778 (43.95)**	5.17063 (21.77)**	5.48051 (22.67)**
PEAK99	0.28233 (8.89)**	-	0.25131 (4.05)**
POST99	0.02619 (0.78)	-	-
MAXOCC	0.04480 (5.49)**	0.07052 (5.18)**	0.05240 (3.39)**
BATHS	0.17136 (8.30)**	0.12868 (4.80)**	0.03907 (1.08)
FPLACE	-	0.07948 (2.55)*	0.06944 (1.67)
GRLAWN	-	-	-
CONTEM	0.32341 (3.90)**	-	-
DOCK	0.16526 (3.67)**	-	-
DECK	0.09965 (2.99)**	0.21981 (4.48)**	-
RAFT	-	-	-
SPORCH	0.11444 (4.20)**	-	-
BOCAN	0.16846 (3.57)**	-	-
WFRONT	0.23418 (5.22)**	0.44393 (8.63)**	0.17969 (4.61)**
LVIEW	0.13794 (3.84)**	-	0.09092 (1.90)*
ISLAND	-	-	-
SD	-	0.06949 (1.79)*	-
AMB98	0.00988 (2.76)**	-	-
FIRE98	-	0.00539 (1.80)*	0.00843 (1.73)
HSTR98	-0.00084 (-1.45)*	0.00221 (1.65)	-
POL98	-	-0.00515 (-2.17)**	-0.00185 (-1.41)
TAX98	0.01170 (3.40)**	0.01711 (3.32)**	0.01664 (2.02)**
R ²	0.7448	0.9010	0.7441
N	278	78	48

- The dependent variable is lnPRI99.

- Numbers in parenthesis are t-statistics. T-statistics denoted by “**” are significant at a five percent significance level. T-statistics denoted by “*” are significant at a ten percent significance level.

TABLE 6.3: Hedonic Rent Results for the Year 1998

Variable	FIRM1	FIRM2	FIRM3
INTERCEPT	-	5.42237 (19.86)**	5.28580 (25.13)**
PEAK98	-	-	0.17966 (3.41)**
POST98	-	-	-
MAXOCC	-	0.05921 (3.66)**	0.06170 (2.91)**
BATHS	-	0.11899 (4.13)**	0.04952 (1.37)
FPLACE	-	0.09779 (2.90)**	-
GRLAWN	-	-	-
CONTEM	-	-	-
DOCK	-	-	0.12413 (2.33)**
DECK	-	0.34428 (4.69)**	-
RAFT	-	-	-
SPORCH	-	-	0.11260 (2.35)**
BOCAN	-	-	-
WERONT	-	0.28491 (3.79)**	0.19313 (4.44)**
LVIEW	-	-	0.14742 (3.25)**
ISLAND	-	-	-
SD	-	-	-
AMB97	-	-	-
FIRE97	-	0.00177 (1.06)	0.00891 (2.08)**
HSTR97	-	-	-
POL97	-	0.00239 (1.24)	-0.00165 (-1.26)
TAX97	-	0.01466 (3.25)**	0.01527 (2.33)**
R ²	-	0.8904	0.8143
N	-	74	44

- The dependent variable is lnPRI98.
- Numbers in parenthesis are t-statistics. T-statistics denoted by “***” are significant at a five percent significance level. T-statistics denoted by “**” are significant at a ten percent significance level.

TABLE 6.4: Residual Demand Model Estimation Results

VARIABLES	FIRM1	FIRM2	FIRM3
Intercept	8.57160 (2.73)**	7.95767 (1.63)**	5.03362 (5.05)**
Log (Quality Adjusted Quantity)	-0.26055 (-4.92)**	-0.31613 (-3.72)**	-0.06171 (-2.95)**
Log (Cost Index for the Industry)	2.16470 (4.43)**	-2.38835 (-4.06)**	0.17622 (0.94)
Log (Cost Index for the Firm's competitors)	0.16509 (7.49)**	0.77670 (11.14)**	0.11875 (2.80)**
Holidays	0.17896 (2.91)**	0.14590 (1.25)	-0.07253 (-1.94)*
Log (Wage Index for SIC Code 58)	-2.84637 (-6.13)**	-	-
Log (Wage Index for SIC Code 70)	-	1.70270 (1.73)*	0.19477 (1.90)**
R-Square	0.8122	0.8527	0.5741
F-Value	31.14	41.68	10.51

- The dependent variable is the logarithm of the quality adjusted rent index.
- Numbers in parenthesis are t-statistics. T-statistics denoted by “***” are significant at a five percent significance level. T-statistics denoted by “*” are significant at a ten percent significance level.

TABLE 6.5: Year 2000-Marginal Price and Marginal Cost of a Selected Number of Attributes

		PRODUCT ATTRIBUTES										
		MAXOCC	BATHS	CONTEM	WFRONT	LVIEW	SD	DOCK	DECK	ISLAND	RAFT	BOCAN
FIRM 1	Marginal Price	71.99 (5.83)	177.85 (20.94)	235.62 (56.39)	174.09 (35.55)	224.75 (30.12)	-	215.87 (38.91)	-	123.14 (81.96)	188.81 (68.24)	171.33 (38.32)
	Marginal Cost	54.05 (4.26)	130.33 (11.24)	163.60 (19.64)	144.51 (13.36)	156.95 (14.70)	-	159.43 (15.66)	-	106.78 (22.42)	140.93 (20.62)	139.03 (13.76)
FIRM 2	Marginal Price	83.94 (17.50)	152.95 (39.63)	-	448.24 (69.13)	-	57.39 (43.63)	-	357.63 (67.13)	-	-	-
	Marginal Cost	57.51 (11.25)	104.79 (22.34)	-	307.09 (55.16)	-	39.32 (17.62)	-	245.01 (46.33)	-	-	-
FIRM 3	Marginal Price	50.23 (12.69)	71.14 (30.10)	-	169.58 (32.29)	120.75 (37.31)	-	-	-	-	-	-
	Marginal Cost	47.12 (1.60)	65.75 (3.07)	-	159.11 (4.85)	113.30 (4.30)	-	-	-	-	-	-

Note: Figures in parentheses are standard errors.

TABLE 6.6: Year 1999-Marginal Price and Marginal Cost of a Selected Number of Attributes

		PRODUCT ATTRIBUTES										
		MAXOCC	BATHS	CONTEM	WFRONT	LVIEW	SD	DOCK	DECK	SPORCH	RAFT	BOCAN
FIRM 1	Marginal Price	41.06 (7.48)	154.12 (18.89)	304.50 (75.74)	200.29 (41.06)	133.86 (32.67)	-	150.93 (41.15)	95.17 (30.48)	103.93 (24.91)	-	157.32 (43.07)
	Marginal Cost	30.41 (2.99)	115.83 (9.84)	218.55 (25.94)	158.27 (15.40)	93.19 (11.28)	-	111.71 (13.59)	67.38 (9.53)	77.31 (8.67)	-	113.87 (14.20)
FIRM 2	Marginal Price	87.24 (16.83)	159.26 (33.17)	-	549.33 (63.68)	-	86.01 (48.14)	-	272.00 (60.76)	-	-	-
	Marginal Cost	59.77 (6.52)	109.11 (12.68)	-	376.34 (24.33)	-	58.92 (18.24)	-	186.34 (23.10)	-	-	-
FIRM 3	Marginal Price	44.54 (13.18)	33.24 (30.86)	-	152.75 (33.15)	77.27 (40.80)	-	-	-	-	-	-
	Marginal Cost	41.79 (1.54)	31.18 (2.75)	-	143.32 (4.58)	72.50 (3.94)	-	-	-	-	-	-

Note: Figures in parentheses are standard errors.

TABLE 6.7: Year 1998-Marginal Price and Marginal Cost of a Selected Number of Attributes

		PRODUCT ATTRIBUTES										
		MAXOCC	BATHS	CONTEM	WFRONT	LVIEW	SD	DOCK	DECK	SPORCH	RAFT	BOCAN
FIRM 1	Marginal Price	-	-	-	-	-	-	-	-	-	-	-
	Marginal Cost	-	-	-	-	-	-	-	-	-	-	-
FIRM 2	Marginal Price	65.86 (17.91)	132.39 (32.04)	-	316.95 (83.66)	-	-	-	383.03 (81.55)	-	-	-
	Marginal Cost	45.12 (9.84)	90.70 (18.77)	-	217.14 (46.69)	-	-	-	262.42 (51.71)	-	-	-
FIRM 3	Marginal Price	47.82 (16.43)	38.36 (27.90)	-	149.65 (33.71)	114.24 (35.11)	-	96.18 (41.23)	-	87.26 (37.12)	-	-
	Marginal Cost	44.87 (1.80)	36.00 (2.55)	-	140.42 (4.55)	107.19 (4.03)	-	90.24 (4.19)	-	81.88 (3.78)	-	-

Note: Figures in parentheses are standard errors.

TABLE 6.8: Year 2000 Property Tax Shifting for Firm 1

TOTAL ANNUAL PROPERTY TAX SHIFTING		Property Tax Capitalization Rate = 0%	Property Tax Capitalization Rate = 50%	Property Tax Capitalization Rate = 100%
PROPERTY TAX SHIFTING UNDER IMPERFECT COMPETITION	Discount Rate = 3%	37.80% (0.1809)	47.48% (0.2272)	57.15% (0.2735)
	Discount Rate = 5%	63.00% (0.3015)	72.68% (0.3478)	82.35% (0.3941)
	Discount Rate = 8%	100.80% (0.4824)	110.48% (0.5287)	120.15% (0.5750)
PROPERTY TAX SHIFTING UNDER PERFECT COMPETITION (PRICE-COST MARKUP =0)	Discount Rate = 3%	27.96% (0.1338)	35.12% (0.1680)	42.28% (0.2023)
	Discount Rate = 5%	46.60% (0.2230)	53.76% (0.2572)	60.92% (0.2915)
	Discount Rate = 8%	74.56% (0.3568)	81.72% (0.3910)	88.88% (0.4253)

Note: Figures in parentheses are standard errors.

TABLE 6.9: Year 1999 Property Tax Shifting for Firm 1

TOTAL ANNUAL PROPERTY TAX SHIFTING		Property Tax Capitalization Rate = 0%	Property Tax Capitalization Rate = 50%	Property Tax Capitalization Rate = 100%
PROPERTY TAX SHIFTING UNDER IMPERFECT COMPETITION	Discount Rate = 3%	35.10% (0.1032)	43.27% (0.1272)	51.43% (0.1512)
	Discount Rate = 5%	58.50% (0.1720)	66.67% (0.1960)	74.83% (0.2200)
	Discount Rate = 8%	93.60% (0.2752)	101.77% (0.2992)	109.93% (0.3232)
PROPERTY TAX SHIFTING UNDER PERFECT COMPETITION (PRICE-COST MARKUP =0)	Discount Rate = 3%	25.96% (0.0763)	32.00% (0.0941)	38.03% (0.1118)
	Discount Rate = 5%	43.26% (0.1272)	49.30% (0.1450)	55.34% (0.1627)
	Discount Rate = 8%	69.22% (0.2035)	75.26% (0.2213)	81.30% (0.2391)

Note: Figures in parentheses are standard errors.

TABLE 6.10: Year 2000 Property Tax Shifting for Firm 2

TOTAL ANNUAL PROPERTY TAX SHIFTING		Property Tax Capitalization Rate = 0%	Property Tax Capitalization Rate = 50%	Property Tax Capitalization Rate = 100%
PROPERTY TAX SHIFTING UNDER IMPERFECT COMPETITION	Discount Rate = 3%	45.33% (0.2619)	56.12% (0.3242)	66.91% (0.3866)
	Discount Rate = 5%	75.55% (0.4365)	86.34% (0.4988)	97.13% (0.5612)
	Discount Rate = 8%	120.88% (0.6983)	131.67% (0.7607)	142.46% (0.8231)
PROPERTY TAX SHIFTING UNDER PERFECT COMPETITION (PRICE-COST MARKUP =0)	Discount Rate = 3%	31.00% (0.1791)	38.38% (0.2217)	45.76% (0.2644)
	Discount Rate = 5%	51.67% (0.2985)	59.05% (0.3412)	66.43% (0.3838)
	Discount Rate = 8%	82.66% (0.4776)	90.05% (0.5203)	97.43% (0.5629)

Note: Figures in parentheses are standard errors.

TABLE 6.11: Year 1999 Property Tax Shifting for Firm 2

TOTAL ANNUAL PROPERTY TAX SHIFTING		Property Tax Capitalization Rate = 0%	Property Tax Capitalization Rate = 50%	Property Tax Capitalization Rate = 100%
PROPERTY TAX SHIFTING UNDER IMPERFECT COMPETITION	Discount Rate = 3%	51.33% (0.1545)	61.40% (0.1848)	71.47% (0.2151)
	Discount Rate = 5%	85.55% (0.2575)	95.62% (0.2878)	105.69% (0.3181)
	Discount Rate = 8%	136.88% (0.4120)	146.95% (0.4423)	157.02% (0.4726)
PROPERTY TAX SHIFTING UNDER PERFECT COMPETITION (PRICE-COST MARKUP =0)	Discount Rate = 3%	35.10% (0.1057)	41.99% (0.1264)	48.88% (0.1471)
	Discount Rate = 5%	58.51% (0.1761)	65.39% (0.1968)	72.28% (0.2176)
	Discount Rate = 8%	93.61% (0.2818)	100.50% (0.3025)	107.38% (0.3232)

Note: Figures in parentheses are standard errors.

TABLE 6.12: Year 1998 Property Tax Shifting for Firm 2

TOTAL ANNUAL PROPERTY TAX SHIFTING		Property Tax Capitalization Rate = 0%	Property Tax Capitalization Rate = 50%	Property Tax Capitalization Rate = 100%
PROPERTY TAX SHIFTING UNDER IMPERFECT COMPETITION	Discount Rate = 3%	43.98% (0.1356)	52.42% (0.1616)	60.85% (0.1876)
	Discount Rate = 5%	73.30% (0.2260)	81.74% (0.2520)	90.17% (0.2780)
	Discount Rate = 8%	117.28% (0.3616)	125.72% (0.3876)	134.15% (0.4136)
PROPERTY TAX SHIFTING UNDER PERFECT COMPETITION (PRICE-COST MARKUP =0)	Discount Rate = 3%	30.08% (0.0927)	35.85% (0.1105)	41.62% (0.1283)
	Discount Rate = 5%	50.13% (0.1546)	55.89% (0.1724)	61.67% (0.1901)
	Discount Rate = 8%	80.21% (0.2472)	85.97% (0.2651)	91.75% (0.2829)

Note: Figures in parentheses are standard errors.

TABLE 6.13: Year 2000 Property Tax Shifting for Firm 3

TOTAL ANNUAL PROPERTY TAX SHIFTING		Property Tax Capitalization Rate = 0%	Property Tax Capitalization Rate = 50%	Property Tax Capitalization Rate = 100%
PROPERTY TAX SHIFTING UNDER IMPERFECT COMPETITION	Discount Rate = 3%	36.75% (0.1974)	49.20% (0.2643)	61.64% (0.3311)
	Discount Rate = 5%	61.25% (0.3290)	73.70% (0.3959)	86.14% (0.4627)
	Discount Rate = 8%	98.00% (0.5264)	110.45% (0.5934)	122.89% (0.6601)
PROPERTY TAX SHIFTING UNDER PERFECT COMPETITION (PRICE-COST MARKUP =0)	Discount Rate = 3%	34.48% (0.1852)	46.16% (0.2479)	57.84% (0.3107)
	Discount Rate = 5%	57.47% (0.3087)	69.15% (0.3714)	80.83% (0.4342)
	Discount Rate = 8%	91.95% (0.4939)	103.63% (0.5566)	115.31% (0.6194)

Note: Figures in parentheses are standard errors.

TABLE 6.14: Year 1999 Property Tax Shifting for Firm 3

TOTAL ANNUAL PROPERTY TAX SHIFTING		Property Tax Capitalization Rate = 0%	Property Tax Capitalization Rate = 50%	Property Tax Capitalization Rate = 100%
PROPERTY TAX SHIFTING UNDER IMPERFECT COMPETITION	Discount Rate = 3%	49.92% (0.2475)	68.76% (0.3409)	87.61% (0.4344)
	Discount Rate = 5%	83.20% (0.4125)	102.04% (0.5059)	120.89% (0.5994)
	Discount Rate = 8%	133.12% (0.6600)	151.96% (0.7534)	170.81% (0.8469)
PROPERTY TAX SHIFTING UNDER PERFECT COMPETITION (PRICE-COST MARKUP =0)	Discount Rate = 3%	46.84% (0.2322)	64.52% (0.3199)	82.20% (0.4076)
	Discount Rate = 5%	78.07% (0.3870)	95.75% (0.4747)	113.43% (0.5624)
	Discount Rate = 8%	124.91% (0.6193)	142.59% (0.7069)	160.27% (0.7946)

Note: Figures in parentheses are standard errors.

TABLE 6.15: Year 1998 Property Tax Shifting for Firm 3

TOTAL ANNUAL PROPERTY TAX SHIFTING		Property Tax Capitalization Rate = 0%	Property Tax Capitalization Rate = 50%	Property Tax Capitalization Rate = 100%
PROPERTY TAX SHIFTING UNDER IMPERFECT COMPETITION	Discount Rate = 3%	45.81% (0.1968)	64.20% (0.2758)	82.58% (0.3548)
	Discount Rate = 5%	76.35% (0.3280)	94.74% (0.4070)	113.12% (0.4860)
	Discount Rate = 8%	122.16% (0.5248)	140.55% (0.6038)	158.93% (0.6828)
PROPERTY TAX SHIFTING UNDER PERFECT COMPETITION (PRICE-COST MARKUP =0)	Discount Rate = 3%	42.98% (0.1847)	60.23% (0.2588)	77.48% (0.3329)
	Discount Rate = 5%	71.64% (0.3078)	88.89% (0.3819)	106.14% (0.4560)
	Discount Rate = 8%	114.62% (0.4924)	131.87% (0.5665)	149.12% (0.6406)

Note: Figures in parentheses are standard errors.

FIGURE 6.1: Property Tax Shifting under Varying Discount Rates: The Case of Imperfect Competition and a Zero Percent Property Tax Capitalization Rate

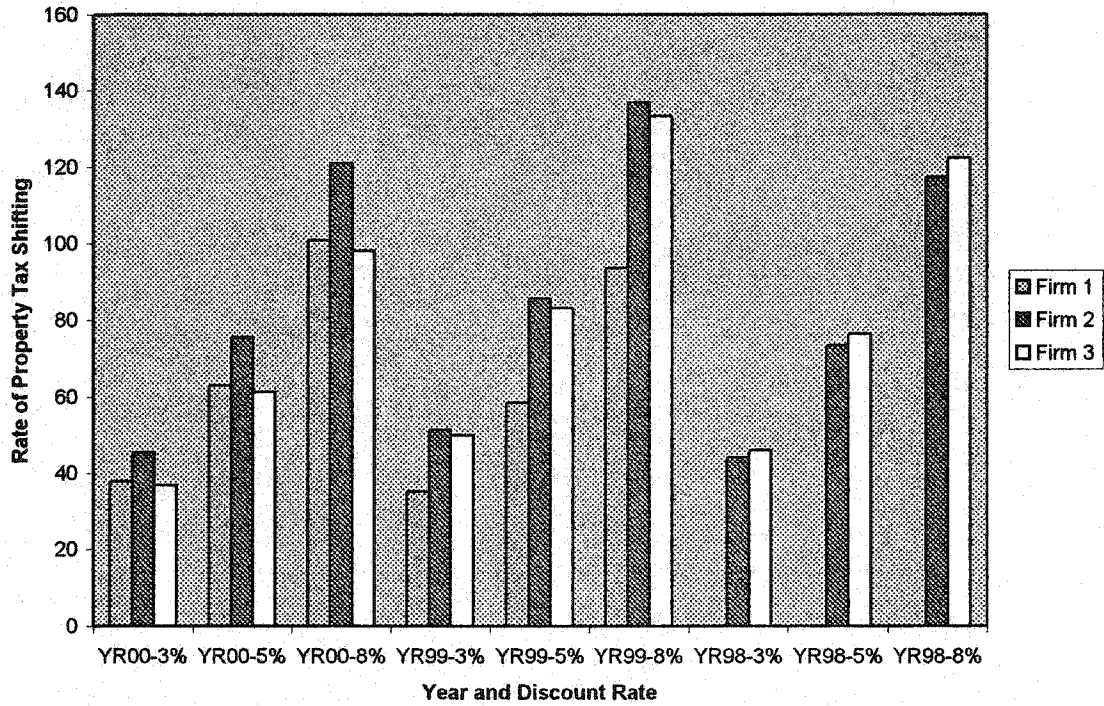


FIGURE 6.2: Property Tax Shifting under Varying Discount Rates: The Case of Imperfect Competition and a Fifty Percent Property Tax Capitalization Rate

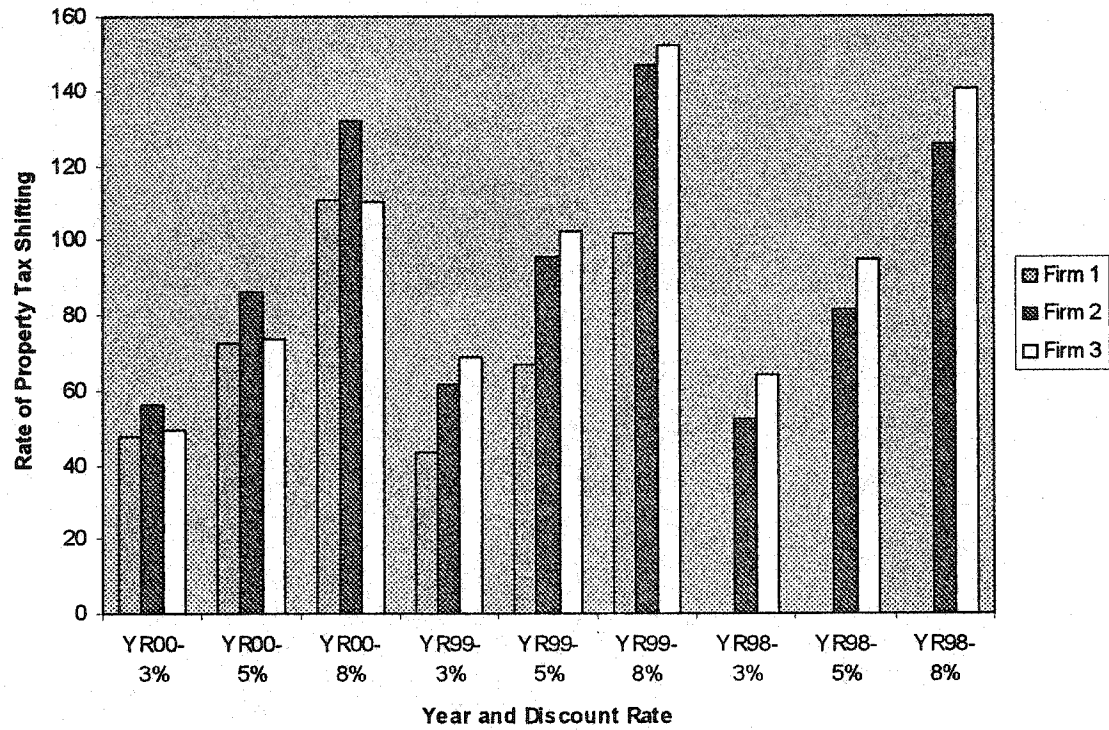


FIGURE 6.3: Property Tax Shifting under Varying Discount Rates: The Case of Imperfect Competition and a One Hundred Percent Property Tax Capitalization

Rate

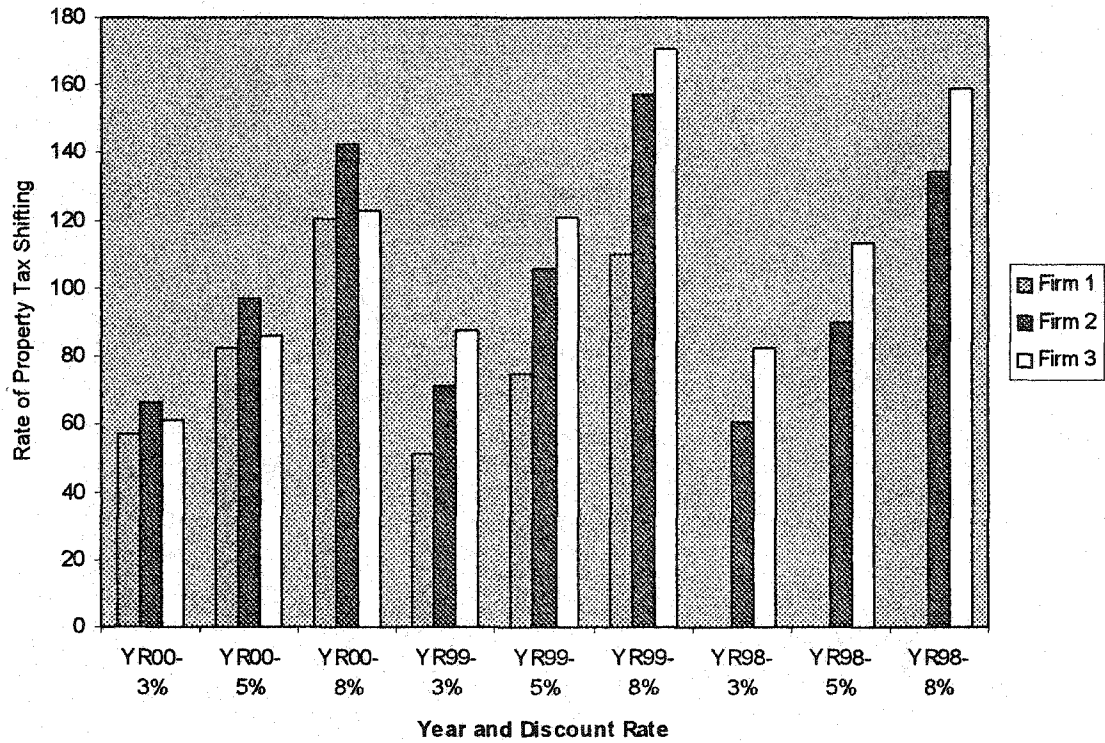


FIGURE 6.4: Property Tax Shifting under Varying Discount Rates: The Case of Perfect Competition and a Zero Percent Property Tax Capitalization Rate

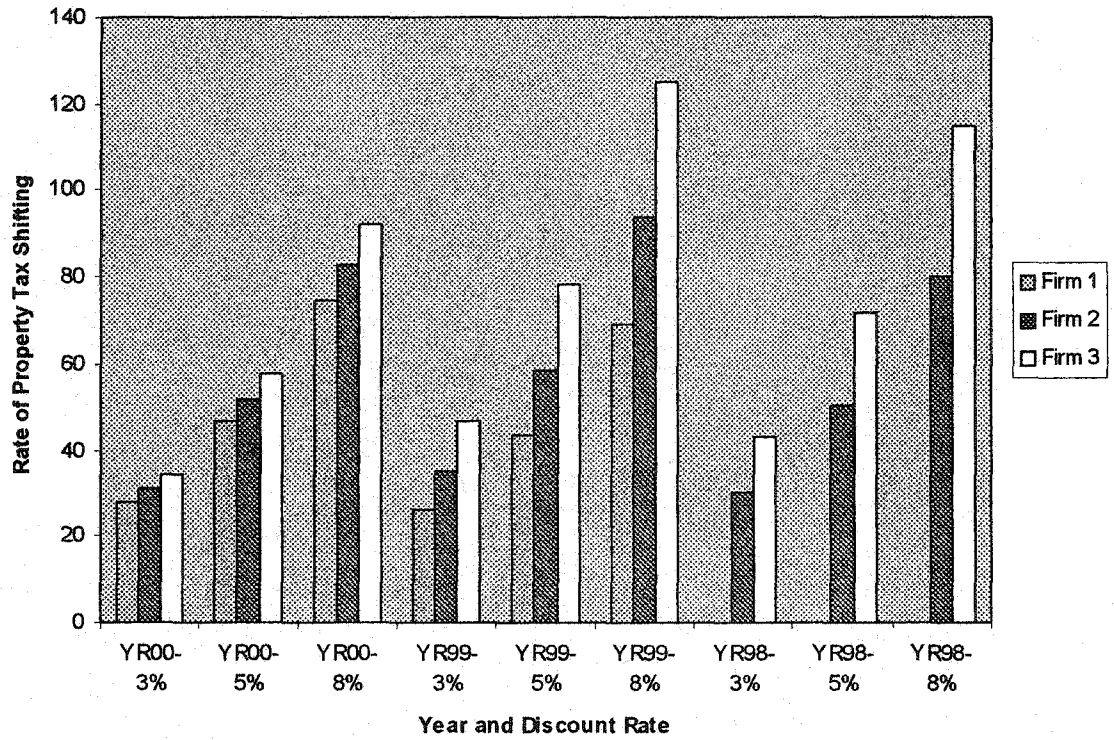


FIGURE 6.5: Property Tax Shifting under Varying Discount Rates: The Case of Perfect Competition and a Fifty Percent Property Tax Capitalization Rate

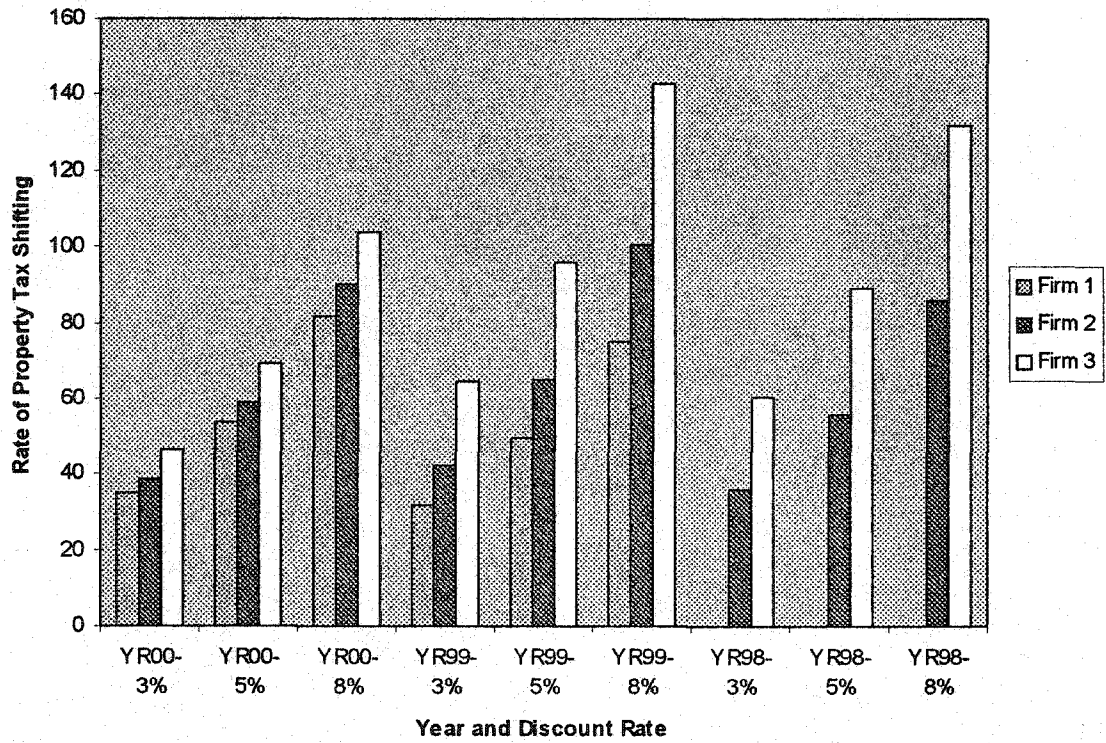
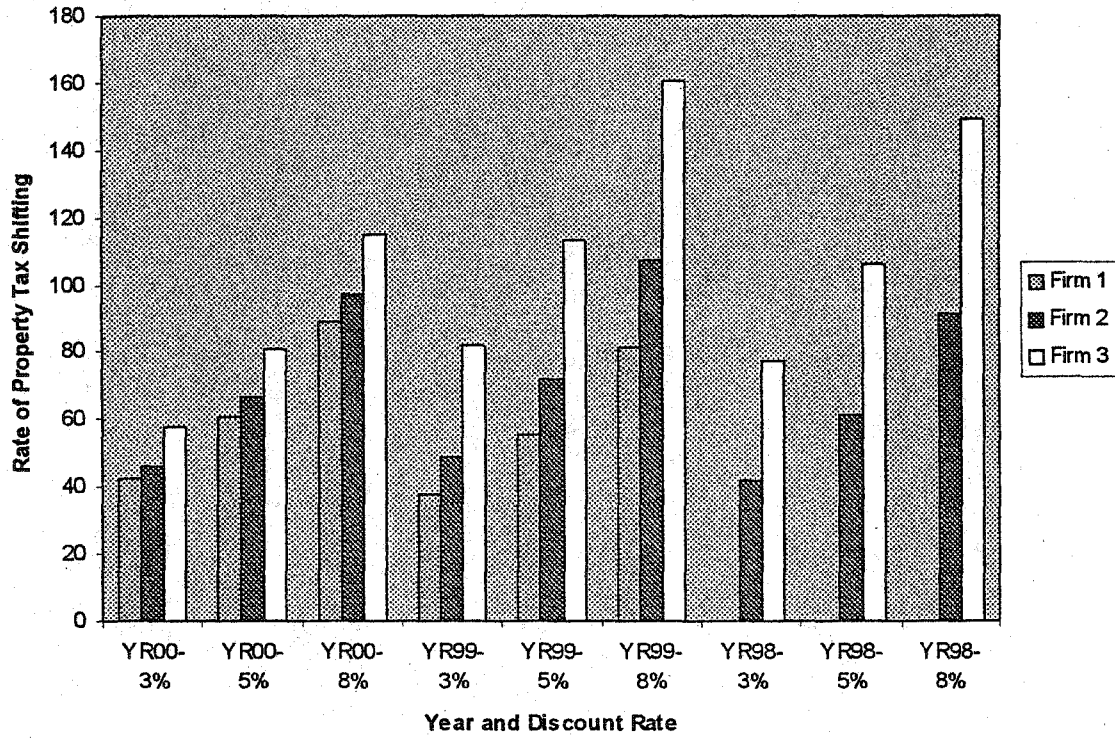


FIGURE 6.6: Property Tax Shifting under Varying Discount Rates: The Case of Perfect Competition and a One Hundred Percent Property Tax Capitalization Rate



CHAPTER VII

CONCLUSION

One of the objectives of this dissertation is to examine whether financial incentives exist for firms to conserve environmental amenities such as lakes and oceans. The hedonic method is used to estimate the marginal price of each property attribute. Then a series of steps are taken to recover the marginal cost of each property attribute. The results indicate that most of the market power exercised by each of the firms is derived from the environmental amenity, namely the lake. More specifically, the attributes that command very high premiums above their marginal cost are the attributes that are inherently linked to the lake (WFRONT and LVIEW), or the attributes that allow the renter to better enjoy the amenities provided by the presence of the lake (BOCAN, DOCK, DECK, RAFT and SPORCH). The most important conclusion that can be drawn from this analysis is that financial incentives exist for firms to conserve site-specific environmental amenities.

Another objective of this dissertation is to assess, using hedonic methods, the impact of market structure on the relationship between property taxation and the rental price of property. There are a plethora of studies that utilize hedonic methods to empirically examine the relationship between property taxation and the sales/rental price of properties. A detailed presentation of these studies is provided in Chapter II.

These studies implicitly assume highly competitive housing markets. This is a required assumption since Rosen (1974)'s theoretical results are derived under this assumption. However, not all housing markets are highly competitive. In this dissertation, the competitive markets assumption is relaxed. In the theoretical part of this dissertation, the hedonic framework is extended to accommodate both market structure and the local public sector. In the empirical part, for each firm, the average rate of property tax shifting under the current (less competitive) market structure and the rate that would prevail under perfectly competitive conditions are derived.

This exercise discloses some very interesting findings. First, in general, the property tax shifting rate for all of the firms is significantly high, and in some cases greater than 100%. This implies that, in these specific cases, the firm is able to pass more than the owner's property tax liability onto the renter. The demand for vacation rentals in the New Hampshire Lakes Region is primarily made up of out-of-state visitors, mostly from southern New England states. However, statistics concerning the residency of the property owners are not readily available. If the majority of the property owners are New Hampshire residents, then this result may imply that tax exporting is taking place. On the other hand, if the majority of the property owners are non-residents, then this result may suggest that tax redistribution among non-residents is taking place rather than tax exporting. Second, a significant portion of the property tax shifting achieved by Firm 1 and Firm 2 is due to the presence of imperfect competition. The contribution of market structure to Firm 3's ability to shift property taxes is small. A general conclusion that can be drawn from this finding is the following: In a less competitive rental housing market, depending on the degree of the market power exercised by the firm, the structure of the

market may significantly augment the firm's ability to shift property taxes from property owners to property renters. This result can be further interpreted as indicating that, in certain cases, the simplifying assumption of competitive housing markets that all past studies have appealed to, may not be valid.

The issues addressed in this dissertation are ripe for further investigation. In other words, there are many opportunities for future research:

The question of whether financial incentives exist for firms to conserve environmental amenities is very important. The findings of this dissertation reaffirm Taylor and Smith's (2000) conclusion that such financial incentives exist. The work done in this dissertation is an improvement over Taylor and Smith (2000), because the analysis accounts for the local public sector. Future researchers should further examine the link between market structure and the local public sector and investigate whether local public policy may be able to augment the financial incentives that exist for firms to conserve environmental amenities.

Concerning the relationship between property taxation and the rental price of housing, this dissertation concludes that the structure of the market may have a significant impact on the extent of property tax shifting. The methodology that is used in this dissertation to account for the impact of market structure on the relationship between property taxation and the sales/rental price of property can be readily applied to other areas. For example, the methodology can be used to examine the impact of market structure on the extent to which a per-unit tax is capitalized into the price of a composite product.

APPENDICES

APPENDIX 8.1

MCFADDEN'S THEOREM

Theorem: Suppose that individual utility is specified by equation (3.1) and G is a nonnegative function defined over R^N which satisfies the following:

- 1) G is homogeneous to degree one.
- 2) G approaches infinity as any of its arguments approach infinity.
- 3) The partial derivatives of G with respect to n distinct variables exist and are continuous, nonnegative if n is odd, and positive if n is even, $n=1, \dots, N$.

Furthermore, assume that the distribution function $F(\varepsilon) = \exp [-G(e^{\varepsilon^1}, \dots, e^{\varepsilon^N})]$ has finite moments, and define an aggregate indirect utility as follows:

$$V[\phi(p_1, z_1), \dots, \phi(p_1, z_1), Y] = M \ln \phi_0(Y/M) + \\ M \ln G[[\phi(p_1, z_1)^{-1}, \dots, \phi(p_1, z_1)^{-1}] \quad (A8.1)$$

Then:

- 1) Expected demand $X_i = Mx_i P_i$ equals $-(\partial V / \partial p_i) / (\partial V / \partial Y)$.
- 2) V is a utilitarian social welfare function for the individual utilities in equation (3.1).
- 3) V is convex in (p_1, \dots, p_N) provided that $\ln \phi_i(p_i, z_i)$ is concave in p_i .

APPENDIX 8.2

FEENSTRA'S RESULT

The third term in equation (3.20) will equal zero if and only if:

$$\partial\pi_i/\partial q_i = \sum_K^{k+1} (\partial^2\pi_i/\partial q_i\partial\lambda_{ik})\lambda_{ik} \quad (\text{A8.2})$$

This equality holds if and only if $\partial\pi_i/\partial q_i$ is homogeneous to degree one.

Homogeneity to degree one implies that $\pi_i(q_i, \lambda_i)$ is of the form:

$$\pi_i(q_i, \lambda_i) = \bar{\pi}_i(q_i, \lambda_i) + g_i(\lambda_i) \quad (\text{A8.3})$$

where $\bar{\pi}_i(q_i, \lambda_i)$ is homogeneous to degree one in λ_i . Inverting (A8.3) yields a quality adjusted price of the general form:

$$\bar{\theta}_i(p_i, \lambda_i) = \bar{\theta}_i [(p_i - g_i(\lambda_i), \lambda_i)] \quad (\text{A8.4})$$

where $\bar{\theta}_i$ is homogenous to degree one in all of its arguments. A special case of (A8.4), with the restriction that h_i is homogenous to degree one, is:

$$\bar{\theta}_i(p_i, \lambda_i) = \psi_i [(p_i - g_i(\lambda_i)/h_i(\lambda_i)] \quad (\text{A8.5})$$

APPENDIX 8.3

EXISTENCE OF AN EQUILIBRIUM

Since the hedonic approach is an equilibrium approach, it is necessary to demonstrate that the model reaches equilibrium. One sufficient condition to attain an interior maximum is to assume that profits are quasi-concave in a firm's own prices and attributes. If this is so, then the objective function is quasi-concave in attributes. If an interior maximum is attained at z^*_i , then the objective function must be locally concave around this point. This implies that the matrix of the second order condition for the maximization problem is negative semi-definite in a neighborhood of z^*_i (Feenstra, 1995, 638-639).

APPENDIX 8.4

RATES OF PROPERTY TAX SHIFTING UNDER IMPERFECT COMPETITION FOR FIRM 1 IN THE YEAR 2000

A. Computing the Annual Rent Differential due to the Ten Cent Increase in Tax per One Thousand Dollars of Assessed Property Value

$$\ln P_i = \beta X_i + 0.0126 t_i, \quad (\text{A8.6})$$

where P_i is the rental price, X_i denotes the vector of explanatory variables other than the tax rate, and t_i denotes the full value tax per 1000 dollars of assessed property value.

10 cent tax differential = 0.126 percentage change in weekly rent.

Median rental price for Firm 1's year 2000 inventory = \$987.5.

10 cent tax differential = $(0.00126)(\$987.5) = \1.24 weekly rent differential.

Annual rent differential = (total number of weeks, in the year, in which the firm rents out at least one property) (average annual occupancy rate) (1.24).

Annual rent differential = $(22)(0.3407)(1.24) = \$9.33$.

Annual Rental Income from Median Property = $(\$987.5)(22)(0.3407) =$
\$7,401.71.

B. The Rate of Property Tax Shifting Assuming a Three Percent Discount Rate and No Property Tax Capitalization

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 0%.

Market Value of Median Property = $\$7,401.71 / (0.03 + 0) = \$246,724$.

Given median property value = \$246,724, then a 10 cent tax differential leads to a \$24.67 annual change in the owners tax liability, $\$9.33 / \$24.67 = 37.80\%$ of which is passed onto the renter.

C. The Rate of Property Tax Shifting Assuming a Five Percent Discount Rate and No Property Tax Capitalization

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 0%.

Market Value of Median Property = $\$7,402.71 / (0.05 + 0) = \$148,038$.

Given median property value = \$148,038, then a 10 cent tax differential leads to a \$14.80 annual change in the owners tax liability, $\$9.33 / \$14.80 = 63.00\%$ of which is passed onto the renter.

D. The Rate of Property Tax Shifting Assuming an Eight Percent Discount Rate and No Property Tax Capitalization

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 0%.

Market Value of Median Property = $\$7,402.71 / (0.08 + 0) = \$92,521$.

Given median property value = \$92,521, then a 10 cent tax differential leads to a \$9.252 annual change in the owners tax liability, $\$9.33 / \$9.25 = 100.80\%$ of which is passed onto the renter.

E. The Rate of Property Tax Shifting Assuming a Three Percent Discount Rate and a Property Tax Capitalization Rate of Fifty Percent

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 0.77%.

Market Value of Median Property = $\$7,402.71 / (0.03 + 0.0077) = \$196,436$.

Given median property value = \$196,436, then a 10 cent tax differential leads to a \$19.64 annual change in the owners tax liability, $\$9.33 / \$19.64 = 47.48\%$ of which is passed onto the renter.

F. The Rate of Property Tax Shifting Assuming a Five Percent Discount Rate and a Property Tax Capitalization Rate of Fifty Percent

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 0.77%.

Market Value of Median Property = $\$7,402.71 / (0.05 + 0.0077) = \$128,324$.

Given median property value = \$128,324, then a 10 cent tax differential leads to a \$12.83 annual change in the owners tax liability, $\$9.33 / \$12.83 = 72.68\%$ of which is passed onto the renter.

G. The Rate of Property Tax Shifting Assuming an Eight Percent Discount Rate and a Property Tax Capitalization Rate of Fifty Percent

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 0.77%.

Market Value of Median Property = $\$7,402.71 / (0.08 + 0.0077) = \$84,417$.

Given median property value = \$84,417, then a 10 cent tax differential leads to a \$8.442 annual change in the owners tax liability, $\$9.33 / \$8.442 = 110.48\%$ of which is passed onto the renter.

H. The Rate of Property Tax Shifting Assuming a Three Percent Discount Rate and a Property Tax Capitalization Rate of One Hundred Percent

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 1.536%.

Market Value of Median Property = $\$7,402.71 / (0.03 + 0.01536) = \$163,177$.

Given median property value = \$163,177, then a 10 cent tax differential leads to a \$16.32 annual change in the owners tax liability, $\$9.33 / \$16.32 = 57.15\%$ of which is passed onto the renter.

I. The Rate of Property Tax Shifting Assuming a Five Percent Discount Rate and a Property Tax Capitalization Rate of One Hundred Percent

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 1.536%.

Market Value of Median Property = $\$7,402.71 / (0.05 + 0.01536) = \$113,245$.

Given median property value = \$113,245, then a 10 cent tax differential leads to a \$11.32 annual change in the owners tax liability, $\$9.33 / \$11.32 = 82.35\%$ of which is passed onto the renter.

J. The Rate of Property Tax Shifting Assuming an Eight Percent Discount Rate and a Property Tax Capitalization Rate of One Hundred Percent

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 1.536%.

Market Value of Median Property = $\$7,402.71 / (0.08 + 0.01536) = \$77,618$.

Given median property value = \$77,618, then a 10 cent tax differential leads to a \$7.76 annual change in the owners tax liability, $\$9.33 / \$7.76 = 120.15\%$ of which is passed onto the renter.

APPENDIX 8.5

RATES OF PROPERTY TAX SHIFTING UNDER PERFECT COMPETITION FOR FIRM 1 IN THE YEAR 2000

A. Computing the Annual Rent Differential due to the Ten Cent Increase in Tax per One Thousand Dollars of Assessed Property Value

$$\ln P_i = \beta X_i + 0.0126t_i, \quad (\text{A8.7})$$

where P_i is the rental price, X_i denotes the vector of explanatory variables other than the tax rate, and t_i denotes the full value tax per 1000 dollars of assessed property value.

$$\text{Marginal cost of the tax rate} = (0.0126) (1 - 0.2606) = 0.0093.$$

$$10 \text{ cent tax differential} = 0.93 \text{ percentage change in weekly rent.}$$

$$\text{Median rental price for Firm 1's year 2000 inventory} = \$987.5.$$

$$10 \text{ cent tax differential} = (0.00093)(\$987.5) = \$0.92 \text{ weekly rent differential.}$$

Annual rent differential = (total number of weeks, in the year, in which the firm rents out at least one property) (average annual occupancy rate) (0.92).

$$\text{Annual rent differential} = (22)(0.3407)(0.92) = \$6.90.$$

$$\text{Annual Rental Income from Median Property} = (\$987.5)(22)(0.3407) = \$7,401.71.$$

B. The Rate of Property Tax Shifting Assuming a Three Percent Discount Rate and No Property Tax Capitalization

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 0%.

Market Value of Median Property = $\$7,401.71 / (0.03 + 0) = \$246,724$.

Given median property value = \$246,724, then a 10 cent tax differential leads to a \$24.67 annual change in the owners tax liability, $\$6.90 / \$24.67 = 27.96\%$ of which is passed onto the renter.

C. The Rate of Property Tax Shifting Assuming a Five Percent Discount Rate and No Property Tax Capitalization

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 0%.

Market Value of Median Property = $\$7,401.71 / (0.05 + 0) = \$148,034$.

Given median property value = \$148,034, then a 10 cent tax differential leads to a \$14.80 annual change in the owners tax liability, $\$6.90 / \$14.80 = 46.60\%$ of which is passed onto the renter.

D. The Rate of Property Tax Shifting Assuming an Eight Percent Discount Rate and No Property Tax Capitalization

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 0%.

Market Value of Median Property = $\$7,401.71 / (0.08 + 0) = \$92,521$.

Given median property value = \$92,521, then a 10 cent tax differential leads to a \$9.25 annual change in the owners tax liability, $\$6.90 / \$9.25 = 74.56\%$ of which is passed onto the renter.

E. The Rate of Property Tax Shifting Assuming a Three Percent Discount Rate and a Property Tax Capitalization Rate of Fifty Percent

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 0.77%.

Market Value of Median Property = $\$7,401.71 / (0.03 + 0.0077) = \$196,436$.

Given median property value = \$196,436, then a 10 cent tax differential leads to a \$19.64 annual change in the owners tax liability, $\$6.90 / \$19.64 = 35.12\%$ of which is passed onto the renter.

F. The Rate of Property Tax Shifting Assuming a Five Percent Discount Rate and a Property Tax Capitalization Rate of Fifty Percent

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 0.77%.

Market Value of Median Property = $\$7,401.71 / (0.05 + 0.0077) = \$128,324$.

Given median property value = \$128,324, then a 10 cent tax differential leads to a \$12.83 annual change in the owners tax liability, $\$6.90 / \$12.83 = 53.76\%$ of which is passed onto the renter.

G. The Rate of Property Tax Shifting Assuming an Eight Percent Discount Rate and a Property Tax Capitalization Rate of Fifty Percent

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 0.77%.

Market Value of Median Property = $\$7,401.71 / (0.08 + 0.0077) = \$84,417$.

Given median property value = \$84,417, then a 10 cent tax differential leads to a \$8.44 annual change in the owners tax liability, $\$6.90 / \$8.44 = 81.72\%$ of which is passed onto the renter.

H. The Rate of Property Tax Shifting Assuming a Three Percent Discount Rate and a Property Tax Capitalization Rate of One Hundred Percent

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 1.536%.

Market Value of Median Property = $\$7,401.71 / (0.03 + 0.01536) = \$163,177$.

Given median property value = \$163,177, then a 10 cent tax differential leads to a \$16.32 annual change in the owners tax liability, $\$6.90 / \$16.32 = 42.28\%$ of which is passed onto the renter.

I. The Rate of Property Tax Shifting Assuming a Five Percent Discount Rate and a Property Tax Capitalization Rate of One Hundred Percent

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 1.536%.

Market Value of Median Property = $\$7,401.71 / (0.05 + 0.01536) = \$113,245$.

Given median property value = \$113,245, then a 10 cent tax differential leads to a \$11.32 annual change in the owners tax liability, $\$6.90 / \$11.32 = 60.92\%$ of which is passed onto the renter.

J. The Rate of Property Tax Shifting Assuming an Eight Percent Discount Rate and a Property Tax Capitalization Rate of One Hundred Percent

Median tax rate for Firm 1's year 2000 inventory = 1.536%.

The portion of the tax rate that is capitalized into the price of property = 1.536%.

Market Value of Median Property = $\$7,401.71 / (0.08 + 0.01536) = \$77,619$.

Given median property value = \$77,619, then a 10 cent tax differential leads to a \$7.76 annual change in the owners tax liability, $\$6.90 / \$7.76 = 88.88\%$ of which is passed onto the renter.

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