Property Tax Capitalization: Theory and Empirical Evidence

Jay M. Lillywhite
Utah State University

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PROPERTY TAX CAPITALIZATION: THEORY

AND EMPIRICAL EVIDENCE

by

Jay M. Lillywhite

A thesis submitted in partial fulfillment
of the requirements for the degree
of
MASTER OF SCIENCE
in
Economics

Approved:

W. Cris Lewis
Major Professor

H. Craig Peterson
Committee Member

Chris Fawson
Committee Member

James P. Shaver
Dean of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

1994
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Jay M. Lillywhite
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ABSTRACT

Property Tax Capitalization: Theory and Empirical Evidence

by

Jay M. Lillywhite, Master of Science

Utah State University, 1994

Major Professor: Dr. W. Cris Lewis
Department: Economics

In an environment of increasing government expenditures financed largely through taxes, including a relatively visible and large residential property tax, the issue of whether property taxes are capitalized into market values is increasingly important. Property tax capitalization is the reflection of property taxes in the value of real property. The capitalization of property tax does not necessarily pose a problem; rather, problems arise when homes identical to each other have different taxes and these differentials are then capitalized into market values. These capitalized tax differentials result in large capital gains and losses to owners of real estate.

This study (1) reviews existing economic theory and empirical evidence on the capitalization of property taxes, (2) develops a model of property valuation inclusive of tax effects, and (3) estimates the parameters of this model using a comprehensive data set.
of over 334 home sales in the Logan, Utah area. The empirical results include an estimate of the tax capitalization effect. Two closely related issues are also addressed in the study. They include: (1) changes in real estate prices, including a suggested method for measuring such change and (2) a study of property tax equity, including two specific measures of tax fairness.

The conclusions are (1) tax differentials are capitalized; (2) real estate prices in the study area increased approximately 10 percent per year from 1989 to 1992; and (3) there is significant variation in assessment ratios.
CHAPTER 1

INTRODUCTION

In an environment of increasing government expenditures financed largely through taxes, including a relatively visible and large residential property tax (as shown in Table 1 and Figure 1 below), the issue of whether property taxes are capitalized into market values is increasingly important. In order to understand why property tax capitalization has become so important, it is necessary to first define property tax capitalization as well as some terminology commonly used in its study.

Property tax capitalization is the reflection of property taxes in the value of real property, i.e., if taxes are capitalized, the value of property decreases following an increase in property taxes. The capitalization of property tax itself does not necessarily

TABLE 1

<table>
<thead>
<tr>
<th>Revenue Source</th>
<th>Dollars (In Billions)</th>
<th>Percent of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales Taxes</td>
<td>181.4</td>
<td>022.7</td>
</tr>
<tr>
<td>Property Taxes</td>
<td>150.1</td>
<td>018.8</td>
</tr>
<tr>
<td>Federal Grants</td>
<td>131.4</td>
<td>016.4</td>
</tr>
<tr>
<td>Income Taxes</td>
<td>106.2</td>
<td>013.3</td>
</tr>
<tr>
<td>Non Taxes</td>
<td>077.6</td>
<td>009.7</td>
</tr>
<tr>
<td>Payroll Taxes</td>
<td>060.2</td>
<td>007.5</td>
</tr>
<tr>
<td>Corporate Profit Taxes</td>
<td>023.6</td>
<td>002.9</td>
</tr>
<tr>
<td>Other</td>
<td>070.0</td>
<td>008.7</td>
</tr>
</tbody>
</table>

pose a problem; rather, problems arise when homes identical to each other have different taxes and these differentials are then capitalized into market values. These capitalized tax differentials result in large capital gains and losses to owners of real estate.

Differences in value caused by tax differentials can be written in equation form as:

\[ V_B^A = \sum_{t=1}^{n} \frac{T_A - T_B}{(1 + r)^t} \]  

(1-1)

where \( V_B^A \) is the difference between the market values of home A and home B, \( T_A \) and \( T_B \) are the assessed taxes on homes A and B, respectively, \( r \) is the discount rate used by households, and \( n \) is the expected life of the tax differential -- referred to as the discounting horizon. The property tax differential is said to be fully capitalized if the differential value is equal to the present value of the differential in property tax payments. For example, if the present value of the differential in property taxes increases by one
dollar, then for the property tax to be fully capitalized the value of the property must
decrease by one dollar.

The degree or rate of capitalization, often referred to in percentage terms, can
be defined as the actual difference in market values divided by the expected difference in
market values as determined by the present value of the tax differential (i.e., the right-
hand-side of equation 1-1 above). The definition of "degree of capitalization" is a
relative term as it depends on the household discount rate and discounting horizon.

Interjurisdictional Tax Differentials

Sources of tax differentials that may be capitalized are inter- and intra-
jurisdictional. In the case of interjurisdictional tax differentials, homes in areas with high
average property tax rates may have lower market values than homes in low tax rate
areas. Table 2 shows property tax rates by counties for Utah for 1990. By using this tax
rate information, if Salt Lake County uses a 1.07 percent tax rate on a home with a
market value of $100,000, the annual property tax would be $1,070. If Dagget County
applies a rate of 0.58 percent of market value to a comparable home, the annual tax
would be $580. Discounting the differences in taxes (using a 30-year horizon and a
discount rate of 7.4 percent\(^1\)), a rational buyer would pay $5,844 more for the home in
the lower tax county. This assumes no differences in the package of public services at
the two locations. If this assumption of equal public services does not hold and the
higher tax area provides better public services, then the tax differential is not necessarily

---

\(^1\) The use of 7.4 percent comes from a study by Cropper and Portney (1992), in which they estimate the
implicit discount rate used by individuals in evaluating public expenditures.
capitalized. Rather, rational buyers realize they are buying a different bundle of housing and public services and are willing to pay higher taxes.

### TABLE 2

**PROPERTY TAX RATES FOR UTAH COUNTIES, 1990**

<table>
<thead>
<tr>
<th>County</th>
<th>Tax Rate</th>
<th>County</th>
<th>Tax Rate</th>
<th>County</th>
<th>Tax Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaver</td>
<td>0.0078</td>
<td>Iron</td>
<td>0.0086</td>
<td>Sevier</td>
<td>0.0080</td>
</tr>
<tr>
<td>Box Elder</td>
<td>0.0063</td>
<td>Juab</td>
<td>0.0081</td>
<td>Summit</td>
<td>0.0075</td>
</tr>
<tr>
<td>Cache</td>
<td>0.0084</td>
<td>Kane</td>
<td>0.0075</td>
<td>Tooele</td>
<td>0.0088</td>
</tr>
<tr>
<td>Carbon</td>
<td>0.0092</td>
<td>Millard</td>
<td>0.0080</td>
<td>Uintah</td>
<td>0.0085</td>
</tr>
<tr>
<td>Daggett</td>
<td>0.0058</td>
<td>Morgan</td>
<td>0.0085</td>
<td>Utah</td>
<td>0.0085</td>
</tr>
<tr>
<td>Davis</td>
<td>0.0097</td>
<td>Piute</td>
<td>0.0094</td>
<td>Wasatch</td>
<td>0.0090</td>
</tr>
<tr>
<td>Duchesne</td>
<td>0.0088</td>
<td>Rich</td>
<td>0.0081</td>
<td>Washington</td>
<td>0.0084</td>
</tr>
<tr>
<td>Emery</td>
<td>0.0083</td>
<td>Salt Lake</td>
<td>0.0107</td>
<td>Wayne</td>
<td>0.0072</td>
</tr>
<tr>
<td>Garfield</td>
<td>0.0073</td>
<td>San Juan</td>
<td>0.0074</td>
<td>Weber</td>
<td>0.0106</td>
</tr>
<tr>
<td>Grand</td>
<td>0.0084</td>
<td>Sanpete</td>
<td>0.0096</td>
<td>State Average</td>
<td>0.0098</td>
</tr>
</tbody>
</table>

An understanding of the Utah Uniform School Fund equalization program is essential to understanding the property tax problem. Elementary and secondary school operating programs are largely financed by the Uniform School Fund, a fund consisting primarily of state income tax revenues. The purpose of the equalization program is to redistribute state income tax revenues from school districts with above average levels of real property value per student to districts with below average real property value per student.

The funds from this Uniform School Fund program are distributed to local school districts on the basis of weighted pupil units (WPUs). One WPU is assigned for each student in grades 1 through 12, and 0.55 units are assigned to each half-day kindergarten student. In 1992 the funding level was set at $1,408 for each WPU. This
funding level is considered the amount needed to provide students with an "acceptable" level of education. Thus, the state guarantees each school district within the state this amount for each WPU, with additional allowances for other related purposes such as busing requirements, handicapped programs, and teacher career-ladder\textsuperscript{2} programs. In 1992 these additional allowances averaged $323 per WPU. The difference between revenues generated by a minimum property tax rate in each school district and the minimum funding level set by the state is provided to the school district from the Uniform School Fund. In those counties where the state-mandated property tax rate generates more than the state-guaranteed funding level\textsuperscript{3} ($1,408 per WPU in 1992), the school district is required to return the excess to the state to be used in the Uniform School Fund.

In equation form, the Uniform School Fund allocates funds (F) to a county according to the following equation:

\begin{equation}
F = \left[ fl - \left( \frac{\rho \cdot M}{WPU} \right) \right] \times WPU
\end{equation}

where $fl$ is the funding level per WPU, $\rho$ is the state mandated property tax rate, and $M$ is the total market value of real property in the county. In this equation the only variable that the county can influence is $M$, assessed market value of real property within the

\textsuperscript{2} The career-ladder program allows teachers to enhance their base pay by developing and / or administering programs such as music, drama, and sport programs.

\textsuperscript{3} In 1992 only three school districts (Millard, South Summit, and Park City) generated more than $1,408 per WPU, and consequently were required to return the excess back to the Uniform School Fund.
county. Clearly an incentive exists for a county to keep the assessed market values low in order to maximize its share of funds from the Uniform School Fund. This incentive to hold down assessed value may lead to large disparities in the effective tax rate among counties and these disparities may be capitalized into property values.

The problem of equity in tax assessment continues to be an important issue in Utah. This concern was reflected in a 1969 law designed to reduce tax assessment inequality. The law required all homes within the state to be appraised every five years by the Utah Tax Commission. Efforts to continually appraise properties throughout the state continued for the next seven years, but because of rapid inflation and the difficulty of appraising the large number of properties, the goal of the legislation was not met and disparities in assessed values continued. Since 1969, efforts have continued to insure taxing equality, but the problem still exists. In 1993 the state legislature required all homes to be reappraised every 5 years, this time by county assessors.

State officials have recognized the incentive to keep assessed values low, as well as the inherent difficulty in appropriately appraising homes, and have enacted measures to standardize the assessment process. One such guideline involves the periodic review of the ratio of actual sales price to assessed value. State officials obtain sales information from recently sold homes and compare that information with assessed values. The guidelines permit the average of the assessments to be within ten percent of the average sales price. If the average assessed value lies outside this range, the state can require the county assessor to factor the assessments for the entire county. Factoring consists of an across-the-board increase or decrease of property values.
throughout the county. For example, if the State Tax Commission examines a number of homes which have recently sold in the county and finds that the average assessed value is 15 percent less than the average sales price, the commission can order the county to factor all assessed values up by 15 percent.

**Intrajurisdictional Tax Differentials**

Within a taxing jurisdiction, tax differenentials arise when real property is not assessed consistently (i.e., where there is variability in the ratio of assessed value to market value). If buyers are rational, these differentials will be capitalized into property values. This intrajurisdictional tax differential can be caused by changes in market values over time and inconsistent appraisals by the county assessors. Further, the criteria used by mortgage lenders in marking mortgage loans may impose rationality on buyers as explained below.

**Changes in Market Values over Time.** It is not uncommon for residential properties of equal market value to have appraised values that differ by 20 to 30 percent because assessments are made in different years. For example, consider a home assessed 5 years ago at $80,000. An identical home assessed today may be valued at $104,000 due to a 30 percent price appreciation over the 5-year interval\(^4\). Applying a tax rate of 0.85 percent and assuming that the tax differential is fully capitalized (using 7.4 percent

---

\(^4\) In Chapter 5 the issue of appreciation of residential homes is discussed. It is estimated that the value of homes in the Logan area has increased 10 percent per year over the last three years. Thus, two comparable homes in Logan which have had more than three years between their respective appraisals could have an assessment differential of 30 percent.
and a 30-year discounting horizon), the market price for the home assessed at $80,000 would be $2,433 more than the comparable home assessed at a later time.

**Inconsistent Assessments.** Even with government regulations and new sophisticated computer programs, the assessment process remains subjective. For a variety of reasons ranging from incompetence to the inherent difficulty in estimating market values, the assessment ratios within one taxing jurisdiction can and generally do vary significantly. Figure 2 below shows the relationship of property tax and market value in the study area. If each home were assessed perfectly, the scatter-plot would be a straight line, but as noted by the distance of the points off the straight line, assessments in the study area do vary significantly.

![Fig. 2. Relationship of property taxes and market value for 1992 sales data](image)

**Mortgage Lender Criteria.** The existence of property tax capitalization can also be explained by current requirements of mortgage lending institutions. These regulations require that the ratio of monthly housing expense (including principal and interest, taxes,
and insurance) as a percentage of gross monthly income meet a certain level.\(^5\)

Assuming no down payment, the mortgage payment for a home can be approximated by:

\[
PMT = V \cdot \frac{r}{[1 - (1 + r)^{-t}]} \tag{1-3}
\]

Where \(PMT\) is the principal and interest payment, \(V\) is the value of the home, \(r\) is the mortgage lending interest rate, and \(t\) is the length of the loan. As \(t\) approaches infinity, the monthly mortgage payment approaches the interest rate multiplied by the value of the home. The maximum loan amount (\(L\)) depends on the monthly payment for principal and interest (\(PMT\)) and for taxes (\(TAX\)) and insurance (\(INS\)).

\[
L = \frac{PMT}{[1 - (1 + r)^{-t}]} - \frac{INS + TAX}{[1 - (1 + r)^{-t}]} \tag{1-4}
\]

Because the maximum monthly payment as a percentage of income is set by the lender, the effect of a higher tax on a given property is to reduce the amount that can be borrowed. That is, the only way for a buyer to offset a higher tax is to lower the principal and interest payment which in turn lowers the total loan amount. The buyer cannot bid as much for a property if the taxes are higher than for a comparable property with lower taxes. Thus, mortgage lending institutions force rationality on those who may not have acted in a rational manner independently. That is, the limitations on the

---

\(^5\) Currently, the standard percentage limit for housing expenses as a percentage of gross income for conventional loans is 28 percent. The Federal Housing Administration (FHA) has a similar limit set at 29 percent of gross monthly income.
maximum payment and, in turn, maximum borrowing capacity can, and probably does lead to capitalization of property taxes. For example, a potential buyer agrees to buy a home having an above average tax assessment. After applying for a mortgage loan, the buyer finds that the maximum amount that can be borrowed is less than the sales price because the property tax is above average. The buyer may have to renegotiate the price based on the maximum loan amount. In this way, lending criteria impose rationality on the buyer and result in a lower market value because of the higher property tax.

Objectives

The objectives of this thesis are (1) to review existing economic theory and empirical evidence on the capitalization of property taxes; (2) to develop a model of property valuation inclusive of tax effects; and (3) to estimate the parameters of this model using a comprehensive data set of over 334 home sales in the Logan, Utah area. The empirical results will include an estimation of the capitalization effect.

Two closely related issues are also addressed in the thesis. They include: (1) a study of recent real estate price appreciation, including a suggested method for measuring such appreciation; (2) a study of property tax equity.
CHAPTER 2
LITERATURE REVIEW

There have been many attempts to empirically test for property tax capitalization. This chapter provides a review of studies on residential property tax capitalization as well as such related subjects as capitalization of tax differentials on commercial properties, the appropriate discount rate, and the length of the discounting horizon.

In a 1968 study designed to examine the incidence of property tax shifting, Orr hypothesized that because of the wide range of property tax rates within a metropolitan area, the conventional assumption that the supply of capital is perfectly elastic must be reexamined. If the assumption that supply is perfectly elastic is relaxed, then the view that occupants, rather than owners, bear the entire portion of the real property tax assessed on residential improvements must be altered. Using ordinary least squares, the author estimated the relationship between tax rates and residential rents. Specifically he regressed residential rent against three variables measuring the determinants of supply and three variables measuring the determinants of demand, including a tax variable (the property tax rate on single-family homes). It was hypothesized that only if tax differentials are shifted forward would the tax variable enter significantly in the determination of market rents, indicating that tax differentials give rise to rent
differentials. The equation was estimated for a sample of residential properties in 31 communities in the Boston urbanized area. The property tax variable had a value of 0.211 with an insignificant t-statistic (0.58), indicating that differentials in property tax rates were not shifted forward to occupants as conventional theory had suggested, but rather that the incidence of property tax differentials fell on the owners of the properties.

In 1969 Oates studied the effects that property taxes and public expenditures had on property values. Using data from 53 municipalities around New York, Oates regressed the median value of owner-occupied dwellings for each community 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, and the percentage of families in the community with an income of less than $3,000 per year. Using both ordinary least squares as well as two-stage least squares, the author found that the property tax had a significantly negative effect on property value. Using a 5 percent discount rate and a 40-year discounting horizon, the equation suggested that nearly two-thirds of the tax increase is being capitalized in the form of decreased property values. Oates recognized several problems with the procedures used (mainly simultaneous-equation bias), and concluded by noting that caution must be used as to the degree of reliability that can be given to the results.

Pollakowski (1973) critiqued and then replicated the Oates’ study. His criticisms included: (1) Oates’ use of educational expenditure per pupil as a proxy variable for the level of public service. The author argued that if it is assumed that local-
government services other than education also influence property values, then the use of only educational expenditure introduces a bias in the estimation of property tax capitalization. (2) An improper explanatory variable, median family income, is used as a proxy for "intangible" aspects of a home and neighborhood. But income is endogenous and its use as an explanatory variable artificially increases the apparent explanatory power of the regression model. (3) Inappropriate use is made of an estimation method. The Oates study used several predetermined variables (median number of years of school completed by males over age 25, population density, percentage of dwellings owner occupied, percentage of the population enrolled in public elementary and secondary schools) which, in the author's opinion, were correlated with the error term, making their use invalid in the context of two-stage least squares. (4) The choice of sample communities makes the attainment of results consistent with the Tiebout hypothesis more likely than otherwise might have been. Pollakowski's opinion is that the submarket chosen by Oates (New Jersey) is likely to produce results consistent with the Tiebout hypothesis. Because of Oates' selection of the study area, the author claimed that any conclusions drawn about the Tiebout mechanism and the optimality of public-private resource allocation can only be applied to this submarket.

---

6 In 1956 Charles M. Tiebout proposed the hypothesis that the provision of local government services "reflects the preferences of the population more adequately than they can be reflected at the national level." Tiebout proposed a model where a market solution could lead to optimal expenditure on local public goods. In his model each family seeks out a community offering the mix of public services it most prefers at the lowest price (as measured by taxes) and locates accordingly so that a fully efficient solution is generated in the sense that each family gets the bundle of local services it most desires, subject to its budget constraint.
In replicating Oates' study, Pollakowski used data for 19 cities in the San Francisco, Oakland, and San Jose areas. Following the Oates study exactly, and then with several changes deemed appropriate due to the change in study areas, the author concluded that the application of the Oates' equation to a different metropolitan area yields rather unsatisfactory results, thus implying that capitalization estimates are sensitive to model specification.

In Oates' reply (1973), he conceded that the use of only one variable to represent public services may lead to biased estimates of the regression coefficients in his original paper. With the exception of adding a public service variable (i.e., municipal spending per capita on all functions other than public schools and debt service), he re-estimated his original equation, again using two-stage least squares. The addition of the public service variable raised the estimated degree of tax capitalization from about two-thirds to roughly full capitalization. Though Oates remained committed to the use of two-stage least squares and his original predetermined variables, he restated and confirmed the conclusion of Pollakowski -- i.e., that capitalization estimates are sensitive to model specification.

Arguing that Oates (1969) restated Tiebout's model into a simpler question of whether households have preferences for a mix of taxes and public services, Edel and Sclar (1974) extended his capitalization model to consider supply adjustment in the local public goods market. Data from towns in the Boston metropolitan area for the period 1930 to 1970 were used to relate home values to local taxes and services over different time periods. Six distance variables were used as well as variables on highway
maintenance expenditures, school expenditures, population density, tax rate, and owner occupancy, which are used to capture amenity factors not explained by distance. Using the 1970 regression estimates (the regression equations for data prior to 1970 used a nominal tax rate, which may be inappropriate when using a real discount rate) with an 8 percent real discount rate suggests a property tax capitalization rate of about 50 percent.

Hamilton (1976) argued that the impression conveyed by Oates that consumer responsiveness to local fiscal variables must necessarily lead to a correlation between fiscal variables and property values is incorrect. He suggested that empirical evidence of such a relationship must be due to either a disequilibrium where there is a temporary shortage of fiscal shelters, or persistent systematic differences in production functions either for raising revenue or producing public services. Further, while the results of the Oates study did not follow necessarily from the Tiebout hypothesis, it did fulfill its objective by rejecting the hypothesis that consumers ignore local fiscal variables when making their location decisions.

King (1977) argued that Oates as well as many of those who had commented on that study had misspecified the capitalization equation. Specifically, the misspecification arises because the tax rate is used, rather than the tax burden in the capitalization model. Further he suggested that the tax burden may be correlated with the error term, so a more efficient way of specifying the equation is to remove the tax burden from the right-hand-side of the equation and subtract it from the value of the home, thus making the dependent variable the value of the home net of the tax burden. He derived a maximum likelihood estimate of the extent of capitalization by estimating
the regression equation while varying the capitalization coefficient over the interval of 0.1 to 1 and observing changes in the value of $R^2$. Using the Oates data and the maximum likelihood technique, King estimated capitalization at 63 percent of complete capitalization using a 5 percent discount rate and a 40-year horizon.

Reinhard (1981) built on the King model using Oates' data and revising King's equation to account for the discounting of future values of tax streams. Using a procedure similar to that of King's, i.e., an iterative nonlinear technique (a maximum likelihood procedure), the extent of property tax capitalization was estimated. With a 2.6 percent discount rate and an infinite discounting horizon, capitalization was estimated at 100 percent.

McDougall (1976) studied the degree that public services are capitalized into property values and at the same time estimated the degree of property tax capitalization in 35 metropolitan communities in the Los Angeles area. The author hypothesized that the value of homes is a function of structural characteristics, neighborhood and community characteristics, the property tax rate, and the availability of locally provided public services. Using two-stage least squares, the estimated decline in property value as the result of increased tax liability suggested a tax capitalization rate of almost 50 percent. A discount rate of 5 percent and an infinite time horizon were used.

Meadows (1976) demonstrated that an empirical verification of the Tiebout result is more complicated than previously thought. Specifically, there are problems with intercommunity differentials in local property taxes and in residential property values. In his attempt to reverify the Tiebout results, the author used two-stage least squares on
data from several northeastern New Jersey suburbs in 1960 and 1970. In both years the author noted capitalization of intercommunity differentials in property tax rates as indicated by a negative and statistically significant coefficient on property tax in the regression equations.

Rosen and Fullerton (1977, p. 439) presented empirical results on tax capitalization using output measures, i.e., test scores for elementary students as a measure of public services. Reproducing the study of Oates (1969) using the test scores of students instead of public school expenditures, the authors used data from 53 northeastern New Jersey communities for the years 1960 and 1970. Using a discount rate of 6 percent and a horizon of 40 years, the authors conclude that "about 88 percent of the tax differential is capitalized." This capitalization rate is well above the 75 percent rate found when using per pupil expenditure as a measure of public service benefit.

Lewis and McNutt (1979, p. 359) used a multiequation model of property valuation to estimate the extent that tax differentials are capitalized. With a system of equations exactly identified so that the model could be reduced to a single-form equation, they showed that a one percent increase in property tax would result in a -0.22 to -0.25 percent decrease in market value. The authors used an example of a $50,000 home for which the annual property tax rate is 1.3 percent of the market value. (The annual property tax would be $650.) Using the market value/tax elasticity shown above yields a $110 price change (0.22 percent) associated with a one percent change in the annual tax. This gives an implicit capitalization effect of $17 per dollar change in tax. The authors concluded that because assessments are not accurate, "the property tax
system being employed in at least one city is randomly conferring large capital gains and
loses on owners of real property."

Richardson and Thalheimer (1981) used data on home sales for Fayette County
Kentucky during 1973-74 to estimate property tax capitalization. Two models were
developed in the study. The first model considered capitalization independent of home
value (an additive model); the second model was adapted with the assumption that
capitalization is affected by home value (a multiplicative model). By using ordinary least
squares regression, a discount rate of 8 percent, and a 10-year time horizon, the additive
model showed 60 percent of full capitalization while the multiplicative model showed 73
percent of full capitalization.

Wheaton (1984) studied the incidence of interjurisdictional differences in
property taxes in commercial property. By using the Boston SMSA as a study area, the
extent of tax capitalization in commercial business was estimated. The author concluded
that: (1) the burden of property tax is not passed on to consumers or to labor, but
remains on the owners of the capital or possibly is partially shifted back to the owners of
the land; and (2) there may be significant resource allocation effects from inter-
jurisdictional tax differences due to changes in the location of capital within the city and
in the quantity of the city's capital stock.

Yinger, Bloom, Borsch-Supan, and Ladd (1984) in a comprehensive study of
property tax capitalization provided evidence of capitalization in several Massachusetts
communities. Using a variety of regression techniques (two-stage least squares, OLS,
nonlinear least squares, nonlinear two-stage least squares), they reported that in the three
cities with the best data -- Waltham, Brockton, and Barnstable -- the degree of tax
capitalization was 21 percent, 16 percent, and 33 percent, respectively.

Finally, Hobson (1986, p. 372) provided an analytical framework for examining
the distribution of the burden of residential property tax. He found that "the shifting of
the residential property tax remains an empirical issue." He also concluded that the
empirical results showing the distribution of the burden of residential property taxes rely
heavily on the relative magnitudes of the elasticity of demand for housing, the elasticity
of supply of land to individual taxing jurisdictions, and the degree of population mobility
between taxing jurisdictions.

This literature review reveals a wide variety of methods used to estimate the
extent of property tax capitalization. Several conclusions are drawn: First, it is difficult
to measure the extent or degree of capitalization. Note the variety of methods and
procedures used. Several methodologies are presented, including the examination of
aggregate data (e.g., Oates' 1969 study) as well as the examination of cross-sectional
micro data (e.g., King's 1977 study). A wide range of estimation procedures also has
been used, including ordinary least squares, two-stage least squares, nonlinear least
squares, and maximum likelihood estimates.

A second conclusion is that even though each study varies in its methodology
and procedure, all determined that tax differentials are capitalized to some degree. The
evidence found in empirical studies to this point suggests that the capitalization of
property taxes does exist.
CHAPTER 3
CONCEPTUAL MODEL OF TAX CAPITALIZATION

When property taxes are not applied uniformly, a discriminatory tax is essentially created as the market works to equalize returns of each dollar invested in real property. Consider homes within one taxing and service jurisdiction. The market value (V) of any home is equal to the discounted value of real rent (R) the home can generate less the present value of real taxes (T) paid. In equation form this is shown as:

\[ V = \sum_{t} \left[ \frac{R}{(1 + r)^t} - \frac{T}{(1 + r)^t} \right] \]  

where \( t \) is the year and \( r \) is the discount rate. If an infinite horizon is assumed, this equation simplifies to:

\[ V = \frac{R}{r} - \frac{T}{r} \]

Given a property tax rate \( \rho \), this equation can be modified to show the tax as the property tax rate multiplied by the value of the home

\[ V = \frac{R}{r} - \frac{\rho \cdot V}{r} \]
Solving this equation for \( V \) yields:

\[
V = \frac{R}{r + \rho}
\]  

(3-4)

Now the value of the home is inversely related to both the tax rate and the discount rate, i.e.,

\[
\frac{\partial V}{\partial \rho} < 0
\]

(3-5)

and

\[
\frac{\partial V}{\partial r} < 0.
\]

If the real discount rate is held constant, the net effect of a change in the tax rate is:

\[
\frac{\partial V}{\partial \rho} = \frac{-R}{(r + \rho)^2}
\]

(3-6)

Assuming a real discount rate \( r \) of 3 percent and a tax rate \( \rho \) of one percent, and an annual rent \( R \) of $4,000, the market value would be $100,000, i.e.,

\[
V = \frac{4,000}{0.03 + 0.01} = 100,000
\]

(3-7)

If the annual rent is fixed but the tax rate increases 10 percent, from \( \rho = 0.01 \) to \( \rho = 0.011 \), the value of the home falls to $97,561. That is,
Given the fixed rent and a discount rate of 3 percent, a 10 percent increase in the
property tax rate has reduced the market value by $2,439 or about 2.4 percent. This
implies a value-to-tax rate elasticity of about -0.24. The capitalization effect is:

\[
\frac{\Delta V}{\Delta T} = \frac{-2,439}{100} = 24.39.
\]

Thus, a one dollar increase in tax causes a $24.39 decline in market value.

This is defined in the literature as full capitalization and assumes an infinite
discounting horizon and no change in the supply of housing. Clearly, the latter would be
affected because the tax rate change affects the rate of return on real property. That is,
et returns have fallen because \((R - T)\) has fallen. In the long-run we would expect
investment in housing to fall below what it would have been in the absence of a tax
increase and, thus, \((R)\) should increase until a normal return has once again been
achieved. Given that the housing stock changes slowly, this could take several years.

The actual property tax on the i\(^{th}\) property \((T_i)\) can be viewed as containing two
elements, an average tax \((\bar{T})\) plus a random component \((T^*)\) that results from the
vagaries in the assessment process. By using these two elements, the property tax for
the i\(^{th}\) property can be written as:
where $T_i$ is the average tax or the tax if all properties were assessed uniformly.

For two equivalent properties where the flow of housing and public services is equal, the net benefits of housing services provided ($R$) and the cost of those services as related by the average tax should be the same, so that the difference in market value between the two homes should reflect only the present value of the differences in the random component of the property tax. For any two otherwise identical properties that differ only in the level of property taxes, the difference in market price should be:

$$P_i - P_j = \sum_{i=1}^{n} \frac{T_i^* - T_j^*}{(1 + r)^i}$$

(3-11)

where $n$ is the discounting horizon and $r$ is the rate at which the differences are discounted. When property taxes are not applied uniformly, i.e., where $T_i^* \neq T_j^*$, a discriminatory tax essentially is created as the market works to equalize returns of each dollar invested in all of the area's property. Economic theory suggests that rational participants in this market are aware of tax differentials and, thus, the full effect of the property tax differential should be capitalized. In the following, two conceptual models of property tax capitalization are developed.
Consider a model consisting of four equations in four endogenous and \( P + 1 \) exogenous variables. First, property taxes are assumed to be exogenously determined. While this assumption is unrealistic, it allows for direct estimation of the capitalization effect. This assumption is relaxed in Model 2 where the actual tax is determined endogenously:

\[ T^A = T_0^A \]  

(3-12)

The observed market value is composed of two elements. The first is the "true" market value, that is, the market value of the property net of any capitalization effects, and the second is the capitalization effect (C), which may be positive or negative. This relationship can be shown as:

\[ M^s = M^* + C \]  

(3-13)

The "true" market value is a linear function of the characteristics of the property \( (X_1, X_2, \ldots, X_P) \), independent of any capitalization effect, i.e.,

\[ M^* = b_{50} + b_{51}X_1 + \ldots + b_{5P}X_P \]  

(3-14)

The capitalization effect is determined as:

\[ C = b_{31} \cdot (T^* - T^A) \]  

(3-15)
where

\[ b_{31} = \sum_{t=1}^{n} \frac{1}{(1 + r)^t} \]

which is simply the present value annuity factor for a series of \( n \) payments of $1.00 discounted at a periodic rate of \( r \). \( T^* \) is the "true" tax burden or the tax rate multiplied by the "true" market value, i.e.,

\[ T^* = \rho \cdot M^* \] (3-16)

Empirical estimation of the "true" tax in equation (3-16) is impossible, as the "true" tax is a function of the "true" market value, and only actual market value is available and it contains the effects of an unknown capitalization effect. However, it is possible to combine equations (3-12) through (3-16) in a reduced form and then use ordinary least-squares to estimate the parameters of the structural system. Of particular importance is the parameter \( b_{31} \), the capitalization effect. Table 3 summarizes the endogenous and exogenous variables included in this structural system.

### TABLE 3

<table>
<thead>
<tr>
<th>STRUCTURAL SYSTEM SUMMARIZATION FOR STRUCTURAL MODEL 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observable</strong></td>
</tr>
<tr>
<td>Endogenous</td>
</tr>
<tr>
<td>( M^6 )</td>
</tr>
<tr>
<td>( M^* ), ( T^* ), ( C )</td>
</tr>
</tbody>
</table>

7 The reduced form is an equation or system of equations where all of the right-hand-side variables are exogenous.
By substituting equations (3-12), (3-14), (3-15), and (3-16) into equation (3-13), we obtain a reduced form equation for the sales price of homes. From this reduced form, we can then estimate the parameters of the structural equations. In particular, the degree of capitalization can be determined. Below are the steps involved in solving for the reduced form equation. Substituting equation (3-14) into (3-13) yields:

\[ M^s = b_{50} + b_{51}X_1 + \ldots + b_{5p}X_p + C \]  

(3-18)

Substituting equation (3-15) into equation (3-18) yields:

\[ M^s = b_{50} + b_{51}X_1 + \ldots + b_{5p}X_p + b_{31}(T - T^\alpha) \]  

(3-19)

Substituting equation (3-16) into equation (3-19) yields:

\[ M^s = b_{50} + b_{51}X_1 + \ldots + b_{5p}X_p + b_{31}(\rho(b_{50} + b_{51}X_1 + \ldots + b_{5p}X_p) - T^\alpha) \]  

(3-20)

Simplifying this equation (3-20) yields a reduced form equation:

\[ M^s = \gamma_0 + \gamma_1X_1 + \ldots + \gamma_pX_p + b_{31}(-T^\alpha) \]  

(3-21)

where
\[
\begin{align*}
\gamma_0 &= b_{30}(1 + b_{31}\rho), \\
\gamma_1 &= b_{31}(1 + b_{31}\rho), \\
\gamma_i &= b_{3i}(1 + b_{31}\rho), \\
\gamma_p &= b_{3p}(1 + b_{31}\rho)
\end{align*}
\]

We are able to estimate \( b_{31}, \gamma_0, \gamma_1, \ldots, \gamma_p \) directly from equation (3-21). In addition to the ability to directly estimate the capitalization effect (i.e., \( b_{31} \)), it is possible to estimate the parameters of equation (3-14) indirectly. This is shown in the relationships:

\[
\gamma_i = b_{3i}(1 + b_{31}\rho) \quad i = 1, 2, \ldots, p
\]  

(3-22)

Solving for the \( b_{3i} \) we obtain:

\[
b_{3i} = \frac{\gamma_i}{1 + b_{31}\rho} \quad i = 1, 2, \ldots, p
\]

This ability to derive estimates of \( b_{30}, b_{31}, \ldots, b_{3p} \) will be valuable in the estimation of the capitalization effect in Model 2.

Model 2

Now consider a model that expands Model 1 by making the actual property tax a function of the structural characteristics of the property. This model uses equations (3-12) through (3-16) except that equation (3-12) is changed to show that the assessed
value is a function of the structural characteristics of the home. This can be shown in
equation form as:

\[ T^A = \rho M^A \]  

(3-23)

where

\[ M^A = b_{10} + b_{11}X_1 + \ldots + b_{1p}X_p \]  

(3-24)

It is assumed that the same variables that affect "true" market value are used by the
assessor, except that the coefficients on those variables probably are different because
the assessment process differs from the market process. By substituting equations (3-
23), (3-14), (3-15), and (3-16) into equation (3-13), we again are able to find a reduced
form equation. Below are the steps leading to that equation. Substituting (3-14) and (3-
15) into (3-13) gives:

\[ M^s = b_{50} + b_{51}X_1 + \ldots + b_{5p}X_p + b_{31}(T^* - T^A) \]  

(3-25)

Substituting (3-16) and (3-23) into (3-25) yields:

\[ M^s = b_{50} + b_{51}X_1 + \ldots + b_{5p}X_p + \\
\quad b_{31}[\rho(b_{50} + b_{51}X_1 + \ldots + b_{5p}X_p) - (b_{10} + b_{11}X_1 + \ldots + b_{1p}X_p)] \]  

(3-26)

Simplifying and combining terms yields the reduced form equation as:
\[ M^s = \alpha_0 + \alpha_1 X_1 + \ldots + \alpha_p X_p \]

where

\[
\alpha_0 = b_{50}(1 + b_{31}\rho) - b_{31}b_{10},
\]

\[
\alpha_1 = b_{31} + b_{31}b_{31}\rho - b_{31}b_{11},
\]

\[
\alpha_p = b_{2p} + b_{31}b_{5p}\rho - b_{31}b_{1p}
\]

Unfortunately, it is not possible to directly estimate the capitalization effect \( b_{31} \). The system of equations is underidentified so that we cannot go from the estimates of \( \gamma_i \) to find the structural parameters of the underlying equations.

It appears as though this model adds no new insight into the capitalization effect. But with the help of parameters estimated in Model I, this model can estimate the capitalization effect indirectly. Consider the fact that

\[
\alpha_0 = b_{50}(1 + b_{31}\rho) - b_{31}b_{10}
\]

Solving this equation for the capitalization effect \( b_{31} \) gives:

\[
b_{31} = \frac{\alpha_0 - b_{50}}{\rho b_{50} - b_{10}}
\]

Using the estimate of \( b_{50} \) from Model I, we are able to solve equation (3-28) and obtain an estimate of the capitalization effect \( b_{31} \). Two approaches to the estimation of this effect are discussed below.
**Approach A.** The first approach requires an estimate of the effect tax rate. This can be accomplished by computing the mean tax rate within the study area. In equation form, the mean tax rate is:

\[ \rho = \sum \frac{T^A}{M^s} \]  

where \( T^A \) is the actual tax and \( M^s \) is the selling price of properties within the subject area.

Next we need to estimate \( b_{10} \), the intercept term for the assessed value equation. This can be done using ordinary least squares where assessed value is regressed against \( X_1, X_2, \ldots, X_p \), the variables representing the structural and economic characteristics of the property used by the assessor in determining a value for the property. For purposes of this study it is assumed that the assessor uses the same characteristics as do the participants in the market but evaluates them differently.

We also need to estimate \( \alpha_0 \), the intercept term in equation (3-27). This is accomplished by regressing the selling price of homes against the explanatory variables \( X_1, X_2, \ldots, X_p \).

Finally we solve for \( b_{50} \) found in the reduced form equation in Model 1. With the estimates of \( \rho, b_{10}, \alpha_0 \), and \( b_{50} \), we are able to solve equation (3-28) for \( b_{31} \).

**Approach B.** The second approach assumes that \( b_{10} \) is equal to zero. This assumption seems logical in that when the variables representing the structural and economic qualities of the property are zero, the assessor will not assign a value to the
property. Using the effective tax rate and the estimate of $b_{50}$, the capitalization rate can then be estimated.

Both economic theory and the empirical evidence cited in Chapter 2 indicate that differential taxes on comparable properties can create large capital gains and losses for property owners when those differentials are capitalized. The empirical work in the next chapter suggests that differentials do exist in the study area and that these differentials indeed are capitalized.
CHAPTER 4
EMPIRICAL ESTIMATION

The Study Area

With the models formulated in Chapter 3 we are ready to estimate the
capitalization effect of property taxes for one taxing jurisdiction. Data collected over a
period of 3 years (1989 through 1992) for the city of Logan and surrounding areas are
used in the estimation. Logan is a community of 33,000 people located in Cache County
(population 72,000) about 80 miles north of Salt Lake City. The economic base of the
area includes the following major employers: (1) Utah State University; (2) Weslo /
Proform, manufacturers of fitness equipment such as stair climbers, treadmills, and
weight lifting equipment; (3) the Cache County and Logan City School Districts; (4)
E.A. Miller and Tri Miller Meat Packing, specializing in the processing of beef and pork
products for distribution throughout the Intermountain West; and (5) cheese-processing
companies including Cache Valley Dairy and Gossner Foods.

The Data Set

Data from the Multiple Listing Service maintained by a group of local real
estate professionals are used in estimating the parameters of the model. The data include
listing price, selling price, size of homes in square feet, presence of a garage,
construction type, taxes as reported by real estate agents, and the year the home was
built. In addition, the actual property tax and assessed value for each property sold were obtained from the Cache County Assessor’s office.

In order to control for outliers such as historical homes and homes located on unusually large tracts of land (often small farms), two limitations were placed on the data. The first limited the data to homes located on acreage less than 0.75 acres. The second excluded homes that are more than 75 years old. With these limitations the data set included 334 observations.

**Estimation Results: Model 1**

Based on Lewis and McNutt (1978), Model 1 assumes that the assessed valuation of a home is determined exogenously. As discussed in Chapter 3, this may be unrealistic, but allows for the direct estimation of the capitalization effect and provides valuable information needed in the alternative model. In Model 1 the capitalization effect is estimated by regressing the sales price of homes against a set of variables measuring the economic and functional characteristics of the home and property, and the property tax. Recall that equation (3-21) shows a reduced form equation for that system

\[ M^a = \gamma_0 + \gamma_1 X_1 + \ldots + \gamma_p X_p + b_{31} T + \varepsilon \]

where
\[
\gamma_0 = b_{50} \cdot (1 + b_{31} \cdot \rho) \\
\gamma_1 = b_{51} \cdot (1 + b_{31} \cdot \rho) \\
\vdots \\
\gamma_p = b_{5p} \cdot (1 + b_{31} \cdot \rho)
\]

The parameters \(b_{31}\) and the \(b_{5i}\) are from the structural equations. Because equation (3-21) has only one endogenous variable and an independent error term (\(e\)), the function can be estimated using ordinary least-squares regression. The following variables are used to represent the economic and functional characteristics that determine the market prices of residential property\(^1\).

\(X_1\) -- the total square feet on the main and the upper floors of the home. This variable is used as a measure of the size of the home. It is expected that the price of a home is positively related with its size.

\(X_2\) -- the square feet on the lower floor, i.e., the basement. This is included to capture another size dimension of the home. Again, it is expected that this variable would have a positive effect on market price.

\(X_3\) -- lot size in acres.

\(X_4\) -- age of the home in years. Here, we expect that as the age of a home increases, the value of the home decreases, i.e., a negative relationship between price and age.

---

\(^1\) It is important to note that although the selling price of a home is dependent upon many physical, economic, and aesthetic characteristics, the variables selected have been chosen to represent that vast set of characteristics. Given the relatively high value of the coefficient of determination (\(R^2 = 0.81\)), it appears that the set chosen is adequate.
$X_5$ -- a dummy variable for brick construction (i.e., $X_5 = 1$ if the home is constructed with brick and $X_5 = 0$ otherwise). This variable serves as a surrogate for quality of construction. It is assumed that a home constructed with brick has also had other materials used in its construction that are associated with higher quality. The coefficient on this variable is expected to be positive.

$X_6$ -- construction other than brick or frame. This variable represents other forms of construction material such as stucco. Frame construction was left out to avoid the "dummy variable trap." Assuming that the materials used in these other forms of construction are more expensive than wood and represent higher quality of construction, we would expect this variable to have a positive effect on selling price.

$X_7$ -- a dummy variable where $X_7 = 1$ for a 2-car garage and 0 for a carport or single-car garage. This variable is used to identify homes built with a 2-car (or larger) garage. It is hypothesized that this variable is positively related to the sales price of a home.

$T$ -- actual property tax on the property.

Table 4 shows the results of regressing the selling price of homes against these eight explanatory variables. From these results several observations are made. First, all of the coefficients have the correct sign. Second, all the coefficients except for $X_5$ and $X_6$ are significant at the 10 percent or lower probability level. Finally, the value of $R^2$
### TABLE 4

ORDINARY LEAST SQUARES REGRESSION RESULTS FOR ESTIMATION OF TAX CAPITALIZATION -- MODEL 1

<table>
<thead>
<tr>
<th>Regression Statistics</th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
<td>0.9004</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R Square</td>
<td>0.8107</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R Square</td>
<td>0.8060</td>
<td></td>
<td></td>
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<tr>
<td>Standard Error</td>
<td>13,844.31</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>333.0000</td>
<td></td>
<td></td>
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<table>
<thead>
<tr>
<th>ANOVA</th>
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<tbody>
<tr>
<td></td>
<td>df</td>
<td>SS</td>
<td>MS</td>
<td>F</td>
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<td>-------</td>
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<td>----</td>
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</tr>
<tr>
<td>Regression</td>
<td>8</td>
<td>265,9843E+9</td>
<td>33,2480E+9</td>
<td>173.4696</td>
</tr>
<tr>
<td>Residual</td>
<td>324</td>
<td>62,0994E+9</td>
<td>191,6609E+6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>332</td>
<td>328,0830E+9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Standard Error</th>
<th>t-Stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>5,135.1471</td>
<td>1.5813</td>
<td>0.1147</td>
</tr>
<tr>
<td>X1 -- Square Feet Upper Floors</td>
<td>22.0002</td>
<td>2.2452</td>
<td>9.7989</td>
</tr>
<tr>
<td>X2 -- Square Feet Lower Floors</td>
<td>10.5896</td>
<td>1.8531</td>
<td>5.7145</td>
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<tr>
<td>X3 -- Lot Size (Acres)</td>
<td>20,270.9210</td>
<td>7,900.4226</td>
<td>2.5658</td>
</tr>
<tr>
<td>X4 -- Age (Years)</td>
<td>-165.8458</td>
<td>50.3775</td>
<td>-3.2986</td>
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<tr>
<td>X5 -- Brick Construction</td>
<td>265.9006</td>
<td>1.731.0245</td>
<td>0.1333</td>
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<tr>
<td>X6 -- Other Construction</td>
<td>76.1713</td>
<td>2.570.6600</td>
<td>0.0299</td>
</tr>
<tr>
<td>X7 -- 2-Car Garage</td>
<td>3,997.1554</td>
<td>1,967.9126</td>
<td>1.8779</td>
</tr>
<tr>
<td>T -- Tax</td>
<td>49.0377</td>
<td>6.5052</td>
<td>7.5382</td>
</tr>
</tbody>
</table>

(0.81) for the regression indicates a significant portion of the variation in the price of homes has been explained by the independent variables. The t-statistic for the tax coefficient is significant at the 0.01 level. The coefficient for the tax variable, i.e., the present value annuity factor, is 49.04, which indicates that taxes are capitalized but the estimate seems too high to be plausible. The high value for this estimated parameter will be discussed later in the chapter.

**Estimation Results: Model 2**

In Model 2, property tax is treated as an endogenous variable. Recall that we will estimate the capitalization effect indirectly from equation (3-28):
This is more realistic but requires several additional steps in the estimation of the capitalization effect. First, we need to estimate the effective tax rate. Recall that the effective tax rate as shown in equation (3-27) is:

\[ b_{31} = \frac{\alpha_0 - b_{50}}{\rho \cdot b_{50} - b_{10}} \]

where \( T^A \) is the actual tax and \( M^S \) is the selling price. By using this equation the mean effective property tax rate for the data set is 0.00835 or 0.835 percent of the selling price.

We next need to estimate \( b_{10} \), the intercept term in equation (3-23). Table 5 shows the results of regressing assessed value against the explanatory variables \( X_1, X_2, \ldots, X_p \). The coefficient \( b_{10} \) is 19,792.50 and as shown by a t-statistic of 7.53 is highly significant.

Next we need to estimate the reduced form equation (3-27) to obtain an estimate of \( \alpha_0 \). Table 6 shows the results of regressing the sales price of homes against the explanatory variables \( X_1, X_2, \ldots, X_7 \). From the results of the regression it can be seen that all the coefficients have the correct sign and except for \( X_5 \) and \( X_6 \) are significant at the 10 percent (or lower) level. The coefficient \( \alpha_0 \) has a value of 13,952.26.
TABLE 5

ORDINARY LEAST SQUARES REGRESSION RESULTS FOR MODEL 2 (DEPENDENT VARIABLE -- ASSESSED VALUE)

<table>
<thead>
<tr>
<th>Regression Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
</tr>
<tr>
<td>R Square</td>
</tr>
<tr>
<td>Adjusted R Square</td>
</tr>
<tr>
<td>Standard Error</td>
</tr>
<tr>
<td>Observations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>df</td>
</tr>
<tr>
<td>Regression</td>
</tr>
<tr>
<td>Residual</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Standard Error</th>
<th>t Stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>19,792.5030</td>
<td>2,626.7461</td>
<td>7.5350</td>
</tr>
<tr>
<td>X1</td>
<td>25.3760</td>
<td>1.4750</td>
<td>17.2035</td>
</tr>
<tr>
<td>X2</td>
<td>15.8880</td>
<td>1.8400</td>
<td>11.4801</td>
</tr>
<tr>
<td>X3</td>
<td>7,569.0770</td>
<td>6,831.2357</td>
<td>1.1080</td>
</tr>
<tr>
<td>X4</td>
<td>-347.6892</td>
<td>39.7379</td>
<td>-8.7464</td>
</tr>
<tr>
<td>X5</td>
<td>6,204.2593</td>
<td>1,470.2925</td>
<td>4.2197</td>
</tr>
<tr>
<td>X6</td>
<td>3,438.8555</td>
<td>2,204.9612</td>
<td>1.5566</td>
</tr>
<tr>
<td>X7</td>
<td>6,659.7457</td>
<td>1,071.0146</td>
<td>3.8638</td>
</tr>
</tbody>
</table>

TABLE 6

ORDINARY LEAST SQUARES REGRESSION RESULTS FOR MODEL 2 (DEPENDENT VARIABLE -- SELLING PRICE)

<table>
<thead>
<tr>
<th>Regression Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
</tr>
<tr>
<td>R Square</td>
</tr>
<tr>
<td>Adjusted R Square</td>
</tr>
<tr>
<td>Standard Error</td>
</tr>
<tr>
<td>Observations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>df</td>
</tr>
<tr>
<td>Regression</td>
</tr>
<tr>
<td>Residual</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Standard Error</th>
<th>t Stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>13,952.2633</td>
<td>3,278.9453</td>
<td>4.2551</td>
</tr>
<tr>
<td>X1</td>
<td>33.0468</td>
<td>1.8413</td>
<td>17.9476</td>
</tr>
<tr>
<td>X2</td>
<td>17.6891</td>
<td>1.7276</td>
<td>10.2392</td>
</tr>
<tr>
<td>X3</td>
<td>24,793.1757</td>
<td>8,527.3746</td>
<td>2.9075</td>
</tr>
<tr>
<td>X4</td>
<td>-321.7819</td>
<td>49.6045</td>
<td>-6.4869</td>
</tr>
<tr>
<td>X5</td>
<td>2,917.6798</td>
<td>1,835.3539</td>
<td>1.5897</td>
</tr>
<tr>
<td>X6</td>
<td>1,593.3543</td>
<td>2,752.4347</td>
<td>0.5789</td>
</tr>
<tr>
<td>X7</td>
<td>6,697.2826</td>
<td>2,085.9134</td>
<td>3.1676</td>
</tr>
</tbody>
</table>
Once the effective tax rate, the value of \( b_{10} \), and the value of \( \alpha_0 \) have been estimated, the final step in solving for a capitalization effect under Approach A of Model 2 is to derive the value of \( b_{50} \) from the reduced form in Model 1. Recall that equation (3-22) solved for \( b_{5i} \) is:

\[
b_{5i} = \frac{\gamma_i}{1 + b_{31}\rho}
\]

where \( \gamma_i \) is the coefficient of \( X_i \) in the reduced form equation, \( b_{31} \) is the coefficient of the tax variable in the reduced form equation, and \( \rho \) is the effective tax rate. Solving this equation using information gained through the estimation of Model 1, we have:

\[
b_{50} = \frac{5,135.15}{1 + 49.04(0.00835)}
\]

\[
b_{50} = 3,643.28
\]

With estimates for \( \rho \), \( b_{10} \), \( \alpha_0 \), and \( b_{50} \) we can estimate the capitalization effect from equation (3-28) as:

\[
b_{31} = \frac{\alpha_0 - b_{50}}{\rho b_{50} - b_{10}}
\]

\[
b_{31} = \frac{13,952.26 - 3,643.28}{0.00835(3,643.28) - 19,792.50}
\]

\[
b_{31} = -.52
\]
From the results of Approach A it appears that capitalization of the property tax does not exist (-0.52 is considered equal to zero). From the results of Model 1, and those to follow for Model 2, Approach B, it would seem that this approach (Approach A) has failed to account for all items affecting the capitalization of taxes.

Approach B assumes that the intercept term for the assessed value equation (i.e., \( b_{10} \)) is equal to zero. By using this assumption and substituting in the estimated values for the coefficients in equation (3-26), the present value annuity factor \( b_{31} \) is solved as:

\[
b_{31} \approx \frac{\alpha_2 - b_{50}}{\rho b_{50} - b_{10}}
\]

\[
b_{31} = \frac{13,952.26 - 3,643.28}{0.00835(3,643.28) - 0}
\]

\[
b_{31} = 338.87
\]

Clearly, this is too high to be realistic. The capitalization rate as estimated under Model 1 of 49.04 is high but perhaps plausible if we consider inflationary market conditions during the study period. During the 1989-92 period, bank savings rates ranged between 5 and 8 percent and mortgage loan rates were in the 9-10 percent areas. At the same time inflation in residential home prices was about 10 percent per year\(^2\). Thus the real rate of interest faced by buyers may have been near zero or perhaps even negative.

Table 7 shows several combinations of discount rates and horizons that could yield a

\(^2\) The next chapter estimates the changes in home values in Cache County during the study period.
capitalization effect of 49. A buyer who viewed the real discount rate as zero and had a 49-year horizon would apply a capitalization rate of 49 to each dollar of tax differential. Unfortunately, this implies an expectation that the real discount rate would be zero for the next 49 years, which is not realistic. Obviously, the estimate is too high.

### TABLE 7

COMBINATIONS OF DISCOUNT RATE AND HORIZONS IMPLYING A CAPITALIZATION FACTOR OF 49

<table>
<thead>
<tr>
<th>Discount Rate (Percentage)</th>
<th>Discount Horizon (Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>049.00</td>
</tr>
<tr>
<td>0.25</td>
<td>052.34</td>
</tr>
<tr>
<td>0.50</td>
<td>056.35</td>
</tr>
<tr>
<td>0.75</td>
<td>061.31</td>
</tr>
<tr>
<td>1.00</td>
<td>067.67</td>
</tr>
<tr>
<td>1.25</td>
<td>076.32</td>
</tr>
<tr>
<td>1.50</td>
<td>089.20</td>
</tr>
<tr>
<td>1.75</td>
<td>112.31</td>
</tr>
<tr>
<td>2.00</td>
<td>197.55</td>
</tr>
</tbody>
</table>

It appears that tax differentials are capitalized but we have not been able to determine a realistic capitalization factor. The estimated present value annuity factor of 49 suggests that some important information may have been left out. The $R^2$ of 0.80 is fairly high for cross-sectional data, but at the same time it may suggest that important information within the regression was left out.

For example, the effect of neighborhood quality has not been estimated. This variable is somewhat subjective in that it requires the researcher to value different neighborhood qualities. One suggestion for estimating this variable is to use a surrogate variable such as gross income. It is also possible that our measure of the quality of
construction is inadequate. Brick construction was used as a surrogate for construction quality, but may not have fully captured the desired information. One might also consider using a variable that represents the distance of a home from the community center. The inclusion of this variable would incorporate the mono-centric urban land-use model in this analysis.

With the results obtained in Model 2, it might prove valuable to examine the process in which the county assessor values residential property. It was assumed in our model that the assessor uses the same variables as does the market participant, but with different values placed on those variables. If the assessor uses other variables or some other method of valuing real property, the coefficients in the regression model would be different, leading to an estimated present value annuity factor that is more plausible.

Though the magnitude of the estimated capitalization effect is implausible, the empirical results of this chapter reinforce the findings of most who have studied this problem -- that is, property taxes are capitalized.
CHAPTER 5
CHANGES OF REAL ESTATE VALUES IN
CACHE COUNTY, UTAH: 1990-1992

Although property tax differentials can develop under a variety of conditions, in a market where property values are changing these differentials are more likely to develop. This is because properties are assessed at different times. For example, consider two homes in an area where real estate values are increasing 10 percent per year over a period of 3 years. A home built in the first year is assessed based on a value of $100,000. A home identical to the first is built in the third year but because market values have increased an average of 30 percent, this home has an assessed value of $130,000. Even if the assessor accurately measures the value of the two homes, they will have different tax burdens because market values have increased. In a market consisting of rational consumers, this tax differential will be capitalized into market values.

Many states, including Utah, have recognized that the practice of appraising homes at different time periods (especially in a market where values are rapidly changing) leads to tax burden inequalities. As discussed earlier, the Utah legislature passed a law in 1969 designed to reduce this problem by requiring the Utah State Tax Commission to appraise all homes every 5 years. Efforts to continually appraise properties throughout the state continued for several years, but because of the difficulty
in appraising the large number of properties, the goal was abandoned. Since then, the
time interval between assessments has increased, with some homes having not been
reappraised since 1973.

In 1993, the legislature again passed a law requiring all homes within the state
to be appraised every 5 years, but this time assigned the responsibility to county
assessors rather than to the Utah State Tax Commission. But, even if the legislature’s
goal is met and properties are appraised every 5 years, an environment of changing
market values can cause tax differentials, and these differentials can be expected to be
capitalized into the value of homes.

Because changes in residential real estate values can affect property tax
capitalization, it is important in a study of tax capitalization to measure changes in
property value. In this chapter, two models for measuring the changes in such values are
developed and used to estimate changes in market values for homes in the study area

Model 1

The first model regresses the selling prices of homes within the study area
against the same structural variables used in Chapter 4. Those variables include: (1)
square feet on both the upper and main floors; (2) square feet in the basement; (3) lot
size in acres; (4) age; (5) a dummy variable used to represent homes constructed with
brick; (6) a dummy variable used to represent other building material such as cement or
stucco; and (7) a dummy for homes with 2-car garages. In addition, Model 1 uses 2
additional dummy variables to represent different time periods. That is, a dummy variable for homes sold in 1991 (i.e., \( X = 1 \) if sold in 1991 and \( X = 0 \) otherwise) and a dummy for homes sold in 1992 (i.e., \( X = 1 \) if sold in 1992 and \( X = 0 \) otherwise). Once the regression equation has been estimated, an average value for each of the explanatory variables is calculated\(^3\). These averages are then used in the sales price equation to find the average sales price in 1990, 1991, and 1992.

Table 8 shows the mean values for the variables and Table 9 shows the results of the regression analysis. By using the parameter estimates in Table 9 and the averages in Table 8, the sales price for the "average" home sold in 1990, 1991, and 1992 can be estimated. The estimated sales prices for the "average" home for each year are shown in the upper portion of Table 10. The horizontal axis labeled "Predicted Value In:"

### TABLE 8

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>VARIABLES</th>
<th>VARIABLES</th>
<th>VARIABLES</th>
<th>VARIABLES</th>
<th>VARIABLES</th>
<th>VARIABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SALE PRICE</td>
<td>SIZE</td>
<td>LIVING AREA LOWER</td>
<td>SQUARE FEET LOWER</td>
<td>SLOPE GAUGE</td>
<td>TOTAL CONSTRUCTION</td>
</tr>
<tr>
<td>TOTAL</td>
<td>$64,258.47</td>
<td>37.73</td>
<td>1364.18</td>
<td>679.56</td>
<td>0.04</td>
<td>0.59</td>
</tr>
<tr>
<td>YEAR 1990</td>
<td>$64,258.47</td>
<td>37.73</td>
<td>1364.18</td>
<td>679.56</td>
<td>0.04</td>
<td>0.59</td>
</tr>
<tr>
<td>YEAR 1991</td>
<td>$73,995.66</td>
<td>37.73</td>
<td>1364.18</td>
<td>679.56</td>
<td>0.04</td>
<td>0.59</td>
</tr>
<tr>
<td>YEAR 1992</td>
<td>$73,995.66</td>
<td>37.73</td>
<td>1364.18</td>
<td>679.56</td>
<td>0.04</td>
<td>0.59</td>
</tr>
</tbody>
</table>

\(^3\) Four averages are actually calculated. The first three are averages for the sales data of each year, i.e., the average age of homes sold in 1990, 1991, and 1992; the average lot size of homes sold in 1990, 1991, and 1992, etc. The last average is the average for all homes sold in the 3 years combined.
TABLE 9

ORDINARY LEAST SQUARES REGRESSION RESULTS FOR ESTIMATING CHANGES IN REAL ESTATE VALUES -- MODEL 1

<table>
<thead>
<tr>
<th>Regression Statistics</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
<td>0.8839</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>R Square</td>
<td>0.7849</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted R Square</td>
<td>0.7793</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard Error</td>
<td>13,928.2455</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>356.0000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ANOVA</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>df</td>
<td>SS</td>
<td>MS</td>
<td>F</td>
</tr>
<tr>
<td>Regression</td>
<td>9.0000</td>
<td>2.440E+11</td>
<td>2.721E+10</td>
<td>140.2645</td>
</tr>
<tr>
<td>Residual</td>
<td>346.0000</td>
<td>6.712E+10</td>
<td>1.940E+08</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>355.0000</td>
<td>3.120E+11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Standard Error</th>
<th>t Stat</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>11,441.6718</td>
<td>3,078.9705</td>
<td>3.7161</td>
</tr>
<tr>
<td>AGE</td>
<td>-326.4755</td>
<td>34.4765</td>
<td>-9.4093</td>
</tr>
<tr>
<td>LOT-SIZE (ACRES)</td>
<td>25,739.4266</td>
<td>10.468.9962</td>
<td>2.4586</td>
</tr>
<tr>
<td>SQUARE FEET UPPER</td>
<td>28,8531</td>
<td>1.6241</td>
<td>17.7652</td>
</tr>
<tr>
<td>SQUARE FEET LOWER</td>
<td>17.0673</td>
<td>1.5847</td>
<td>10.7698</td>
</tr>
<tr>
<td>2-CAR GARAGE</td>
<td>5,849.6402</td>
<td>1,862.6351</td>
<td>3.1405</td>
</tr>
<tr>
<td>BRICK CONSTRUCTION</td>
<td>4,654.7296</td>
<td>1,611.7297</td>
<td>2.8880</td>
</tr>
<tr>
<td>OTHER CONSTRUCTION</td>
<td>2,634.1688</td>
<td>2,540.8637</td>
<td>1.0367</td>
</tr>
<tr>
<td>1991</td>
<td>7,059.6273</td>
<td>2,390.6534</td>
<td>2.9596</td>
</tr>
<tr>
<td>1992</td>
<td>12,702.8972</td>
<td>1,725.4357</td>
<td>7.3617</td>
</tr>
</tbody>
</table>

represents the parameter estimates obtained in Table 9. The vertical axis labeled “Average Home Sold In:” represents the average values shown in Table 8, so that the first cell in Table 10 can be interpreted as the predicted sales price of a home sold in 1990 for the home with characteristics equal to the averages for 1990 homes shown in Table 8. The lower part of Table 10 converts these sales prices into a simple price index where the 1990 predicted sales price is used as a base for the first row. The 1991 predicted sales price is used as a base for the second row, and the 1992 predicted sales price is used as a base for the third row. Based on the estimates from Model 1, the value of the average home sold in Cache County has increased during the 3-year study period an average of about 10 percent per year. If this increase in value continues, even with assessments occurring every 5 years, tax differentials will be substantial, and could lead
to capital gains and losses to property owners as the differences are capitalized in market values.

TABLE 10

ESTIMATED AVERAGE REAL ESTATE PRICES WITH PERCENTAGE INCREASE INDEX -- MODEL 1

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Home</td>
<td>$64,558</td>
<td>$71,618</td>
<td>$77,261</td>
</tr>
<tr>
<td>Sold In:</td>
<td>$68,636</td>
<td>$75,695</td>
<td>$81,338</td>
</tr>
<tr>
<td></td>
<td>$67,144</td>
<td>$74,204</td>
<td>$79,846</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Predicted Value</th>
<th>1990</th>
<th>1991</th>
<th>1992</th>
</tr>
</thead>
<tbody>
<tr>
<td>(In Percentage Terms)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Home</td>
<td>100%</td>
<td>111%</td>
<td>120%</td>
</tr>
<tr>
<td>Sold In:</td>
<td>100%</td>
<td>110%</td>
<td>119%</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>111%</td>
<td>119%</td>
</tr>
</tbody>
</table>

Model 2

The second model uses three separate regression equations to estimate changes in property value over time. In using the same explanatory variables, the average variable data for each year (1990, 1991, and 1992) are used to estimate a market value equation. The parameters for these regression equations are reported in Tables 11, 12, and 13.

Once the parameters from these three equations have been estimated, the mean values for the explanatory variables (as reported in Table 8) are substituted into the
TABLE 11

ORDINARY LEAST SQUARES REGRESSION RESULTS FOR ESTIMATING CHANGES IN REAL ESTATE VALUES FOR 1990 -- MODEL 2

<table>
<thead>
<tr>
<th>Regression Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
</tr>
<tr>
<td>R Square</td>
</tr>
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<th>ANOVA</th>
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<tbody>
<tr>
<td>df</td>
</tr>
<tr>
<td>Regression</td>
</tr>
<tr>
<td>Residual</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Error</td>
</tr>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>AGE</td>
</tr>
<tr>
<td>LOT-SIZE (ACRES)</td>
</tr>
<tr>
<td>SQUARE FEET UPPER</td>
</tr>
<tr>
<td>SQUARE FEET LOWER</td>
</tr>
<tr>
<td>2-CAR GARAGE</td>
</tr>
<tr>
<td>BRICK CONSTRUCTION</td>
</tr>
<tr>
<td>OTHER CONSTRUCTION</td>
</tr>
</tbody>
</table>

TABLE 12

ORDINARY LEAST SQUARES REGRESSION RESULTS FOR ESTIMATING CHANGES IN REAL ESTATE VALUES FOR 1991 -- MODEL 2

<table>
<thead>
<tr>
<th>Regression Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple R</td>
</tr>
<tr>
<td>R Square</td>
</tr>
<tr>
<td>Adjusted R Square</td>
</tr>
<tr>
<td>Standard Error</td>
</tr>
<tr>
<td>Observations</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>df</td>
</tr>
<tr>
<td>Regression</td>
</tr>
<tr>
<td>Residual</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Error</td>
</tr>
<tr>
<td>Intercept</td>
</tr>
<tr>
<td>AGE</td>
</tr>
<tr>
<td>LOT-SIZE (ACRES)</td>
</tr>
<tr>
<td>SQUARE FEET UPPER</td>
</tr>
<tr>
<td>SQUARE FEET LOWER</td>
</tr>
<tr>
<td>2-CAR GARAGE</td>
</tr>
<tr>
<td>BRICK CONSTRUCTION</td>
</tr>
<tr>
<td>OTHER CONSTRUCTION</td>
</tr>
</tbody>
</table>
estimated equation in order to obtain estimated "average" sales prices for the three separate years. Table 14 shows these estimated average sales price, again with a price index representing changes in real estate values in percentage terms. The results are quite similar to those determined under Model 1, with estimated values of real estate increasing at an average rate of about 10 percent per year.

With these estimates we can provide an example showing the source of a tax differential and the effect on market price. Suppose a home is appraised in 1990 at a market value of $100,000. An identical home built in 1992 is appraised at $120,000 because there has been a 20 percent increase in market prices. Using a tax rate of 0.9 percent of market value, the tax on the 1990 home is $900 whereas the tax on the 1992

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Standard Error</th>
<th>t-Stat</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>19,579.0880</td>
<td>3,577.2940</td>
<td>5.5043</td>
</tr>
<tr>
<td>AGE</td>
<td>-269.5220</td>
<td>-43.9767</td>
<td>-6.1288</td>
</tr>
<tr>
<td>LOT-SIZE (ACRES)</td>
<td>4,774.9655</td>
<td>12,817.9655</td>
<td>0.3725</td>
</tr>
<tr>
<td>SQUARE FEET UPPER</td>
<td>31.4929</td>
<td>2094.5317</td>
<td>15.5033</td>
</tr>
<tr>
<td>SQUARE FEET LOWER</td>
<td>19,4795</td>
<td>2,0631</td>
<td>9.4118</td>
</tr>
<tr>
<td>2-CAR GARAGE</td>
<td>8,170.0829</td>
<td>2,378.3521</td>
<td>3.4353</td>
</tr>
<tr>
<td>BRICK CONSTRUCTION</td>
<td>5,419.8434</td>
<td>1,992.2632</td>
<td>2.7204</td>
</tr>
<tr>
<td>OTHER CONSTRUCTION</td>
<td>4,564.0053</td>
<td>3,515.7866</td>
<td>1.2930</td>
</tr>
</tbody>
</table>
### TABLE 14

**ESTIMATED AVERAGE REAL ESTATE PRICES WITH PERCENTAGE INCREASE INDEX -- MODEL 2**

<table>
<thead>
<tr>
<th></th>
<th>Average Home Sold In:</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1990</td>
<td>1991</td>
<td>1992</td>
<td></td>
</tr>
<tr>
<td><strong>Predicted Value In:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>$64,558.47</td>
<td>$71,002.16</td>
<td>$77,914.01</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>$69,153.11</td>
<td>$75,781.26</td>
<td>$81,568.98</td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>$67,978.77</td>
<td>$74,061.74</td>
<td>$79,820.60</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Average Home Sold In:</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1990</td>
<td>1991</td>
<td>1992</td>
<td></td>
</tr>
<tr>
<td><strong>Predicted Value (In Percentage Terms)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1990</td>
<td>100%</td>
<td>110%</td>
<td>121%</td>
<td></td>
</tr>
<tr>
<td>1991</td>
<td>100%</td>
<td>110%</td>
<td>118%</td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>100%</td>
<td>109%</td>
<td>117%</td>
<td></td>
</tr>
</tbody>
</table>

home is $1,080 -- a difference of $180. If this difference is fully capitalized into the value of the homes, then the home that was appraised in 1993 will have a market value $2,147 less than the home appraised in 1990$^4$.

The estimates of Model 1 and Model 2 show significant changes in the value of residential real estate in Cache County. If the values of homes within the study area continue to climb at magnitudes suggested in these two models, tax differentials will continue to occur, and these tax differentials will continue to be capitalized into market values.

$^4$ Using a discount rate of 7.4 percent and a discounting horizon of 30 years.
CHAPTER 6
MEASURES OF PROPERTY TAX EQUITY

When taxes vary significantly within a single taxing jurisdiction while the level of public goods and services remains constant, property tax can be considered as the cost of owning property, rather than payment for goods and services provided by the government. Often these tax differentials arise when real property is not assessed consistently (i.e., where there is variability in the ratio of assessed value to market value).

Two measures can be used to determine equity in the assessment process, and in turn the tax burdens. The first measure is the coefficient of intrajurisdictional dispersion. This statistic measures the differences in individual assessments compared to the median assessment. The second measure is the intrajurisdictional price-related differential. This statistic measures the differences in assessment ratio, i.e., the ratio of assessed value to market value throughout the “true” market value range. Below, both of these statistics are discussed and then used to measure the tax equity within the study area.

The Coefficient of Intrajurisdictional Dispersion

This statistic measures the average difference in individual assessment ratios from the median of those ratios. These differences can then be shown as a percentage of the median ratio. The statistic is computed as:
where $R_m$ is the median assessment ratio, $R_i$ is the assessment ratio for the $i^{th}$ property, and $n$ is the number of properties examined. The larger the value for the coefficient of interjurisdictional dispersion, the more variation there is in assessment ratios. (If all properties were assessed at the same percentage of market value, the coefficient value would be zero.)

The coefficient of intrajurisdictional dispersion is computed below for several groupings of properties within the study area. The first ratio is computed for all observations within Cache County, including several rural communities outside of Logan. The coefficient is determined as:

$$C_d = \left( \frac{\sum |R_i - R_m|}{R_m n} \right) \times 100$$

For this grouping including the rural communities, the average deviation from the median assessment ratio is almost 17 percent.
A second ratio is computed for observations in the Logan area, including observations in North Logan, Providence, and River Heights -- three major communities surrounding Logan. This coefficient is computed as:

\[
C_d = \left[ \frac{\left( \sum |R_i - 0.880952| \right) / 390}{0.880952} \right] \times 100
\]

\[C_d = 15.81\]

For the properties within this four-city subarea, the coefficient of intrajurisdictional dispersion is nearly 16 percent.

A final coefficient is computed for the city of Logan alone. This coefficient is computed as:

\[
C_d = \left[ \frac{\left( \sum |R_i - 0.877980406| \right) / 298}{0.877980406} \right] \times 100
\]

\[C_d = 16.95\]

Here, again the dispersion of assessment ratios is nearly 17 percent. Although these measures are less than the 24.1 percent reported by Lewis (1978) for the state of Utah in 1971 (it was during this period that the state legislature mandated that the Utah State Tax Commission would assess all properties within the state every 5 years) with coefficients ranging from 16 percent to nearly 17 percent, significant tax differentials do exist within Cache County. When these differences are capitalized into market prices as
economic theory and the empirical estimation in the previous chapter suggest, large capital gains and loses are relayed to owners of real property.

The Intrajurisdictional Price-Related Differential

This statistic is computed by dividing the average assessment ratio by the ratio of the total assessed value to total market value. In equation form this can be shown as:

\[
D = \left[ \frac{R_i}{(\sum A_i / \sum V_i)} \right] \times 100
\]

where \( R_i \) is the average assessment ratio, \( A_i \) represents the assessed value for the \( i^{th} \) property, and \( V_i \) represents the market value for the \( i^{th} \) property. With this measure, a coefficient over 100 translates into lower assessment ratios for higher value properties and higher assessment ratios for lower value properties. If this occurs, then in effect the property tax becomes a recessive tax, i.e., the tax burden as a percentage of income decreases as income increases (assuming that higher income individuals own higher valued homes).

The intrajurisdictional price-related differential is computed for three separate subgroups of the study area. The first coefficient represents the differentials found throughout the entire study area. This statistic is computed as:

\[
D = \frac{0.8841699}{(36,098,034 / 418,06,930)} \times 100
\]

\[D = 102.40\]
A second price-related differential is estimated for the four main cities within the study area (Logan, River Heights, North Logan, and Providence). This coefficient is determined as:

\[ D = \left( \frac{0.8838106}{\frac{25,774,450}{29,965,720}} \right) \times 100 \]

\[ D = 102.75 \]

A final price-related differential is computed for the city of Logan alone. This is shown below:

\[ D = \left( \frac{0.8838704}{\frac{18,489,993}{21,552,749}} \right) \times 100 \]

\[ D = 103.03 \]

The coefficients of price-related differentials for all three groups show evidence that assessment ratios do decline with increases in home values. This decline is modest, and shows improvement when compared to the price-related differential of 110 in 1971 as reported by Lewis (1978).

Both measures of tax equality suggest that tax differentials exist within Cache County. These differentials (as shown in Chapter 3) are then capitalized into the values of homes within the area -- thus randomly conferring capital gains and losses on owners of property.
CHAPTER 7
CONCLUSION

In this study we have attempted to determine if property tax differentials on residential properties are capitalized. We have: (1) examined the nature of the property tax system in Utah; (2) reviewed previous studies on tax capitalization and related subjects; (3) developed a theoretical model for estimating the degree of tax capitalization within a single taxing jurisdiction; (4) estimated the key parameters of that model; and (5) examined two related issues, i.e., price changes over time and property tax equity. This chapter contains a number of conclusions that have been reached.

With the current system of school financing in Utah, a clear incentive exists for each county to keep the assessed values low in order to maximize its share of money from the Uniform School Fund. This incentive to keep assessed values low should lead to tax differentials among counties and these differentials may be capitalized into the value of homes. Officials have recognized this inherent problem and have attempted to enact measures to insure taxing equity such as laws mandating reappraisal every 5 years and policies such as “factoring” county assessments. The effectiveness of these measures has yet to be fully determined, but some evidence exists that tax equity has increased since the Lewis study in 1978.
In a comprehensive review of studies performed throughout the United States (studies which used both cross-sectional micro data and aggregate data), a vast majority of researchers concluded that tax capitalization occurred. The degree of capitalization found varied as the researchers hypothesized different discount rates and horizons.

The theoretical models developed here followed that of Lewis and McNutt (1979). First, a model was developed that assumed the tax burden was exogenously determined. While the assumption of an exogenous tax probably is unrealistic, it allowed the capitalization effect (i.e., the implicit present value annuity factor) to be estimated directly. A second model relaxed the assumption of exogenously determined taxes. This model’s structural system is underidentified, and thus the capitalization effect had to be estimated indirectly.

When property values are changing, tax differentials are more likely to develop. This is because properties are assessed at different times. Also, in such a period real discount rates may be low. Thus the study of price changes becomes an important part of a study on property tax capitalization. In Chapter 6 two models were developed to help estimate value changes in property. In Model 1, the selling price of homes is regressed against a set of structural variables. The regression used two dummy variables to represent different time periods, i.e., $X = 1$ if sold in 1990 and $X = 0$ otherwise. The second model used three separate regression equations, one for each year studied. Once the regression estimates have been made, the predicted sales price for the average home for each year is computed for each year. The changes between these predicted sales
prices then were used to create a price index. Both models showed an average price appreciation of about 10 percent per year over the 3 year period.

Two measures were discussed relative to property tax equity. The first was the coefficient of intrajurisdictional dispersion. This statistic measures the average difference in individual assessment ratios (the ratio of assessed value to market value) from the median, and quantifies the variability in assessment ratios. The second statistic estimated is the intrajurisdictional price-related differential, which measures the differences in assessment ratios over the range of market values. This statistic indicates whether there is a correlation between value and assessment ratio.

Both statistics were computed for several subgroups of data. The coefficient of intrajurisdictional dispersion had an average value of about 16 percent, suggesting a significant amount of variability among the assessment ratios. The intrajurisdictional price-related differential had an average value of about 102.5, indicating a modest degree of regressivity in the assessment process, i.e., larger homes are assessed at a lower rate than smaller or lower priced homes. The data for 1989-92 reveal improvement over conditions reported by Lewis in 1978.

Although property tax equity has improved in the past 20 years, more can be done. Several solutions are suggested here. They include increasing the availability of tax information, use of econometric methods in the assessment process, and a less conservative approach -- a self-assessment process.

A relatively simple and inexpensive method of increasing property tax equity is to make property tax information, including assessment procedures and neighboring
assessments, more readily available. Because property taxes and property assessments are public information, they are obtainable from local county assessors and recorders. This information, though, is sometimes difficult to find and interpret. Publication of tax burdens and assessments would allow owners of property to compare similar homes and would increase participation in the system’s equalization program. (Currently, an equalization program exists which allows owners to dispute their taxes and if warranted to have their taxes lowered).

The second method is to implement econometric methods in the assessment process. Currently many assessment offices employ assessors who retrieve information and apply that information in a long and time-consuming process of applying cost tables to determine assessment values. Though the continual assessment process always will be needed in order to report additions and improvements to properties, the use of economic modeling in a computer-generated environment would add accuracy and time savings to the current system. This valuation would use a hedonic price equation to determine market value as a function of characteristics such as lot size, structure size, and number of rooms (i.e., number of bedrooms, number of bathrooms, etc.). The information could then be kept in a computer database, and updated on a continual basis. In this way computer technology could enhance the appraiser’s valuation and insure increased accuracy.

A radical and probably politically impossible alternative to the two approaches discussed above would be to allow the property owner to determine market value. Lewis (1978) has suggested a program in which every year each owner would set the
market value on his or her property. The self-valuation would constitute a legal offer to
sell at that price. If the price attracted a qualified buyer, then the owner could either
raise the value up (and thus raise the tax) or sell the property at the price offered.

This study has provided insight on the property tax capitalization issue.
Because of the limited focus of this study, several suggestions are made for further study
on the subject. The large coefficient for the tax variable in the regression equation
suggests that something may have been left out of the model. Researchers may want to
increase the number of explanatory variables used in the model.

A second suggestion for further study is to broaden the scope to include other
communities or counties in Utah and possibly other states. With the widespread use of
computerized multiple listing services, the cost of expanding the study has fallen.
REFERENCES


