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MEASURING THE INDIRECT FISCAL IMPLICATIONS OF
LAND USE PLANNING AND NATURAL AMENITIES ON
PROPERTY TAX REVENUES: A METHODOLOGICAL
FRAMEWORK

presented by

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MEASURING THE INDIRECT FISCAL IMPLICATIONS OF LAND USE PLANNING AND NATURAL AMENITIES ON PROPERTY TAX REVENUES: A METHODOLOGICAL FRAMEWORK

By

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ABSTRACT

MEASURING THE INDIRECT FISCAL IMPLICATIONS OF LAND USE PLANNING AND NATURAL AMENITIES ON PROPERTY TAX REVENUES: A METHODOLOGICAL FRAMEWORK

By

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The limitations of fiscal evaluation methods are addressed by using a modified hedonic pricing technique to document and quantify the indirect contributions of surrounding land use patterns and natural amenities to property tax revenues. The hedonic pricing function uses multiple regression analysis to decompose the assessed "true cash value" of single and multi-family residential, commercial and industrial building and land values based on their respective structural and location-based characteristics. The method is tested in seven case study communities in Oakland County, Michigan.

Structural and location-based characteristics incorporated within hedonic models produce statistically significant results, explaining between 35.8% to 68.8% of the variance in assessed land values and 80.6% to 91.3% of the variance in assessed building values. Methodological outcomes demonstrate that planning policies and regulations that define the spatial composition of land use development patterns indirectly add and subtract from the property tax base of case study communities. Benefits, challenges and limitations associated with the application of hedonic pricing techniques to fiscal analysis are presented and implications to planning practice are discussed.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1
INTRODUCTION

1.1 Introduction and Problem Statement

The fiscal implications of land use planning and regulation are not well understood by planners (Huddleston, 2005). The limitations to fiscally-informed planning practice are based in the constraints of "value" as defined by a monetized economy and the shortcomings of traditional fiscal evaluation techniques that do not fully account for the value of public, comprehensive land use planning in a community. Traditional methods such as fiscal impact analysis and other closely related quantitative techniques, measure the direct, current, and public costs and revenues associated with development to the local jurisdictions where growth is taking place (Burchell, 1978). Current fiscal analysis techniques are not designed to account for the value interactions between land use patterns (Kotval and Mullin, 2006), the spatial dimensions of growth (Dekel, 1995) and the cumulative outcomes of local government planning and investment (Heikkila and Davis, 1997).

Under current valuation frameworks, the economic and fiscal value of planning merely coincides with the direct market value of development, and does not account for the indirect "value added" to the development by the advantages and disadvantages of location created by land use planning. The location-based benefits of place that influence property values represent the true purpose and value of planning to a community and its residents. Without a method to quantify the "value-added" of planning to property values in a community, planners will never be able to truly understand, communicate, or measure the fiscal outcomes of planning policies and regulations. This thesis attempts to address this problem by introducing a new methodological framework for fiscal analysis.

As the foundation of this thesis, the limitations of conventional fiscal techniques are explored through the revenue side of the fiscal equation. The "value of planning" is quantified by measuring the indirect contributions of surrounding land use patterns and natural amenities to private property values and ultimately the property tax base of local communities. The property tax accounts for the largest source of local government revenue in the United States (Michigan State Assessors Board, p. 1-1) and is assessed based on an estimate of the true market value of real property. Therefore, the property tax represents a vital and direct connection between private, economic value and public, fiscal value.

The property tax captures the economic and fiscal value of planning in two distinctive ways. First, zoning and building codes *directly* influence the value of real property and property tax revenues by defining the functions and development characteristics of land and land improvements. The price paid for real property and the property taxes captured under land use regulations represents the extent to which planners have evaluated the property tax revenue outcomes of planning.

The value of real property and property tax revenues are also *indirectly* influenced by the location-based advantages and disadvantages created by the spatial distribution of land uses and zoning regulations. The price of a building or land represents not only a bundle of physical characteristics but also a set of location specific attributes (Chesire and Shepherd, 1995). In a monetized economy, the benefits of place cannot be explicitly bought, sold, or owned by a private entity but rather, are defined by the willingness to pay for market goods (i.e. a building or land parcel) that maintain a set of specific location attributes (Field, 2001 & Taylor, 2003).

1.2 Research Questions and Approach

This thesis asks at a basic level, "*what is the indirect value of planning and how can it be measured?*" For the purpose of this thesis, the value of planning is defined by the spatial distribution of land use patterns and natural amenities that indirectly influence property values and property tax revenues.

To measure the indirect value of planning, a modified "hedonic pricing" method is tested. "The hedonic method for non-market valuation is an econometric technique that uses market transactions to ascertain the value of characteristics associated with variations in products. By observing the price differentials between two product varieties, the monetary trade-offs individuals are willing to make with respect to variations are inferred indirectly" (Taylor, 2003, p. 332). In the spirit of improving the practice of fiscal analysis, assessed true cash value rather than market transactions are used to ascertain the value contributions of surrounding land use patterns and natural amenities to property values and property tax revenues in seven case study communities in Oakland County, Michigan. To improve the science of fiscal analysis through hedonic pricing, three methodological research questions are explored. (1) Is the hedonic pricing method an effective tool to document and measure the indirect impact of location-based attributes on property values and property tax revenues? (2) What adjustments must be made to the hedonic pricing model to effectively measure the fiscal impacts of land use patterns and natural amenities? (3) What spatial variables represent the planned environment, how should they be incorporated within the hedonic-fiscal analysis, and what are the sources of data?

To ultimately improve planners' understanding of the fiscal implications of land use patterns and natural amenities, four research questions are used to interpret the outcomes of methodological techniques: (1) Which surrounding land use and natural amenity patterns significantly impact property tax revenues? (2) How do significant value relationships differ between different land uses? (3) What are the fiscal implications associated with significant value relationships? (4) And finally, what are the implications to planning policy and practice?

1.3 Research Objectives

The overall purpose of this thesis is to document and quantify the indirect fiscal implications of existing land use and natural amenity patterns to a community's property tax base in order to understand the value-added of comprehensive land use planning to a community and its residents. The fiscal implications of planning policies and regulations are evaluated through findings that reveal how the proximity to specific land uses affects the value of other land uses and how certain mixes of land uses add or detract from property tax revenues. Three primary objectives of this research aim to help improve the planner's ability to document and measure the indirect value of planning.

The first objective of this thesis is to document the fiscal implications of property tax theory, law and assessment practice to a community's property tax base and inform the hedonic modeling of property tax revenues. To achieve this objective, Michigan's "property tax equation" is applied to deconstruct the property tax base of seven case study communities in Oakland County using 2007 assessment data provided by the

Oakland County Equalization Department. Analyses of property taxes are informed by legislative guidelines mandated by the Michigan General Property Tax Act and Michigan Tax Assessors Training Manual.

The second objective of this thesis aims to improve fiscal analysis techniques through hedonic pricing. A hedonic pricing technique applies multiple regression analysis to measure relationships between property values and the surrounding planned environment for single and multi-family residential, commercial and industrial land uses. Regression coefficients reveal statistically significant causal relationships between property values and spatial variables and assign an implicit value to variables. Significant coefficients are then transformed using Michigan's property tax equation to measure the indirect fiscal impacts.

It should be noted that while a plethora of hedonic studies and applications exist, this study may be one of the first applications of the hedonic pricing technique to measure implicit property tax revenues attributed to the planned environment. The goal here is not to master the hedonic pricing technique as it applies to fiscal analysis, but rather to document methodological outcomes, challenges, limitations and lessons learned.

Finally, this thesis aims to improve the planners understanding of property tax revenues and the fiscal dimensions of policies that impact the property tax base indirectly. Findings will help planners better understand, communicate and plan for fiscal sustainability and will help improve coordination and mutual understanding between planning and property assessment professions.

1.4 Research Hypothesis

A testable hypothesis exists with each independent variable incorporated within the hedonic pricing model. For any given independent variable, the null hypothesis is that no significant relationship exists between the assessed true cash value of real property and the independent variable analyzed, all else equal.

From a higher elevation, surrounding land use patterns are hypothesized to cause both increases and decreases in the assessed value of real property. Causal relationships between property values and surrounding land use patterns are predicted to be unique to the land use being analyzed. Distance to the land use pattern is hypothesized to influence variations in value relationships between property values and spatial variables. Natural amenities, particularly lakes, are believed to significantly influence surrounding property values, especially residential values in rural communities. Due to the nature of property appraisal, the physical characteristics of building improvement are predicted to outweigh the value of location-based attributes. The location-based advantages and disadvantages that influence property values may be minimal on individual properties, but the cumulative impacts of these value relationships will likely be associated with significant fiscal impacts on a community-wide basis.

1.5 Thesis Overview

Chapter Two begins with a thorough analysis of Michigan property tax theory and assessment practice based on the Michigan General Property Tax Act and the Michigan Tax Assessors Manual. Case study communities are introduced and analyzed. Direct fiscal impacts of land use patterns are measured and the key differences between case study communities are analyzed based on urban, suburban and rural characteristics. Implications of property tax assessment are related to land use planning patterns.

Analysis of tax assessment sets the stage modeling relationships between assessed values and the planned environment in Chapter Three.

Chapter Three introduces the theoretical concepts of hedonic pricing and defines the methodology used in this thesis. A six step process for estimating the hedonic pricing function through multiple regression analysis is presented which includes (1) definition of values estimated, (2) selection of dependent variables, (3) selection of independent variables, (4) the sample geographic and real estate market frame (5) functional form of the hedonic model and (6) issues of spatial dependence and correlation. Each step in the estimation of the hedonic price function details the issues, challenges and benefits of using assessor's data within the framework of Michigan's property tax equation. Results of the hedonic pricing model are then presented. Interpretation begins by documenting statistically significant impacts on private real property values. Significant relationships between real property values and surrounding land use and natural amenity patterns are then translated to measure the fiscal impact of these relationships.

The thesis concludes in Chapter Four with a summary of findings. Limitations of the hedonic pricing technique and suggestions for future research and improvements are emphasized in the conclusion. Finally, opportunities and challenges of applying these techniques to the planning profession are discussed.

CHAPTER 2
PROPERTY TAX ASSESSMENT IN MICHIGAN: IMPLICATIONS FOR LAND USE PLANNING AND THE BOTTOM LINE

2.1 Property Tax Assessment Theory and Practice in Michigan

In Michigan, the General Property Tax Act, PA 206 of 1893 (M.C.L Sec. 211.1-211.157) establishes the legal foundation for taxation where, "all property, real and personal, within the jurisdiction of this state, not expressly exempted, shall be subject to taxation" (Sec. 211.1). Michigan uses an ad valorem tax system where taxes are based on the market value of property, commonly referred to "true cash value." Section 27 (1) of PA 206 defines "true cash value" as the usual selling price of a property at the time of assessment, being the price that could be obtained for the property at private sale.

Sec. 27(1) highlights the vital role that land use patterns and natural amenities play in the determination of true cash value, establishing that "the assessor shall consider the advantages and disadvantages of location; quality of soil; zoning; existing use; present economic income of structures…" among other factors.

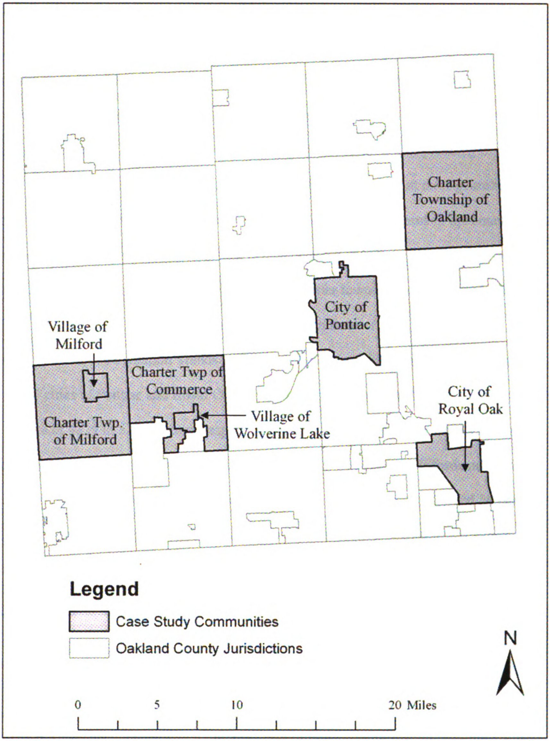
The planner influences the determination of assessed true cash value in two important ways. Land use planning and regulation influences the type, characteristics and location of development, which directly impacts assessed real property values and in large part determines the makeup of the property tax base from a land use perspective. The spatial arrangement of land uses and public infrastructure creates advantages and disadvantages associated with location, therefore indirectly impacting assessed real property values and property tax revenues.

2.2 Introduction to Property Tax Analysis in Case Study Communities

In order to document direct revenue impacts of existing land use patterns and the fiscal implications of Michigan's General Property Tax Act, the property tax bases of seven communities in Oakland County, Michigan are analyzed. The case study approach uses 2007 raw assessment data provided by the Oakland County Equalization Department, 2007 spatial data provided by the Oakland County Department of Community and Economic Development, and the principles of assessment practice mandated by the Michigan General Property Tax Act and the Michigan Tax Assessors Training Manual in order to research relationships between property tax assessment and land use development patterns.

Case study communities are introduced in "Figure 1: Selected Case Study Communities," which provides a map of case study communities and is supplemented by a population analysis in "Table 1: Population Trends in Case Study Communities." Land use patterns and direct sources of property value and property tax revenue are documented in each case study community.

Figure 1: Map of Case Study Communities



Oakland County is located in southeast Michigan and is the second most populated county in Michigan. Oakland County is composed by a diverse range of urban, suburban and rural communities. Typical of many metropolitan areas across America, suburban and exurban communities in Oakland County have experienced an increase in population and development investment, while central cities have experienced decline and disinvestment. To best analyze the indirect fiscal implications of planning in different types of communities, case study jurisdictions were chosen based on three primary criteria: (1) to represent the urban transect, (2) capture growth patterns in the county as a whole, and (3) the availability of assessors data. The cities of Pontiac and Royal Oak, villages of Wolverine Lake and Milford and the charter townships of Commerce, Milford and Oakland were chosen for fiscal analysis based on these criteria.

"Table 1: Population Trends in Case Study Communities" demonstrates that the central cities of Pontiac and Royal Oak have lost between seven and eight percent (decline of 4829 to 5348 persons respectively) of their total population from 1990 to 2000, while the suburban and exurban communities of Commerce, Milford and Oakland Charter Township have experienced population gains ranging between 26 and 50 percent. The Village of Wolverine Lake located adjacent to Commerce Township has experienced minimal population loss while the Village of Milford small population gains.

Table 1. Population Trends in Case Study Communities

	Population		Population Change	
Community	**1990**	**2000**	**Total Change**	**Percent Change**
City of Pontiac	71,166	66,337	-4,829	-7%
City of Royal Oak	65,410	60,062	-5,348	-8%
Charter Township of Commerce	26,955	34,764	7,809	29%
Village of Wolverine Lake	4,727	4,415	-312	-7%
Charter Township of Milford	12,121	15,271	3,150	26%
Village of Milford	5,511	6,272	761	14%
Charter Township of Oakland	8,227	13,071	4,844	59%

The City of Pontiac, centrally located in Oakland County, maintains a diverse tax base associated with a mix of residential and non-residential land uses shown in "Table 2. City of Pontiac Land Use and Property Value Patterns." Density plays an important role in determining direct property tax revenues in a community. Dense commercial and residential development is a source of significant property value and tax revenue within Pontiac. For a central city, uncharacteristically large amounts of vacant land exist in Pontiac. In the majority of these cases, vacant lands are residential lots with abandoned or razed structures, representing a significant loss of potential taxable value.

Table 2. City of Pontiac Land Use and Property Value Patterns

Land Use	Acres	Estimated True Cash Value	Property Tax Revenue	% Total Revenue
Commercial	776	$626,696,729	$10,136,787	20.2%
Industrial	1,627	$580,618,599	$10,545,030	21.0%
Mobile Home Park	68	$9,989,966	$182,864	0.4%
Multi-Family	507	$199,709,118	$3,122,264	6.2%
Public/Institutional*	1,342	$41,683,830	$597,261	1.2%
Railroad	61	$521,257	$13,408	0.0%
Recreation/Conservation	704	$440,050	$6,178	0.0%
Single Family, 1 to 2.5 acres	136	$16,852,028	$192,799	0.4%
Single Family; 14,000 to 43,559 s.f.	447	$122,855,095	$1,595,231	3.2%
Single Family; 2.5 to 4.9 acres	63	$4,045,514	$40,218	0.1%
Single Family; 5 to 9.9 acres	12	$606,479	$4,130	0.0%
Single Family; 8,000 to 13,999 s.f.	732	$378,303,248	$5,157,346	10.3%
Single Family; Less than 8,000 s.f.	1,767	$1,210,847,853	$16,312,785	32.5%
Single Family; More than one unit per acre	125	$20,934,325	$151,317	0.3%
Transportation, Utility, Communication	361	$14,245,262	$260,697	0.5%
Vacant	1,860	$133,416,576	$1,903,255	3.8%
Water**	10	$2,000	$53	0.0%
Undefined	337	$21,807	$179	0.0%
TOTAL	10,935	$3,361,789,736	$50,221,800	100.0%

* Public/Institutional contains both taxable and tax exempt properties. Most taxable public/institutional properties are hospitals

** In a few cases, water land use desginations represent minor inconsistencies in labeling between Equalization and Community Planning Departments

The City of Royal Oak is the oldest of the case study communities. Like Pontiac, Royal Oak demonstrates a diverse tax base representative of a central city shown in "Table 3. City of Royal Oak Land Use and Property Value Patterns." Royal Oak relies more heavily on commercial land uses than industrial land use as a source of property tax revenue when compared to the City of Pontiac. High density residential uses on lots less than 14,000 square feet account for over 65% of City's tax base.

Table 3. City of Royal Oak Land Use and Property Value Patterns

Land Use	Acres	Estimated True Cash Value	Property Tax Revenue	% Total Revenue
Commercial	377	$681,132,313	$12,846,577	15.8%
Industrial	165	$136,334,075	$2,707,263	3.3%
Multi-Family	382	$313,104,944	$6,555,839	8.1%
Public/Institutional	554	$15,882,146	$353,886	0.4%
Railroad	1	$0	$0	0.0%
Recreation/Conservation	583	$6,955,173	$127,088	0.2%
Single Family, 1 to 2.5 acres	12	$2,879,253	$31,864	0.0%
Single Family; 14,000 to 43,559 s.f.	408	$283,720,369	$3,906,187	4.8%
Single Family; 8,000 to 13,999 s.f.	912	$882,953,349	$12,657,625	15.6%
Single Family; Less than 8,000 s.f.	2,204	$2,858,545,942	$41,577,753	51.1%
Single Family; More than one unit per acre	1	$808,490	$15,793	0.0%
Transportation, Utility, Communication	55	$12,916,575	$243,706	0.3%
Vacant	43	$17,727,784	$310,851	0.4%
TOTAL	5,698	$5,212,960,413	$81,334,432	100.0%

Commerce Township, a growing suburban community rich in natural amenities, demonstrates a diverse range of land uses. "Table 4. Charter Township of Commerce Land Use and Property Value Patterns," demonstrate that high density residential land uses account for over 60% of the township's tax base while commercial and industrial land uses account for a combined 20% of the community's tax base. Commerce Township's total property tax base is over $2 million greater than the city of Pontiac and collects the highest total property tax of all case study townships.

Table. 4 Charter Township of Commerce Land Use and Property Value Patterns

Land Use	Acres	Estimated True Cash Value	Property Tax Revenue	% Total Revenue
Agricultural	209	$4,939,139	$31,684	0.1%
Commercial	495	$386,959,092	$6,667,902	12.7%
Extractive	303	$5,284,314	$97,588	0.2%
Industrial	563	$265,848,691	$4,788,735	9.1%
Mobile Home Park	209	$25,275,747	$542,138	1.0%
Multi-Family	177	$19,226,350	$394,256	0.8%
Public/Institutional	554	$9,751,557	$180,344	0.3%
Recreation/Conservation	4,881	$79,544,484	$614,407	1.2%
Single Family; 1 to 2.5 acres	982	$212,487,610	$2,575,319	4.9%
Single Family; 10 acres or greater	331	$13,156,811	$129,224	0.2%
Single Family; 14,000 to 43,559 s.f.	2,538	$1,629,236,145	$19,805,773	37.8%
Single Family; 2.5 to 4.9 acres	400	$36,131,729	$422,133	0.8%
Single Family; 5 to 9.9 acres	322	$20,815,832	$212,748	0.4%
Single Family; 8,000 to 13,999 s.f.	1,128	$1,023,507,435	$12,162,154	23.2%
Single Family; Less than 8,000 s.f.	121	$155,654,543	$1,620,374	3.1%
Single Family; More than one unit per parcel	222	$4,210,280	$55,654	0.1%
Transportation, Utility, Communication	152	$4,977,816	$73,256	0.1%
Vacant	2,213	$197,073,090	$1,970,915	3.8%
Water	70	$5,000	$4	0.0%
Undefined	18	$0	$0	0.0%
TOTAL	15,888	$4,094,085,665	$52,344,607	100%

The Village of Wolverine Lake is a small community located adjacent to Commerce Township. "Table 5. Village of Wolverine Lake Land Use and Property Value Patterns" demonstrate that over 90% of the community's property tax base consists of residential uses.

Table 5. Village of Wolverine Lake Land Use and Property Value Patterns

Land Use	Acres	Estimated True Cash Value	Property Tax Revenue	% Total Revenue
Commercial	21	$8,800,729	$194,613	3.2%
Multi-Family	40	$7,138,015	$154,393	2.6%
Public/Institutional	11	$0	$0	0.0%
Recreation/Conservation	75	$567,980	$6,149	0.1%
Single Family; 1 to 2.5 acres	11	$3,353,645	$43,927	0.7%
Single Family; 14,000 to 43,559 s.f.	220	$122,391,615	$1,774,781	29.4%
Single Family; 2.5 to 4.9 acres	3	$1,023,275	$9,869	0.2%
Single Family; 8,000 to 13,999 s.f.	257	$192,925,238	$2,862,887	47.4%
Single Family; Less than 8,000 s.f.	47	$60,257,906	$873,277	14.4%
Vacant	137	$9,836,611	$123,970	2.1%
Undefined	0	$0	$0	0.0%
TOTAL	822	$406,295,014	$6,043,867	100%

Milford Township is a rural but suburbanizing community located on the western edge of Oakland County. Development in the township consists primarily of medium and low density residential land uses shown in "Table 6. Milford Charter Township Land Use and Property Value Patterns." Single family land uses on lots 1 to 5 acres represent 55 percent of the property tax base. Recreational and conservation land use and well as industrial uses account for a significant portion of land use.

Table 6. Milford Charter Township Land Use and Property Value Patterns

Land Use	Acres	Estimated True Cash Value	Property Tax Revenue	% Total Revenue
Agricultural	189	$4,015,462	$12,731	0.1%
Commercial	80	$18,362,887	$304,590	1.5%
Extractive	436	$5,055,324	$42,524	0.2%
Industrial	1,922	$197,036,148	$3,951,331	18.9%
Mobile Home Park	154	$15,132,067	$309,681	1.5%
Multi-Family	6	$507,147	$10,949	0.1%
Public/Institutional	89	$3,855,441	$80,707	0.4%
Recreation/Conservation	5,729	$22,404,960	$84,650	0.4%
Single Family; 1 to 2.5 acres	2,363	$462,258,536	$6,676,398	31.9%
Single Family; 10 acres or greater	1,008	$29,421,787	$333,683	1.6%
Single Family; 14,000 to 43,559 s.f.	223	$94,956,008	$1,375,983	6.6%
Single Family; 2.5 to 4.9 acres	3,099	$344,963,753	$4,875,107	23.3%
Single Family; 5 to 9.9 acres	1,636	$88,304,276	$1,170,379	5.6%
Single Family; 8,000 to 13,999 s.f.	34	$27,501,182	$393,043	1.9%
Single Family; Less than 8,000 s.f.	9	$8,534,547	$109,338	0.5%
Transportation, Utility, Communication	192	$3,888,133	$54,489	0.3%
Vacant	2,877	$97,208,947	$1,129,663	5.4%
Undefined	1	$60,375	$0	0.0%
TOTAL	20,049	$1,423,466,980	$20,915,248	100%

The Village of Milford is a mature community located in the heart of Milford Charter Township. "Table 7. Village of Milford Land Use and Property Value Patterns" demonstrates that Milford Village is the urban hub of Milford. Commercial land uses account for nearly a quarter of Milford Village's tax base compared to only 1.5 percent of Milford Township's tax base. The majority of residential land uses are on lots ranging from 8,000 square feet to one acre in size revealing a much denser residential development pattern than Milford Township. Overall, residential uses account for 60 percent of the Village's total tax base.

Table 7. Village of Milford Land Use and Property Value Patterns, 2007

Land Use	Acres	Estimated True Cash Value	Property Tax Revenue	% Total Revenue
Commercial	91	$113,981,026	$2,038,583	22.7%
Industrial	23	$5,505,062	$114,361	1.3%
Multi-Family	142	$34,422,720	$419,729	4.7%
Public/Institutional	121	$1,005,200	$24,626	0.3%
Recreation/Conservation	173	$72,960	$545	0.0%
Single Family; More than one unit per parcel	0	$123,792	$2,235	0.0%
Single Family; Less than 8,000 s.f.	43	$47,498,046	$760,539	8.5%
Single Family; 8,000 to 13,999 s.f.	246	$210,047,380	$3,314,595	36.9%
Single Family; 14,000 to 43,559 s.f.	210	$111,664,932	$1,768,763	19.7%
Single Family; 1 to 2.5 acres	70	$16,890,362	$255,880	2.8%
Single Family; 2.5 to 4.9 acres	27	$2,554,979	$35,917	0.4%
Single Family; 5 to 9.9 acres	25	$901,447	$15,973	0.2%
Single Family; 10 acres or greater	22	$654,513	$11,812	0.1%
Transportation, Utility, Communication	2	$208,892	$2,859	0.0%
Vacant	166	$16,820,836	$228,117	2.5%
Water	2	$0	$0	0.0%
TOTAL	1,365	$562,352,147	$8,994,534	100.0%

Oakland Charter Township is an affluent and growing rural community located on the eastern border of Oakland County. Nearly half of the tax base and over $1.2 billion of estimated property value exists in residential properties of one quarter to one acre lots. The development market in Oakland Township is driven by a demand for high quality, low density residential development.

Table 8. Charter Township of Oakland Land Use and Property Value Patterns, 2007

Land Use	Acres	Estimated True Cash Value	Property Tax Revenue	% Total Revenue
Agricultural	257	$9,793,420	$23,818	0.1%
Commercial	79	$34,972,013	$709,567	2.1%
Industrial	4	$2,719,694	$61,507	0.2%
Mobile Home Park	87	$8,228,109	$185,980	0.5%
Multi-Family	88	$149,670	$2,038	0.0%
Public/Institutional	329	$2,678,757	$31,595	0.1%
Recreation/Conservation	5494	$77,700,543	$793,950	2.3%
Single Family; More than one unit per parcel	75	$955,039	$13,003	0.0%
Single Family; Less than 8,000 s.f.	33	$47,511,296	$630,927	1.8%
Single Family; 8,000 to 13,999 s.f.	83	$108,426,743	$1,459,837	4.2%
Single Family; 14,000 to 43,559 s.f.	1665	$1,261,753,077	$16,735,049	48.7%
Single Family; 1 to 2.5 acres	1621	$418,351,320	$5,305,177	15.4%
Single Family; 2.5 to 4.9 acres	1908	$268,934,522	$3,291,668	9.6%
Single Family; 5 to 9.9 acres	1753	$127,335,950	$1,491,606	4.3%
Single Family; 10 acres or greater	3244	$94,327,957	$1,043,030	3.0%
Transportation, Utility, Communication	57	$977,212	$19,186	0.1%
Vacant	5245	$202,153,350	$2,591,626	7.5%
Undefined	1	$0	$0	0.0%
TOTAL	22,022	$2,666,968,672	$34,389,566	100%

2.2 Measuring Assessed True Cash Value

Assessors employ a specific set of economic principles and legally established methods to determine TCV for any given property. There are three common methods used to determine the value of property in the appraisal profession: the cost approach, sale comparison approach and the income approach (Eckert et al., 1990). In Michigan, assessors primarily use cost and sales comparison approaches to appraise real property. The cost approach to assessment serves as the starting point for determining TCV. The cost approach, sometimes called the "summation approach," consists of adding together land value and improvement value. The International Association of Assessing Officers (1990) state the formula for the cost approach as:

$$V = LV + IV$$

Where V is the market value, LV is the land value and IV is the depreciated improvement value. Improvement value is defined as the cost new (CN) of improvements less depreciation (D), resulting in a final equation of:

$$V = LV + (CN - D)$$

The cost approach to value is based on the economic principle of substitution (Eckert et al., 1990). The principle of substitution assumes that an informed buyer will pay no more for a property than it would cost to create an exact replica of the property with the same utility, amenities and function (Michigan State Assessors Board [MSAB], 2002, p. 9-2). Here, the principle of substitution draws an important distinction between replacement cost and reproduction cost, which is fundamental to assessing practice in Michigan.

The State Tax Commission recommends that reproduction cost be used as the starting point for assessing the "cost new" of building improvements within the framework of the cost approach (MSAB, 2002, 9-6). The Michigan State Assessors Board (2002) defines reproduction cost as, "the cost of construction at current prices of an exact duplicate or replica using the same materials, construction standards, design, layout, and quality of workmanship, embodying all the deficiencies, superadequacies, and obsolescence of the subject building" (9-6). This differs from replacement cost which is, "the cost of construction at current prices of a building having utility equivalent to the building being appraised but built with modern materials and according to current standards, design, and layout" (9-6).

Michigan assessing departments utilize standard "cost schedules" and "depreciation rates" as the basis for estimating initial improvement value (MSAB, 2002, p.9-3). Assessors apply standard cost schedules adopted by the Michigan State Tax Commission to estimate the reproduction cost (or cost new) of building improvements. Cost schedules specify cost "multipliers" for specific building type, characteristics and class which are applied to comparable properties being assessed. Adjustments are then made by the assessor to account for various aspects of design and workmanship in construction.

Standard depreciation rates are applied to the reproduction cost of the improvement to account for the loss of value and utility attributed to the age of the structure. The result is an improvement value that represents cost new less depreciation. Standard depreciation rates are adopted by the Michigan State Tax Commission for non-residential and residential structures. Commercial and industrial structures depreciate at a rate of 1.5 percent to 4 percent each year depending on the quality of construction (MSAB, 2002, p. 9-13). All residential structures depreciate at a constant rate of one percent each year all else constant. (MSAB, 2002, p. 9-56) Along with depreciation rates, the State Tax Commission also defines an "effective life" for improvements. The effective life of a building improvement is reached when it no longer physically depreciates as long it is used. The typical effective life of a residential building is 55 years. The effective life of commercial and industrial buildings can range from 60 to 25 years depending on the quality of materials used in construction (MSAB, 2002, pp.9-15, 9-56). It should be noted that in addition to physical depreciation from natural aging, functional and economic obsolesce can accelerate depreciation while additions made to the property in some cases can counteract the assessment of depreciation.

The cost approach and the application of standard cost schedules and depreciation rates have two primary benefits to the practice of assessment: efficiency and equity. The Michigan State Assessors Board (2002) states, "the cost approach is well adapted to a mass appraisal environment, in which many properties must be appraised together, and is currently the most widely utilized of the three approaches to value"(p. 4-15). In mass appraisal, where efficiency and accuracy are the primary objectives, cost schedules and depreciation rates have been integrated within computerized BS&A assessing software, allowing for the automated application of cost multipliers and depreciation rates based on the building attributes and class. The cost new, less depreciation values computed by assessing software are commonly referred to as the "manual value" in the property appraisal profession.

To adequately assess building improvements based on their "true cash value," Michigan assessors adjust the cost new less depreciation to account for local real estate market conditions using an Economic Condition Factor (ECF). The ECF for a given property is based on recent sales of comparable properties. The Michigan State Assessors Board (2002) specifies the equation for determining an ECF as:

$$ECF = (SV/(CN\text{-}D))$$

The ECF for a recently sold property is the ratio of improvement sale value (SV) to improvement manual value (CN-D). Economic Condition Factors are calculated for all arm's length transactions in a county and are then applied to comparable properties to adjust the manual value to a more accurate assessed market value. Calculations of ECFs require numerous recent sales that occur during the same time period to ensure accuracy (MSAB, 2002, p.9-27). Assessors break down their community into various "neighborhoods" of comparable properties based on similar economic and physical characteristics, which helps guide application of ECFs to appropriate comparables.

The Michigan State Assessors Board states (2002) that, "care must sometimes be taken to limit the size of the ECF area so as not to encompass neighborhoods which do not belong together. This could lead to an ECF which properly values the ECF area as a whole but incorrectly values the neighborhoods which make up the whole" (9-28). The Michigan Assessor's Manual does not establish a standardized practice for determining ECF neighborhood boundaries. Often times ECFs can be spread across an entire county, in order to find comparables for unique properties.

Based on the application of the sales comparison and cost approach to property assessment practice in Michigan, the equation for calculating the true cash value of a property can be alternatively defined as:

$$TCV = LV + ((CN\text{-}D) * ECF)$$

2.4 Analysis of the True Cash Value of Building Improvements in Case Study Communities

Property appraisal methods used to estimate the assessed true cash value of building improvements maintains important implications for a community's bottom line that are driven by the quality and age of current building stock as well as local real estate market conditions. Tables 9 through 11 examine the determinants of assessed true cash improvement value (referred to as building value in tables) in case study communities. For each land use classification in case study communities, the average estimated true cash value, manual value, age and economic condition are presented for each construction class. Construction class is based on a scale of A through D with A representing the highest construction quality and D representing the lowest quality. Tables highlight key similarities and differences between the quality and age of building stock as well as the real estate market conditions that exist in cities, villages and townships.

Table 9. Basic Determinants of City Assessed Residential Building Values, 2007

Community	Residential Class	Residential Parcels	Average Estimated TCV	Average Manual Value	Aveage Age	Average ECF
Pontiac						
	A	2	$523,892	$516,642	48	1.01
	B	48	$266,262	$206,506	43	1.23
	BC	300	$188,002	$191,889	20	0.98
	C	5148	$108,679	$97,293	31	1.13
	CD	11642	$66,572	$55,823	39	1.19
	D	476	$39,941	$34,707	45	1.15
Royal Oak						
	A	1	$968,982	$328,468	57	2.95
	B	32	$492,306	$212,169	42	2.39
	BC	83	$455,160	$212,335	26	2.22
	C	19812	$148,124	$71,149	46	2.13
	CD	815	$107,567	$51,734	49	2.17
	D	50	$78,895	$31,740	57	2.47

"Table 9. Basic Determinants of City Assessed Residential Building Values," reveal that major differences exist in current residential real estate markets in the City Royal Oak and Pontiac, highlighted by Economic Condition Factors (ECF). While older residential buildings in Royal Oak have experienced a slightly higher degree of depreciation than those in Pontiac (shown by average manual values), single family residences have sold at a much average higher price. Average residential ECFs in Royal Oak are all well over 200 percent, demonstrating that residential selling prices are two times greater than the cost new, less depreciation. The majority of residential buildings in Pontiac are built in the CD construction classes compared to class C in Royal Oak, therefore demonstrating that the City of Pontiac has a lower overall quality of building stock than Royal Oak. While Pontiac maintains ECFs of over 100 percent in most cases, real estate market conditions add only 13 to 19 percent to residential manual values compared to 113 to 150 percent for the majority of homes in Royal Oak.

A breakdown of average manual values demonstrates that relatively similar residential reproduction costs exist in both cities, when holding age constant. Construction class appropriately demonstrates that higher quality construction results in buildings that are more costly to reproduce.

"Table 10. Basic Determinants of Township and Village Assessed Residential Building Values" demonstrate noticeable difference between the age of city, village and township residential properties, especially in high quality construction classes. Residential development built within the last ten years represents a significant source of value in case study townships and villages.

The average manual value in Commerce, Oakland and Milford Townships are extremely high within A through BC construction classes, representing some of the most valuable residential property in Oakland County. In the case of some of the higher priced construction classes, residential properties have an average ECF of less than 100%, demonstrating that homes are selling for less than their depreciated reproduction cost. In cases where manual values are low to start with, which is the case in many older central cities, ECFs less than 100 percent would cripple the property tax base, but in affluent communities it has a minimal effect.

Table 10. Basic Determinants of Township and Village Assessed Residential Building Values, 2007

Community	Residential Class	Residential Parcels	Average Estimated TCV	Average Manual Value	Aveage Age	Average ECF
Commerce Township						
	A	29	$1,024,369	$825,772	10	1.25
	B	2098	$324,487	$325,400	10	0.99
	BC	2330	$222,288	$216,060	14	1.03
	C	5666	$122,780	$111,912	26	1.09
	CD	545	$51,181	$44,945	37	1.14
	D	7	$30,087	$25,077	45	1.20
Wolverine Lake Village						
	A	5	$719,250	$621,273	14	1.16
	B	53	$359,410	$295,036	18	1.22
	BC	135	$233,248	$186,052	24	1.25
	C	1271	$105,452	$97,668	28	1.07
	CD	149	$54,805	$49,631	33	1.12
	D	0	$0	$0	0	0
Milford Township						
	A	63	$893,526	$876,245	8	1.01
	B	1208	$340,571	$346,309	12	0.97
	BC	552	$206,128	$203,632	20	0.99
	C	958	$137,925	$129,457	25	1.05
	CD	105	$78,833	$61,668	37	1.27
	D	60	$52,759	$34,394	43	1.54
Milford Village						
	A	1	$912,190	$760,158	3	1.20
	B	218	$276,506	$299,853	13	0.93
	BC	220	$190,852	$200,279	15	0.99
	C	1113	$117,616	$92,564	32	1.30
	CD	217	$82,177	$59,862	37	1.39
	D	23	$56,388	$35,315	44	1.60
Oakland Township						
	A	557	$852,308	$888,513	10	0.94
	B	2333	$354,043	$401,252	11	0.88
	BC	726	$205,478	$211,874	21	0.97
	C	1398	$143,047	$145,078	26	0.98
	CD	110	$65,353	$66,416	40	0.98
	D	27	$52,251	$40,914	43	1.24

Michigan's method of estimating the true cash value of building improvements, which emphasizes the role of age and quality, have less pronounced impacts on non-residential uses when compared to residential uses. "Table 11. Basic Determinants of Assessed Commercial, Industrial and Multi-Family Building Values" demonstrate the fiscal implications of building class, age, and economic conditions for multi-family, commercial and industrial uses in the case study communities.

Table 11. Basic Determinants of Assessed Commercial, Industrial and Multi-Family Building Values in Case Study Communities, 2007

	Building Class	Number of Parcels	Average Estimated TCV	Average Manual Value	Aveage Age	Average ECF
Commercial						
	A	45	$2,445,340	$2,211,322	14	1.18
	B	9	$2,656,288	$2,282,402	48	1.16
	C	1649	$593,849	$523,061	48	1.16
	D	320	$443,387	$395,783	54	1.13
	User Defined	35	$363,554	$332,343	47	1.12
Industrial						
	A	6	$992,394	$1,126,235	13	0.94
	B	1	$526,562	$626,860	6	0.84
	C	494	$1,686,034	$1,803,117	33	0.98
	D	20	$505,916	$537,821	27	1.01
	User Defined	78	$833,744	$861,585	20	1.04
Multi-Family						
	A	2	$3,522,120	$3,518,964	5	1.16
	B	25	$2,305,475	$2,389,490	10	0.98
	BC	19	$195,815	$152,079	5	1.32
	C	231	$496,373	$429,246	29	1.16
	CD	1	$129,501	$98,480	47	1.31
	D	445	$959,601	$842,946	62	1.17
	User Defined	36	$1,353,555	$1,145,222	41	1.18

Economic conditions seem to be supporting a relatively healthy market for multi-family and commercial uses, less so for industrial uses. Much of the industrial development in the case study communities is aging past 20 years, while the majority commercial and multi-family residential development ranges between 30 and 60 years old. The age and depreciation of non-residential buildings puts central cities like Pontiac and Royal Oak, which rely heavily on a non-residential property tax base, at a distinct disadvantage. Commercial and industrial depreciation rates adopted by the Michigan Tax Commission shown in Table 12 suggest that much of the non-residential development in the case study communities is reaching or is past its effective life.

Table 12. Commercial and Industrial Depreciation Rates

Building Characteristics	Annual Depreciation	Life Expectancy
Heavy reinforced concrete or heavy steel frame with masonry	1.5%	60-65
Reinforced concrete, steel or wood frame with masonry or wood walls	2.0%	50
Light steel or wood frame with masonry or wood walls	2.5%	40
Inexpensive retail structures and low-cost storage buildings	3.0%	30-35
Sheds, low-cost hangars and utility buildings	4.0%	20-25

In the absence of new commercial and industrial development, case study cities are forced to rehabilitate or redevelop physically obsolete buildings to combat a collectively aging built environment and depreciating property tax base.

2.5 Land Value in Case Study Communities

In the analysis of TCV little has been said about the value of land and for good reason. The Michigan State Assessors Board provides very little guidance on the determination of land value. Land values are usually determined by comparable vacant land sales and are influenced by several factors, such as location, economic conditions, physical differences, and restrictions such as zoning and building codes (MSAB, 2002, p. 7-1). Two factors in the valuation of land maintain important fiscal implications to Michigan communities. First, land does not physically depreciate therefore land values usually remain stable or increase. This finding suggests that land preservation initiatives can play an important role in maintaining fiscal stability as long as vacant land sales do not significantly decrease. Second and perhaps most germane to the planner, is the role of highest and best use in the valuation of land.

Highest and Best Use (HBU) is a fundamental starting point in the assessment of land value (MSAB, 2002, p. 3-17). HBU usually coincides with current use, which supports equitable and legally cautious assessment practices. Appendix A. provides detailed tables on vacant land values in all case study communities. An example of vacant land values in two cities is included here in Table 13 to illustrate the concept of land valuation and the fiscal implications of zoning practices.

Table 13. Vacant City Land Values Based on Highest and Best Use, 2007

CLASS	Acres	Total Land Value	Average $/Acre	Average $Tax/Parcel	Total Tax Revenue
Pontiac					
Commercial Improved	19.8	$2,641,221	$106,597	$242,971	$485,941
Commercial Vacant	197.7	$15,127,195	$147,170	$1,069	$256,529
Apartment Improved	0.9	$78,326	$87,119	$11,076	$11,076
Apartment Vacant	71.7	$4,339,012	$98,797	$405	$29,185
Industrial Vacant	251.9	$17,544,204	$107,679	$1,598	$201,394
Residential Improved	8.3	$436,000	$61,179	$1,701	$69,754
Residential Vacant	630.7	$39,867,674	$89,384	$207	$598,513
Lake Vacant	1.0	$12,000	$12,021	$315	$315
Condo Improved	2.6	$533,200	$216,235	$2,975	$35,698
Condo Vacant	107.0	$21,690,088	$310,969	$429	$214,847
TOTAL	1291.6	$102,268,920	$79,178	$490	$1,903,255
Royal Oak					
Commercial Vacant	6.0	$2,402,675	$422,077	$5,441	$54,411
Apartment Vacant	0.1	$17,520	$174,235	$287	$287
Industrial Vacant	0.5	$90,833	$166,785	$965	$1,929
Utility Vacant	0.1	$15,318	$205,340	$386	$386
Residential Improved	3.3	$930,515	$286,762	$2,792	$58,624
Residential Vacant	20.8	$5,619,254	$272,617	$1,498	$155,760
Condo Improved	2.2	$525,000	$319,338	$3,079	$21,554
Condo Vacant	2.3	$711,530	$306,859	$1,627	$17,899
TOTAL	35.2	$10,312,645	$292,704	$1,980	$310,851

The City of Pontiac contains over 1,291 acres of vacant land compared to only 35 acres in the City of Royal Oak. Classifications of vacant land identify properties with vacant building improvements as well as those that do not include any improvements. In the City of Royal Oak, a smaller supply of available land, coupled with an assumed higher demand, create higher vacant land values for commercial, residential and condo uses when compared to the City of Pontiac. Zoning regulations, which determine the function of property, clearly maintain fiscal consequences. On average, commercial and industrial land values per acre are greater than residential land values. Higher density residential zoning that creates HBUs of multi-family and condo uses are also associated with higher land values than less dense residential land values in cities.

2.6 Composition of the Property Tax Base in Case Study Communities

In Michigan, property tax assessment is based on a measure of true cash value. Table 14 and 15 present the three basic components of true cash value; improvement values, which include buildings and yard improvements and land values for case study cities and townships and villages.

Table 14. Basic Components of Property Tax Revenue in Case Study Cities, 2007

Land Use	Total Building Improvement Tax Revenue	Total Land Tax Revenue	Yard Improvement Tax Revenue	Total Tax Revenue
Commercial	$16,028,331	$6,559,527	$468,290	$22,983,363
Industrial	$10,575,485	$2,145,481	$531,326	$13,252,293
Mobile Home Park	$182,864	$48,047	$1,261	$182,864
Multi-Family	$8,538,240	$1,305,702	$96,194	$9,678,102
Public/Institutional	$809,284	$137,972	$3,892	$951,148
Railroad	$0	$13,351	$58	$13,408
Recreation/Conservation	$100,967	$30,749	$1,549	$133,265
Single Family; More than one unit per acre	$41,315	$125,719	$76	$167,111
Single Family: Less than 8,000 s.f.	$45,567,828	$12,243,017	$76,969	$57,890,538
Single Family: 8,000 to 13,999 s.f.	$13,514,955	$4,260,158	$39,858	$17,814,971
Single Family; 14,000 to 43,559 s.f.	$4,158,914	$1,317,181	$25,323	$5,501,418
Single Family, 1 to 2.5 acres	$170,127	$53,097	$1,439	$224,663
Single Family; 2.5 to 4.9 acres	$25,842	$14,151	$225	$40,218
Single Family; 5 to 9.9 acres	$2,559	$1,515	$56	$4,130
Transportation, Utility, Communication	$265,250	$203,043	$27,156	$504,403
Vacant	$615,924	$1,581,346	$16,835	$2,214,105
Water	$0	$53	$0	$53
TOTAL	$100,597,885	$30,040,108	$1,290,507	$131,556,053

Table 15. Basic Components of Property Tax Revenue in Case Study Townships and Villages, 2007

Land Use	Total Building Improvement Tax Value	Total Land Tax Revenue	Yard Improvement Tax Revenue	Total Tax Revenue
Agricultural	$7,506	$60,673	$55	$68,233
Commercial	$6,451,314	$3,155,984	$307,954	$9,915,255
Extractive	$1,764	$138,276	$71	$140,111
Industrial	$6,759,545	$1,885,296	$271,097	$8,915,934
Mobile Home Park	$1,037,799	$361,463	$495	$1,037,799
Multi-Family	$842,884	$203,402	$8,449	$981,365
Public/Institutional	$226,471	$87,507	$3,294	$317,272
Recreation/Conservation	$528,959	$961,436	$9,307	$1,499,702
Single Family: More than one unit per parcel	$52,567	$18,250	$77	$70,892
Single Family; Less than 8,000 s.f.	$2,254,698	$1,730,235	$9,518	$3,994,455
Single Family; 8,000 to 13,999 s.f.	$12,697,098	$7,431,058	$64,350	$20,192,516
Single Family; 14,000 to 43,559 s.f.	$28,784,497	$12,427,968	$234,719	$41,460,350
Single Family; 1 to 2.5 acres	$10,425,224	$4,311,990	$119,485	$14,856,701
Single Family; 2.5 to 4.9 acres	$5,829,239	$2,731,091	$74,359	$8,634,694
Single Family; 5 to 9.9 acres	$1,776,236	$1,090,058	$24,416	$2,890,707
Single Family: 10 acres or greater	$754,146	$753,443	$10,162	$1,517,750
Transportation, Utility, Communication	$23,547	$125,333	$909	$149,789
Vacant	$413,560	$5,581,034	$49,698	$6,044,291
Water	$0	$4	$0	$4
TOTAL	$78,867,054	$43,054,502	$1,188,415	$122,687,822

Building improvements account for a greater share of the property tax base in cities (76%) than in townships (63%), demonstrating that density and build-out play an important role in shaping the property tax base. Land values account for 10% more of the property tax base in townships and villages when compared to case study cities. Land values are not influenced by depreciation, therefore the larger share of the property tax base accounted for by land values may help stabilize revenues in rural and developing communities.

Cities maintain a more diversified tax base compared to townships which rely primarily on residential land uses as a source of property tax revenue. Single family residential land uses account for 76% of the total tax base in townships and villages compared to 62% in cities. Commercial and industrial uses account for a combined 27.5% of the total property total tax base in cities compared to 15% in townships and villages. Multi-family uses account for 7.4% of the cities property tax base but less than one percent in townships and villages.

2.7 Fiscal Implications of Michigan's Property Tax Equation

Michigan's property tax equation highlights four driving factors that affect property tax revenues produced by different land uses; construction quality, building age building size and market conditions. The quality of construction serves as the foundation for determining improvement value through the specification of appropriate cost schedules and depreciation rates. A high quality building stock will add greater value to a community and will depreciate at a slower rate (in the case of non-residential uses) than a low quality building stock.

Due to the reproduction cost framework that guides the cost approach to assessment Michigan, building size maintains a positive relationship with assessed manual values and property tax revenues. Communities that zone for larger buildings or have the real estate market to support such developments, receive higher tax contributions per building improvement, especially those built to superior construction quality.

Calculations of cost new, less depreciation, create a distinct fiscal advantage for newer communities when compared to older communities, holding all else constant. As communities age, real estate market conditions expressed through the economic condition factor can play a vital role in mitigating or compounding the negative fiscal impacts of building depreciation. Within a built-out community, the value of real estate transactions must increase at a rate equal to or greater than the rate of depreciation to maintain or grow the property tax base of the current building stock. In the absence of market transactions, improvement values and associated tax revenues would continue to decrease at the rate of depreciation. In a worst case scenario, real estate sales that are less than the estimated manual value (resulting in an ECF of less than one) would lower the estimated true cash value of other comparable properties, creating a ripple effect that could decrease a community's property tax base significantly.

2.8 Informing Hedonic Pricing Analysis of Indirect Fiscal Impacts through Applications of Michigan Property Tax Equation

Upon review of Michigan's property tax equation, it is determined that the hedonic pricing function can adequately measure the implicit contributions of land use and natural amenity patterns to assessed residential and non-residential property values. However, to translate implicit values derived from assessed property values to a measure of fiscal impact, the hedonic pricing function must be supplemented with other computational techniques. "Figure 2. Methodological Framework" presents a diagram of the analytical model that is used to measure indirect fiscal impacts. Each stage in the model is justified through discussion of Michigan's General Property Tax Act and established assessor practice on subsequent pages. This introduction to the methodological framework aims to lay the foundation for a more detailed methodological discussion presented in Chapter 3.

Figure 2. Methodological Framework

Stage One: Define Dependent and Independent Variables to be Measured

Linear Multiple Regression Analysis for Building Value
Dependent Variable
Building Value (Cost new, less depreciation adjusted by ECF)

Independent Variables
Building Characteristic Variables
Adjacent Land Use Variables
Buffer Land Use Variables
Socioeconomic Variables

Linear Multiple Regression Analysis for Land Value
Dependent Variable
Land Value

Independent Variables
Lot Size
Adjacent Land Use Variables
Buffer Land Use Variables
Socioeconomic Variables

Stage Two: Interpret Significant Determinants of Assessed Building and Land Value

Multiple Regression Analysis (MRA) Interpretation & Adjustments
Analyze and improve model
Identify statistically significant determinants of building and land values
Coefficients = Implicit Price for independent variables in linear MRA models

Stage Three: Calculate "Implicit" Tax Revenues Associated with Building and Land Values for each Parcel

Implicit Building Value Calculations
Calculate implicit prices for building values
IBVi

Calculate implicit tax revenues for building value coefficients (*BVITRi*) for each parcel *x*
$BVITRix = IBVix * PTVx * Mx$

Where *IBVix* is the implicit building value for independent variable *i*, property x, multiplied by the *PTV* percent taxable value and the local property tax millage rate *M* for each parcel *x*.

Implicit Land Value Calculations
Calculate implicit prices for land values
ILVi

Calculate implicit tax revenues land value coefficients (*LVITRi*) for each parcel *x*
$LVITRix = ILVix * PTVx * Mx$

Where *ILVix* is the implicit land value for independent variable *i*, property *x* multiplied by the *PTV* percent taxable value and the local property tax millage rate *M* for parcel *x*.

Stage Four: Summation of "Implicit" Tax Revenues for Building and Land Value Models

Summation of Implicit Tax Revenues
$\sum ITRix = BVITRix + LVITRix$

Aggregate total implicit tax revenues (ITR) are calculated for significant independent variables (*i*) for building and land values for all parcels (*x*)

In stage one and two, the hedonic pricing function can be used to decompose the assessed true cash value of real property given three key assumptions. First, the measure of "true cash value" is assumed to be an accurate measurement of a property's market value. Given legislative mandates set forth by Michigan's General Property Tax Act and applications of Economic Condition Factors to capture market trends, assessed true cash value meets this criteria while allowing for accurate modeling of fiscal impacts in stages three and four. The second assumption is that the assessed true cash value of building improvements and land should be modeled separately to be consistent with assessor practice. Based on review of the Michigan Tax Assessors Training Manual it is clear that a unique set of attributes are considered when determining the value of land versus the value of a land improvement; selection of independent variables aim to capture these factors using the best data available. The third assumption is that independent variables included in the hedonic model maintain a statically significantly causal relationship with assessed true cash value at the 95 percent confidence interval and that only those significant variables are associated with indirect fiscal impacts.

Stages three and four, transform modeling outcomes measured in assessed true cash value to a measure of taxable value from which property tax revenues are derived and fiscal impacts can be estimated. Michigan General Property Tax specifies that local property taxes are paid based the "taxable value" of real property, which represents the lesser of "state-equalized value" and "capped value." Taxable value is not to exceed 50 percent of true cash value for a property, as equalized[1] (Sec. 27a.1). This is the state

[1] The true cash value of property "as equalized" refers to the equalization process applied by County Board of Commissioners (CBC) and State Tax Commission (STC) which is used to ensure equitable and accurate

equalized value or SEV. The Michigan General Property Tax also establishes that, "the taxable value of each parcel of property adjusted for additions and losses shall not increase by more than the increase in the immediately preceding year in the general price level, or 5 %, whichever is less until ownership is transferred. When full or part ownership of the parcel of property is transferred as defined by law, the parcel shall be assessed at the applicable proportions of current state equalized value" (Sec. 2(a)-2(b), MSAB, 2002, p.8-1). The Michigan State Assessors Board emphasizes that, "the constitutional limit or cap on annual increases in taxable value is not applicable to increases in assessed values, (only to taxable value). Assessors are required to annually estimate the true cash value of each parcel and establish an assessment based upon that estimate." (MSAB, 2002, 8-2).

As discussed earlier in stages one and two, the hedonic model assumes that assessed true cash value is the most complete and accurate value from which implicit prices for spatial variables can be derived. The reasoning is that taxable value may differ between two exact properties depending on when the property is sold or the rate of the previous year's increase, which therefore can create different ratios of taxable value to assessed true cash value. Due to the fact that taxable value, not the assessed true cash value, determines the amount of property taxes paid, two additional steps must be added to the hedonic model to capture the fiscal impact of model outcomes shown in steps three and four. In step three, each coefficient is multiplied by the ratio of taxable value to assessed true cash value for each parcel affected. This step transforms the implicit prices

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assessment of true cash value. When the CBA and STC check annual tax rolls, each body determines if properties are less or greater than 50% of true cash value, and is required to "equalize" inadequate assessments by adding to or deducting from the valuations in order capture 50% of true cash value which represents the true cash value of that class of property.

of each variable from a measure of assessed true cash value to taxable value, which is then multiplied by the applicable millage rate for each parcel to derive the "implicit tax revenue" associated with a hedonic modeling coefficient. Step four, simply aggregates the implicit tax revenues for any given significant value determinant to ascertain the indirect fiscal impact of that value determinant on a community wide basis.

CHAPTER 3
MEASURING THE INDIRECT FISCAL IMPACTS OF THE BUILT AND NATURAL ENVIRONMENT

3.1 Measuring Indirect Fiscal Impacts through Hedonic Pricing

Planners have traditionally analyzed the fiscal impacts of development based on a *direct* contribution of costs or revenues to the community where the development is taking place (Burchell, 1978). The failure to account for the *indirect* fiscal implications of amenity value and value interactions between land use patterns is a major limitation of traditional fiscal analysis techniques (Kotval and Mullins, 2007). To quantify the indirect fiscal impacts of land use patterns and natural amenities, a modified hedonic pricing method is applied to the property tax base in case study communities. The hedonic pricing method uses multiple regression analysis to quantify statistically significant relationships between assessed real property values and surrounding land use, as well as natural and public amenity patterns, from which the indirect fiscal impacts are obtained.

Hedonic pricing is an econometric tool commonly used in non-market valuation studies. Hedonic pricing techniques have been used to assign an implicit monetary value to non-market goods such as parks and recreational opportunities (Kluvankova, 1998; Pendleton, L. & Mendelsohn, R. 2000), air quality (Zabel & Keil 2000; Chattopadhyay, 1999), water quality (Boyle et. al, 1999; Legget & Bockstael, 2000), wetlands (Mahan, 2000), view (Benson, 1998), transit (Cervero & Duncan, 2001) school quality and crime (Dubin & Goodman, 1982), zoning (Asabere & Huffman, 1997) and land use patterns (Bockstael, 1996; Geoghegan et al., 1997).

"The hedonic pricing method uses market transactions to determine the value of characteristics associated with a product. By observing the price differential between two variations in the product, the monetary trade-offs individuals are willing to make with respect to those characteristics are indirectly inferred" (Taylor, 2002 p. 332). Taylor (2002, p. 340-360) identifies six fundamental steps in estimating the hedonic pricing function which include:

1. Define the value to be estimated
2. Select the dependent variable
3. Select independent variables
4. Determine sample frame
5. Specify the functional form of the hedonic price function
6. Address spatial dependence and correlation.

These steps are used to frame mythological assumptions and techniques applied within this study.

(1) Define the value to be estimated. The hedonic model will quantify the "implicit value" of surrounding built and natural land use patterns by decomposing monetary variations in assessed true cash value. Hedonic pricing functions are estimated for single and multi-family residential, commercial and industrial land uses. Implicit values for each hedonic pricing function must be translated to a measure of "implicit property tax revenue." To obtain implicit property tax revenues, statistically significant implicit value coefficients are multiplied by the assessed to taxable value ratio and the local millage rate for each parcel. Parcel records are then aggregated to ascertain net implicit property tax revenue.

(2) Selecting the dependent variable. Assessed building and land values serve as the dependent variable in the hedonic pricing function. Consistent with assessment

practices, the hedonic pricing functions for building improvements and land are estimated separately and then combined to create a cumulative estimate of implicit value. Assessed "true cash" building and land values, which are the basis for property tax assessment in Michigan, are used instead of market transactions. Assessed building and land values allow for accurate quantification of "implicit property tax revenues" associated with independent variables.

The use of assessed values rather than market transactions represents a fundamental departure from traditional hedonic pricing methods. Assessed values for all parcel records are used, therefore eliminating sample selection biases, a frequently cited shortcoming of sales transaction data (Taylor, 2002, p. 343). The primary reasoning for using sales transactions instead of assessed value is founded on assessor bias. Assessed value may not reflect the value that a given property owner places on the value of a property's characteristics. This limitation is addressed in two ways.

First, the examination of assessor methods detailed in Chapter Two identify methodological issues and assumptions applied in the calculation of assessed TCV which inform accurate hedonic pricing techniques using assessed true cash building and land values. Secondly, a rich set of assessor data is supplemented using other key observational characteristics, which allow for a more robust determination of factors that may influence assessed building and land values.

(3) Selecting independent variables. Independent variables included in this hedonic pricing study include two types of independent variables: property characteristics and location characteristics. "Table 16. Description of Property Variables Used in Regression Analysis," identifies independent variables that describe property

characteristics. Property variables for case study communities were derived using Oakland County assessment data provided by the Oakland County Equalization Department.

Table 16. Description of Property Variables Used in Regression Analysis	
Variable	**Variable Description**
Basic Building Characteristics	
ACRES*	Lot size
AGE*	Effective age of a building
FLRAREA*	Square feet of floor area
CLASS*	Property class based on quality of construction 1 if D; 1.5 if CD; 2 if C; 2.5 if BC; 3 if B; 3.5 if AB; 4 if A
NOBLD	Number of residential buildings per lot
RESFULLB	Number of full baths
RESHLFB	Number of half baths
RESNOBED	Number of bedrooms
RESGRGAREA	Square feet of garage area
RESGARTYP	Number of car garages
Building Exterior	
RESEXT1	Aluminum,vinyl,aluminum,vinyl; 1 if yes, 0 if no
RESEXT2	asbestos; 1 if yes, 0 if no
RESEXT3	Block; 1 if yes, 0 if no
RESEXT4	Brick,brick/siding,brickcrete; 1 if yes, 0 if no
RESEXT5	Composition; 1 if yes, 0 if no
RESEXT6	Log,pine/cedar, wood; 1 if yes, 0 if no
RESEXT7	Stone, stone/siding; 1 if yes, 0 if no
RESEXT8	Stucco; 1 if yes, 0 if no
RESEXT9	Asphalt, dryvit, lap siding, masonite, metal; 1 if yes, 0 if no
Building Style	
RESSTYLE1	Bi-level; 1 if yes, 0 if no
RESSTYLE2	Bungalow; 1 if yes, 0 if no
RESSTYLE3	Cape cod; 1 if yes, 0 if no
RESSTYLE4	Colonial/2; 1 if yes, 0 if no
RESSTYLE5	Contemporary; 1 if yes, 0 if no
RESSTYLE6	Log; 1 if yes, 0 if no
RESSTYLE7	Multi-tenant; 1 if yes, 0 if no
RESSTYLE8	Other; 1 if yes, 0 if no
RESSTYLE9	Raised ranch; 1 if yes, 0 if no
RESSTYLE10	Ranch; 1 if yes, 0 if no
RESSTYLE11	Single family; 1 if yes, 0 if no
RESSTYLE12	TriLevel/qudor; 1 if yes, 0 if no

Table 16 cont. Description of Property Variables Used in Regression Analysis	
RESSTYLE13	Tudor; 1 if yes, 0 if no
RESSTYLE14	Townhouse/duplex; 1 if yes, 0 if no
RESSTYLE15	Mobile/module; 1 1 if yes, 0 if no

Three types of spatial variables are incorporated in the regression model to document the "advantages and disadvantages of location." The three typologies of location-based variables include: socio-economic characteristics, adjacent land use development patterns and surrounding land use development patterns. The first set of characteristics examines the impact of socioeconomic characteristics on assessed value. The vast majority of existing hedonic studies include information on race, income, and in some cases education. Examples from existing literature indicates that increases in median income maintain a positive relationship with non-residential property values (Bollinger et. al, 1998), educational attainment increases residential property values (Asabere & Huffman, 1997) and that racial diversity may reduce the selling price of residential homes (Cervero & Duncan, 2004).

Table 17. Social Characteristics of Case Study Communities, 2000

	Race		Educational Attainment		
Community	Percent White	Non-White	High School	Percent Bachelor's	Percent Master's or Greater
City of Pontiac	39%	61%	33%	7%	3%
City of Royal Oak	95%	5%	23%	26%	4%
Charter Township of Commerce	97%	3%	24%	23%	6%
Village of Wolverine Lake	98%	2%	30%	17%	6%
Charter Township of Milford	97%	3%	24%	20%	11%
Village of Milford	97%	3%	27%	22%	9%
Charter Township of Oakland	94%	6%	18%	29%	19%

Table 17 shows that case study communities are relatively homogenous with respect to race, with the exception of the City of Pontiac. Educational attainment is highest in Milford and Oakland Townships, with over 10 percent of the population maintain masters or professional degrees and over 20 percent of the population four-year bachelor's degrees. While educational attainment is evenly represented in case study townships and villages, the City of Royal Oak has a population with a much higher educational attainment than that of Pontiac. Table 18 demonstrates that wealth is much higher on average in case study townships and villages than in cities. The City of Pontiac has the lowest median household income of just over $31,000 which is over $20,000 less than the City of Royal Oak which has the second lowest median household income.

Table 18. Housing and Income Characteristics in Case Study Communities, 2000

	Housing and Income Characteristics			
Community	Housing Units	Percent Own	Percent Rent	Median Household Income
City of Pontiac	24,234	92%	8%	$31,207
City of Royal Oak	28,880	96%	4%	$52,252
Charter Township of Commerce	12,361	96%	4%	$72,702
Village of Wolverine Lake	1,683	97%	3%	$65,682
Charter Township of Milford	5,470	97%	3%	$67,672
Village of Milford	2,435	97%	3%	$59,688
Charter Township of Oakland	4,341	96%	4%	$102,034

Socioeconomic characteristics included in the regression analysis are shown in Table 19. Socio-economic characteristics were derived using 2000 Census block group SF1 and SF3 datasets. Census block group boundaries were overlaid with parcel boundaries using a GIS system to assign individual socioeconomic values to individual parcels.

Table 19. Description of Socio-Economic Variables Used in Regression Analysis	
Variable	**Variable Description**
PERWHITE	Percent of total population that is white exclusively
PERNWHITE**	Percent of total population that is not white exclusively
PERHS	Percent of total population with high school attainment
PERBSMSPHD	Percent of total population with bachelors, masters or PhD attainment
MEDINCOME	Median household income
PEROWN	Percent of owner occupied housing units
PERRENT**	Percent renter occupied housing units

**Removed from the multiple regression analysis to avoid the dummy variable trap.

The second set of location-based independent variables focus on the role that adjacent uses play in the determination of assessed value, shown in Table 19[2]. Spatial information on land use, natural amenities, roads, and public facilities were provided in a GIS format by the Oakland County One-Stop Shop while classifications for spatial variables were provided by the Department of Community and Economic Development.

Adjacent variables describe land uses, natural amenities, public facilities and capital investments including roads that are physically adjacent to the land use of interest. Using GIS, each category of land use to be modeled was selected, and then adjacent land uses were classified using the "select by location, share a line segment, use selected features" criteria and were coded accordingly. Adjacent variables represent true adjacency. Parcels that were located across the road from each other do not share parcel boundaries therefore are not defined as adjacent.[3] It should also be noted that for each regression model, adjacent uses that match the land use being modeled were removed from the analysis (i.e. adjacent industrial parcels were removed from industrial models).

[2] Missing numbers in variable codes represent removal of an independent variable early in model design
[3] This may be too rigid of a test to determine the monetary effect of mixed use zoning or incompatible land uses. For future analyses a 100 or 200 meter buffer may provide more telling results.

Table 20. Description of Adjacent Land Use Variables Used in Regression Analysis	
Variable	**Variable Description**
Adjacent Land Uses	
A002	Parcels adjacent to multi-family; 1 if adjacent, 0 if otherwise
A003	Parcels adjacent to commercial or office; 1 if adjacent, 0 if otherwise
A005	Parcels adjacent to industrial; 1 if adjacent, 0 if otherwise
A006	Parcels adjacent to mobile home park; 1 if adjacent, 0 if otherwise
A007	Parcels adjacent to public and institutional; 1 if adjacent, 0 if otherwise
A008	Parcels adjacent to single family parcels with more than one unit; 1 if adjacent, 0 if otherwise
A009	Parcels adjacent to single family with lot size 1 - 2.5 acres; 1 if adjacent, 0 if otherwise
A010	Parcels adjacent to single family 14000 to 43,559 sq ft; 1 if adjacent, 0 if otherwise
A011	Parcels adjacent to single family with lot size 2.5 - 5 acres; 1 if adjacent, 0 if otherwise
A012	Parcels adjacent to single family with lot size 5 - 10 acres; 1 if adjacent, 0 if otherwise
A013	Parcels adjacent to single family 8000 - 13999 sq ft; 1 if adjacent, 0 if otherwise
A014	Parcels adjacent to single family with lot size greater than 10 acres; 1 if adjacent, 0 if otherwise
A015	Parcels adjacent to single family less than 8000 sq ft; 1 if adjacent, 0 if otherwise
A016	Parcels adjacent to utility and transportation land uses; 1 if adjacent, 0 if otherwise
A017	Parcels adjacent to vacant parcels; 1 if adjacent, 0 if otherwise
Adjacent Natural Amenities	
A019	Parcels adjacent to lakes or ponds less than 19 acres; 1 if adjacent, 0 if otherwise
A020	Parcels adjacent to lakes or ponds between 19 and 49 acres; 1 if adjacent, 0 if otherwise
A021	Parcels adjacent to lakes or ponds less than 49 and 100 acres; 1 if adjacent, 0 if otherwise
A022	Parcels adjacent to lakes or ponds greater than 100 acres; 1 if adjacent, 0 if otherwise
A023	Parcels adjacent to river or stream; 1 if adjacent, 0 if otherwise
A024	Parcels adjacent to wetland (any size); 1 if adjacent, 0 if otherwise
A027 *	parcels adjacent to natural areas with priority one; 1 if adjacent, 0 if otherwise
A028 *	parcels adjacent to natural areas with priority two; 1 if adjacent, 0 if otherwise
A029 *	parcels adjacent to natural areas with priority three; 1 if adjacent, 0 if otherwise
*Natural conservation priorities are established in Oakland County Conservation Plan	

Table 20 cont. Description of Adjacent Land Use Variables Used in Regression Analysis

Adjacent to Public Infrastructure	
A030	Parcels adjacent to recreation area (of any type); 1 if adjacent, 0 if otherwise
A031	Parcels adjacent to municipally owned park or recreation area; 1 if adjacent, 0 if otherwise
A034	Parcels adjacent to school; 1 if adjacent, 0 if otherwise
A040	Parcels adjacent to urban interstate; 1 if adjacent, 0 if otherwise
A041	Parcels adjacent to urban principal arterial; 1 if adjacent, 0 if otherwise
A042	Parcels adjacent to urban non-freeway; 1 if adjacent, 0 if otherwise
A043	Parcels adjacent to county, local, urban local road; 1 if adjacent, 0 if otherwise
A044	Parcels adjacent to county, local, rural local road; 1 if adjacent, 0 if otherwise
A045	Parcels adjacent to county, local, urban collector road; 1 if adjacent, 0 if otherwise
A046	Parcels adjacent to county, primary, rural minor arterial road; 1 if adjacent, 0 if otherwise
A047	Parcels adjacent to county, primary, rural major collector road; 1 if adjacent, 0 if otherwise
A048	Parcels adjacent to county, primary, urban non-freeway; 1 if adjacent, 0 if otherwise
A049	Parcels adjacent to county, primary, urban minor arterial road; 1 if adjacent, 0 if otherwise
A050	Parcels adjacent to county, primary, urban collector road; 1 if adjacent, 0 if otherwise
A051	Parcels adjacent to city, major, urban local road; 1 if adjacent, 0 if otherwise
A052	Parcels adjacent to city, major, urban collector road; 1 if adjacent, 0 if otherwise
A053	Parcels adjacent to city, major, urban minor arterial road; 1 if adjacent, 0 if otherwise
A054	Parcels adjacent to city, major, urban non-freeway; 1 if adjacent, 0 if otherwise
A055	Parcels adjacent to city, minor, urban local road; 1 if adjacent, 0 if otherwise

The final group of location-based independent variables focuses on the contributions of surrounding land uses and natural amenities to assessed building and land values. "Proximity variables," shown in Table 21 define land uses located within a quarter mile of a given property[4]. Quarter mile buffers are a frequently cited distance incorporated within many hedonic studies and represent a commonly cited walking distance in the planning profession. To create proximity variables a GIS buffer function was used. Quarter mile buffers were created for each land use using the "select by location, intersect function" to identify and code proximity variables.

Table 21. Description of Proximity Variables Used in Regression Analysis	
Variable Code	**Variable Description**
B001	Within .25 miles of agriculture; 1 if yes, 0 if no
B002	Within .25 miles of multi-family; 1 if yes, 0 if no
B003	Within .25 miles of commercial and office; 1 if yes, 0 if no
B005	Within .25 miles of industrial; 1 if yes, 0 if no
B006	Within .25 miles of mobile home park; 1 if yes, 0 if no
B007	Within .25 miles of public or institutional; 1 if yes, 0 if no
B008	Within .25 miles of railroad; 1 if yes, 0 if no
B009	Within .25 miles of recreation area (of any type); 1 if yes, 0 if no
B013	Within .25 miles of utility and transportation; 1 if yes, 0 if no
B014	Within .25 miles of lake or pond, between 0 and 19 acres; 1 if yes, 0 if no
B015	Within .25 miles of lake or pond, between 19 and 49 acres; 1 if yes, 0 if no
B016	Within .25 miles of lake or pond, between 49 and 100 acres; 1 if yes, 0 if no
B017	Within .25 miles of lake or pond greater than 100 acres; 1 if yes, 0 if no
B018	Within .25 miles of stream or river; 1 if yes, 0 if no
B021	Within .25 miles of natural areas, priority one; 1 if yes, 0 if no
B022	Within .25 miles of natural areas, priority two; 1 if yes, 0 if no
B023	Within .25 miles of natural area, priority three; 1 if yes, 0 if no
B024	Within .25 miles of schools; 1 if yes, 0 if no
B032	Within .25 miles of government facility 1 if yes, 0 if no
B033	Within .25 miles of fire station; 1 if yes 0 if no
B034	Within .25 miles of police station; 1 if yes 0 if no
B037	Within .25 miles of wetland; 1 if yes 0 if no

Few studies have examined the impact of land use patterns on property values. Bockstael (1996) and Geoghegan et. al (1997) emphasize that the value of a residential

[4] Missing numbers or ill-logical sequence of numbers in variable codes represents removal or manipulation of an independent variable early in model design.

parcel is affected by the pattern of surrounding land uses and landscape, not just the specific features of point locations. Geoghegan et al. (1997) and Acharya and Bennet use indices to address the spatial differences in land use patterns and the affects on property values. While these indices present some indication of the surrounding number of land uses, they fail to indicate the land uses that compose that mix. For this reason, emphasis of this study relies on dummy variables to model the implicit values of proximity variables.

(4) Sample frame. The hedonic price function is an equilibrium function that describes a specific market (Taylor, 2002, p. 350). In Oakland County, separate real estate markets are assumed to exist for single family residential uses in cities versus townships and villages, therefore two single-family hedonic pricing functions are estimated. Commercial, industrial and multi-family are assumed to operate in one real estate market in Oakland County, therefore hedonic pricing functions include parcel records from all case study communities. It should be noted that the vast majority of records in non-residential and multi-family models are found in the City of Pontiac and City of Royal Oak.

(5) Functional form of the hedonic price function. Linear multiple regression analysis is used to estimated the hedonic price function for assessed building and land values. While linear multiple regression analysis is usually not the preferred econometric technique (Taylor, 2002, p. 339) it offers several benefits given the orientation of this study. Linear regression techniques enable straight forward implicit price interpretation and calculations. Linear regressions also meet the research goal of identifying statistically significant relationships in which land use patterns and natural amenities influence

assessed property values. It should be noted that linear functional forms will likely distort the implicit value of square footage and lot size which maintain non-linear relationships with property value. Box-cox regression forms that allow for linear and non-linear specifications were tested (see limitations for more information).

(6) Address Spatial Dependence and Correlation. Appendix B. explores potential affects of spatial bias on statistically significant regression coefficients. Appendix B breaks down hedonic model samples, identifying statistically significant independent variables and the number and percentage of cases in the sample and associated average building and land values. Given the strong spatial component of independent variables spatial autocorrelation could exist, which is especially true for adjacent variables which usually demonstrate a very small percentage of the sample. Simple logic tests founded on the economic principles of scarcity and utility are applied when interpreting spatial biases. For example, lakefront properties compose less than five percent of the total overall residential sample. In this case, scarcity and utility of private waterfront ownership increase demand, resulting in higher building and land values, therefore the issue of spatial autocorrelation diminishes. Spatial biases are recognized when the utility of the property is not clearly influenced by an adjacent land use or natural feature, and location merely coincides with extreme observations in reliable value determinants such as age, class and square footage.

3.2 Empirical Estimates and Regression Results

Linear multiple regression analysis is used to estimate the hedonic pricing function for assessed "true cash" building value and land value for residential, commercial, industrial and multi-family land uses. Table 55 and 56 presents the summaries of MRA model outcomes.

Table 22. Building Value Model Summaries

Land Use	R	R Square	Adjusted R Square	Std. Error of the Estimate	df	F	Sig.
City Single Family Residential	0.935	0.874	0.874	25,217.87	87	3,054.66	0.000
Township Single Family Residential	0.929	0.863	0.862	43,837.61	96	1,401.25	0.000
Commercial	0.898	0.806	0.800	541,526.02	55	144.79	0.000
Industrial	0.954	0.910	0.900	2,479,714.58	48	97.46	0.000
Multi-Family	0.956	0.913	0.906	401,287.69	57	118.82	0.000

Table 23. Land Value Model Summaries

Land Use	R	R Square	Adjusted R Square	Std. Error of the Estimate	df	F	Sig.
City Single Family Residential	0.829	0.688	0.687	13,001.17	60	1,403.02	0.000
Township Single Family Residential	0.813	0.661	0.660	37,144.31	70	596.24	0.000
Commercial	0.825	0.681	0.673	283,826.72	51	80.57	0.000
Industrial	0.618	0.381	0.323	587,397.96	44	6.56	0.000
Multi-Family	0.598	0.358	0.310	145,808.93	48	7.56	0.000

Building value and land value models produced statistically significant results demonstrated by R-squared values that explain between 35.8% to 68.8% of the variance in land values and 80.6% to 91.3% of the variance in assessed building values. Building value models demonstrate a high degree of explanatory power and relative consistency in comparison to land value models. Building value models explain approximately 87% of the variance in assessed value for city single family residential buildings, 86% for township and village residential buildings, 80% commercial buildings, and 91% for industrial and multi-family buildings. Land value models explain 83% and 81% of the variance in land values for single family residential, 68% for commercial, 38% for industrial and 35% for multi-family residential.

Constant terms were significant for city single family residential building value

(-82,552) models, township and village single family residential building value (126,271) and land value models (326,066), and commercial building value (468,755) models.[5] Constant terms were insignificant for city single family land values, industrial and multi-family models and commercial land value models. Constant terms, or the starting point (y-intersect) for projecting the best-fit regression line, play an important role in interpretation of regression coefficients. Of greatest consequence, the negative constant term for city residential building values indicates that several positive relationships exist that raise residential values up to positive values from a negative starting point.

Regression coefficients are considered statistically significant if they demonstrate a significance level of less than 5 percent. Regression coefficients represent the implicit values assigned to independent variables. In the case of dummy variables, the coefficient equals the implicit price of the associated variable. In the cases of independent variables expressed as a scale or percentage, implicit prices must be transformed to show the incremental change in monetary value attributed to an incremental change in percentage or scalar value.

3.2.1. Basic Property Attributes

"Table 24. Linear Regression Coefficient Estimates for Residential Building Characteristics," demonstrates that basic property attributes including class, age, square footage, lot size and the number of structures were statistically significant in almost all cases for residential and non-residential building value models, in line with Michigan assessor practice.

[5] The unit of measurement for the constant term is dollars, just as the unit of measurement for implicit regression coefficients. The constant term represents the starting value from which the best-fit regression line is projected.

Table 24. Linear Regression Coefficient Estimates for Basic Property Attributes

Land Use	Coefficient	Std. Error	T	Sig.
City Single Family Residential				
Class	17,114.06	710.68	24.08	.000
Age	-1,207.94	15.95	-75.72	.000
Floor Area	63.60	0.49	130.07	.000
Lot Size (BV)	6,377.24	1,375.20	4.64	.000
Lot Size (LV)	80,765.45	550.85	146.62	.000
Number of Buildings	48,563.28	763.75	63.59	.000
Township Single Family Residential				
Class	33,846.08	1,249.15	27.10	.000
Age	-1,257.21	41.37	-30.39	.000
Floor Area	70.37	0.76	92.71	.000
Lot Size (BV)	-87.57	127.03	-.69	.491
Lot Size (LV)	11,084.12	106.46	104.11	.000
Number of Buildings	-37,186.06	4,289.36	-8.67	.000
Commercial				
Class	-25,603.43	35,465.73	-.72	.470
Age	-5,737.43	555.12	-10.34	.000
Floor Area	55.33	1.28	43.18	.000
Lot Size (BV)	14,455.45	12,490.79	1.16	.247
Lot Size (LV)	194,264.04	4,159.73	46.70	.000
Number of Buildings	-8,975.12	14,653.13	-.61	.540
Industrial				
Class	1,114,488.29	545,361.33	2.04	.042
Age	-29,512.95	7,057.14	-4.18	.000
Floor Area	18.36	0.46	39.95	.000
Lot Size (BV)	43,644.73	4,234.67	10.31	.000
Lot Size (LV)	9,830.25	755.52	13.01	.000
Number of Buildings	745,183.30	48,979.63	15.21	.000
Multi-Family				
Class	165,572.62	44,360.42	3.73	.000
Age	-355.21	950.42	-.37	.709
Floor Area	33.25	0.67	49.68	.000
Lot Size (BV)	5,002.63	5,503.07	.91	.364
Lot Size (LV)	14,674.95	1,848.86	7.94	.000
Number of Buildings	-4,834.07	4,142.23	-1.17	.244

3.2.1.1 Construction Class

Construction class is a statistically significant determinant of building value for single family, industrial and multi-family land uses, confirming that a positive relationship exists between quality of construction and building value. Construction class is modeled using a scale of one to four with one (typically referred to as Class D) representing the lowest construction quality and four (Class A) the highest quality. The implicit price of an incremental change in residential construction class accounts for $33,846 of building value in townships and villages and $17,114 in cities. Construction quality can account for a potential difference of $101,538 in building value when comparing class A and D residential properties in township and village residential markets and $51,342 in city markets. Construction class accounts for $1.11 million incremental change in building value for industrial properties, however it should be noted that over 80% of the industrial sample is designated as class C (2) construction. For multi-family uses, construction quality adds an incremental value of $165,500 to building value.

Construction class was found to be an insignificant determinant of commercial building value, indicating that other factors related to building or location characteristics may outweigh the role that quality plays in the determination of commercial building value.

3.2.1.2 Age

Age demonstrates a statistically significant negative relationship with single family, commercial and industrial building values. An incremental increase in age for non-residential properties is associated with a $25,603 decrease in commercial properties and $29,512 for industrial properties, which adequately represent standard depreciation schedules adopted by the State Tax Commission. Age has a similar impact in case study residential markets representing, a $1,207 incremental decrease of building value in city residential structures and $1,257 for township and village structures.

3.2.1.3 Square Footage

In line with a priori expectations, square footage is a statistically significant determinant of building values in all cases. Square footage coefficients are the highest for township and village single family residential buildings at $70.37 per square foot and lowest for industrial buildings at $18.36 per square foot. Single family residential building values (city $63.60 and township-village $70.37) are higher than non-residential (commercial $55.33, industrial $18.36) and multi-family ($33.25) values due to economies of scale realized from larger building footprints.

3.2.1.4 Lot Size

Lot size was modeled for both building value and land value models. While lot size is not a building attribute, it is assumed to correlate with market preference for built structures, which is inline with application of the ECF. Lot size is positively correlated with land values in all cases. Lot size contributes $194,264 per acre to land value for commercial land uses, $80,765 for city single family residential, $14,675 for multi-family uses, $11,084 for township and village uses and $9,830 for industrial lands. Lot size variables for land value models clearly demonstrate the value implications of density. For high density uses such as single family residential, commercial and multi-family uses, the value of land increases, but for low density or large lot sizes land values are lower.

Lot size shows both significant and insignificant relationships with building value. Lot size is a significant determinant of building value for city residential ($6,377 per acre) properties and industrial properties ($43,644). In both of these cases, market preference for larger lots likely drives the significant positive relationship with building value, while in the case of commercial, township residential and multi-family uses lot size does not determine increased market demand for buildings.

3.3.1.5 Number of Structures

The number of structures, while not clearly interpreted by assessors, represents "secondary structures," which can be significant for industrial properties in particular. The number of buildings is positive and significant for city residential properties ($48,563) and negative and significant for township and village single family uses (-$37,186). Each additional industrial structure, adds $745,183 in building value for industrial properties. It should be noted that the number of buildings, as coded and interpreted by assessors requires additional study to be accurately modeled.

3.3.2 Residential Building Attributes.

Residential building attribute, shown in "Table 25: Linear Regression Coefficient Estimates for Residential Building Characteristics," including the number of bathrooms and garage size contribute positively to building value in line with modeling expectations. The number of bedrooms however demonstrates significant negative relationships with building value in both city and township and village models. One possible explanation for the negative coefficient associated with bedrooms is "double counting" of floor area. The number of bedrooms and bathrooms is already accounted for in square footage, therefore the value of square footage and bathroom coefficients may be artificially high while the negative value of bedrooms may demonstrate a necessary reduction in building area values. When modeling the value contributions of a garage, a similar double counting scenario appeared when both garage area and garage type (number of cars) were modeled together. Exclusion of bedrooms and bathrooms would likely improve the efficiency of models and more accurately measure the value impacts of floor area or vice versa.

Table 25. Linear Regression Coefficient Estimates for Residential Building Characteristics

	City Model				Township and Village Model			
	Coefficient	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Bedroom	-3,288.90	204.15	-16.11	.000	-6,779.77	413.57	-16.39	.000
Full Bath	15,504.38	309.16	50.15	.000	24,483.87	630.17	38.85	.000
Half Bath	9,642.36	326.55	29.53	.000	12,553.68	677.68	18.52	.000
Garage Area	24.72	0.64	38.52	.000	36.84	1.49	24.65	.000
Garage Type	0.00	0.01	-.18	.855	-6,073.56	608.64	-9.98	.000
Residential Exteriors*								
Asbestos	-1,212.68	547.75	-2.21	.027	11,687.86	3,321.17	3.52	.000
Block	-5,541.91	1,920.34	-2.89	.004	-2,473.29	4,964.57	-.50	.618
Brick	14,702.11	341.63	43.04	.000	22,227.06	759.60	29.26	.000
Composition	-1,629.94	1,206.10	-1.35	.177	13,335.27	9,491.91	1.40	.160
Wood	572.96	1,179.54	.49	.627	8,559.83	3,630.38	2.36	.018
Stone	9,542.60	3,345.91	2.85	.004	60,058.08	8,651.71	6.94	.000
Stucco	5,949.01	1,406.81	4.23	.000	31,199.89	11,778.11	2.65	.008
Other	-4,669.68	3,853.77	-1.21	.226	-5,367.44	5,023.22	-1.07	.285
Residential Style**								
Bi-Level	-22,846.53	2,604.36	-8.77	.000	-33,249.74	6,624.74	-5.02	.000
Bungalow	13,735.98	378.05	36.33	.000	21,609.48	3,815.83	5.66	.000
Cape Cod	-4,439.44	1,888.26	-2.35	.019	2,539.84	5,561.94	.46	.648
Colonial	2,821.52	530.99	5.31	.000	-4,569.26	1,829.56	-2.50	.013
Contemporary	-713.22	4,053.71	-.18	.860	33,402.40	2,618.90	12.75	.000
Other	-21,290.76	838.03	-25.41	.000	-13,151.59	3,426.78	-3.84	.000
Single Family	16,169.85	401.13	40.31	.000	-518.42	2,193.45	-.24	.813
Tri-Level/Qudor	-34,503.17	1,389.28	-24.84	.000	-11,476.05	21,977.44	-.52	.602
Tudor	-26,251.95	3,205.58	-8.19	.000	66,885.02	7,710.93	8.67	.000
Townhouse/Duplex	-9,996.63	3,611.25	-2.77	.006				

*Aluminum, aluminum and vinyl, vinyl were removed from the analysis to avoid the dummy variable trap, coefficients represent a deviation in value when compared to aluminum and vinyl exteriors.

**Ranch building styles were removed from the analysis to avoid the dummy variable trap, coefficients represent a variation in value when compared to ranch housing styles

Wood represent log, pine and cedar and wood building materials

Other represents asphalt, dryvit, lap siding, masonite, metal and other building materials

3.2.2.1 Residential Exteriors

Residential exteriors are associated with both positive and negative contributions to building value in case study communities. High quality building materials such as brick ($14,700 city; $22,220 township), stone ($9,540 city; $60,000 township) and stucco ($6,000 city; $32,000 township) add significant value to residential buildings. Low quality materials, especially those found in older city residential properties, such as asbestos (-$1,200), block (-$5,500) and composition (-$1,630) detract from building value.

3.2.2.2 Residential Building Style

Residential building styles contribute to a high degree of variation in value between city and township residential markets. For example, contemporary ($33,400) and tudor ($66,900) building styles add significant value to residential buildings in townships and villages but subtract value from city residential properties (contemporary -$700 and tudor, -$26,250). Similarly, colonial building styles contribute $2,800 to building value in cities but subtract over $4,500 in townships and villages. Bi-level, tri-level and "other" building styles diminish building value in both residential markets while bungalow building styles add value. These results help confirm that fundamentally different real estate markets exist between case study communities.

3.2.3 Socio-Economic Characteristics

Building and land value models reveal that social and economic conditions play an influential role in determining residential property values and to a lesser extent non-residential property values. "Table 26. Linear Regression Coefficient Estimates for Socioeconomic Attributes" demonstrates that race, educational attainment and household income variables maintain a positive relationship with residential building and land values in cities and a negative relationship in townships and villages. While outcomes for socioeconomic variables fell in line with expectations for city models, unexpected relationships in the townships and village could be explained by large census block configurations with relatively consistent socioeconomic attributes causing a spatial statistical bias.

Table 26. Linear Regression Coefficient Estimates for Socioeconomic Attributes

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
City Single Family Residential								
White (%)	319.23	737.88	43.26	.000	104.53	361.78	28.89	.000
H.S. Education (%)	152.84	2,345.20	6.52	.000	-30.87	1,200.63	-2.57	.010
College Education (%)	915.42	2,042.72	44.81	.000	502.82	994.98	50.54	.000
Med. Household Income	0.21	0.02	10.40	.000	0.20	0.01	19.22	.000
Owner-Occupied (%)	-82.10	1,088.92	-7.54	.000	-97.10	550.55	-17.64	.000
Township Single Family Residential								
White (%)	-699.05	18,261.06	-3.83	.000	-2,029.85	15,225.03	-13.33	.000
H.S. Education (%)	-613.28	10,330.89	-5.94	.000	-564.53	8,678.46	-6.50	.000
College Education (%)	-147.80	6,623.42	-2.23	.026	95.92	5,427.28	1.77	.077
Med. Household Income	-0.26	0.04	-6.57	.000	-0.05	0.03	-1.38	.167
Owner-Occupied (%)	-475.83	6,406.41	-7.43	.000	-316.23	5,400.13	-5.86	.000
Commercial								
White (%)	-469.86	75,517.88	-.62	.534	1,293.91	39,352.28	3.29	.001
H.S. Education (%)	2,837.37	227,617.19	1.25	.213	1,955.99	118,884.34	1.65	.100
College Education (%)	3,345.28	167,977.95	1.99	.047	4,536.46	87,713.26	5.17	.000
Med. Household Income	3.50	1.54	2.27	.024	-0.69	0.81	-.85	.394
Owner-Occupied (%)	-3,607.17	100,826.94	-3.58	.000	-1,182.13	52,757.19	-2.24	.025
Industrial								
White (%)	-7,807.72	899,267.86	-.87	.386	-25.96	202,707.06	-.01	.990
H.S. Education (%)	-53,581.04	2,985,471.96	-1.79	.073	8,171.23	674,789.78	1.21	.227
College Education (%)	-26,661.59	1,740,583.90	-1.53	.126	9,194.39	393,952.56	2.33	.020
Med. Household Income	18.88	15.78	1.20	.232	0.77	3.57	.21	.830
Owner-Occupied (%)	-32,767.42	1,014,022.79	-3.23	.001	-9,502.98	229,504.84	-4.14	.000
Multi-Family								
White (%)	574.84	123,182.75	.47	.641	11.83	41,472.88	.03	.977
H.S. Education (%)	1,953.57	274,964.18	.71	.478	1,535.11	97,840.76	1.57	.117
College Education (%)	2,300.12	233,418.36	.99	.325	1,574.84	82,859.90	1.90	.058
Med. Household Income	-1.15	2.78	-.42	.678	-0.27	0.97	-.27	.784
Owner-Occupied (%)	-2,652.01	156,249.43	-1.70	.090	-1,268.14	54,870.66	-2.31	.021

Coefficients are adjusted to show dollar increase in building and land value associated with percentage increase in independent variables that are expressed as a percentage

Med. household income stands for median household income, H.S. stands for high school education, owner-occupied stands for percentage of households that are owner-occupied

Racial diversity is a statistically significant determinant of building and land value for residential properties but not for multi-family and only commercial land value in the case of non-residential properties. Regression results show that the percentage of the population that is white maintains a negative relationship with townships and cities residential property values, demonstrated by an incremental decrease in value of approximately $700 in building value and over $2,000 in land value. In case study cities, as the percentage of the white population increases, so to does residential building value ($319) and land value ($104).

College education maintains a positive relationship with city single family building ($915) and land values ($502), commercial property (building, $3,345) and industrial land values $4,536) and demonstrates the broadest and highest value impacts across land use type of any statistically significant socioeconomic variable.

3.2.4 Adjacent and Surrounding Land Use Patterns

Adjacent and buffer variables measure the dynamic value interactions between different land uses and geographic land use patterns. For each land use model, coinciding land use variables (i.e. adjacent and buffer commercial variables are removed from commercial building and land models) are removed to better interpret value implications of mixed use development. In the case of single family residential models, buildings with a lot size less than 8,000 square feet, the highest density residential designation, are removed to interpret the implications of surrounding residential densities on building and land values. It should be noted that residential buffer variables are removed from the analysis because they cover the vast majority of land area within the case study communities.

Table 27. Impacts of Land Use Patterns on City Single Family Residential Property Values

Linear Regression Coefficient Estimates for Adjacent Land Uses

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
City Single Family Residential								
Multi-Family	-1,199.91	714.71	-1.68	.093	434.05	366.79	1.18	.237
Commercial	-4,587.69	795.01	-5.77	.000	885.71	409.43	2.16	.031
Industrial	-2,996.66	1,852.39	-1.62	.106	-3,071.69	953.25	-3.22	.001
Public-Institutional	-2,283.13	836.68	-2.73	.006	-2,134.40	428.80	-4.98	.000
Utility-Transportation	475.54	731.31	.65	.516	-290.48	376.90	-.77	.441
Vacant	482.10	409.65	1.18	.239	-1,384.72	209.11	-6.62	.000
Single Family Residential								
More than one unit per lot	13,771.19	4,236.64	3.25	.001	21,873.97	2,166.82	10.09	.000
Lot size; 8,000 - 13,999 s.f.	-2,846.59	276.30	-10.30	.000	2,983.83	139.52	21.39	.000
Lot size; 14,000-25,000 s.f.	4,427.49	459.15	9.64	.000	-154.80	228.99	-.68	.499
Lot size; 1-2.5 ac.	1,626.89	1,815.73	.90	.370	-38,548.59	906.42	-42.53	.000
Lot size; 2.5 - 5 ac.	248.00	3,401.56	.07	.942	-51,271.94	1,721.92	-29.78	.000
Lot size; 5 - 10 ac.	13,936.70	8,838.79	1.58	.115	-86,925.45	4,527.88	-19.20	.000

Linear Regression Coefficient Estimates for Land Uses within Quarter Mile Buffer

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
City Single Family Residential								
Multi-Family	-1,744.92	360.35	-4.84	.000	-2,404.91	250.35	-4.92	.056
Commercial	4,522.34	409.93	11.03	.000	-1,835.69	210.38	-8.73	.000
Industrial	243.69	339.68	.72	.473	-2,481.56	173.74	-14.28	.000
Mobile Home	-7,672.21	1,098.47	-6.98	.000	-5,554.27	565.21	-9.83	.000
Public-Institutional	-729.67	432.15	-1.69	.091	-1,308.17	222.31	-5.88	.000
Railroad	1,488.58	402.44	3.70	.000	-136.07	205.66	-.66	.508
Utility-Transportation	-1,734.27	307.18	-5.65	.000	168.49	157.86	1.07	.286

Table 27 demonstrates that adjacent commercial land uses decrease city single family residential building values by -$4,587 but increase building value by $4,522 when within a quarter mile, suggesting that neighborhood commercial nodes may elevate surrounding residential livability and property values if properly designed. Public and institutional uses detract from city residential property values in the cases of adjacency (-$4,417 combined building and land implicit values) and proximity (-$1,308 land value only). Industrial land uses do not impact city residential building values, but do impact land values to the magnitude of -$3,072 in the case of adjacency and -$2,481 in the case of quarter mile proximity. Multi-family and mobile homes located within a quarter mile coincide with decreases in city building value of -$1,744 and -$7,672 respectively, however adjacent condo developments (residential uses with more than one unit per lot) may increase building value significantly, suggesting that quality or design of development may mitigate the impacts higher residential densities on single family property values. It is unclear whether city residential densities impact property values. Adjacent residential lot sizes of 8,000 to 14,000 square feet decrease city building values by -$2,846 but increase land values by $2,983, therefore having minimal overall impact. As lot size decreases, adjacent land values fall in cities, however few samples exist to confirm this finding.

Table 28. Impacts of Land Use Patterns on Township and Village Single Family Residential Property Values

Linear Regression Coefficient Estimates for Adjacent Land Uses

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Township Single Family Residential								
Multi-Family	-6,058.62	2,891.22	-2.10	.036	-4,856.66	2,445.00	-1.99	.047
Commercial	7,002.13	2,403.50	2.91	.004	3,507.70	2,033.72	1.72	.085
Industrial	5,188.24	5,254.06	.99	.323	-12,183.30	4,421.36	-2.76	.006
Public-Institutional	5,174.10	2,948.58	1.75	.079	2,386.15	2,496.73	.96	.339
Utility-Transportation	-8,247.15	3,833.86	-2.15	.031	6,040.10	3,242.61	1.86	.063
Vacant	7,639.46	753.70	10.14	.000	11,391.77	636.04	17.91	.000
Single-Family Residential								
More than one unit per lot	-20,229.08	4,554.60	-4.44	.000	-32,837.22	3,841.87	-8.55	.000
Lot size; 8,000 - 13,999 s.f.	-5,351.37	825.65	-6.48	.000	-6,767.27	682.60	-9.91	.000
Lot size; 14,000-25,000 s.f.	2,044.71	720.49	2.84	.005	2,426.98	596.11	4.07	.000
Lot size; 1-2.5 ac.	884.61	861.67	1.03	.305	51.31	719.04	.07	.943
Lot size; 2.5 - 5 ac.	398.51	1,099.23	.36	.717	2,583.02	915.94	2.82	.005
Lot size; 5 - 10 ac.	-1,500.87	1,305.76	-1.15	.250	5,035.91	1,101.76	4.57	.000
Lot size; greater than 10 ac.	-5,193.15	1,597.22	-3.25	.001	3,002.52	1,350.23	2.22	.026

Linear Regression Coefficient Estimates for Land Uses within Quarter Mile Buffer

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Township Single Family Residential								
Agricultural	-12,112.80	1,577.24	-7.68	.000	6,593.11	1,325.85	4.97	.000
Multi-Family	-378.73	967.83	-.39	.696	-3,881.03	815.98	-4.76	.000
Commercial	1,492.40	849.35	1.76	.079	-4,976.92	715.40	-6.96	.000
Industrial	1,299.60	1,339.53	.97	.332	-4,991.11	1,130.71	-4.41	.000
Mobile Home	-1,268.23	2,742.64	-.46	.644	-14,545.88	2,311.95	-6.29	.000
Public-Institutional	1,464.49	796.86	1.84	.066	-6,721.56	672.87	-9.99	.000
Railroad	-8,691.54	2,004.46	-4.34	.000	-11,518.91	1,679.63	-6.86	.000
Utility-Transportation	-4,302.34	801.40	-5.37	.000	-1,784.34	674.86	-2.64	.008

Table 28 shows that residential land values in townships and villages are significantly affected by surrounding non-residential land uses and residential densities but not building values. Single family land values are negatively impacted by all non-residential uses located within a quarter mile proximity except for agricultural, with value reductions ranging from -$14,545 for mobile homes to -$1,784 for utility and transportation uses. Nearby commercial and industrial uses reduce single family residential land values by nearly -$5,000 each. Adjacent residential densities of less than 14,000 square feet (-$12,118 combined building and land value) and condos (-$53,066 combined building and land value) reduce property values significantly while lot sizes of 14,000 to 25,000 square feet ($4,470 combined building and land value), 2.5 to 5 acres ($2,583) and 5 to 10 ($5,035) increase property values.

Table 29. Impacts of Land Use Patterns on Multi-Family Property Values

Linear Regression Coefficient Estimates for Adjacent Land Uses

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Multi-Family								
Commercial	97,161.55	51,117.16	1.90	.058	81,372.57	18,066.10	4.50	.000
Industrial	-204,129.23	114,382.65	-1.78	.075	-106,668.03	40,960.78	-2.60	.009
Public-Institutional	-12,781.11	61,717.99	-.21	.836	35,474.43	21,970.85	1.61	.107
Utility-Transportation	-303,855.11	157,416.62	-1.93	.054	126,272.66	55,666.94	2.27	.024
Vacant	3,320.72	48,489.64	.07	.945	5,611.52	17,326.39	.32	.746
Single Family Residential								
Lot size; less than 8,000 s.f.	-122,901.75	37,941.55	-3.24	.001	-13,086.74	13,428.56	-.97	.330
Lot size; 8,000 - 13,999 s.f.	31,731.27	38,498.04	.82	.410	30,613.97	13,790.43	2.22	.027
Lot size; 14,000-25,000 s.f.	57,480.40	57,152.86	1.01	.315	24,831.09	20,606.16	1.21	.229
Lot size; 1-2.5 ac.	-38,048.28	143,816.27	-.26	.791	53,169.87	51,641.12	1.03	.304

Linear Regression Coefficient Estimates for Land Uses within Quarter Mile Buffer

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Multi-Family								
Commercial	236,907.86	93,490.80	2.53	.012	14,316.76	32,903.97	.44	.664
Industrial	-66,765.66	40,271.31	-1.66	.098	-7,872.28	14,345.08	-.55	.583
Mobile Home	517,624.42	191,420.15	2.70	.007	85,865.39	67,980.33	1.26	.207
Public-Institutional	-125,228.10	64,178.12	-1.95	.051	-75,902.36	23,166.84	-3.28	.001
Railroad	-18,502.33	50,785.74	-.36	.716	18,670.43	18,049.67	1.03	.301
Utility-Transportation	-25,348.94	43,685.40	-.58	.562	3,266.18	15,565.47	.21	.834

Table 29 demonstrates that adjacent and surrounding land uses impact the value of multi-family properties in different ways. Commercial land uses add significant value to multi-family properties, with adjacent commercial properties adding $81,372 to land values and commercial uses within a quarter mile adding $236,907 to building value. Public-institutional and utility-transportation uses located within a quarter mile detract from multi-family value, while the presence of mobile homes may increase multi-family property values.

Table 30. Impacts of Land Use Patterns on Commercial Property Values

Linear Regression Coefficient Estimates for Adjacent Land Uses

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Commercial								
Multi-Family	24,536.60	55,062.68	.45	.656	87,542.09	28,817.55	3.04	.002
Industrial	-194,305.85	57,665.17	-3.37	.001	-107,556.11	30,115.50	-3.57	.000
Public-Institutional	-66,903.20	51,098.83	-1.31	.191	32,620.20	26,772.36	1.22	.223
Utility-Transportation	-226,711.67	80,011.53	-2.83	.005	-129,111.30	41,850.66	-3.09	.002
Vacant	28,206.13	34,219.72	.82	.410	-25,185.33	17,905.79	-1.41	.160
Single Family Residential								
Lot size; less than 8,000 s.f.	-25,323.45	32,770.66	-.77	.440	-24,895.79	17,128.45	-1.45	.146
Lot size; 8,000 - 13,999 s.f.	37,661.44	40,134.69	.94	.348	6,549.24	20,978.65	.31	.755
Lot size; 14,000-25,000 s.f.	8,030.67	54,960.57	.15	.884	-17,671.47	28,631.34	-.62	.537
Lot size; 1-2.5 ac.	-121,714.18	134,981.65	-.90	.367	-120,311.38	70,720.23	-1.70	.089
Lot size; 2.5 - 5 ac.	567,080.44	199,584.43	2.84	.005	-777,696.10	102,202.38	-7.61	.000
Lot size; 5 - 10 ac.	220,017.96	219,072.29	1.00	.315	-788,537.45	114,050.14	-6.91	.000

Linear Regression Coefficient Estimates for Land Uses within Quarter Mile Buffer

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Commercial								
Multi-Family	76,496.50	40,704.15	1.88	.060	49,156.92	21,268.22	2.31	.021
Industrial	-41,733.46	32,838.93	-1.27	.204	-34,460.57	17,142.28	-2.01	.045
Mobile Home	-175,969.96	83,848.39	-2.10	.036	-238,432.54	43,904.03	-5.43	.000
Public-Institutional	-82,554.67	49,797.53	-1.66	.098	-91,950.45	26,041.03	-3.53	.000
Railroad	43,047.06	35,266.43	1.22	.222	-16,371.02	18,320.30	-.89	.372
Utility-Transportation	-10,812.95	31,804.75	-.34	.734	45,828.70	16,627.99	2.76	.006

Table 30 shows that commercial building and land values appear to be affected by fewer adjacent and surrounding land uses when compared to residential properties, however the magnitude of value impacts is much higher when significant relationships exist. Regression findings suggest that certain mixes of land uses are fiscally beneficial while others are not. For example, adjacent multi-family land uses increase commercial building values by $87,542, while adjacent high-intensity land uses such as industrial facilities (-$301,861) and utility-transportation (-$251,896) uses detract from commercial property values. Multi-family land uses located within a quarter mile increase commercial land values by $49,156 while industrial properties within a quarter mile coincide with decreases of -$34,460.

Table 31. Impacts of Land Use Patterns on Industrial Property Values

Linear Regression Coefficient Estimates for Adjacent Land Uses

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Industrial								
Multi-Family	78,239.53	539,471.79	.15	.885	-72,024.61	122,312.66	-.59	.556
Commercial	-146,717.50	276,296.48	-.53	.596	59,704.50	61,921.43	.96	.335
Public-Institutional	-300,492.46	614,328.89	-.49	.625	-150,861.65	136,264.95	-1.11	.269
Utility-Transportation	500,870.62	426,141.29	1.18	.240	42,854.35	96,346.89	.44	.657
Vacant	-482,849.78	269,071.02	-1.79	.073	73,677.14	60,631.62	1.22	.225
Single Family Residential								
Lot size: less than 8,000 s.f.	-509,481.26	554,360.50	-.92	.359	-44,414.48	125,166.82	-.35	.723
Lot size; 8,000 - 13,999 s.f.	334,703.46	525,338.57	.64	.524	-46,728.16	118,313.81	-.39	.693
Lot size: 14,000-25,000 s.f.	213,569.90	822,078.78	.26	.795	-348,953.32	185,836.96	-1.88	.061
Lot size; 1-2.5 ac.	992,379.80	796,766.66	1.25	.214	98,071.61	180,421.16	.54	.587

Linear Regression Coefficient Estimates for Land Uses within Quarter Mile Buffer

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Industrial								
Multi-Family	-984,917.59	384,186.07	-2.56	.011	-277,221.22	84,880.60	-3.27	.001
Commercial	561,106.38	422,985.07	1.33	.185	-365,780.60	94,583.50	-3.87	.000
Mobile Home	406,084.15	646,229.44	.63	.530	-41,775.70	144,515.26	-.29	.773
Public-Institutional	141,123.23	281,438.38	.50	.616	15,470.56	63,652.01	.24	.808
Railroad	317,110.73	291,343.35	1.09	.277	203,290.35	65,883.89	3.09	.002
Utility-Transportation	-129,836.71	318,866.48	-.41	.684	-165,890.58	71,341.25	-2.33	.020

Table 31 shows that surrounding land use patterns significantly influence industrial property values while adjacent land uses do not. Regression coefficients demonstrate that multi-family uses located within a quarter mile, can detract over -$1.2 million dollars (building and land coefficients combined) from industrial property values while nearby commercial facilities detract -$365,780 in industrial land value. Railroads, which often serve to support industrial facilities, increase industrial land values by $203,290.

3.2.5 Adjacent and Surrounding Natural Amenities

"Table 32. Impacts of Natural Amenities on Single Family Residential Property Values in Cities" reveals that natural amenities contribute positively and negatively to property values in cities Lakefront properties add significant value to city single family residential properties. Small lakes, less than 19 acres do not significantly impact building values but increase adjacent land values by $50,850. Lakes between 19 and 49 acres in size contribute $19,621 to building values but subtract over $15,000 in land value. Large lakes, over 100 acres in size, add over $187,000 to adjacent property values. While lakefront locations add value to buildings and land, properties within a quarter mile of lakes of all sizes coincide with statistically significant decreases in building and land value in most cases, suggesting that distance to natural amenities may have both negative and positive implications to property values. River and wetlands are associated with negative contributions to city residential land values and are statistically significant in all cases except the adjacent riverside building value, suggesting that these areas should be buffered and preserved. Natural areas are associated with decreases to adjacent residential land values, however properties within a quarter mile of natural areas coincide with $2,450 increases in residential land value.

Table 32. Impacts of Natural Amenities on Single Family Residential Property Values in Cities

Linear Regression Coefficient Estimates for Adjacent Natural Amenities

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
City Single Family Residential								
Lake; 0-19 ac.	5,792.67	7,482.04	.77	.439	50,849.94	3,815.56	13.33	.000
Lake; 19-49 ac.	19,621.46	4,446.30	4.41	.000	-15,013.57	2,288.28	-6.56	.000
Lake; 100+ ac.	95,824.07	9,016.60	10.63	.000	91,440.04	4,627.82	19.76	.000
River	-1,598.10	3,492.97	-.46	.647	-38,320.62	1,786.11	-21.45	.000
Wetland	-18,542.98	3,481.20	-5.33	.000	-24,695.33	1,782.00	-13.86	.000
Natural Area; priority three	-4,833.94	2,983.54	-1.62	.105	-15,269.86	1,532.73	-9.96	.000

Linear Regression Coefficient Estimates for Natural Amenities within Quarter Mile Buffer

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
City Single Family Residential								
Lake; 0-19 ac.	-42.67	356.99	-.12	.905	-894.56	181.99	-4.92	.000
Lake; 19-49 ac.	-17,589.89	1,056.86	-16.64	.000	-2,612.07	540.61	-4.83	.000
Lake; 100+ ac.	-2,824.00	977.26	-2.89	.004	2,791.44	496.04	5.63	.000
River	-5,497.61	577.05	-9.53	.000	-3,720.10	296.92	-12.53	.000
Wetland	-9,305.82	731.95	-12.71	.000	-1,982.07	371.06	-5.34	.000
Natural Area; priority two	-49,694.16	25,274.47	-1.97	.049	-24,673.84	13,023.62	-1.89	.058
Natural Area; priority three	516.64	705.29	.73	.464	2,453.29	361.08	6.79	.000

Table 33 demonstrates that natural amenities contribute positively and negatively to property values in townships and villages more so than in case study cities. Lakes of all sizes contribute significantly and positively to adjacent residential building and land values, with value contributions ranging from approximately $5,000 (lake 0-19 acres) to nearly $175,000 (lakes over 100 acres). The size of the lake plays a key role in determining contribution to value, with significant variations demonstrated in both building and land value models. Unlike city residential properties, township and village residential properties benefit from quarter mile proximity to lakes, with statistically significant results demonstrated in most cases. Similar to city residential properties, wetlands and rivers decrease property values for adjacent and proximate township and village residential properties. This finding suggests that preservation of sensitive environmental resources, and buffering those resources from development, may create a win-win scenario for environmental protection and fiscal planning objectives. Natural areas contribute significantly to residential building and land values in some cases, with adjacent and buffer properties experiencing decreases in land values and increases in building value.

Table 33. Impacts of Natural Amenities on Single Family Residential Property Values in Townships and Villages

Linear Regression Coefficient Estimates for Adjacent Natural Amenities

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Township Single Family Residential								
Lake; 0-19 ac.	2,731.60	1,602.58	1.70	.088	5,004.94	1,355.54	3.69	.000
Lake; 19-49 ac.	19,644.35	4,412.70	4.45	.000	58,435.87	3,732.68	15.66	.000
Lake; 49-100 ac.	11,973.92	3,202.98	3.74	.000	11,796.40	2,708.54	4.36	.000
Lake; 100+ ac.	35,926.12	1,421.96	25.27	.000	139,041.43	1,183.92	117.44	.000
River	827.36	2,675.13	.31	.757	12,156.41	2,257.15	5.39	.000
Wetland	-5,264.95	1,609.35	-3.27	.001	-1,600.35	1,359.47	-1.18	.239
Natural Area; priority one	4,529.91	2,758.66	1.64	.101	-12,789.11	2,317.31	-5.52	.000
Natural Area; priority two	-3,350.11	2,035.43	-1.65	.100	-3,406.31	1,719.27	-1.98	.048
Natural Area; priority three	7,116.20	1,774.50	4.01	.000	-164.44	1,499.19	-.11	.913

Linear Regression Coefficient Estimates for Natural Amenities within Quarter Mile Buffer

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Township Single Family Residential								
Lake; 0-19 ac.	-2,034.92	1,093.46	-1.86	.063	9,278.34	919.19	10.09	.000
Lake; 19-49 ac.	6,764.65	1,261.74	5.36	.000	906.20	1,064.93	.85	.395
Lake; 49-100 ac.	11,599.85	1,657.60	7.00	.000	-11,322.13	1,379.00	-8.21	.000
Lake; 100+ ac.	13,817.19	941.10	14.68	.000	9,281.73	777.68	11.94	.000
River	-1,496.60	840.24	-1.78	.075	-2,512.02	708.66	-3.54	.000
Wetland	-3,636.49	762.33	-4.77	.000	-6,667.28	643.86	-10.36	0
Natural Area; priority one	-846.65	1,298.68	-.65	.514	-11,460.44	1,081.08	-10.60	.000
Natural Area; priority two	5,652.21	924.96	6.11	.000	-251.88	778.82	-.32	.746
Natural Area; priority three	6,980.95	726.83	9.60	.000	-4,147.45	613.35	-6.76	.000

For multi-family and non-residential land uses, natural amenities rarely contribute to property values. Table 34 demonstrates statistically significant cases for multi-family uses that include lakefront properties (-$129,862) and properties within a quarter mile of rivers (-$48,600). Both commercial ($79,861) and industrial ($332,019) property values benefit from lakeside ownership. Industrial properties adjacent and within a quarter mile of wetlands, coincide with decreases in building value.

Table 34. Impacts of Natural Amenities on Non-Residential and Multi-Family Property Values

Linear Regression Coefficient Estimates for Adjacent Natural Amenities

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Multi-Family								
Lake; 0-19 ac.	-37,495.73	166,658.88	-.225	.822	-129,863.00	59,263.51	-2.191	.029
Wetland	-203,071.47	165,099.64	-1.230	.219	-110,520.69	58,795.96	-1.880	.061
Commercial								
Lake; 0-19 ac.	219,476.21	110,451.83	1.987	.047	-139,615.62	57,369.90	-2.434	.015
River	27,934.19	142,176.17	.196	.844	-94,833.76	74,386.25	-1.275	.203
Wetland	29,619.80	156,545.24	.189	.850	-227,460.39	80,975.18	-2.809	.005
Industrial								
Lake; 0-19 ac.	496,230.67	418,284.08	1.186	.236	332,019.76	93,850.32	3.538	.000
Wetland	-1,540,143.87	715,685.57	-2.152	.032	51,414.42	161,147.21	.319	.750

Linear Regression Coefficient Estimates for Natural Amenities within Quarter Mile Buffer

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Multi-Family								
River	60,475.50	69,601.84	.87	.385	-48,607.33	24,619.53	-1.97	.049
Wetland	-64,647.04	71,827.60	-.90	.368	-40,380.50	24,873.81	-1.62	.105
Commercial								
River	38,893.72	42,291.10	.92	.358	-36,142.94	22,027.05	-1.64	.101
Wetland	16,100.75	46,338.40	.35	.728	67,747.82	24,256.48	2.79	.005
Industrial								
River	-674,879.47	480,539.87	-1.40	.161	-15,018.53	108,724.76	-.14	.890
Wetland	-785,535.12	301,939.14	-2.60	.010	53,167.66	68,425.20	.78	.438

3.2.6 Adjacent and Surrounding Capital Facilities

"Table 35. Impacts of Capital Facilities on Single Family Residential Property Values" shows the impacts of adjacent and surrounding parks, recreation areas, schools, government facilities, and police and fire stations on residential property values in cities.

Recreation and parks contribute significantly to adjacent residential buildings in both cities and townships. Recreation uses contribute positively to adjacent city residential building values ($6,076) and township residential land values located within a quarter mile ($3,294) but detract from adjacent township building values (-$7,238) and city property values within a quarter mile (-$2,222). Schools significantly influence city residential property values when located within a quarter mile distance, however impacts are marginal. Government uses located within a quarter mile distance detract value from residential building values in cities (-$4,197) but add value to township and villages ($9,378). Fire stations located within a quarter mile increase city residential building values, but do not significantly contribute to property values in townships and villages. Police stations located within a quarter mile increase city residential property values ($3,456), but detract from township and village residential building values (-$16,724).

Table 35. Impacts of Capital Facilities on Single Family Residential Property Values

Linear Regression Coefficient Estimates for Adjacent Capital Facilities								
	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
City Single Family Residential								
Recreation	6,076.15	1,821.00	3.34	.001	1,342.52	937.47	1.43	.152
Park	-13,581.27	2,053.91	-6.61	.000	-216.33	1,056.39	-.20	.838
School	-2,340.98	2,539.59	-.92	.357	-2,818.00	1,307.40	-2.16	.031
Government	-1,401.95	7,672.09	-.18	.855	5,897.01	3,953.62	1.49	.136
Township and Village Single Family Residential								
Recreation	-7,283.65	1,484.35	-4.91	.000	-1,908.63	1,253.68	-1.52	.128
Park	-4,034.46	3,575.06	-1.13	.259	3,037.46	3,024.85	1.00	.315
School	-6,479.65	4,692.25	-1.38	.167	419.75	3,972.82	.11	.916
Government	3,552.57	5,600.75	.63	.526	3,919.95	4,742.05	.83	.408

Linear Regression Coefficient Estimates for Capital Facilities within Quarter Mile Buffer								
	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
City Single Family Residential								
Recreation	-1,153.19	545.72	-2.11	.035	-1,069.94	279.91	-3.82	.000
Park	3,135.15	359.42	8.72	.000	-288.27	183.39	-1.57	.116
School	813.38	317.45	2.562	.010	-791.65	163.06	-4.855	.000
Government	-4,197.20	812.89	-5.163	.000	698.47	414.16	1.686	.092
Fire	4,440.98	953.37	4.658	.000	928.81	486.59	1.909	.056
Police	5,805.79	1,971.56	2.945	.003	-2,349.89	1,014.10	-2.317	.020
Township and Village Single Family Residential								
Recreation	51.75	750.18	.07	.945	3,294.10	633.36	5.20	.000
Park	2,304.59	1,014.16	2.27	.023	645.65	855.08	.76	.450
School	1,125.70	1,236.28	.911	.363	-1,326.31	1,044.47	-1.270	.204
Government	9,378.51	3,031.94	3.093	.002	-1,992.92	2,560.94	-.778	.436
Fire	-4,641.64	3,248.61	-1.429	.153	4,498.92	2,746.40	1.638	.101
Police	-16,724.87	3,607.37	-4.636	.000	-2,650.53	3,048.23	-.870	.385

Table 36 demonstrates that in most cases, the location and type of capital facilities do not impact multi-family and non-residential property values. Police stations located within a quarter mile contribute positively to multi-family property values ($323,995) and commercial building values. Industrial property values may benefit greatly from quarter mile proximity to government uses ($1.5 million) and recreation uses ($242,506).

Table 36. Impacts of Capital Facilities on Non-Residential and Multi-Family Property Values

Linear Regression Coefficient Estimates for Adjacent Capital Facilities								
	Building Value Models				Land Value Models			
Land Use	Coefficient	Std. Error	T	Sig.	Coefficient	Std. Error	T	Sig.
Commercial								
Recreation	-79,660.87	103,802.54	-.767	.443	-127,501.84	54,329.25	-2.347	.019
Park	38,372.81	142,581.30	.269	.788	15,751.15	74,698.75	.211	.833
School	-66,312.59	131,167.63	-.51	.613	79,423.59	68,444.81	1.16	.246
Government	-323,329.01	140,943.36	-2.29	.022	-45,973.77	72,238.90	-.64	.525
Industrial								
Recreation	245,035.46	627,609.27	.390	.696	-41,431.47	142,149.78	-.291	.771
Park	-1,716,731.28	1,048,135.55	-1.638	.102	-193,623.87	236,468.65	-.819	.413
Multi-Family								
Recreation	-30,243.19	172,502.30	-.175	.861	149,210.81	61,860.92	2.412	.016
Park	588,377.34	222,216.89	2.648	.008	-58,720.06	80,276.76	-.731	.465
School	381,162.29	229,263.27	1.66	.097	-106,873.06	82,833.46	-1.29	.197
Linear Regression Coefficient Estimates for Capital Facilities within Quarter Mile Buffer								
	Building Value Models				Land Value Models			
Land Use	Coefficient	Std. Error	T	Sig.	Coefficient	Std. Error	T	Sig.
Commercial								
Recreation	-35,015.88	39,987.56	-.88	.381	-10,187.11	20,859.12	-.49	.625
School	-449.08	31,048.33	-.01	.988	4,291.39	16,245.16	.26	.792
Government	17,482.51	45,065.25	.39	.698	38,930.23	23,533.15	1.65	.098
Fire	-71,161.93	55,211.18	-1.29	.198	-3,509.06	28,822.08	-.12	.903
Police	140,958.09	60,601.47	2.33	.020	-27,078.04	31,655.68	-.86	.392
Industrial								
Recreation	252,919.40	328,979.10	.77	.442	242,506.64	74,138.54	3.27	.001
School	-308,137.17	362,148.41	-.85	.395	-48,944.29	81,878.76	-.60	.550
Government	1,215,231.31	443,888.78	2.74	.006	343,059.78	100,464.14	3.41	.001
Multi-Family								
Recreation	79,593.75	69,549.82	1.14	.253	5,828.05	24,351.77	.24	.811
Park	39,412.33	45,960.83	.86	.391	27,216.34	16,162.08	1.68	.093
School	-22,538.39	42,114.00	-.54	.593	-3,368.92	15,209.03	-.22	.825
Government	23,598.19	56,592.10	.42	.677	-14,069.60	20,086.70	-.70	.484
Fire	-100,292.28	82,535.61	-1.22	.225	-23,547.36	29,445.19	-.80	.424
Police	261,859.27	87,020.89	3.01	.003	62,096.69	30,472.25	2.04	.042

3.2.7 Transportation Infrastructure and Access

Transportation access and traffic patterns were hypothesized to have significant impacts on assessed residential and non-residential property values, particularly land values. The application of road classifications identifies impact of location along interstate, freeway, arterial, collector, or local road classes managed by county and cities as defined by the US Department of Transportation.

Table 37. Impacts of Transportation Infrastructure on City Residential Property Values

Linear Regression Coefficient Estimates for Road Classifications

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
City Single Family Residential								
Road not classified in PA 51	-8,833.07	1,013.03	-8.72	.000	12,345.12	509.32	24.24	.000
Urban Interstate	-4,380.94	2,724.28	-1.61	.108	-7,021.01	1,402.73	-5.01	.000
Urban Non-Freeway	-5,506.62	1,172.93	-4.69	.000	-1,868.05	598.03	-3.12	.002
County Local, Urban Local	-14,911.11	4,909.56	-3.04	.002	-7,301.14	2,528.72	-2.89	.004
County Primary, Urban Non-Freeway	-22,796.41	3,921.95	-5.81	.000	-3,689.39	2,020.54	-1.83	.068
County Primary, Urban Minor Arterial	-13,544.27	3,262.76	-4.15	.000	-264.17	1,680.24	-.16	.875
County Primary, Urban Collector Primary	-2,382.49	4,068.52	-.59	.558	1,123.95	2,096.81	.54	.592
City Major, Urban Local	4,848.41	512.69	9.46	.000	-263.17	262.52	-1.00	.316
City Major, Urban Collector	3,397.41	653.13	5.20	.000	-2,617.69	335.42	-7.80	.000
City Major, Minor Arterial	-11,108.37	948.40	-11.71	.000	-1,955.97	486.77	-4.02	.000
City Major, Urban Non-Freeway	-7,697.75	748.93	-10.28	.000	-6,508.41	384.80	-16.91	.000
City Minor, Urban Local Road	3,164.05	532.15	5.95	.000	329.71	273.16	1.21	.227

Table 37 shows that road functions coincide with statistically significant impacts on single family residential building and land values in cities. High-impact, high traveled roads detract from adjacent residential property values. Urban interstates (with and without freeway status) subtract -$7,021 and -$7,374 from residential property values, county primary non-freeway roads subtract over -$26,000 and arterial roads detract between -$13,808 and -$13,063 respectively. Increases in residential property value coincide with location along urban local and collector roads ranging from a high of $4,848 for urban major local roads to $780 for urban collector roads.

Table 38. Impacts of Transportation Infrastructure on Residential Property Values in Townships and Villages

Linear Regression Coefficient Estimates for Road Classifications								
	Building Value Models				Land Value Models			
Land Use	Coefficient	Std. Error	T	Sig.	Coefficient	Std. Error	T	Sig.
Township and Village Single Family Residential								
Road not classified in PA 51	1,408.35	936.45	1.50	.133	1,756.84	789.07	2.23	.026
Urban Interstate	6,889.12	45,203.18	.15	.879	212,251.28	38,146.69	5.56	.000
Urban Non-Freeway	-12,395.62	18,112.57	-.68	.494	5,099.50	15,333.90	.33	.739
County Local, Urban Local	-3,162.04	949.71	-3.33	.001	-7,162.17	801.78	-8.93	.000
County Local, Rural Local	12,533.40	2,378.43	5.27	.000	6,750.61	2,002.87	3.37	.001
County Local, Urban Collector Local	-16,891.13	2,457.98	-6.87	.000	-6,325.85	2,071.85	-3.05	.002
County Primary, Rural Minor Arterial	-20,582.48	4,831.32	-4.26	.000	16,579.30	4,071.46	4.07	.000
County Primary, Rural Major Collector	-11,066.32	3,723.92	-2.97	.003	21,869.50	3,121.77	7.01	.000
County Primary, Urban Non-Freeway	-4,393.31	3,951.78	-1.11	.266	-4,399.09	3,343.58	-1.32	.188
County Primary, Urban Minor Arterial	-1,533.37	1,226.68	-1.25	.211	-6,694.03	1,029.98	-6.50	.000
County Primary, Urban Collector Primary	-4,676.29	2,131.09	-2.19	.028	-9,584.57	1,797.78	-5.33	.000
City Major, Urban Local	-1,579.25	2,709.24	-.58	.560	-6,674.44	2,288.41	-2.92	.004
City Major, Urban Collector	19,743.66	5,042.43	3.92	.000	4,491.68	4,254.15	1.06	.291
City Major, Minor Arterial	11,713.06	3,041.97	3.85	.000	6,154.22	2,566.67	2.40	.017
City Minor, Urban Local Road	2,234.54	1,384.37	1.61	.107	1,159.56	1,155.89	1.00	.316

Table 38 demonstrates that unlike cities, township and village residential land values located along interstates coincide with value increases of $212,251. This finding may suggest that township and village residents value efficient access to regional destinations which supports their rural or suburban living preference. Arterial roads impact township, village and city residential property values in similar ways. County rural primary (-$4,003) and urban arterials (-$6,694), along with county urban collector (-$23,216) all detract from residential property values however collector roads in villages add $19,743 and arterials add $11,713 to property values. Rural local roads add $39,026 to property values while urban local roads subtract between $-6,674 and $10,324 respectively. Overall, road functions and class seem to have a larger impact on residential property values in townships and villages than cities, however it should be noted that spatial autocorrelation may bias regression coefficients.

Table 39. Impacts of Transportation Infrastructure on Multi-Family Property Values

Linear Regression Coefficient Estimates for Road Classifications

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Multi-Family								
Road not classified in PA 51	24,573.37	63,403.29	.39	.698	68,614.25	21,701.20	3.16	.002
Urban Non-Freeway	-252,818.31	74,118.23	-3.41	.001	-7,311.87	26,563.27	-.28	.783
County Local, Urban Local	-317,586.95	189,791.61	-1.67	.095	-172,960.61	67,167.22	-2.58	.010
County Primary, Urban Non-Freeway	66,495.39	144,324.58	.46	.645	29,348.59	51,951.16	.56	.572
County Primary, Urban Minor Arterial	-135,191.42	90,837.63	-1.49	.137	-20,242.69	32,791.58	-.62	.537
City Major, Urban Local	-97,063.50	50,934.06	-1.91	.057	-8,387.18	18,367.16	-.46	.648
City Major, Urban Collector	36,709.13	49,909.47	.74	.462	12,753.14	17,942.51	.71	.477
City Major, Minor Arterial	-348,201.70	86,663.16	-4.02	.000	29,060.11	30,483.77	.95	.341
City Major, Urban Non-Freeway	144,014.36	46,810.06	3.08	.002	80,596.92	16,618.80	4.85	.000
City Minor, Urban Local Road	-20,666.13	42,179.26	-.49	.624	46,517.42	14,843.56	3.13	.002

Unlike, single family residential and non-residential land uses, regression coefficients for multi-family uses shown in Table 39 do not demonstrate a clear relationship with road classification. Multi-family locations along city non-freeway interstates coincide with a $224,610 increase in property value, however, state non-freeway interstates subtract -$252,818 from multi-family building values. Locations along minor local roads result in an increase of $46,517 in multi-family land values, however county urban local roads coincide with a decrease of -$172,960 in land values.

Table 40. Impacts of Transportation Infrastructure on Commercial Property Values

Linear Regression Coefficient Estimates for Road Classifications

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Commercial								
Road not classified in PA 51	-60,490.83	46,962.79	-1.29	.198	45,343.48	24,548.05	1.85	.065
Urban Interstate	-30,064.67	38,890.25	-.77	.440	147,893.97	20,270.87	7.30	.000
County Local, Urban Local	160,281.39	73,742.37	2.17	.030	89,635.71	38,646.36	2.32	.020
County Primary, Urban Non-Freeway	78,284.69	68,009.25	1.15	.250	99,009.51	35,525.36	2.79	.005
County Primary, Urban Minor Arterial	-59,789.93	48,745.77	-1.23	.220	-63,783.77	25,399.41	-2.51	.012
County Primary, Urban Collector Primary	-83,312.98	133,250.71	-.63	.532	-47,961.38	69,734.67	-.69	.492
City Major, Urban Local	-30,134.32	39,372.46	-.77	.444	1,901.79	20,571.91	.09	.926
City Major, Urban Collector	39,386.71	41,050.52	.96	.337	-18,702.04	21,503.97	-.87	.385
City Major, Minor Arterial	-44,135.51	41,501.82	-1.06	.288	55,780.09	21,689.10	2.57	.010
City Major, Urban Non-Freeway	-48,313.43	36,449.38	-1.33	.185	28,080.45	18,925.20	1.48	.138
City Minor, Urban Local Road	-50,633.73	27,767.31	-1.82	.068	-17,319.19	14,534.38	-1.19	.234

Table 40 shows that commercial land values are significantly influenced by road functional classifications, however building values are not. Commercial locations along highly traveled urban interstates ($147,893), urban non-freeway ($99,009) and city arterials ($55,780) increase land values while locations along minor county arterials (-$63,783) detract from property values.

Table 41. Impacts of Transportation Infrastructure on Industrial Property Values

Linear Regression Coefficient Estimates for Road Classifications

	Building Value Models				Land Value Models			
Land Use	**Coefficient**	**Std. Error**	**T**	**Sig.**	**Coefficient**	**Std. Error**	**T**	**Sig.**
Industrial								
Road not classified in PA 51	-536,704.82	277,754.64	-1.93	.054	-19,194.53	62,963.87	-.30	.761
Urban Interstate	-1,168,102.65	669,949.46	-1.74	.082	-62,905.34	151,146.15	-.42	.677
County Local, Urban Local	-837,911.86	359,109.78	-2.33	.020	-44,944.94	81,089.36	-.55	.580
County Primary, Urban Non-Freeway	1,303,341.30	739,550.35	1.76	.079	432,081.75	166,485.62	2.60	.010
County Primary, Urban Minor Arterial	142,479.99	390,852.51	.36	.716	-67,164.30	88,398.57	-.76	.448
County Primary, Urban Collector Primary	-578,804.03	980,553.92	-.59	.555	-14,645.59	221,365.32	-.07	.947
City Major, Urban Local	228,313.75	384,978.19	.59	.553	313,689.56	86,614.45	3.62	.000
City Major, Urban Collector	213,377.80	379,313.13	.56	.574	292,063.81	82,833.25	3.53	.000
City Major, Minor Arterial	-580,258.82	538,657.21	-1.08	.282	418,349.26	119,939.22	3.49	.001
City Major, Urban Non-Freeway	-1,896,920.86	580,206.22	-3.27	.001	442,581.37	125,248.15	3.53	.000
City Minor, Urban Local Road	-560,424.52	325,216.42	-1.72	.086	78,921.74	72,265.97	1.09	.275

Table 41 demonstrates a positive relationship between travel intensity and industrial land values. Industrial location along city local ($313,689), collector ($292,063), minor arterials ($418,349) and non-freeway ($442,581) road classes along with county non-freeway ($432,081) classifications increase land value.

3.1 Quantification of Implicit Property Tax Revenues Attributed to Surrounding Land Use Patterns and Natural Amenities

Through the application of multiple regression analysis techniques and hedonic pricing theory, statistically significant indirect relationships between assessed property values and surrounding land use and natural amenity patterns were discovered. The value dynamics between property values and surrounding land use patterns and natural amenities translate into implicit property tax revenues for the case study communities which are presented in Tables 42 through 47.

Table 42. City Total Implicit Single Family Property Tax Revenues Attributed to Surrounding Land Use Patterns

Land Use	City of Pontiac	City of Royal Oak	City Total
Multi-Family	-$321,684	-$424,773	-$746,458
Commercial	$543,944	$643,678	$1,187,622
Industrial	-$305,048	-$109,637	-$414,684
Mobile Home	-$66,830	$0	-$66,830
Public-Institutional	-$320,809	-$335,910	-$656,718
Utility-Transportation	-$195,042	-$144,079	-$339,121
Vacant	-$106,947	-$7,292	-$114,240

Table 42 reveals that within case study cities, commercial properties adjacent to and within a quarter mile of single family residential properties contribute over $543,000 to the property tax base in the City of Pontiac and over $673,000 to the property tax base of the City of Royal Oak. In cities, adjacent commercial land uses significantly detract from assessed building values but significantly add to adjacent single family land values. Overall adjacent commercial properties decrease single family property tax revenues in the case study communities by nearly -$54,000. Commercial uses located within a quarter mile proximity increase property tax revenues attributed to building value by over $2.03 million while subtracting from property taxes from residential land values by nearly $796,000. Overall commercial lands add nearly $1.2 million dollars in property tax revenue through value-added relationships with single family residential lands in case study cities.

Other adjacent and surrounding land uses, detract from single family property values and ultimately single family property tax revenues. The biggest indirect fiscal impact on city residential single family property taxes are associated with multi-family land uses (-$746,458), public-institutional uses (-$656,718) and industrial uses

(-$414,684).

Table 43. Township and Village Total Implicit Single Family Property Tax Revenues Attributed to Surrounding Land Use Patterns

Community	Commerce Twp.	Wolverine Lake Village	Milford Twp.	Milford Village	Oakland Twp.	Township and Village Total
Agricultural	$45,238	$0	$15,207	$0	$20,041	$80,486
Multi-Family	-$107,414	-$51,404	-$9,032	-$119,455	-$13,349	-$300,653
Commercial	-$196,042	-$55,549	-$21,373	-$115,356	-$42,363	-$430,683
Industrial	-$4,188	$0	-$5,213	-$2,757	$0	-$12,158
Mobile Home	-$33,188	$0	-$17,086	$0	-$3,071	-$53,345
Public-Institutional	-$311,510	-$100,587	-$54,205	-$162,394	-$92,280	-$720,975
Utility-Transportation	-$194,441	-$5,455	-$27,728	-$79,315	-$89,217	-$396,157
Vacant	$504,679	$72,668	$255,587	$71,671	$248,235	$1,152,840

Table 43 demonstrates that in case study townships and villages, surrounding agricultural uses and vacant land add value to residential properties and ultimately the residential property tax base, suggesting that "rural amenities" indirectly benefit the residential property tax base in case study townships. When located within a quarter mile radius, agricultural uses increase residential property tax revenues via land values by over $80,486 while vacant parcels, when located adjacent to residential properties, increase single family property tax revenues by over $1.15 million in townships and villages. Surrounding "urban" non-residential and multi-family uses detract from the residential property tax base, confirming that "rural character" is a source of value to both residents and government in rural communities. Unlike cities, adjacent and surrounding commercial uses detract from residential building and land values resulting in an overall decrease of -$430,683 from the residential property tax base. Other uses such as public-institutional and utility-transportation and multi-family uses detract from single family property values and property tax contributions.

Table 44. Township and Village Total Implicit Single Family Property Tax Revenues Attributed to Surrounding Water-based Natural Amentites

Community	Lake, 0-19 acres	Lake, 19-49 acres	Lake, 49-100 acres	Lake, 100+ acres	River	Wetland
Commerce Twp.	$1,132,842	$186,520	$33,358	$3,050,171	$12,904	-$296,232
Milford Twp.	$306,550	$21,280	$14,202	$144,997	$3,964	-$112,719
Milford Village	$167,876	$0	$7,805	$15,948	$1,343	-$65,858
Oakland Twp.	$492,731	$6,619	$17,619	$0	$27,527	-$214,634
Wolverine Lake Vill.	$210,649	$16,182	$0	$1,220,969	$0	-$38,909
Township and Village Total	$2,310,648	$230,601	$72.984	$4,432,085	$45,737	-$728.353

Modeling the relationship between single family residential property taxes and surrounding natural amenities confirms that "rural" natural amenities, especially lakes and natural conservation areas, are a major source of public value in rural and suburban townships and villages. Table 44 demonstrates that lakes of all sizes, contribute to the property tax base indirectly by adding value to single family residences. Small lakes, 0 – 19 acres, add over $2.3 million in property tax revenues. Small lakes add over $56,000 in property tax revenue through adjacent lakefront properties and add over $2.25 million to township and village revenues by increasing surrounding residential land values located within a quarter mile. Large lakes, over 100 acres in size, contribute a total of $4.4 million in property tax revenues indirectly and over $3 million in property tax revenue to Commerce Charter Township alone. Large lakes increase waterfront property tax revenues by $2.6 million and increase residential property tax revenues located within a quarter mile by $1.8 million. While lakes add value to waterfront and surrounding home values, not all water-based natural amenities contribute positively to the property tax base. Locations next to wetlands decrease property taxes from residential building value by over -$64,000 while quarter mile proximity decreases property taxes by over - $663,000.

Table 45. Township and Village Total Implicit Single Family Property Tax Revenues Attributed to Surrounding Land-based Natural Amentites

Community	Natural Area, priority one	Natural Area, priority two	Natural Area, priority three
Commerce Twp.	-$9,073	$81,004	$369,781
Milford Twp.	-$31,312	$44,815	$140,322
Milford Village	-$919	$20,867	$24,976
Oakland Twp.	-$10,985	$105,681	$168,248
Wolverine Lake Vill.	$0	$0	$24,080
Township and Village Total	-$52,289	$252,367	$727,407

Modeling outcomes shown in Table 45 reveal that natural conservation initiatives add value to the residential property tax base indirectly by increasing surrounding residential home values. While natural areas with the highest level of conservation priority detract from adjacent residential land values, quarter mile proximity to priority two and three natural areas increase property taxes derived from building values by $280,000 and $656,000 respectively. Modeling results suggest that preserving high priority natural areas such as wetlands while enabling residential access to high quality lakes and natural areas can provide win-win scenarios for fiscal and environmental planning objectives.

Table 46. City Total Implicit Single Family Property Tax Revenues Attributed to Surrounding Natural Amentites

Community	City of Pontiac	City of Royal Oak	City Total
Lake, 0-19 acres	-$56,292	-$41,544	-$97,836
Lake, 19-49 acres	-$40,655	$0	-$40,655
Lake, 100+ acres	$43,026	$0	$43,026
River	-$348,098	$0	-$348,098
Wetland	-$267,873	$0	-$267,873
Natural Area, priority two	-$269,349	$0	-$269,349
Natural Area, priority three	$37,569	$10,498	$48,067

Contrary to findings in townships and villages, Table 46 shows that city residential properties do not benefit monetarily from surrounding water-based natural amenities. While lakes only marginally increase city waterfront land and building values, they detract from surrounding neighborhood property values as a whole, suggesting that water quality or access may play a major role in determining indirect value contributions of natural amenities to a city's property tax base. Priority three natural conservation areas add value indirectly to property tax revenues by increasing residential land values located within a quarter mile, suggesting that open space may amplify the positive fiscal impacts of higher housing densities.

Table 47. Total Implicit Non-Residential and Multi-Family Property Tax Revenues Attributed to Surrounding Land Use Patterns

	Surrounding Land Uses		
Land Use Analyzed	Multi-Family	Commercial	Industrial
Multi-Family	-	$3,615,585	-$37,227
Commercial	$1,958,748	-	-$1,524,416
Industrial	-$8,271,685	-$4,176,748	-

Dynamic fiscal relationships exist between surrounding land use patterns and non-residential and multi-family property values that create positive and negative indirect sources of property tax revenue within the case study communities. "Table 47. Total Implicit Non-Residential and Multi-Family Property Tax Revenues Attributed to Surrounding Land Use Patterns," demonstrates how surrounding land uses (shown in columns) impact the property tax revenues of multi-family, commercial and industrial land uses (in rows). When compared to single family residential land uses, comparatively fewer statistically significant relationships exist between surrounding land uses patterns and non-residential property values, however, the magnitude of these monetary relationships can be great.

A mutually beneficial fiscal relationship exists between multi-family and commercial land uses. When located within a quarter mile, commercial land uses increase multi-family building values, indirectly increasing property tax revenues by over $3.45 million in the case study communities. Multi-family land uses located within a quarter mile of commercial properties, increase commercial land values, resulting in property tax increases of $1.7 million. Commercial and multi-family land uses also positively benefit from being located adjacent to one another, with land value increases contributing over $386,000 to the bottom line.

In case study cities, regression results reveal that mixed-use zoning policies have contributed positively and negatively to private property values and public property tax revenues. Findings suggest that mixed-use policies that encourage a mix of residential, multi-family and commercial development result in net increases in property values and property tax revenues within case study cities. In these mixed-use development scenarios, integration of commercial uses appear to mitigate the negative fiscal relationships between surrounding single family and multi-family property values through increased neighborhood livability.

Mixed-use policies that encourage a mix of industrial, multi-family and commercial development result in a net decrease in property values and property tax revenues within case study communities. Industrial properties located adjacent to multi-family and commercial uses decrease commercial and multi-family property tax contributions by over -$797,000 combined. Industrial uses located within a quarter mile of commercial properties, detract approximately -$764,000 in property tax revenue derived from commercial land. While it comes as no surprise that high intensity industrial uses negatively impact neighboring land uses, regression results reveal that multi-family and commercial land uses have a much greater negative impact on industrial land values than vice versa. Multi-family and commercial land uses located within a quarter mile of industrial uses, subtract over $12 million in industrial property tax contributions through decreases in building and land value. Findings suggest that clustering non-residential land uses while buffering industrial uses can maximize industrial property tax contributions while mitigating nuisance effects such as traffic, noise, air pollution, and aesthetics.

CHAPTER 4.
SUMMARY OF FINDINGS, LIMITATIONS, SUGGESTIONS FOR FUTURE RESEARCH AND APPLICATIONS TO THE PLANNING PROFESSION

4.1 Summary of Findings

The spatial distribution of land use patterns and natural amenities are found to have significant impacts on assessed building and land values, and consequentially, property tax revenues. Applications of a hedonic pricing framework within property tax analysis demonstrates that the total value of a property tax base represents not only direct contributions associated with the structural characteristics and function of land development, but also a set of location specific characteristics which determine the value and utility of real property. The attributes of location that influence property value are defined through land use planning, regulation and development. Results confirm that the value of "location, location, location," is defined differently by different users of the land.

"Figure 3. Summary of Indirect Fiscal Impacts Attributable to Surrounding Land Use Patterns in Case Study Communities," presents a summary of the indirect fiscal impacts of land use planning and development patterns in the case study communities. Findings demonstrate that there are key fiscal tradeoffs associated with certain mixes of land uses.

Figure 3. Summary of Indirect Fiscal Impacts Attributable to Surrounding Land Use Patterns in Case Study Communities

		Land Use Property Values Read down to evaluate impacts of surrounding land uses in rows on indirect property tax revenues in columns			
		Residential	Commercial	Industrial	Multi-Family
Indirect Fiscal Impacts of Surrounding Land Uses	**Residential**		↔	↔	↓
	City Total	-	-	-	-$738,475
	Twp/Village Total				
	Commercial	↑↓		↓	↑
	City Total	+$1,187,622	-	-$4,176,748	+$3,615,585
	Twp/Village Total	-$430,683			
	Industrial	↓	↓		↓
	City Total	-$414,684	-$1,524,416	-	-$37,227
	Twp/Village Total	-$12,158			
	Multi-Family	↓	↑	↓	
	City Total	-$746,458	+$1,958,748	-$8,271,685	-
	Twp/Village Total	-$300,653			

Key	Decrease in Property Value	Increase in Property Value	Insignificant Relationship with Property Value
Change in Value	↓	↑	↔

In case study cities, single family residential, commercial and multi-family land uses located within a quarter mile proximity of each other create "value-added" relationships that account for $6.7 million in property tax revenue. Increased livability associated with residential locations within walking distance of commercial uses, accounts for $1.2 million (2%) of the city single family property tax base and $3.6

million (33%) of the multi-family tax base. These findings suggest that mixed-use policies that encourage high density nodes of commercial and multi-family development, surrounded by walkable single family neighborhoods, create both public and private value in cities.

The property values of non-residential uses are also impacted by surrounding land use patterns. A negative fiscal relationship exists between industrial, multi-family and commercial uses in the case study communities. Industrial properties located adjacent to multi-family and commercial uses decrease commercial and multi-family property tax contributions by less than 2% combined. However, multi-family and commercial land uses located within a quarter mile of industrial uses, subtract over $12 million in industrial property tax contributions, accounting for decrease in value equal to approximately 55% of the total industrial property tax base.

Consistent with a preference for rural character, single family residential land uses in townships and villages do not value mixed use land use patterns, but rather value close proximity to natural amenities. Figure 4. presents a summary of indirect fiscal impacts attributable to surrounding natural amenities in case study communities. Proximity to water and land based natural amenities account for nearly $7.3 million in tax revenue and nearly eight percent of the total single family residential property tax base in case study townships and villages.

Surrounding parks and recreation areas indirectly increase property tax revenues from multi-family uses. This finding suggests that negative fiscal impacts associated with neighboring single and multi-family land uses can be mitigated through green infrastructure planning.

Figure 4. Summary of Indirect Fiscal Impacts Attributable to Surrounding Natural Amenities in Case Study Communities

Land Use Property Values Read down to evaluate impacts of surrounding natural amenities in rows on property values in columns				
		City Residential	Twp/Village Residential	Multi-Family
Value Impacts of Surrounding Natural Amenities	**Lakes**	↓	↑	↑
	Total	-$95,456	+$7,046,318	-$41,762
	Wetlands	↓	↓	↔
	Total	-$267,873	-$728,353	-
	Rivers	↓	↑	↔
	Total	-$348,098	+$45,737	-
	Natural Areas	↑↓	↑	↔
	Total	-$221,283	+$927,486	-
	Recreation & Parks	↑	↔	↑
	Total			+382,515
	Decrease in Property Value	Increase in Property Value	Insignificant Relationship with Property Value	
	↓	↑	↔	

While surrounding land use patterns and natural amenities do maintain statistically significant relationships with assessed building and land values, they account for a relatively small portion of the variance in assessed value and ultimately the property tax base. Building characteristics, namely construction quality, age and size play a major role in determining the composition and resiliency of the property tax base. Residential structures depreciate at a linear rate of one percent each year until they reach 55 years of age at which time depreciation detracts a constant 45% of the reproduction value. Non-residential structures can depreciate anywhere from 1.5 to four percent depending on the quality of construction and maintain an effective life of anywhere from 20 to 65 years.

The negative fiscal consequences of depreciation are mitigated through a healthy real estate market, in fact, only actual and comparable sales transactions greater than the manual value (cost new, less depreciation) result in property tax revenue increases due to the application of the ECF. Only when a property is sold on the market can its maximum taxable value be achieved. When real estate market conditions are strong, legislative limits imposed by the Michigan General Property Tax Act cap the annual rate of property tax increase by less than five percent or the rate of inflation which ever is less. However, when real estate market conditions are weak, as is the case in Michigan currently, sales transactions less than the manual value will systematically drive down assessed property values.

4.2 Limitations and Suggestions for Future Research

The hedonic pricing model adopted in this study represents a theoretical starting point from which a fiscal analyst can document and measure the positive and negative value contributions of land use planning, natural amenities and development characteristics to property values and property tax revenues. Improvements to this fiscal analysis method can be made in three primary areas (1) functional form of the hedonic model (2) design of independent variables and (3) the temporal dimension of property tax revenues.

4.2.1 Functional Form of the Hedonic Model

The functional form of the multiple regression models employed in this thesis can be improved by accounting for linear and non-linear relationships associated with development characteristics. A double-log linear box-cox transformation may present an ideal model specification from which the non-linear relationship of variables such as square footage, age and lot size can be more adequately modeled while still incorporating the linear shift in value that adjacent and proximity variables were proven to possess. The double log transformation is desirable due to the comparative ease of calculating implicit prices of independent variables which requires the analyst to measure implicit prices within the framework of the difference in value from a mean property value. The double log transformation requires a much higher degree of mathematical aptitude than most planners or fiscal analysts are likely to posses and may be better suited for the experienced economist.

It should be noted that the analyst did attempt three different box-cox transformations (right-hand log, left-hand log and double log) for residential building and land values models using the same data set used in the linear regression models. The number of dummy variables resulted in model interference amongst all transformations except the right-handed log model, demonstrated by an r-squared value of one. Removal of dummy variables resulted in models free of interference, but less explanatory power, especially amongst land use adjacent and buffer variables. For this reason, the box-cox transformation may be better suited for hedonic studies that focus on the value impacts of a single set of public goods or attributes.

4.2.2 Design of Independent Variables

The explanatory power of dummy variables as designed in this study, especially land use proximity variables, is limited. For example, a dummy variable that states "the property is located within 0.25 miles of a commercial use" does not identify how many commercial uses are present within the quarter mile area. Similarly, dummy variables do not account for the percentage of land area within the quarter mile buffer that consists of any given land use. The degree to which different land use patterns impact property values is likely to be influenced by the density and the percentage of land area maintained by different uses.

Two alternatives were tested to address the limitations identified in buffer variable design. First, the analyst created quarter mile buffers around each parcel and applied the clip GIS function to dissolve parcel buffers over land use layers therefore capturing the land use composition of each buffer. Using Microsoft Access, the analyst was able to group common land use elements and count the number of common land uses as well as sum the areas of land uses within each parcel buffer. This method was tested on a very small sample using Commerce Township parcels and water features, which delivered adequate results but longer than desirable processing times. When the method was extended to all case study communities using land use layers in MSU's GIS lab, processing time ran for over eight hours and was terminated before completion. Exploration of alternative GIS methods that can more accurately and efficiently capture the proximate land use composition of very large parcel layers merits future attention and is likely to advance the hedonic modeling of land use planning and other geographic variables. Vector-raster conversions, density applications, and VBA coding offer potential solutions.

The second method adopted to improve explanatory power of land use proximity variables made use of indices as specified by Acharya and Bennett (2001). The design of mix indices specifies the number of land uses within a distance of any given parcel. For example, a mix index of five demonstrates that there are five different land uses within a quarter mile of a parcel, but does not identify what those five land uses are. Similar to buffer variables, the mix index does not demonstrate the number of common land uses or the area that any one land use maintains within any given parcel buffer. The methodological design of Acharya and Bennett indices warrants further exploration.

Application of hedonic pricing techniques within a fiscal framework presents a promising new direction for research in the fields of non-market valuation. Given the methodological similarities between hedonic pricing techniques and property assessment, future research efforts should begin with a comprehensive inventory of assessment practices established through state legislation, emphasizing similarities and differences as they relate to the identification of market and non-market factors that determine value, application of assessment and MRA methods, and implications of assessment methods to the bottom line in local communities.

The International Association of Assessment Officers encourages the use of hedonic pricing techniques as tools to support mass appraisal and sales comparison assessment methods (IAAO). Applications of multiple regression analysis however, were not uncovered through the case study analysis.

4.2.3 Temporal Dimensions

Finally, several potential applications exist in the hedonic modeling of time-series data. Identifying and measuring changes in property values and property tax revenues requires assessor's data for two points in time. The logistics of accounting for new construction, parcel divisions, sales, and a host of other potential issues will greatly increase the complexity of already complex data management and integrity. Possibilities do exist to measure the impacts of social, environmental and economic change on current values by designing certain independent variables to account for change.

Using a time series approach may also further support the use of assessor's data over the traditional use of sales data. Hedonic time series studies requires properties be sold twice, greatly limiting and most likely biasing samples. The use of time series assessor's data may allow for a more adequate measurement of factors that influence market conditions and value as they relate to public property appraisal. Extrapolation of property tax revenues at future points in time would require critical assumptions to account for changes in millage rate, predictions on inflation and the nuances of capped vs. equalized value, future sale prices, and a host of other issues.

4.3. Applications to Planning Policy and Practice

Integrating knowledge of property tax assessment within the constructs of planning enables the capacity to pursue fiscal sustainability through informed long-range planning efforts. The methodological framework tested in this thesis helps support comprehensive land use planning and regulation, by assigning an actual fiscal value to development patterns built under planning guidelines.

In many ways, the findings of this thesis confirm what planners have always thought to be valuable planning, fiscal or otherwise. For example, mixed-use policies often aim to achieve objectives in urban livability, walkability, and local commerce. Modeling outcomes demonstrate that mixed-use nodes of commercial and multi-family uses in urban single family neighborhoods are fiscally beneficial, therefore confirming this win-win scenario for planning policy. Mixed use policies that concentrate high-intensity uses can detract value from these land uses in urban areas, especially over time as these buildings depreciate. During a visioning session for the 2008 City of Pontiac Master Plan, local residents cited the mix of land uses as something that they didn't like about their community. Residents described the mix of high-intensity land uses as a "concrete jungle" that creates nuisances for local residents.

While the methods adopted in this thesis effectively document and assign a monetary value to the dynamic relationships between land uses, the time, resources and knowledge required for completing such an analysis will greatly limit its application in planning practice. This method most likely won't tell planners anything they don't already know, but it will provide fiscal statistics to further support decision making. Application of this method has little relevance for a local jurisdiction, but is best applied at a regional level. Only in counties or metropolitan areas, and especially those engaged in growth management and inter-jurisdictional planning, should this technique be considered a worth while endeavor. In order to make this method and its outcomes applicable to local jurisdictions, much more work needs to be done. This methodological framework must be replicated in regions across America to create a critical mass of work that can conclusively document common significant indirect fiscal relationships and their value. A comprehensive collection of common findings, including indirect fiscal "multipliers" like the cost multipliers presented in Burchell's seminal Fiscal Impact Guidebook, would allow for more efficient and holistic local fiscal evaluation and planning efforts.

Detailed examination of the nexus between land use policy and property tax revenues should continue to go beyond the measure of direct fiscal impacts. While this study was successful in quantifying the indirect fiscal impacts of built and natural land use patterns, findings are limited to a single point in time. Changes in the physical and socioeconomic conditions, which are of primary interest to community planners, drive changes in property value and property tax revenue over the long-term. Integrating a temporal dimension to this analysis would greatly support pursuit of fiscal sustainability and examination. A regional scope of analysis would be highly favored in a property tax hedonic modeling that incorporates a time series framework. In this regard, adopting a comparative community approach would likely provide more robust findings that could help explain and predict local real estate market dynamics while putting findings in a more understandable perspective.

APPENDICES

Appendix A. Highest and Best Use Analysis

Table A-1. Vacant City Land Values Based on Highest and Best Use, 2007

CLASS	Acres	Total Land Value	Average $/Acre	Average $Tax/Parcel	Total Tax Revenue
Pontiac					
Commercial Improved	19.8	$2,641,221	$106,597	$242,971	$485,941
Commercial Vacant	197.7	$15,127,195	$147,170	$1,069	$256,529
Apartment Improved	0.9	$78,326	$87,119	$11,076	$11,076
Apartment Vacant	71.7	$4,339,012	$98,797	$405	$29,185
Industrial Vacant	251.9	$17,544,204	$107,679	$1,598	$201,394
Residential Improved	8.3	$436,000	$61,179	$1,701	$69,754
Residential Vacant	630.7	$39,867,674	$89,384	$207	$598,513
Lake Vacant	1.0	$12,000	$12,021	$315	$315
Condo Improved	2.6	$533,200	$216,235	$2,975	$35,698
Condo Vacant	107.0	$21,690,088	$310,969	$429	$214,847
TOTAL	1291.6	$102,268,920	$79,178	$490	$1,903,255
Royal Oak					
Commercial Vacant	6.0	$2,402,675	$422,077	$5,441	$54,411
Apartment Vacant	0.1	$17,520	$174,235	$287	$287
Industrial Vacant	0.5	$90,833	$166,785	$965	$1,929
Utility Vacant	0.1	$15,318	$205,340	$386	$386
Residential Improved	3.3	$930,515	$286,762	$2,792	$58,624
Residential Vacant	20.8	$5,619,254	$272,617	$1,498	$155,760
Condo Improved	2.2	$525,000	$319,338	$3,079	$21,554
Condo Vacant	2.3	$711,530	$306,859	$1,627	$17,899
TOTAL	35.2	$10,312,645	$292,704	$1,980	$310,851

Table A-2.Vacant Township and Village Land Values Based on Highest and Best Use

CLASS	Acres	Total Land Value	Average $/Acre	Average $Tax/Parcel	Total Tax Revenue
Commerce Township					
Commercial Improved	5.9	$730,950	$132,610	$34,894	$104,681
Commercial Vacant	254.6	$27,822,243	$246,678	$8,728	$366,580
Apartment Vacant	37.9	$4,251,516	$116,753	$4,168	$37,516
Industrial Improved	8.8	$281,615	$32,052	$16,536	$16,536
Industrial Vacant	164.2	$23,112,153	$178,939	$2,632	$178,964
Residential Improved	5.4	$1,092,565	$245,105	$4,488	$58,345
Residential Vacant	968.9	$54,342,282	$249,807	$1,097	$611,204
Lake Improved	0.6	$581,390	$1,185,771	$11,377	$22,754
Lake Vacant	128.3	$24,009,177	$476,002	$1,026	$216,441
Condo Improved	10.7	$2,286,847	$259,473	$4,592	$96,438
Condo Vacant	203.5	$40,985,845	$265,331	$580	$261,456
TOTAL	1788.8	$179,496,583			$1,970,915
Wolverine Lake Village					
Commercial Vacant	15.8	$2,303,091	$139,223	$5,747	$22,990
Residential Improved	0.3	$79,296	$265,968	$3,846	$3,846
Residential Vacant	28.5	$4,523,264	$239,267	$905	$67,850
Lake Vacant	4.3	$2,710,058	$751,620	$1,464	$29,284
TOTAL	48.9	$9,615,709			$123,970

Table A-3.Vacant Township and Village Land Values Based on Highest and Best Use

CLASS	Acres	Total Land Value	Average $/Acre	Average $Tax/Parcel	Total Tax Revenue
Milford Township					
Farm Vacant	25.0	$763,976	$30,618	$2,558	$5,116
Commercial Vacant	101.8	$6,145,302	$65,758	$4,731	$52,041
Apartment Vacant	8.2	$742,154	$91,418	$1,299	$3,897
Industrial Improved	2.6	$201,508	$77,900	$8,183	$8,183
Industrial Vacant	632.6	$14,004,511	$53,389	$2,747	$148,359
Utility Vacant	7.6	$139,820	$15,245	$890	$2,669
Residential Improved	12.1	$589,124	$48,303	$7,582	$30,329
Residential Vacant	1673.2	$41,538,350	$64,418	$1,575	$522,919
Lake Improved	1.2	$192,500	$165,818	$521	$521
Lake Vacant	103.8	$3,256,026	$185,199	$965	$39,578
Condo Improved	22.1	$2,042,000	$151,734	$6,106	$79,372
Condo Vacant	252.0	$21,767,470	$171,650	$1,149	$236,681
TOTAL	2842.1	$91,382,741			$1,129,663
Milford Village					
Commercial Improved	3.4	$1,627,619	$489,581	$52,351	$104,701
Commercial Vacant	4.2	$710,186	$269,395	$1,972	$9,861
Apartment Vacant	26.4	$1,199,620	$43,776	$2,321	$13,928
Industrial Vacant	15.8	$1,397,753	$104,354	$706	$5,650
Utility Vacant	7.5	$111,744	$14,884	$2,022	$2,022
Residential Improved	0.2	$54,550	$316,884	$1,710	$1,710
Residential Vacant	66.0	$3,547,184	$173,236	$964	$53,019
Lake Vacant	7.7	$409,344	$63,860	$447	$5,807
Condo Vacant	26.6	$5,158,650	$373,545	$507	$31,417
TOTAL	157.7	$14,216,650			$228,117
Oakland Township					
Commercial Vacant	13.8	$488,071	$99,652	$1,209	$7,255
Industrial Improved	137.7	$1,420,760	$10,321	$22,458	$22,458
Industrial Vacant	214.4	$2,814,543	$57,606	$4,258	$29,803
Residential Improved	22.4	$1,179,598	$116,876	$6,358	$44,504
Residential Vacant	4427.7	$107,757,482	$123,113	$2,512	$1,431,750
Lake Vacant	26.6	$1,555,862	$95,833	$1,136	$20,439
Condo Improved	10.1	$2,098,595	$298,974	$7,216	$101,021
Condo Vacant	320.6	$78,221,422	$319,592	$1,843	$934,396
TOTAL	5173.4	$195,536,333			$2,591,626

Appendix B: Exploration of Spatial Autocorrelation

Table B-1. Exploration of Spatial Autocorrelation in Residential Building Values

Average Residential Property	Average ECF	Average BV	Total No. Cases
RES	1.45	$145,915	59752

Significant Variable at .1	Average ECF	Average BV	No. of Cases	% of Cases
A002	1.6	$133,864	1,607	3%
A003	1.47	$117,516	1,441	2%
A008	1.07	$248,441	135	0%
A009	1.01	$222,743	5,226	9%
A012	0.96	$230,456	1,632	3%
A013	1.45	$136,079	24,729	41%
A014	0.94	$228,817	1,013	2%
A017	1.14	$140,949	11,237	19%
A019	0.98	$239,085	923	2%
A020	1.14	$219,704	144	0%
A021	1.22	$164,754	243	0%
A022	1.28	$245,186	1,311	2%
A024	0.95	$232,178	1,042	2%
A027	1.07	$189,872	341	1%
A029	1.03	$246,775	845	1%
A030	1.26	$157,202	2,422	4%
A039	1.07	$212,018	6,140	10%
A042	1.31	$95,231	521	1%
A043	1.02	$201,670	11,525	19%
A044	0.95	$241,549	455	1%
A045	0.91	$192,872	356	1%
A046	0.96	$169,038	90	0%
A047	0.88	$176,021	167	0%
A048	1.34	$136,319	172	0%
A049	1.07	$172,136	1,665	3%
A050	1.14	$155,539	519	1%
A051	1.8	$131,375	4,248	7%
A052	1.96	$135,720	1,949	3%
A053	1.57	$113,284	1,031	2%
A055	1.7	$116,744	1,329	2%

Table B-1 cont. Exploration of Spatial Autocorrelation in Residential Building Values

Average Residential Property	Average ECF	Average BV	Total No. Cases	
RES	1.45	$145,915	59752	
B001	0.95	$214,667	965	2%
B002	1.62	$120,215	35,481	59%
B003	1.56	$119,895	39,619	66%
B004	1.1	$237,919	413	1%
B005	1.38	$100,309	14,277	24%
B007	1.54	$123,812	41,685	70%
B008	1.75	$129,501	6,923	12%
B009	1.53	$136,423	47,554	80%
B010	1.68	$127,292	31,251	52%
B013	1.42	$122,857	19,089	32%
B014	1.2	$172,273	27,899	47%
B015	1.1	$169,740	2,389	4%
B016	1.17	$142,775	1,231	2%
B017	1.13	$163,083	7,253	12%
B018	1.1	$148,169	7,534	13%
B021	1.07	$175,961	1,898	3%
B022	1	$228,471	3,874	6%
B023	1.09	$194,979	9,401	16%
B024	1.65	$123,902	12,217	20%
B032	1.44	$113,279	4,831	8%
B033	1.4	$106,217	3,208	5%
B034	1.44	$140,333	537	1%
B037	1.04	$197,256	16,068	27%

Table B-2. Exploration of Spatial Autocorrelation in Residential Land Values

Average Residential Property	Average Acres	Average LV	Total No. Cases
RES	0.51	$59,071	59751

Significant Variable at .1	Average Acres	Average LV	No. of Cases	% of Cases
A002	0.31	$43,419	1607	3%
A003	0.33	$45,755	1441	2%
A005	0.72	$37,496	266	0%
A009	2.14	$111,055	5256	9%
A010	0.59	$89,276	16540	28%
A012	5	$150,001	1632	3%
A013	0.25	$58,519	24729	41%
A014	6.19	$164,779	1013	2%
A017	0.95	$66,033	11236	19%
A019	5.13	$154,276	923	2%
A020	0.78	$123,129	144	0%
A021	0.81	$96,493	243	0%
A022	0.59	$237,847	1311	2%
A023	3.63	$130,226	379	1%
A024	4.72	$140,835	1042	2%
A027	4.94	$145,821	341	1%
A028	4.57	$146,753	645	1%
A036	1.46	$92,593	82	0%
A039	1.41	$107,002	6140	10%
A040	0.8	$38,521	123	0%
A042	0.19	$20,488	521	1%
A043	0.83	$100,909	11525	19%
A044	4.27	$145,115	455	1%
A046	5.88	$163,949	90	0%
A047	9	$211,503	167	0%
A048	0.77	$102,212	172	0%
A049	1.9	$107,114	1665	3%
A050	1.61	$101,892	519	1%
A051	0.2	$41,081	4248	7%
A052	0.2	$37,668	1949	3%
A054	0.24	$31,359	1329	2%
A055	0.19	$37,518	36412	61%

Table B-2 cont. Exploration of Spatial Autocorrelation in Residential Land Values

Average Residential Property	Average Acres	Average LV	Total No. Cases	
RES	0.51	$59,071	59751	
B001	1.2	$100,790	965	2%
B002	0.31	$43,419	1607	3%
B003	0.23	$41,813	39618	66%
B004	1.5	$118,091	413	1%
B005	0.28	$29,763	14277	24%
B006	0.84	$45,433	926	2%
B007	0.26	$42,439	41684	70%
B008	0.23	$40,532	6923	12%
B010	0.28	$42,381	31251	52%
B013	0.29	$44,375	19089	32%
B014	0.81	$84,038	27899	47%
B016	0.71	$81,537	1231	2%
B017	0.43	$111,734	7253	12%
B018	0.76	$71,845	7534	13%
B021	2.18	$109,591	1898	3%
B022	1.86	$112,073	3874	6%
B023	0.91	$87,401	9401	16%
B024	0.23	$39,985	12217	20%
B034	0.39	$75,750	537	1%

Table B-3. Exploration of Spatial Autocorrelation in Multi-Family Building Values

Average Multi-Family Property	Average ECF	Average BV	Total No. Cases
APT	1.17	$634,100	701

Significant Variable at .1	Average ECF	Average BV	No. of Cases	% of Cases
A003	1.2	$1,225,493	93	13%
A005	1.3	$535,990	16	2%
A015	1.21	$475,041	368	52%
A016	1.03	$1,832,877	8	1%
A031	1.15	$2,852,072	9	1%
A034	1.12	$1,996,667	22	3%
A042	1.21	$937,848	40	6%
A043	1.02	$641,026	12	2%
A051	1.2	$643,386	108	15%
A053	1.07	$894,016	32	5%
A054	1.18	$1,123,748	141	20%
B003	1.17	$600,568	671	96%
B005	1.21	$567,835	248	35%
B006	1.25	$4,047,188	6	1%
B007	1.16	$609,589	628	90%
B034	1.33	$1,074,412	43	6%
B038	1.14	$1,480,955	32	5%

Table B-4. Exploration of Spatial Autocorrelation in Multi-Family Land Values

Average Multi-Family Property	Average Acres	Average LV	Total No. Cases
APT		$634,100	701

Significant Variable at .1	Average Acres	Average LV	No. of Cases	% of Cases
A003	2.28	$176,713	93	13%
A005	3.31	$81,194	16	2%
A013	1.77	$126,486	190	27%
A016	8.7	$298,839	8	1%
A019	20.3	$219,707	10	1%
A024	15.2	$225,333	9	1%
A030	5.66	$272,471	34	5%
A039	3.73	$145,844	144	21%
A043	20.5	$167,299	9	1%
A054	1.85	$169,354	141	20%
A055	1.18	$103,521	457	65%
B007	1.27	$91,526	628	90%
B010	1.28	$118,476	428	61%
B011	1.16	$39,267	13	2%
B018	2.31	$77,723	78	11%
B034	0.56	$150,405	43	6%
B038	5.07	$243,375	32	5%

Table B-5. Exploration of Spatial Autocorrelation in Commercial Building Values

Average Commercial Property	Average ECF	Average BV	Total No. Cases
COMM	1.15	$578,554	1977

Significant Variable at .1	Average ECF	Average BV	No. of Cases	% of Cases
A005	1.06	$1,005,777	118	6%
A011	1.07	$1,933,505	9	0%
A016	1.11	$1,338,481	54	3%
A019	1.09	$2,381,354	29	1%
A036	1.11	$4,540,431	20	1%
A043	1.14	$1,561,034	75	4%
B002	1.16	$529,944	1,629	82%
B006	1.07	$778,710	50	3%
B007	1.16	$507,693	1,765	89%
B034	1.31	$693,924	172	9%

Table B-6. Exploration of Spatial Autocorrelation in Commercial Land Values

Average Commercial Property	Average Acres	Average LV	Total No. Cases
COMM	0.83	$244,906	1977

Significant Variable at .1	Average Acres	Average LV	No. of Cases	% of Cases
A002	1.37	$462,488	109	6%
A005	2.09	$333,655	118	6%
A009	1.73	$245,670	18	1%
A011	7.45	$624,286	9	0%
A012	8.12	$711,893	7	0%
A016	2.46	$461,042	54	3%
A019	5.9	$990,938	29	1%
A024	7.8	$1,367,972	15	1%
A030	2.8	$519,113	77	4%
A039	2.4	$574,172	166	8%
A042	0.67	$305,189	510	26%
A043	3.19	$722,381	75	4%
A048	2.3	$605,819	104	5%
A049	1.14	$239,771	208	11%
A053	0.95	$260,355	286	14%
B002	0.62	$225,173	1,629	82%
B005	0.84	$179,306	1,015	51%
B006	1.98	$238,248	50	3%
B007	0.64	$206,629	1,765	89%
B013	0.78	$232,703	1,116	56%
B032	0.78	$266,713	556	28%
B037	2.7	$531,355	300	15%

Table B-7. Exploration of Spatial Autocorrelation in Industrial Building Values

Average Industrial Property	Average ECF	Average BV	Total No. Cases
IND	0.98	$1,644,324	513

Significant Variable at .1	Average ECF	Average BV	No. of Cases	% of Cases
A017	0.99	$2,519,846	150	29%
A042	0.95	$710,616	19	4%
A043	1.07	$534,975	68	13%
A054	0.92	$9,230,618	23	4%
A055	0.91	$1,964,201	185	36%
B002	0.92	$905,013	252	49%
B018	0.96	$973,417	41	8%
B032	0.95	$3,682,034	38	7%
B037	1.03	$1,144,252	190	37%

Table B-8. Exploration of Spatial Autocorrelation in Industrial Land Values

Average Industrial Property	Average Acres	Average LV	Total No. Cases
IND	5.5	$326,932	513

Significant Variable at .1	Average Acres	Average LV	No. of Cases	% of Cases
A024	45.2	$906,829	13	3%
A048	5	$751,245	11	2%
A051	13.6	$787,359	60	12%
A052	9.55	$518,012	75	15%
A053	11.1	$1,015,514	27	5%
A054	20.6	$1,030,621	23	4%
A055	4.02	$264,552	185	36%
B002	2.2	$231,143	252	49%
B008	3.44	$323,473	219	43%
B032	7	$691,705	38	7%
B033	0.92	$153,516	16	3%
B038	10.83	$254,208	118	23%

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