THE INFLUENCE OF PRIVATELY AND PUBLICLY INDUCED REZONING ON RESIDENTIAL REAL ESTATE PRICES

by

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(Under the Direction of Velma Zahirovic-Herbert)

ABSTRACT

Conventional zoning and overlay zoning influence the development and the spatial structure of urban environments. This research tests the externality effects of privately and publicly induced rezoning on residential real estate prices at five different distances. Privately induced rezoning, which maintains homogeneous residential neighborhoods, is observed to increase surrounding residential real estate prices. The shift to nonresidential real estate zones from residential real estate zones is associated with negative price shocks for residential real estate. Urban planners can use these results to make more informed decisions as private developers seek to redevelop underutilized urban property within their district.

The spillover effects of publicly induced rezoning such as Tax Allocation Districts or Tax Increment Financing districts are found to be inversely related to distance. Residential real estate located within 1.25 miles from a publicly rezoned district experience positive price externality spillovers. Yet, this positive effect disappears with greater distance. Municipal officials may use these results as they craft legislation to revitalize districts with overlay zoning.

INDEX WORDS: Zoning, Rezoning, Urban Planning, Tax Allocation Districts, Tax Increment Financing, Overlay Zoning

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DEDICATION

To my family and the belief in following one's dream.

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The enduring and unwavering support of my family buttressed me throughout my graduate career. My fiancé, future wife, and partner-in-crime, Dalaney Algiere, kept me sane and focused on the completion of this program. Our nightly conversations brought stability to my otherwise unpredictable world.

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LIST OF ABBREVIATIONS

GDCA	Georgia Department of Community Affairs
IRC	International Residential Code
MARTA	Metropolitan Atlanta Rapid Transit Authority
MLS	Multiple Listing Service
NEC	National Electrical Code
REO	Real Estate Owned
RESO	Real Estate Standards Organization
TAD	Tax Allocation District
TIF	Tax Increment Financing
TOD	Transit Oriented Development
UGB	Urban Growth Boundary

PROLOGUE

Private & Public Rezoning

For over one hundred years, municipal governments adopted and maintained zoning laws, ordinances, and statutes. Zoning "is the division of local government area into districts which are subject to different regulations regarding the use of land and the height and bulk of buildings which are allowable" (Cullingworth, 2002, p. 11). All states have zoning laws (Bassett, 1940). Zoning regulations have extensive financial implications for current and future residents. "Land use control is the most important local regulatory power" (Briffault, 1990, p. 3). A municipality's zoning regulations dictate future development and the municipality's tax digest. Local municipalities can artificially maintain low prices of agricultural land by refusing to rezone agricultural land to higher use functions (Brownstone & De Vany, 1991). Other municipalities increase the prices of residential home values with the adoption of municipal growth controls (Katz & Rosen, 1987).

Zoning research remains an important real estate area. Zoning influences real estate land values and residential real estate prices (Hilber & Robert-Nicoud, 2013; Huang & Tang, 2012; Ohls, Weisberg, & White, 1974). Real estate differs from most other asset classes for two reasons. First, real estate investment either for personal residential housing consumption or for an investment property cannot be diversified. Localized changes in neighborhood conditions, classified in real estate research as externality effects, have the potential to detrimentally influence the real estate investment's value. Second, when compared to the average consumer's total financial assets, real estate, as an investment class, comprises the majority of asset holdings.

Owner-occupied residential real estate accounts for 35% of all household wealth (Weicher, 2017) and 65.9% of total household wealth for the bottom 80% of US households (Wolff, 1998). This overweighed asset class leaves the consumer vulnerable to real estate price fluctuations. As evidenced in the recession in 2007, dramatic price changes in real estate may influence the overall economic marketplace.

Previous academic literature provides evidence of externality effects on residential real estate property prices. Some examples of this research include the externality influence of industrial facilities (Palmquist, Roka, & Vukina, 1997), preserved open green space (Irwin, 2002), and casinos (Buck, Deutsch, Hakim, Spiegel, & Weinblatt, 1991) on nearby land. Municipal governments manage each of these different forms of land use through extensive zoning regulations. However, changes to the existing comprehensive zoning plan may prevent or allow negatively-perceived land use functions within the nearby community. This research explores zoning changes, called rezoning, from two perspectives. The first essay studies privately induced rezoning, while the second essay investigates publically induced rezoning.

The distinction between publicly and privately induced rezoning is the nature of the entity requesting a zone change. Privately induced rezoning begins from the request of a real estate owner or developer. Publicly induced rezoning occurs at the recommendation of a municipal servant or authoritative board. In either case, rezoning may influence surrounding residential real estate prices. Another difference between privately induced rezoning and publicly induced rezoning is geographic scope. Generally, privately induced rezoning contains only one or a few parcels of land per surrounding property at a single point in time. In some cases, publicly induced rezoning represents many more consecutive properties. For example, Busa (2014) researched 125th Street in Harlem. The municipality rezoned a large consecutive block of

real estate at a single point in time. The surrounding properties were influenced by many zone changes at once. Perceived positive or negative peer effects may be magnified by this large publicly induced rezone.

Another difference between the two types of rezoning is end-use functionality. In theory, privately induced rezoning converts the land to its most profitable use. Consider two scenarios of privately induced rezoning. In the first scenario, an existing owner seeks to change the current zone use. In this example, the owner spends time and money to petition the municipality to change the existing comprehensive zoning plan. The benefits for the landowner must outweigh the cost of rezoning. In the second scenario, potential owners or developers may assess the property has greater value as a different zone and may bid higher than competing offers to acquire the real estate. In either case, individuals or developers purchase property for personal consumption or to develop for profitable resale. Compared to the property's current use, the acquisition or repurpose of real estate through a privately induced rezone shifts the land to a higher use.

The end-use functionality of publicly induced rezoning does not necessarily maximize profitability or embody the highest development level of end land-use. Publicly induced rezoning may occur for health, economic, or cultural reasons. Concentration of negative external land use, such as industrial functions, mitigates the negative externalities and increases overall consumer welfare (Freeman III, Herriges, & Kling, 2014; Irwin, 2002). Other publicly induced rezoning seeks to revitalize economically depressed areas. Enterprise zones overlay tax incentives for employment-generating businesses and seek to spur real estate development (Dye & Merriman, 2000). Historic structure zones preserve buildings which have been deemed to provide cultural benefits to the municipality (Paul & Forrest, 1991).

This research seeks to empirically quantify the change in residential real estate price as a result of a nearby rezoned property. Residential real estate prices are capitalized using Rosen's (1974) revealed price theory and hedonic modeling. Rosen's theory underpins much of real estate research using transactional data (de Vor & de Groot, 2011; Farber, 1998; Follain & Jimenez, 1985; Freeman III, 1979; Galster, Tatian, & Pettit, 2003; Harrison Jr & Rubinfeld, 1978). This analysis uses two statistical methods, propensity score matching and hedonic regression.

This dissertation seeks to empirically quantify changes in residential real estate values resulting from rezoning and help inform local policy makers and homeowners. Understanding the influence of rezoning on residential real estate prices is critical for policy makers and municipal officials. Reductions in property values may put downward pressure on property assessments, which in turn could reduce municipal tax revenues. Furthermore, declining residential real estate prices may result in a disgruntled citizenry. Homeowners reveal their willingness to pay for publicly financed neighborhood amenities through residential real estate prices (Gedal & Ellen, 2018). Changes in the community's zoning composition may result in the need to change the supply of public amenities.

The following dissertation contains two empirical essays and one essay discussion connecting the two quantitative findings. The first essay explores the influence of privately induced rezoning on residential real estate prices, while the second essay studies the influence of publicly induced rezoning on residential real estate prices. Both essays adhere to the same progression and contain six chapters. Chapter 1 is an introduction to the topic and presented an overview of the essay. Chapter 2 describes the previous literature of zoning and its influence on residential real estate prices. Additionally, this chapter describes the numerous control variables

that are employed in future modeling. Chapter 3 presents the theoretical model for the study and Chapter 4 provides the statistical framework for the empirical analysis. Chapter 5 is a discussion of the data, results, and implications of the finding. Chapter 6 presented a conclusion for each essay with future implications and limitations of the study. There is an epilogue at the conclusion of the second essay. The geographic proximity of this study allows for the discussion within this section. Since the studied areas are similar, statistical effects between the two empirical essays may be investigated further. As a result, the epilogue compares and contrasts the influence of privately and publicly induced externality effects on surrounding residential real estate price levels.

ESSAY 1: The Influence of Privately Induced Rezoning on Residential Real Estate Prices

CHAPTER 1

INTRODUCTION TO PRIVATE REZONING

Further accentuated by the importance of private homeownership in American culture, the real estate marketplace is a fascinating area of academic research. The pursuit of private residential real estate ownership represents a central feature of the idealistic *American Dream* (Rohe & Watson, 2007). In addition to the connected ethos of the *American Dream* and home ownership, the real estate sector contributes 12.1% of the gross output for all private industries (Bureau of Economic Analysis, 2018). The aggregate market value of owner occupied real estate holdings, including vacant land and mobile homes, amounted to $24.511 trillion in 2017 with a reported household owner equity of $15.189 trillion (Board of Governors of the Federal Reserve System, 2018). Price fluctuations in the real estate market influence macroeconomic trends and the overall health of the United States economy (Chaney, Sraer, & Thesmar, 2012; Girouard & Blöndal, 2001; Goodhart & Hofmann, 2008).

The Case-Shiller Index recorded extreme price declines in the Atlanta market from 2008 to 2012, Figure 1.1. Large declines in residential real estate prices magnify financial pressure upon consumers (Bhatia, 1987; Mian & Sufi, 2010). The degree to which residential real estate market prices impact the economy is a result of multiple factors. A significant portion of American assets are consolidated in the value of the residential property. In aggregate, the 2017 market value of owner-occupied real estate was 22% of total household assets and was greater than the amount of assets held in corporate equities and mutual fund shares (Board of Governors of the Federal Reserve System, 2018). "The home is by far [the American consumer's] largest

financial asset and, unlike owners of corporate stock, home-owners cannot diversify their holdings among several communities ” (Fischel, 2004, p. 317).

In financial research, there are two types of risk, systematic and unsystematic. Systematic risk is undiversifiable risk embedded within the marketplace. This type of risk is considered unpredictable and impossible to completely avoid. Unsystematic risk is unique to the specific asset. Diversification of an investment portfolio into different assets reduces unsystematic risk (Statman, 1987). Unfortunately, unsystematic residential real estate investment risk cannot be diversified. Caplin, Tracy, Chan, and Freeman (1997) proposed an equity-sharing investment strategy between owner-occupiers and investors. However, this divided ownership is much harder for single family dwellings than multi-family structures. Generally, consumers cannot purchase fractions of single family residential real estate. The equity ownership of the residential real estate remains consolidated in one concentrated geographic area. Fischel (2009) argued that the susceptibility of the homeowner’s equity investment to one’s geographic area gave rise to various forms of homeowner protection. His theory, The Homevoter Hypothesis, describes the rise of protectionist policies focused on maintaining the value of residential real estate property. One of his main arguments centered upon the utilization of land use restrictions to prevent the nearby location of nuisance properties.

At first, restrictive covenants between private parties regulated the end-use function of developed real estate. As technology changed and transportation costs declined, American consumers were no longer restricted to urban living. As a result, Americans migrated away from city centers and purchased residential real estate for housing consumption. Private-party restrictive covenants could not afford the necessary protection desired by new homeowners. Consequently, municipal zoning was born.

Advent of Municipal Zoning

Municipal planning "is concerned with the long-term development (or preservation) of an area and the relationship between local objectives and overall community and regional goals" (Cullingworth, 2002, p. 9). Zoning is a mechanism and tool to implement a municipality's comprehensive land use plan. Yet, zoning is an integral aspect of American housing policy. Babcock (1966) asserted "zoning effects the lives of everyone, whether a property-owner or not." Zoning is the systematic division of land into geographic segments, where it separates the geography of the municipality into districts, thereby allowing for the regulation of the buildings and structures according to their use and construction (*Angermeier v. Borough of Sea Girt*, 1958). Each geographic segment may have differing land use functions and construction requirements governing all structures. In the United States, there are 40,000 local governments that administer local zoning. Uniform zoning codes do not exist between municipal jurisdictions. These locals operate within all states and generally function autonomously. Since this research utilizes transactional data for Fulton County, Georgia, the zoning definitions align with Fulton County statute.

This research studies five specific zone types: 1) commercial, 2) industrial, 3) single family residential, 4) multifamily residential, and 5) mixed use. Each of these zone types restricts the end-use functionality of the constructed building. Evidenced by the strict requirements codified in zoning statute, the type of zone greatly influences the nature and function of developed real estate. Each zone type has its own definition, conditions, and constraints, which are enumerated in the following paragraphs.

Commercially zoned regions support structures for business functions. In Fulton County, there are five different zones for commercial activity. Each zone represents a different type of

business activity. Per the statute, commercially zoned districts "provide locations in which neighborhood and community-oriented retail and service activities conclude a transition, or land areas which complement a transition into a more intense activity area" (Zoning Resolution of Fulton County, 1990a). There are sixty-four permitted business uses for commercial land. Additionally, there are height regulations, minimum front/side/rear requirements, minimum lot areas, minimum heated floor areas, and minimum lot frontages. This research combines all five commercial classifications into one commercial zone.

Industrial zones provide the necessary regions for industrial parks and private industrial facilities. Industrial parks may contain manufacturing, fabricating, processing, warehousing, distributing, research, and office functions (Zoning Resolution of Fulton County, 1990b). In addition to height, minimum frontage standards, maximum lot coverage, industrial buildings have exterior wall regulations. Wood siding is not permitted on structures within industrial zoned property. There are four building material types outlined in regulation 10.1.4 for the external walls of the industrial structure. In addition, industrial zone classification contains nuisance provisions to "promote compatibility of the [industrial district] with surrounding areas" (p. 10-3). Activities that may be harmful to health or safety of the citizens of Fulton County are not permitted within these industrial zones. There are only two industrial zoning classifications in Fulton County: light industrial and heavy industrial. Due to overlapping end-use functionality, these two categories are combined into one industrial category.

Single family residential zones are devoted to single and two family dwellings. Within the Fulton County statute, there are ten individual single family zones that differentiate residential real estate based upon structure height, minimum front/side/rear yardage, lot area/width/frontage, minimum heated floor area, and minimum accessory structure requirements

(Zoning Resolution of Fulton County, 1990a). This research condenses all the single family dwelling classifications into one single family zone.

Similar to single family residential zones, multifamily zones are devoted to residential accommodations. There are fourteen multifamily zone designations in Fulton County, which are differentiated by their floor area ratio. The floor area ratio is the total number of square footage of a structure divided by the square footage of the building lot. As an example, a two-story multifamily building that covers one fourth of the building lot has a floor area ratio of 0.5. Higher density zones increase the maximum floor area threshold. Additional provisions for buildings within multifamily zones center upon minimum heated floor area requirements delineated by the number of bedrooms. A three-bedroom apartment cannot have a minimum heated floor area less than 700 square feet, while the minimum square footage for an efficiency or studio apartment cannot be lower than 400 square feet. The footprint of all buildings and parking cannot exceed seventy percent of the total land area. Outdoor recreational area cannot fall below ten percent of the gross land area of the building lot (Zoning Resolution of Fulton County, 1990a).

According to statute, the intent of mixed use zoning is to "encourage flexible, innovative and creative concepts in site planning and efficient use of land and to provide a stable multiple use environment compatible with surrounding uses" (Zoning Resolution of Fulton County, 1990a). Mixed use zones combine elements of residential and commercial end use functions within one zone. The mixed use zone statute mandates a combination of residential buildings with at least two of the following building end uses: commercial, office or institutional. There are thirty-six designated structural uses for mixed use buildings outlined in statute. Storage space, building height, yard setbacks, yard frontages, building separations, minimum heated floor

area, common outdoor area, pedestrian connectivity, and parking are all regulated by zoning statute.

Fulton County statute refers to rezoning as land use petitions (Zoning Resolution of Fulton County, 1990a). Applications for land use petitions are reviewed by the Fulton County Board of Commissioners, the Department of Environment and Community Development, and any recognized community group or organization. Public hearings are required for all rezoning petitions. Public comments are available during the Community Zoning Board meeting. The deterministic vote regarding the rezone cannot occur at the initial Community Zoning Board meeting, but at the following scheduled meeting. Notice for a public meeting must provide at least fifteen days before the meeting but no more than forty-five days.

There are a number of requirements for a rezone petition application, Appendix A. A pre-application review form with notarized and original signatures must be submitted to the Board of Commissioners. A letter of intent with a legal description of the property accompanies the pre-application form. The Board of Commissioners requires an environmental site analysis and site plan adhering to the compliance requirements outlined in the municipal statute. In addition, the owner must provide an impact analysis and public participation plan for rezoning petitions. In some cases, the Board of Commissioners requires a traffic study, metropolitan river protection act pre-review letter, Metropolitan Atlanta Rapid Transit Authority (MARTA) corridor plan review form, development of regional impact review, environmental impact report, and noise study report. Owners must pay a non-refundable filing fee in all rezoning petitions. The Board of Commissioners may require a zoning impact analysis. This impact analysis determines whether the new rezone will be appropriate in use and development of the neighboring and adjacent properties. The analysis explores adverse influences from the zoning proposal. In addition, the

analysis compares the economic uses of the current zone against the potential economic benefits of the rezone. The rezone cannot result in excessive or burdensome use of transportation networks, roadways, public utilities, or strain educational capacity. Lastly, the zoning impact analysis must not adversely contribute to natural resource depletion, or environmental harm.

There are statutes governing the number of rezone actions per individual parcel of land. When the property owner initiates the petition for rezone, the same parcel cannot be rezoned more than once every twelve months. This restriction does not apply if the Board of Commissioners initiates the rezone application. There is a six-month waiting period for a previously denied application. Moreover, the owner must attest to a significantly different proposed rezone application for a previously denied application to be reviewed again. Property owners are entitled to appeals in superior court within thirty days of the Board of Commissioners' decision.

The Board of Commissioners approved all of the rezoned cases in this study. Therefore, one may assume the rezoned petitions adhere to all guidelines and procedures outlined in statute. While statute requires many studies and analyses for each rezone petition, the financial influence of a rezoned property upon neighboring real estate prices still remains unknown.

Introduction to Theory

Residential real estate prices are analyzed using the theory of revealed preferences through house price capitalization (Rosen, 1974). In Rosen's theory, he describes different products with objectively measured attributes and characteristics. The observation of prices combined with the exact characteristics of the product create a revealed preference or hedonic price function. Rosen's theory allows for the comparison of different good, which is ideal for real estate research. All residential real estate properties are unique, since no two properties are

exactly alike. The hedonic approach allows researchers to capitalize the differentiating characteristics of each property. The residential real estate property is "valued for [its] utility bearing attributes or characteristics" (Rosen, 1974, p. 34). Chapter three explains this research theory in greater detail.

Real estate literature describes a fluid process where prices vary according to the presence of amenities and dis-amenities. Any attribute which increases the price of the residential real estate property is considered an amenity. Conversely, characteristics which lower the price of the residential real estate are termed dis-amenities. Amenities or dis-amenities can be internal or external to the property. For example, an additional bathroom has been found to increase the price of residential real estate by 13-18% (Sirmans, Macpherson, & Zietz, 2005); thus, this property characteristic is an internal amenity. However, an additional year of property age diminishes the property's value by one percent (Sirmans et al., 2005) signaling that property age is an internal dis-amenity. External residential real estate price effects, also called peer effects, influence residential real estate prices as well.

External residential real estate price effects, sometimes referenced as peer or neighborhood effects, influence residential real estate prices. For the remainder of this research, external property effects are referred as real estate externalities. These externalities are amenities or dis-amenities which spill over into the residential real estate property's characteristics. For example, high achieving school systems represent an external real estate amenity which increases residential real estate prices (Black, 1999). High polluting industries are an external dis-amenity which lowers the price of residential real estate (Palmquist et al., 1997). Consumers adjust their residential real estate offer price according to the combination of internal and

external amenities, dis-amenities and housing externalities. This pricing adjustment follows utility maximization theory.

The utility maximization theory states that consumers select a bundle of goods along their highest indifference curve tangent to their budget constraint (Follain & Jimenez, 1985). Consumers value different levels of internal property characteristics and external neighborhood effects. Unlike other marketplaces, consumers must purchase the entire bundle of goods and cannot separate the bundle in real estate transactions. Thus, residential real estate price discrepancies between near identical properties yield the influence of their difference in monetary terms. This research assumes consumers purchase their optimal bundle of goods available in residential real estate, which maximizes consumer utility given their individual budget constraint and that non-price barriers do not exist. The optimal purchase assumption eliminates the theoretical bias of non-rational consumers from the research. However, there are other types of bias embedded in this investigation.

Researchers Dehejia and Wahba (2002) describe sample selection bias and causal inference in observational data for non-experimental causal studies. To reduce bias in allocation and compliance Greenland, Pearl, and Robins (1999) recommend randomized-trial experiments. Observational studies using the propensity score matching methodology, which imitates some statistical characteristics of a randomized controlled trial, may reduce confounding (Austin, 2011). This modeling approach accounts for the systematic differences between baseline characteristics for the control and treated groups.

Research Questions

This research uses two statistical techniques to quantify the influence of private rezoning on residential real estate prices, propensity score matching and fixed effects. Does private

rezoning influence residential real estate prices at 0.75, 1.0, 1.25, 1.5, and 2.0 miles? What is the influence on residential real estate prices when non-residential zones (commercial and industrial) are rezoned to residential zones (residential and multifamily)? What is the influence on residential real estate prices when residential zones are rezoned to non-residential zones? Due to sample size limitations, privately induced rezoning from mixed use real estate to another form of land use real estate cannot be studied in this research.

This research defines privately induced rezoning as any change in zone that requires an application and zoning board hearing. Any change in zone category constitutes a rezone. The nature of the party initiating the rezone determines its status as a privately induced rezone. Individuals, businesses, and non-governmental agents constitute private parties. Privately induced rezoning is the change in zone at the request of a private individual, business, or non-governmental agent. This study empirically quantifies the influence of a privately induced property rezone on residential real estate prices. For this calculation, the distance from the rezoned property begins at the center point of rezoned properties and ends at 0.75, 1.0, 1.25, 1.5, and 2.0 miles independently. All residential real estate properties located within this distance measure are considered influenced by the rezone. Residential real estate properties originate from a transactional dataset. To most effectively capture the influence of a nearby rezone, the sale date of the residential real estate property is restricted. The sale date does not exceed 365 days after the municipal approval of the rezone.

Uniqueness & Importance of Research

This research is unique because it seeks to quantify the influence of a privately induced rezone on residential real estate prices. This research fills a gap in housing policy and real estate literature. Prior research explored land values on newly zoned regions in Chicago (McMillen &

McDonald, 2002), however, these findings were attributed to the imposition of a new municipal zone, not rezoning. Other zoning research explores lot prices in unincorporated areas with lower zoning controls (Thorsnes, 2000), yet their research is restricted in scope to only vacant lots. This current research seeks to expand the analysis past vacant lots to analyze the entire property, lot and structure, and be more applicable to a consumer audience. Additional research explores rezone with unimproved agricultural land (Brownstone & De Vany, 1991). This unimproved agricultural research differs from the current research plan as the properties of focus within this dissertation are residential and contain developed structures.

Zoning research is an important endeavor. The most important and common zoning action was the rezoning of land (Kelly, 1994). According to Shertzer, Twinam, and Walsh (2016) "zoning may be more important than either geography or transportation networks . . . in explaining where commercial and industrial activity are located" (p. 1). The location of commercial and industrial activity has widespread consequences for the health of a municipality. These land use functions contribute to the tax digest of a municipality, but do not increase the education budget, which generally constitutes half of a municipality's budget (Oates, 1969). In addition, the location of commercial and industrial activity increases the employment opportunities of the municipality. Greater employment opportunities are associated with population migration, real estate appreciation, and consumer amenities.

This dissertation seeks to analyze rezoning for its influence on surrounding residential real estate property values. McMillen and McDonald (2002) observe the initial impact of zoning on land prices in Chicago, but no work to date explores the influence of rezoning on residential real estate prices. Residential real estate prices influence the overall economy. Bostic, Gabriel, and Painter (2009) conclude that a ten percent decline in residential real estate prices amounts to

a one percentage point decline in real GDP growth. As residential real estate prices decline, homeowners perceive themselves as less wealthy. Economists refer to this change in spending as the wealth effect, where the perception of lower assets may induce lower consumption spending (Bhatia, 1987). In turn, reductions to economic consumption may lower GDP growth in the economy (McConnell, Mosser, & Perez-Quiros, 1999). Eighty percent of the consumption effect associated with residential real estate declines are realized within one year of the asset's decline (Belsky & Prakken, 2004). Therefore, any price changes attributed to rezoning must be captured within a 365-day period.

If privately induced rezoning significantly increases property prices, the surrounding regions could experience the displacement of current residents through migration-induced gentrification. Gentrification results in the upgrading of neighborhoods to a higher status (Hochstenbach & Van Gent, 2015). Gentrification arises from a rapid increase in demand for residential real estate in a localized neighborhood (Marcuse, 1985). The precipitous change in demand results in higher residential real estate quality, tax base, and appeal to private development. However, for gentrification to occur, a specific socio-economic demographic of population demand is required. New residential real estate demand from young, single, population with high skills and wage potential replaces old, non-skilled residents.

Counter to gentrification is a process known as filtering, which is "the process whereby the poor ultimately come to occupy what once were the homes of the rich" (Baer & Williamson, 1988, p. 127). If rezoning reduces the price of residential real estate, the filtering process could be accelerated. As buildings age, they decline in quality and value. Internal amenities become obsolete and the cost of maintenance increases. Demand for aging and obsolete residential real estate maximizes the utility function for low socio-economic owners and renters. With lower

expected residential real estate property values and rents, the maintenance expenditure function declines, inducing further decline and continuing the filtering process of housing stock to a lower level. This research explores the ramifications of privately induced rezoning on the surrounding community and may provide evidence of accelerated gentrification or filtering.

Essay Progression

Chapter 2 of this essay describes the academic literature of zoning and its influence on residential real estate. Chapter 3 contains the theoretical foundation of the research, while Chapter 4 illustrates its methodology and statistical procedures. Chapter 5 provides the results of the empirical calculations and offers a discussion. The last chapter, Chapter 6, concludes the first essay of this dissertation on rezoning. References and appendices can be found following the Chapter 6 conclusion.

CHAPTER 2

PRIVATE REZONING LITERATURE REVIEW

Municipal zoning has governed public and private development and has served as a foundation for comprehensive land use planning for nearly a century. Today, zoning is ubiquitous and widely accepted; however, zoning's origins are fraught with legal challenges and subject to divisive preconceived beliefs. This chapter describes the establishment of zoning in American society. Following the historical account of zoning, the chapter presents a selection of the previous academic literature regarding the evaluation of residential real estate and the influence of rezoning on real estate prices.

Zoning in Society

Prior to zoning ordinances, the function of land use was determined by the property owner. This unregulated discretion created property border tension and poor integration of industrial, commercial, and residential properties. In some cases, developers signed private covenants with surrounding property owners to prevent the development of undesirable industrial buildings around residentially developed areas (Fischel, 2004; Korngold, 2000). Since private covenants are costly to developers, these "nuisance buffer zones" surrounding developed land were inadequate to protect a development from industrial intrusion (Fischel, 2004). Better solutions were needed to protect real estate asset prices.

While comprehensive zoning ordinances did not exist in the 19th century, there were jurisdictions within the United State with statutes regulating the use of buildings. In 1867, San Francisco, CA enacted an ordinance prohibiting specific industrial production facilities in certain

city districts (Cullingworth, 2002). Early case law regarding property function ruled against industrial interests. In 1915, the court ruled against an industrial business for operating a brickwork facility in the countryside. Even though the industrial brickwork facility had been in operation for thirteen years, a recent residential development brought a nuisance lawsuit against the industry (Barros, 2008). The court forced the brickwork facility to cease operating in its current industrial capacity. Supporting this court case was a prior ruling from the Illinois Supreme Court, which stated that the devotion of property to a function through which the public has an interest, ultimately grants the public an interest in its use. The court concluded that the property must be controlled by the public for the common good (*Munn v. Illinois*, 1876).

Historians credit the beginning of municipal zoning to a convergence of technological innovation, migration, and homeowner fear. The invention of steel framed structures and the elevator led to the skyscraper and high density properties in urban cores (Cullingworth, 2002). Skyscrapers allowed the development of taller buildings, which reduce light and views for surrounding properties. Maximum height requirements sought to limit the detrimental influence of these taller buildings on a neighbor's right to light and air (Fischel, 2004). These height restrictions pre-date zoning laws and provide a foundation for municipal regulation of private buildings in the name of the public good.

Prior to the 1920s, industrial buildings were geographically tied to railroads for the transportation of raw and finished products. The invention of freight-hauling trucks reduced the fetters binding industries to railways. Industrial owners could build or relocate factories to cheaper land and away from existing railway networks (Fischel, 2004). The freight-hauling truck impelled industrial sprawl and created a mixture of non-compatible building types. The threat of increased industrial property migration fueled fear among residential property developers and

homeowners. “So long as undesirable properties could encroach upon an area in which good residences and good income-bearing properties were already established, there would be no stability or trust in real estate as an investment” (Cheney, 1920, p. 33). This lack of trust between residential homeowners and industrial migration would extend the zoning movement.

Significant population immigration into urban areas sparked dramatic population growth. From 1890 to 1920, the United States population expanded by 42 million people (Cullingworth, 2002). High populations and low sanitation facilities within urban cores contributed to the unhealthy sanitary conditions of the cities. Prior to the 1940s, there was an urban mortality penalty for living in the urban core compared to the countryside (Haines, 2001). The threat of fires and health epidemics influenced residents to migrate from urban cores to the city’s periphery (Beauregard, 2009).

During this same time-period, mechanized street car lines allowed higher income urban employees to escape the polluted city centers by traveling from apartment complexes outside of the city (Fischel, 2004). Single family residential owners, who were among the highest income residents, disdained the apartment complexes and fought to keep high density apartment buildings segregated from single family residential developments (Cullingworth, 2002). In one instance, residents of a New York City suburban fought to stop a reduction in trolley fares, reasoning that a reduction in transportation cost would allow poorer individuals to locate in their community and commute to work via the cheaper trolley line. Poorer residents were a threat to their personal property investment. These types of threats were exploited by those seeking to promote zoning.

A widely distributed municipal government textbook of the time contained two pictures of residential neighborhoods that were surrounded by natural-gas storage tanks and warehouses

(McMichael & Bingham, 1923). These scenes were labeled as common development occurrences and fueled homeowner and investor fears. Fear drove zoning and comprehensive municipal planning. The greatest fear was the reduction of property value from the construction of a non-compatible structure.

> "Nothing caused an investor so much anguish as the sight of a grocery store being erected next door to a single family residence on which he had lent money. Nothing made whole neighborhoods feel so outraged and helpless as the construction of apartment houses when the private deed restrictions expired and there was no zoning to prevent vacant lots from being used for multifamily structures. Zoning was the heaven-sent nostrum for sick cities, the wonder drug of the planners, the balm sought by lending institutions and householders alike." (Scott, 1971, p. 192)

Once municipalities adopted zoning provisions, developers and homeowners could be assured that nearby tracts of undeveloped land would not be industrialized for an incompatible use (Fischel, 2004).

Zoning favors single family owner occupied residential land-use (McMillen & McDonald, 1991). The reason for this preferential treatment stems from what Fischel (2004) terms the "Homevoter Hypothesis." The Homevoter hypothesis remains grounded in the awareness of differences among public goods between communities (Tiebout, 1956) and the financial incentive for homeowners to protect their real estate assets. Fischel maintains that homeowners have a financial interest in the success of their municipality and become observant citizens of local government. He establishes that citizens mitigate non-diversifiable residential real estate risks through municipal governance. Otherwise, these residents *vote with their feet* and leave the jurisdiction.

While cities such as Boston and Los Angeles were early adopters of comprehensive planning goals (Scott, 1971), most scholars award the first comprehensive municipal zoning ordinance to New York City in 1916 (Cullingworth, 2002). At the time, garment manufactures

were fighting retail merchants and wealthy residents along Fifth Avenue (Toll, 1969). The primary concern in the fight was the commercial value of land (Feagin, 1984). Property values had fallen by fifty percent in the five years leading up to 1916. The Commission on Heights of Buildings recommended the city should regulate building height, use, and area to better the interests of public health and safety. The substantial loss of property value could not have been far from the commission's recommendation.

In 1916, the city's charter was amended to create district provisions and a comprehensive code was established. Unique to the New York City comprehensive code was the heterogeneous regulations by district (Makielski, 1966). This concept revolutionized zoning. Prior regulations applied to all lands equally, without the notion of differing districts. To dissuade legal arguments of discrimination, the New York City zoning ordinance maintained uniform regulations by class of building within each district. Legal scholars attribute this equal structure as a major component of the comprehensive zoning's future legal success (Bassett & McNamara, 1940).

In the years following the New York City comprehensive zoning laws, other municipalities began to enact their own ordinances. By 1922, there were twenty enabling acts by state legislatures, fifty ordinances and almost one hundred zone plans (Haar, 1959). In the same year, F. B. Williams published the first zoning textbook in America, *The Law of City Planning and Zoning*. Yet, Cullingworth (2002) claims the most important contribution to the widespread adoption of zoning came from the Advisory Committee on Building Codes and Zones.

This advisory committee, under Secretary of State Herbert Hoover, drafted the Standard State Zoning Enabling Act which developed into the national model for zoning ordinances. The act, which passed in 1924 was accompanied by a zoning primer booklet. The booklet sold 55,000 copies in its first edition (Toll, 1969). The booklet, written by zoning advocates, was a masterful

work of zoning propaganda. The reprinted 1926 booklet opens with a forceful paragraph to answer the presented question, what is zoning?

> "Zoning is the application of common sense and fairness to the public regulations governing the use of private real estate. It is a painstaking, honest effort to provide each district or neighborhood, as nearly as practicable, with just such protection and just such liberty as are sensible in that particular district. It avoids the error of trying to apply exactly the same building regulations to every part of a city or town regardless of whether it is a suburban residence section, or a factory district, or a business and financial center. It fosters civic spirit by creating confidence in the justice and stability of the protection afforded." (Department of Commerce, 1926, p. 1)

The booklet connects zoning to enjoyment of rights and the protection of unreasonable injury by neighbors. In addition, the authors describe how zoning protects the "fair cash return to individual investors" of commercial property by restricting building size and proximity (Department of Commerce, 1926, p. 1).

Under the section titled *zoning protects property and health,* the authors describe a situation where a *cozy* house becomes devalued with the creation of an apartment house. "There are two vacant lots south [of your home]. If your town is zoned, no one can put up a large apartment house on those lots, overshadowing your home, stealing your sunshine and spoiling the investment of 20 years' savings" (Department of Commerce, 1926, p. 2). In this passage, the authors promote zoning by preying upon consumer fear of the unknown. In subsequent sentences, the authors claim zoning encourages more stable property values compared to properties in un-zoned municipalities. Moreover, they purport that zoning reduces the cost of living by eliminating the scrap of wasted buildings from blighted districts. To further emphasize their message, the authors included a picture to accompany the text, Appendix B.

Following the benefits of zoning. The booklet presents some of the legal challenges which have failed to reverse sensible and comprehensive zoning. After the failed legal challenges, the authors provide step by step instructions for any municipality to create

comprehensive zoning in their home town or region. They offer technical advice regarding correct procedure, getting public support, and zoning enforcement. These guidelines help insure new municipal zoning codes succeed if challenged in court.

Since comprehensive zoning detrimentally impacted some members of society, legal challenges were inevitable. Yet, it took nearly ten years for the Supreme Court to hear a case regarding the constitutionality of zoning. *Village of Euclid v. Ambler Realty Co.* (1926) would become a landmark court case in American zoning. The Village of Euclid, named after the Greek geometrician, is located northeast of Cleveland, Ohio. It's sixteen square-miles front Lake Erie and, due to its location, became a prosperous district. One road in particular, Euclid Avenue housed the millionaire magnets of the region. Locals called the avenue "Prosperity Street" and "Millionaire's Row" (Toll, 1969, p. 214). To the north of Euclid Avenue were farms and undeveloped land, but further north were the Nickel Plate and Lake Shore railroad lines. In 1911, a local real estate business, Ambler Realty Company, began purchasing the undeveloped land behind Euclid Avenue toward the railway lines. In total, the company purchased sixty-eight acres of land. The company invested in this land with the future intent to develop industrial property. Industry would benefit by the railway access to the north and could leverage the commercial activity to the south.

In 1922, Euclid's mayor appointed a commission to investigate and report on a zoning ordinance for the village. One of the commissioners was a long-time homeowner and resident of Euclid Avenue. The commission was tasked to promote the health and welfare of the community. However, according to Toll (1969), village protesters were only interested in their own pieces of property, regardless of the health of the community. The commission used the Zoning Primer provided by the Department of Commerce and drafted a zoning ordinance to

mirror the first zoning ordinance in New York City. The land directly behind Euclid Avenue could only be used for two-family dwellings. Only the furthermost parcels from Euclid Avenue could be used for industrial purposes.

In May 1922, Ambler Realty Co filed suit against the village stating that the new zoning ordinance cut its value of land. They estimated a $7,500 loss for each acre of land. In current 2018 dollars, the loss would amount to $113,176 per acre, $7.5 million total[1]. Ambler claimed the ordinance violated the Fourteenth Amendment by depriving it of property without due process of law. In January 1924, trial judge David Courtney Westenhaver struck down the Euclid zoning ordinance writing, "the only way the village could take Ambler's property was by condemning and paying for it under the power of eminent domain" (Toll, 1969, p. 223).

Undeterred by the legal setback, the Village of Euclid appealed the case to a higher court. In 1926, a slight plurality of the nine Supreme Court justices upheld the constitutionality of the Euclid zoning ordinance. The court opinion written by Justice Sutherland described the societal benefits from comprehensive zoning. "The segregation of residential, business and industrial buildings will make it easier to provide fire apparatus suitable for the character and intensity of the development in each section. It will increase safety and security of home life" (*Village of Euclid, Ohio v. Ambler Realty Co.,* 1926). The court affirmed the constitutionality of compulsory segregation of property land use and upheld the constitutionality of exclusionary zoning to promote sole residential districts (Bettman, 1927). Thus, comprehensive zoning represents an extension of municipal police power to prohibit uses that were not solely considered nuisances. In practice, single family residential real estate could be segregated from commercial shops, industry, or even apartment buildings.

[1] Inflation adjusted using the Bureau of Labor and Statistics calculator at https://data.bls.gov/cgi-bin/cpicalc.pl?cost1=7500&year1=192205&year2=201807

Residential districts were separated into single family dwellings and two family dwellings. Justice Sutherland expressly distinguished apartment properties from residential districts writing, "the development of detached house sections is greatly retarded by the coming of apartment houses, which has sometimes resulted in destroying the entire section for private purposes; that, in such sections very often the apartment house is a mere parasite . . ." (*Village of Euclid, Ohio v. Ambler Realty Co.,* 1926). His strong rhetoric against apartments expanded the implications for the acceptable regulation of land use. Apartments could be a separate "use" classification in zoning statute and, thus, separated from single family dwellings (Cullingworth, 2002). In Sutherland's view, apartment development could destroy a community. Sutherland believed municipal police power should be extended to remove this public threat and prohibit apartment building development in proximity to single family residential real estate.

While the Euclid case upheld the constitutionality of zoning ordinances, not all courts upheld municipal zoning ordinances. An earlier court case reduced the municipal police power of zoning. In *Hadacheck v. Sebastian* (1915), the courts ruled that ordinances could not be retroactive. A new ordinance could not remove an existing building or land use function from continual operation. In *Nectow v. City of Cambridge* (1928), the court found that a constitutional ordinance was applied unconstitutionally. The City of Cambridge divided the municipality into three types of zoning districts: residential, business, and unrestricted. Nectow's land was zoned residential even though the land was near a large Ford Motor Company auto assembling factory, soap factory, and abutted unrestricted land. Moreover, the plaintiffs were under contract with a buyer to dispose of the land for industrial purposes. The buyer refused to purchase the land and Nectow filed suit under the takings clause of the 14th amendment. The court found that there was no practical development potential of the Nectow land as a residential zone. The court continued

that maintaining the residential zone would not promote public health, safety or general welfare of the populace. This court case provided legal context to challenge the practical application of municipal zoning.

The constitutional foundation and legal conclusion of zoning ordinances was to increase the public or societal benefit by restricting the private rights of a few. The entire premise of municipal ordinances is the link between external influences among nearby properties and is one of the empirical tests of this dissertation research. Much legal discourse has been devoted to a connection between residential real estate prices and the surrounding comprehensive zone. The next section of the literature review describes prior research on the evaluation of residential real estate prices.

Evaluating Residential Real Estate

Researchers have calculated real estate prices against a group of covariates for decades. In many cases, the researcher's goal is to produce a true estimate of the market price for the property. As such, the modeling techniques must mirror the marketplace and conditions (Pagourtzi, Assimakopoulos, Hatzichristos, & French, 2003). While researchers have developed more sophisticated modeling techniques over the years, there are two collective factors associated with real estate research that have not changed. The first factor centers upon the intrinsic characteristics of the real estate. The second factor is the external characteristics of the residential real estate or the neighborhood effects.

Intrinsic Characteristics

Sirmans, MacDonald, Macpherson, and Zietz (2006) conducted a meta-analysis for the influence of the most common real estate characteristics in hedonic pricing models. Their analysis reviewed only single family dwellings and restricted studies to maintain consistent

model specifications and characteristic measurements. There were nine characteristics most commonly used in single family residential real estate valuation research: 1) square footage, 2) lot size, 3) age, 4) bedrooms, 5) bathrooms, 6) garage, 7) swimming pool, 8) fireplace, and 9) air conditioning. The following sections define each characteristic and denote their inclusion in the current research study.

Square footage is defined as the amount of livable space within a dwelling. Covered or enclosed porches with heating systems are included in the total square footage of a property. Finished attic space is included in the calculation if the area has at least seven feet of minimum height clearance. Closets and above ground stairways are included. However, garage space and below-grade basement space are omitted. Even if garages and below-grade basements are heated, they cannot be counted towards a residential property's livable square footage.

A parcel of land is a tract of property and may be considered a lot or plot of land. All of these terms are interchangeable and denote the same area. The defined boundaries of the property provide the total distances using metes and bounds and a plat diagram maintained by the taxing municipality. A single lot or parcel of land must be continuous. A non-joined parcel of land cannot be one lot or parcel. Depending on the shape of the area, a property's lot area may be an easier calculation compared to the calculation of the square footage of the dwelling. For rectangular lots, the frontage of the property is multiplied by its depth to yield the total lot area.

A residential property's age is a simple calculation; subtract the completed date of construction from the date the property sold. The age of a property captures subjective consumer taste. New property commands an age price premium (Rubin, 1993). Northcraft and Neale (1987) recorded qualitative data which indicated lower price transactions correlated to property age. "Since the house is not new, its price had to be lower than the listing price. Since it is a 9-

year old house, a deduction of $10,000 seems reasonable" (p. 91). Generally, increased age of a property reduces its transactional price (Sirmans et al., 2006).

With limitation, the age of a property can proxy for property condition. Generally, age and condition are positively correlated. However, indoor and outdoor maintenance can reduce the negative influence of property age by 13% (Wilhelmsson, 2008). The omission of maintenance expenditures from model specification has little influence on subsequent property price values. However, the exclusion of dwelling age from the model injects bias into model estimates (Knight & Sirmans, 1996).

The number of bedrooms within a structure represents an intrinsic characteristic of the property, which influences the valuation of the residential real estate. In theory, the more bedrooms present in a property, the higher its utility to the owner (Sirmans et al., 2006). However, in regression analysis the increase of one bedroom holds constant all other variables, which translates to smaller room sizes as the amount of square footage remains constant. As such, the bedroom covariate may or may not be statistically significant (Sirmans et al., 2006).

A bedroom is defined through its characteristics. It must have a window for egress to the exterior of the property and a door which can be closed. The presence of a window and door satisfy the safety requirements specifying two forms of exit from all bedrooms. In addition, the window of egress cannot be smaller than six square feet and the bedroom floor must measure at least seven feet in any horizontal direction (Ching & Winkel, 2018). Some jurisdictions require bedrooms to have a built in closet within the room, but this provision is not found within the international residential building code.

The number of bathrooms represents another intrinsic property characteristic that could induce a higher property valuation. The National Electrical Code (NEC) defines a bathroom as

‘an area including a basin with one or more the following: a toilet, a urinal, a tub, a shower, a bidet, or similar plumbing fixtures” (National Fire Protection Association, 2014). According to the Georgia Department of Community Affairs (GDCA), the state enforces the NEC among nine other international building codes (Georgia Department of Community Affairs, 2018). Since the data within this dissertation originate from Multiple Listing Services (MLS) transactions, the bathroom definition follows the Real Estate Standards Organization (RESO) data dictionary. RESO, which was incorporated in November of 2011, is an independent trade organization devoted to implement standardization across real estate transactions, multiple-listing services providers, real estate associations, and real estate technology providers (Real Estate Standards Organization, 2018). RESO maintains the definitions of property characteristics for the MLS providers. According to RESO, a bathroom must contain three elements: toilet, sink, bathtub or shower head. By definition, a half bath contains only two of these elements (Real Estate Standards Organization, 2016). Generally, half bathrooms have a sink and toilet. The MLS dataset differentiates between full bathrooms and half baths.

A garage represents a walled structure intended to house a motor vehicle. To be considered a garage, the structure must be fully enclosed. Non-enclosed, permanent or semi-permanent structures are considered carports by RESO. The valuation of a garage is not sensitive to geographical location, time, income or type of data (Sirmans et al., 2006). The presence of a garage or carport was not available in this dataset. Additionally, dummy variables signaling the property characteristic of a swimming pool or air conditioning system were not available within the dataset.

The International Residential Code (IRC) defines a fireplace as an interior assembly consisting of two elements, a hearth and a fire chamber (International Code Council, 2015). The

fire chamber must be constructed using noncombustible material and be outfitted with a chimney with proper ventilation. Proper ventilation requires the removal of combustion air from the interior of the structure. The number of fireplaces within a dwelling serves as a barometer for social value of the dwelling and its occupants (Lawrence, 1989). Characteristics appealing to the social preferences and tastes of higher wealth individuals can lead to residential real estate valuation appreciation (Gibler & Nelson, 2003).

The addition of a deck to the residential real estate property characteristics, which is a flat surface constructed outdoors on elevated ground with a perimeter railing, can affect the property valuation. Decks are raised structures above the grade of the land; horizontal outdoor space built of paved brick, or poured concrete constitutes a patio (TREND, 2014). A deck which adjoins the real estate building is considered a property improvement, while a deck that is separate from the physical structure is a land improvement. The statistical analysis within this dissertation does not differentiate between land and property improvements.

Lawn sprinklers are a real estate amenity, which automatically irrigates grass and promotes an aesthetic façade for a homeowner. Lawn sprinklers, not to be confused with indoor safety sprinklers for fire suppression, can signal wealth and higher status in society. Consumer behavior and residential real estate valuation change when the property characteristics portray higher social rank (Gibler & Nelson, 2003). Sprinkler systems positively affected the price of residential real estate (Sirmans et al., 2005).

These intrinsic property characteristics have been used to control for varying property traits in hedonic regression real estate research (Rosen, 1974; Sirmans et al., 2006; Sirmans et al., 2005). Yet, internal characteristics cannot account for the total price variation. Externalities, or

the presence of nearby peer effects affect residential real estate prices. The next section describes the effects of externalities on residential real estate prices.

Externalities Characteristics

External factors influence the price of residential real estate. These factors can be consumption-based or can represent a perceived detrimental influence upon the property. Researchers are required to have a full range of neighborhood characteristics to obtain stable and reliable estimates (Cheshire & Sheppard, 1995). Research using transactional real estate data assumes consumers, who have complete information, internalize the positive and negative externalities into the purchase price of the real estate. Researchers estimate the influence of the externality on the residential real estate valuation by controlling for the observed externalities in a regression model.

Neighborhood and community amenities influence the relative appeal of residential locations (Bartik & Smith, 1987). Consumer amenities represent a broad range of goods and services. Glaeser, Kolko, and Saiz (2001) describe four critical amenities for urban landscapes. There must be a rich variety of services and consumer goods such as restaurants, theaters, social endeavors. The region must have an aesthetic quality and attractive physical landscape. High quality public services are the third crucial amenity. Transportation speed is their last highly distinguished amenity. The presence of these neighborhood externalities would positively influence higher residential real estate prices compared to properties without such amenities.

Disposable income and the consumption of leisure goods and services increase in tandem (Andersson & Andersson, 2006). While online shopping has increased substantially in the last decade, only 9.46% of all retail sales in 2017 were conducted online (U.S. Census Bureau, 2018). Consumers still value access to a diverse range of products and services at warehouse

clubs and supercenters (Hortaçsu & Syverson, 2015). Retail establishments enhance the attractiveness of an urban region (Öner, 2017) and enhance residential real estate valuations (Song & Sohn, 2007). Small levels of commercial activity were associated with increased residential real estate property valuations, but large amounts of commercial activity nullified the premium and reduced property valuations (Stull, 1975). Consumers view small amounts of nearby commercial activity as an amenity, but the added congestion and noise associated with more commercial activity represents a dis-amenity (Burnell, 1985).

Studies link external amenities to higher residential real estate prices. Residential real estate with a very desirable view of Lake Erie increase residential property premiums by 90% (Bond, Seiler, & Seiler, 2002). Similarly, real estate with a water view in New Zealand experience higher prices compared to those properties without a water view (Bourassa, Hoesli, & Sun, 2005). These researchers found evidence that the supply of water view properties in a geographic location influences the premium value for that benefit. Lower supplies of amenity properties result in higher premiums for that amenity. Their findings reflect the general economic foundation of supply and demand market equilibrium with associated price premiums for lower supply of a demanded good.

Externalities, which may be perceived as healthy or promoting consumer health, positively influence residential real estate prices. Boyle and Kiel (2001) summarize the environmental and real estate literature. Their study focused on literature relating to residential real estate price influences from air quality, drinking water quality, and distance from toxic sites. Greater access to clean air and water amenities increase the price of the residential real estate (Leggett & Bockstael, 2000). Moreover, greater distances from toxic or potentially toxic sites

increase residential real estate prices. “People are willing to pay more to reside in locations further located from perceived dis-amenities” (de Vor & de Groot, 2011, p. 2).

Undesirable land uses have a negative association with residential real estate prices (Farber, 1998). Consumer perception of dis-amenities for either health or safety concerns can influence residential real estate valuations. In Canada, Boxall, Chan, and McMillan (2005) found that residential real estate prices are negatively correlated with natural gas industrial facilities and infrastructure. The authors cite consumer concerns regarding pollution and its health complications. In other research spent nuclear fuel shipments are perceived by consumers to be hazardous and represented a safety risk. In populous urban areas, residential real estate property prices are lower in proximity to the nuclear material shipping lanes compared to similar property distant from the shipping lanes (Gawande & Jenkins-Smith, 2001). High voltage lines, defined as 69,000 volts or more, have a negative association with residential real estate prices (Hamilton & Schwann, 1995). Moreover, specific industrial activities such as large-scale hog operations (Palmquist et al., 1997), shale gas development (Muehlenbachs, Spiller, & Timmins, 2012), and landfill waste management (Ready, 2010) produce negative externalities resulting in negative associations with residential real estate prices.

Another area of considerable research in externalities associated with residential real estate prices is green space or undeveloped open land. Consumers value access to green spaces such as parks or residential real estate locations near preserved land (Crompton, 2000). Even while controlling for spatial autocorrelation, Conway, Li, Wolch, Kahle, and Jerrett (2010) observe significant price premiums for residential real estate adjacent to greenspace. Permanently preserved open land increases residential real estate prices more than developable

open land (Geoghegan, 2002; Irwin, 2002). While these physical amenity attributes denote prices premiums, other amenities such as education are more service quality oriented.

Education quality remains a highly demanded consumer amenity. In her seminal work, Black (1999) empirically calculated consumer willingness to pay for higher quality elementary schools. Consumers were willing to pay 2.5% more for residential real estate for a 5% increase in local elementary school test scores. Other research confirms the educational amenity price premium for residential real estate. A one standard deviation increase in school quality equates to approximately a 4% residential real estate price premium (Nguyen-Hoang & Yinger, 2011). While education quality may be an amenity which induces residential real estate price premiums, there are dis-amenities which may inversely affect prices.

Crime is a dis-amenity, which negatively impacts residential real estate prices through out-migration (Cullen & Levitt, 1999). Development of casinos with their perception of increased neighborhood crime, influences nearby property prices (Buck, Hakim, & Spiegel, 1991). Specific types of crime are more likely to influence residential real estate prices; robbery and aggravated assault crimes are the most impactful on valuations (Ihlanfeldt & Mayock, 2010). In addition to the development and types of crimes that influence residential real estate prices, neighborhoods that undergo a reduction in the top decile of crime rates experience an increase in property prices from 7-19% (Pope & Pope, 2012). While crime represents an external neighborhood safety issue and a potential loss of property, some consumers value transportation amenities as they pertain to the loss of time during a daily commute. Lower access to the infrastructure network increases the duration of commuting which costs time and money.

Transportation amenities can be defined as public goods or services. The physical public goods are the roadway infrastructures while the public services are the supplied bus, rail, or

subway services. There is a residential real estate price premium associated with immediate walking distance to feeder bus transit routes (Munoz-Raskin, 2010). In a meta-analysis on twenty-three studies on rail investments, the majority of rail investments are associated with residential real estate price premiums for locational proximity to rail (Mohammad, Graham, Melo, & Anderson, 2013). The frequency of the rail service is tied to residential real estate prices as well. A doubling of the rail frequency leads to an increase in residential real estate price of 3.5 percent (Debrezion, Pels, & Rietveld, 2006). In addition to the co-location of public transportation, its perception of access is associated with residential real estate price premiums (Cordera, Coppola, dell'Olio, & Ibeas, 2018).

Influence of Zoning on Residential Real Estate Prices

The following section describes the influence of zoning on property development and residential real estate valuations. Zoning, as a municipal construct, is an external market manipulation, which may alter the equilibrium of the marketplace. Zoning ordinances can adjust the density and development of a given district. These changes in density and end-use development may influence real estate prices through a change in amenities or dis-amenities (Fischel, 1990). The sole use of deductive reasoning cannot predict the expected statistical sign direction of externality zoning on aggregate land values in a municipality (Ohls et al., 1974). In some cases, the influence of externality zoning fails to produce uniform results. This research seeks to fill in the gaps within the existing body of zoning literature.

The perception of dis-amenities is a strong driver of residential real estate price fluctuations. Municipal zoning reduces the probability that undesirable uses are co-located with residential real estate. Using data from the first municipal zoning ordinance in 1923 in Chicago, McMillen and McDonald (2002) calculate an increase in price of 19.5 percent for residential real

estate within residentially zoned districts compared with residential real estate within commercially zoned districts. The original Chicago zoning statute created a tiered zoning structure for three types of zones: residential, commercial, and manufacturing. Higher tiered structures could be located within lower zones; however, lower structures could not be located in higher zone tiers. In their findings, the growth rates for residentially and commercially zoned districts diverged. Residential real estate has a higher growth rate compared to commercially zoned residential real estate. The authors hypothesize that homeowners are willing to pay a price premium to exclude non-residential structures in the district. While their research provides an interesting analysis on the changes in residential real estate price for the first imposition of a zoning ordinance, their research does not explore the influence of a rezone on residential real estate prices.

In addition to excluding certain types of structures from a district, zoning may change the amount of potentially developable land within a municipality. Municipal planners may limit residential growth or restrict certain types of facilities. The city of Portland, Oregon, has been subject to numerous real estate studies, since it employs an Urban Growth Boundary (UGB), which is a form of zoning that restricts residential development. The UGB is a growth management tool to restrict property sprawl and encourage residential density (Abbott, 2002). In theory, an external restriction on the number of developable parcels devoted to residential dwellings should increase the price residential real estate if the demand for residential property grows. Phillips and Goodstein (2000) finds the UGB creates upward price pressure on residential real estate inside the boundary. Yet, Jun (2004) claims the UGB does not increase prices beyond normal market appreciation. Nonetheless, the imposition of the UGB changes the residential development potential in the region. A rezone changes the equilibrium supply of a specific type

of end-use functionality within a particular region. For rezones that convert residential property to non-residential property, the overall supply of residential real estate diminishes and if demand for residential property maintains constant, residential real estate prices could increase. Conversely, conversion of non-residential property to residential property could reduce the price of nearby residential real estate, since the conversion increases the supply of dwellings. Moreover, these newly constructed dwellings are deemed more desirable to consumers in comparison to older properties with similar characteristics (Sirmans et al., 2006).

Since zoning ordinances can mandate minimum lot sizes in districts with high land prices, the price for a single family residential property can be artificially expensive. Some view minimum lot size zoning as income exclusionary (Dowall, 1979). Land-use regulations may "serve to maintain housing costs at a level high enough to prevent moderate- or low-income families from purchasing housing" (Katz & Rosen, 1987, p. 150). In his book, Fischel (2009) refers to these exclusionary tendencies as the Homevoter Hypothesis. Homeowners seek to maintain their residential real estate prices through any ordinance or regulation. In addition to property values, safeguarding amenities can be achieved with municipal zoning. In Washington state, rural homeowners supported regulations that maintained their rural countryside amenities (Kondo, Rivera, & Rullman Jr, 2012). Additional information regarding the exclusionary principles of zoning regulations can be found in Ihlanfeldt (2004).

In Denver, CO, a different municipal ordinance restricted the location of supportive housing away from single family residential districts. Supportive housing refers to facilities catering to special needs populations such as the chronically mentally ill, recovering substance abusers, and elderly (Galster et al., 2003). Denver residents believed these supportive housing facilities reduce their residential real estate prices. In Ohio, residential real estate values fell by

forty percent for location in sight of severely mentally disabled facilities; yet, other Ohio residential real estate properties experienced no such declines (Galster & Williams, 1994). In Chicago, IL, the negative impact associated with an announcement for a group home resulted in a reduction of sales prices by thirteen percent if the properties were within sight of the new facility (Colwell, Dehring, & Lash, 2000). If the community protested the announcement, the authors observed an additional seven percent decline in sales prices. The negative perceptions connected to the facility development coupled with heightened community awareness signaled to buyers that the facility was a dis-amenity. Nearby property uses that align with the current zone but are not conforming to the neighborhood may reduce residential real estate prices.

Over the long term, zoning can redistribute the spatial arrangement of a municipality (Shertzer et al., 2016). Houston, TX, is the largest city in the United States without a comprehensive zoning ordinance. In Houston, polluting land use buildings are less segregated compared to other zoned cities in Texas such as Austin, Dallas, and San Antonio. Zoning ordinances force polluting industries to concentrate which reduces the negative externalities of pollution on the nearby properties. Using Chicago data, the authors simulated the spatial arrangement of commercial and industry land use under the absence of municipal zoning and concluded that an un-zoned Chicago would have greater spatially dispersed commercial and industrial sectors. “Over the long-run, urban planning has been effective in creating residential neighborhoods that are distant from undesirable manufacturing uses, and that houses in these neighborhoods are more valuable as a result” (Shertzer et al., 2016, p. 26).

Other research has discovered a link between restrictive land use regulations and extreme market cycle fluctuations. More restrictive municipal zoning amplified price booms and busts in the United States from 2000 to 2009 (Huang & Tang, 2012). The inelasticity of supply

exacerbated the boom-bust cycle according to their research. Municipal restrictions which reduce construction may influence the supply. Minimum lot size, wetlands bylaw restrictions, and septic system regulations in Boston, MA, reduced the amount of construction in the region (Glaeser & Ward, 2009). These municipal regulations are associated with higher residential real estate prices and lower construction levels.

As chapter two illustrates, residential real estate valuations are influenced by internal and external characteristics, which are capitalized by consumers into the purchase price of the property. The next chapter describes hedonic theory. This theory underpins real estate research. Under the framework of this theory, the dependent variable is the transactional sales price of the residential real estate property. Furthermore, the theory validates the use of sales price transactional data as a means to capitalize the real estate's internal and external characteristics.

CHAPTER 3

HEDONIC PRICE THEORY

Rigorous academic research requires the application of theory. Theory underpins the structure of the analysis, model specification, and may provide preliminary support for a specific sign direction on the calculated coefficients. The theoretical foundation for this research aligns with many other real estate research papers as it adopts revealed preferences or hedonic price theory developed by Rosen (1974). Hedonic price theory has been used to investigate the demand characteristic for thousands of research articles ranging from natural ecosystem capital benefits (Costanza et al., 1997) to customer satisfaction, market share, and firm profitability (Anderson, Fornell, & Lehmann, 1994). Within the real estate literature, Rosen's theory has been used to evaluate the influence of higher quality schools (Black, 1999), environmental benefits (Freeman III, 1979), clean air (Harrison Jr & Rubinfeld, 1978), health risks (Farber, 1998), and industrial activity (de Vor & de Groot, 2011) on residential real estate prices.

Rosen (1974) begins his seminal work by describing product differentiation and the value of goods. Non-fungible products or services contain different attributes which distinguishes one from another. One of his assumptions in the hedonic hypothesis relies upon the notion of value. He describes value as a concept of utility-bearing attributes or characteristics. Rosen borrows his concept of *utility* from Daniel Bernoulli's 1738 essay.

> The determination of the value of an item must not be based on its price, but rather on the utility it yields. The price of the item is dependent only on the thing itself and is equal for everyone; the utility, however, is dependent on the particular circumstances of the person making the estimate. (Bernoulli, 1954, p. 24)

This passage illustrates the differences between price and utility. Consumers have equal prices for a good, but their utility for that good may be vastly different. Using a real estate example, Consumer A may earn higher utility for a residential real estate property with an adjoining garage; however, Consumer B, who does not own an automobile, earns substantially less utility for the same attached garage. The garage costs the same for each consumer, yet its utility differs drastically.

In the Rosen (1974) hedonic model, a competitive equilibrium exists in a multi-dimensional plane with buyers and sellers. Goods are described by objective characteristics such that $z = (z_1, z_2, \ldots, z_n)$ where z_i measures the i^{th} characteristic of the good. In his theory, sellers offer a wide variety of goods with differing characteristics. Buyers have complete range to purchase any good within their budget constraint. Moreover, the supply of offered goods equals the amount of demanded goods. Equilibrium prices are matched between buyers and sellers. Thus, the market clears and remains in equilibrium.

In addition to these assumptions, hedonic price theory simplifies the exchange of goods in the marketplace. Any large geographic area with varying property characteristics, even consisting of different locations, census tracts, and environmental factors, constitutes a single marketplace for housing. In this marketplace, there is no resale or secondhand market for goods. Additionally, the brand of the seller is not factored into the purchase decision. Consumers purchase the cheaper of two identical goods sold by two separate vendors. Marketing or branded product premiums do not exist. Lastly, bundled goods cannot be reduced into their components or properties. Rosen (1974) provides the example that two six-foot cars are not equal to one car twelve feet in length. Freeman III (1979) likened the hedonic model to consumers shopping in a grocery store. In this grocery store, consumer cannot shop for individual items, but purchase pre-

filled shopping carts filled with a bundle of items. Differences in prices between the shopping carts, while accounting for the cart's internal characteristics reveals a function of related prices for each of the cart's characteristics. This function represents the buyer's hedonic price regression. The characteristics within each grocery cart contain value and utility for consumers.

Consumer purchasing behavior remains grounded in the maximization of utility. "No individual can improve his position, and all optimum choices are feasible" (Rosen, 1974, p. 35). Utility maximization is based on a number of assumptions. Consumers are rational and attempt to obtain the most personal utility for their expenditures. Consumers have limited incomes and assets. They have a budget constraint with limited resources. Consumers maintain strict cardinal preference orders for various goods and services. Consumers can rank their most desired characteristics and correctly apply prices for each. The final assumption of the utility maximization model centers on price. Every characteristic has a price and consumers must choose alternative goods within their limited resource budget constraint. Consumers allocate monetary resources so that the marginal utility of the next dollar equals the utility lost from the consumption of that dollar. Since there are no options available to consumers to gain additional utility from the purchase of a different basket of goods, consumers satisfy Equation 1.1.

$$\frac{\mu x}{px} = \frac{\mu y}{py} = \cdots = \frac{\mu z}{pz} \qquad (1.1)$$

The consumer's marginal willingness to pay for each characteristic equates to the marginal implicit price of the characteristic. To further the application of the consumer maximization utility function for housing research, the function incorporates the dimension of location and time into the good's bundle of characteristics.

The hedonic model is a two-step technique. In the first step, the implicit price of the characteristic is projected by the hedonic price function. Second, the implicit price is regressed

against the observed covariates to estimate a demand function for consumers. The sales price of the residential real estate is described as a function of its physical attributes, neighborhood peer effects, and location, Equation 1.2. Vector C describes the physical attributes of the residential real estate, the vector N represents a vector of the real estate's neighborhood peer effects, and Z defines the location of the real estate.

$$\text{Price}_{(it)} = \delta C_{it} + \gamma N_{it} + \zeta Z_{it} + \varepsilon_{it};\ t=1, \ldots T \qquad (1.2)$$

This equation describes the hedonic or implicit price function for the sales price of residential real estate property at time period t using the three vectors. The equation may be either linear or non-linear. If linear, the implicit prices are constant for individuals, yet if the equation is not linear, the implicit price for the next unit of the specific characteristic relies upon the quantity of the characteristic. This function provides an estimated price for any property with known characteristics. Differentiating Equation 1.2 calculates the expected increase in housing price to purchase the new housing bundle with an additional N_k unit, Equation 1.3.

$$\frac{dp}{dN_k} = pN_k\ (N_k) \qquad (1.3)$$

The theory obtained the moniker *revealed preferences* from the use of consumer transactional data as the underlying data source. Freeman III et al. (2014) describe revealed preferences as a "take-it-or leave-it" scenario (p. 24). The dataset provides the transaction through which consumers reveal their level of utility in monetary terms. For example, the difference in purchase price of two mostly identical residential real estate properties that differ by one additional bathroom would reveal the utility or price of the additional bathroom.

Omitted Variable Bias

While this research framework has been widely adopted for real estate research, one of its main drawbacks is omitted variable bias. Regardless of the number of control variables, all

relevant neighborhood characteristics cannot be modeled in the functional form of the equation. In this research, there are two types of omitted variable bias, neighborhood level effects and time dependent effects.

To remedy the first level of omitted variable bias, this research employs clustered standard errors at the zip code level of geography and incorporates census tract dummy variables. Clustering standard errors on the zip code may reduce the serial correlation of the unobserved locational effects present within the analysis. Including dummy variables at the census tract effectively calculates the mean residential real estate valuation within each tract. These dummies align unobserved covariates within the boundary and attempt to reduce the omitted variable bias associated with neighborhood peer effects. The second level of omitted variable bias is associated with time and neighborhood trends. Over time, consumer utility may change; thus, the calculated value of the intrinsic characteristic or peer effect may differ. Following Diewert (2003), consumer utility is fixed across all time periods within this research.

Some may contend that private rezoning is not an endogenous event but occurs as a result of a change in future expectation for real estate returns. Simply, private developers or investors may believe a parcel of land can be more profitable as a different land use function. Regardless of land use type, higher profitability may be associated with higher overall property prices in the area. Hedonic regression may incorrectly capture the change in neighborhood trend and attribute this price appreciation or depreciation to a nearby property rezone. To reduce this bias, the research controls for new home construction within each census block group. New residential real estate construction may proxy for profitability trends within the localized residential real estate market. New construction signals that developers believe the neighborhood's real estate value is stable or is trending upward. In addition, new construction may reveal the future

expectations for investment profitability in the area. With this added control variable, the hedonic model reduces the influence of the neighborhood trend and captures the change in rezone on residential real estate prices.

Other Theoretical Considerations

There are other theoretical considerations in this dissertation. Hedonic price theory assumes that consumers have complete or perfect information. Adoption of this theory assumes consumers can correctly identify and value all nearby externalities into the residential real estate purchase price. Researchers have contested the occurrence of perfect information in marketplace transactions (Stigler, 1961; Stiglitz, 2000). The theory assumes there is a cost to obtain the marginal or next level of information. Yet, more detailed information leads to higher costs for consumers (Stiglitz, 2000).

Holding the budget constraint and purchased good price constant, higher total cost for information reduces the ability to purchase the ideal good and shifts the consumer to a lower consumption curve, Figure 1.2. In this illustration, budget constraint line BC_1 contains an informational level of *x* and this line depicts the amount of consumer resources, *q* and *z*, available at *x* level of information. An indifference curve provides a hypothetical consumption level of goods *q* and *z* at point E_1. An increase in the information level from *x* to *y* reduces the overall budget constraint by the tangible cost to achieve *y* level of information. Thus, the budget constraint shifts leftward and the consumer lies at a lower indifference curve tangent to BC_2 at E_2. The cost for a greater level of information reduces the consumer's purchasing power of goods *q* and *z*. This thought experiment illustrates that more information regarding residential real estate property characteristics results in a tradeoff in the amount of final consumption.

Since individual levels of information are not available at the person level, this research adopts the Arrow-Debreu model for commodities. Arrow-Debreu commodities are precisely defined goods, where additional information no longer increases the satisfaction of the consumers (Geanakoplos, 1989). The physical description of the residential real estate coupled with the zip codes and census tracts allows for defined goods. This chapter describes the foundational theory of the dissertation. For more information regarding economic basis for the theory, see Follain and Jimenez (1985), who provide an extensive account of the hedonic price theory and related its application to housing research. The next chapter explains the dataset and methodology used for this research.

CHAPTER 4

METHODOLOGY

While some contend that zoning coincides with market uses and does not modify land use functions (Wallace, 1988), others claim zoning adjusts the physical properties of the neighborhood. The built environment influences consumer behavior (Boarnet & Crane, 2001) and land-use policies can influence the built environment (Cao, Mokhtarian, & Handy, 2007). With these interrelated effects, statistical methods must account for unobserved covariates as the same unobserved factors that influence residential real estate price appreciation could influence a private developer's decision to have property rezoned (Cameron & Trivedi, 2005). Hedonic regression extrapolates the consumer's implicit price function. Yet, the purchase price of the residential real estate may be biased from the built environment. The failure to account for zoning selection bias results in inaccurate estimates (Butsic, Lewis, & Ludwig, 2011).

Propensity Score Matching

The propensity score matching model reduces bias in the estimation of treatment effects with observational data (Rosenbaum & Rubin, 1983). The matching technique "exploits heterogeneity in the zoning status across parcels and provides potentially unbiased estimates of the treatment effect even if the zoning board selects parcels . . . in a non-random fashion" (Butsic et al., 2011, p. 5). Matching provides minimal functional form restrictions in estimation, yet requires correctly specified covariates. This research follows the propensity score matching (PSM) technique and notation of Rosenbaum and Rubin (1983). To begin the PSM technique, causal effects are compared between r_{1i} and r_{01}, where only one of these variables receives a

treatment. Treatment in this research is proximity to a privately induced rezoned property. The propensity score matching (PSM) technique relates the proximity to a private rezone as an endogenous decision to the consumer behavior associated with the purchase price of the residential real estate. In this technique, residential real estate properties that fall within a specified distance to a privately rezoned parcel are matched against similar residential real estate properties outside of the specified distance. The stable unit-treatment represents the assumption that r_{ti} represents unit *i* with treatment *t* (Rubin, 1986). Thus, Equation 1.4 is the random sample estimated from the population, where the estimated quantity is the average treatment effect.

$$E(r_1) - E(r_0) \quad (1.4)$$

The variable z_i=1 if the observation *i* is apportioned to the experimental treatment, proximity to a rezoned parcel. Conversely, z*i*=0 if the observation is in the control group. The variable x_i is a vector of characteristics or covariates for the observation. Equation 1.5 is the individual causal effect, where Y_i is the potential outcome under the treatment or the control group.

$$Y_i(1) - Y_i(0) \quad (1.5)$$

The PSM convention promotes direct comparison through balancing scores. This matching structure compares the outcomes of nearby rezoned residential real estate to those residential real estate properties distant from private rezoning. The technique assumes the same characteristics influence consumer purchasing behavior and that the baseline covariates influence the residential real estate price concomitantly. Since the experiment is randomized, the treatment observations do not differ systematically from the control observations (Rosenbaum & Rubin, 1983). The normal convention used in this technique is to balance the treatment and control groups for better comparisons. Balancing represents a function to align the conditional distribution of the observed covariates for the treated and untreated groups. “A balancing score is

an unbiased estimate of the treatment effect at that value, and consequently pair matching, sub classification and covariance adjustment on a balancing score can produce unbiased estimates of the average treatment effect" (Rosenbaum & Rubin, 1983, p. 42). The propensity score is the function e(x) illustrating the probability that z =1 given some vector of covariates, Equation 1.6.

$$e(x) = pr\ (z=1|x) \tag{1.6}$$

The average treatment effect on the treated (ATT) can only be identified if the outcomes of each *i,* do not differ in the absence of treatment, Equation 1.7. The sum of the expected value of the assignment of the treatment group and control group equals zero. The treatment assignment, ie the group to with observation z_i is assigned, is considered strongly ignorable and the ATT can be interpreted.

$$E(z(0)|r_i=1) - (E(z(0)|r_i=0) = 0) \tag{1.7}$$

The parcel is rezoned if the expected value of the newly rezoned land is greater than the cost of the rezone and its subsequent development. In this research, Y denotes the price outcome of residential real estate property that is either within the designated proximity to a nearby property rezone or outside of that region. The average treatment effect for the treated sample is Equation 1.8, where N is the total number of observations in the sample.

$$\tau_{ATT} = \frac{1}{Nz} \sum_{i=1}^{N} (Y_i(1|z_i = 1) - (Y_i(0|z_i = 1) \tag{1.8}$$

There is a fundamental problem of causal inference. The observations account for only one potential outcome. There is no counterfactual observation. For those properties in the treatment group, a price observation does not exist for the same property as a non-treated observation. Simply, since the variable was treated, researchers have no price data had the property not received treatment.

In a randomized experiment, every observation has some non-zero probability of receiving the treatment. The PSM technique models a random sample with treated and untreated groups (Butsic et al., 2011). The treated and untreated groups must be unconfounded according to Equation 1.9. The expected value of r_i given *x* covariates when assigned to the treated group must equal the same probability for r_i given those same covariates for its inclusion to the control group. Thus, groups are matched to align the covariate distribution, which remains identical regardless of the designation as a treated or untreated group.

$$E[r_i|x, z(1), z(0)= pr[r_i|x]] \quad (1.9)$$

Each individual observation *i* has an assignment value of treatment that was determined by the covariates of *i*, Equation 1.10, and that strictly ranged between zero and one, Equation 1.11.

$$z_i = pr[r_i|x_i] \quad (1.10)$$

$$0 < pr\ (z=1|x) < 1 \quad (1.11)$$

Does privately induced rezoning influence residential real estate transactional prices at 0.75, 1.0, 1.25, 1.5, and 2.0 miles? Using separate models, this research tests for the average treatment effect of the treated for each distance function. Covariates for each model are identical to promote comparison between the spatial differences. In addition to distance, time is another restriction placed upon the treatment variable. The date of each residential real estate property sale, RE_{sale}, is restricted to a 365-day period of time after the file date for each rezone application *b*. Equations 1.12 through 1.16 provide the formula for the creation of the treatment groups for each distance period.

$$File = Rezone_{file} < RE_{sale} < 365;\ Rezone_{file} = 0\ days;\ i\text{-}b < 0.75\ miles \quad (1.12)$$

$$File = Rezone_{file} < RE_{sale} < 365;\ Rezone_{file} = 0\ days;\ i\text{-}b < 1.0\ miles \quad (1.13)$$

$$File = Rezone_{file} < RE_{sale} < 365;\ Rezone_{file} = 0\ days;\ i\text{-}b < 1.25\ miles \quad (1.14)$$

$$\text{File} = \text{Rezone}_{\text{file}} < \text{RE}_{\text{sale}} < 365;\ \text{Rezone}_{\text{file}} = 0 \text{ days};\ \text{i-b} < 1.50 \text{ miles} \quad (1.15)$$

$$\text{File} = \text{Rezone}_{\text{file}} < \text{RE}_{\text{sale}} < 365;\ \text{Rezone}_{\text{file}} = 0 \text{ days};\ \text{i-b} < 2.0 \text{ miles} \quad (1.16)$$

Since the municipal process to rezone property is lengthy, consuming time and monetary resources, the larger time period was selected to capture the greatest number of influenced properties without negatively influencing standard errors. The time restriction of 365 days captures market uncertainty with an unknown rezone approval process and an appropriate period of time after the average approval period.

In the outcome model of the paired matching PSM technique, a logit treatment model construction is used to conduct the conditionality. The natural log of the outcome variable price obtains stronger best-fit statistics. The covariates of the PSM model following commonly used observed characteristics in real estate research and are outlined in the second chapter.

Fixed Effects

While the propensity score model quantifies the price influence of a binary zone change on a nearby residential real estate transaction, the model cannot disentangle the nuances between specific types of zone changes. Another research question this paper seeks to answer separates these zone changes based on end-use zoning. Specifically, this research seeks to quantify the influence on residential real estate transactional prices when non-residential zones (commercial and industrial) are rezoned to residential zones (residential and multifamily). To achieve this goal, a fixed effects model is employed.

The fixed effects model follows the Rosen (1974) hedonic technique, Equation 1.17.

$$\ln(p_i) = \beta X_i + \varepsilon_i \quad (1.17)$$

In this equation, the natural log of the price of a real estate transaction is regressed against its vector of explanatory variables with a normally distributed error with a mean of zero. Since

residential real estate is influenced by its internal characteristics, C, as well as its neighborhood characteristic, N, Equation 1.17 can be expanded into Equation 1.18. The vector Z denotes the specific zoning variables associated with the residential real estate.

$$\ln(p_i) = \delta C_i + \gamma N_i + \varsigma Z_i + \varepsilon_i \quad (1.18)$$

Real estate transactions are influenced by the business cycle. Recessions lead to lower real estate prices compared to expansionary periods. Additionally, inflation rates reduce the value of a single dollar across time. To account for business cycle related market trends and diminished purchasing power, the hedonic model incorporated time dependence, Equation 1.19.

$$\ln(p_{it}) = \delta C_{it} + \gamma N_{it} + \varsigma Z_{it} + \varepsilon_{it} \; ; \; t = 1, \ldots T. \quad (1.19)$$

Again, this research conforms to the time invariant consumer utility hypothesis promoted by Diewert (2003) and confirmed in real estate research by Sirmans et al. (2006).

When residuals are independent and identically distributed, standard errors are unbiased in hedonic regressions. However, when the residuals exhibit observational correlation, the standard errors can be biased. Lower standard errors will overestimate the significance levels of the model, while overinflated standard errors improperly force the researcher to fail to reject the null hypothesis. Neighborhoods may correlate across years as a function of their underlying unobserved covariates and create time-series dependence (Wooldridge, 2010). Neighborhood correlation may violate the assumption of independence where the asymptotic variance of the estimated coefficient is $\frac{\sigma_\varepsilon^2}{\sigma_X^2 NT}$. Clustered standard errors may remedy the violation of independence. However, the number of clusters must be greater than ten for the procedure to estimate the true standard error (Petersen, 2009).

The hedonic analysis takes the functional form of Equation 1.20. The log of the selling price is the dependent variable, which is modeled with the covariates on the right side of the

equation. The full name and its abbreviation of the zoning variables of interest are found in Table 1.1. The beta coefficient on these variables represents the expected change in price for a one unit change in the variable. The fixed effects model incorporates a binary spatial variable, census tract, to account for spatial autocorrelation. Spatial autocorrelation is explained further in the next section. The fixed effects model clustered standard errors at the zip code level to further reduce spatial autocorrelation. The remaining list of covariates are the observed characteristics of the residential real estate.

$$\begin{aligned} ln(Price)_{it} = {} & \beta_0 + \beta_1 * (R\ to\ R)_{it} + \beta_2 * (R\ to\ NR)_{it} + \beta_3 * (R\ to\ M)_{it} + \beta_4 * (NR\ to\ R)_{it} \\ & + \beta_5 * (NR\ to\ NR)_{it} + \beta_6 * (NR\ to\ M)_{it} + \beta_7 * (New\ Construction)_{it} + \beta_8 \\ & * (\ln(Acres))_{it} + \beta_9 * (\ln(Zone\ Size))_{it} + \beta_{10} * (\ln(Living\ Space))_{it} + \beta_{11} \\ & * (Fireplaces)_{it} + \beta_{12} * (Deck\ or\ Patio)_{it} + \beta_{13} * (Basement\ Bath)_{it} + \beta_{14} \\ & * (Association)_{it} + \beta_{15} * (Clubhouse)_{it} + \beta_{16} * (Corner\ Lot)_{it} + \beta_{17} \\ & * (Sprinklers)_{it} + \beta_{18} * (Back\ Yard)_{it} + \beta_{19} * (Bedrooms)_{it} + \beta_{20} \\ & * (Bathrooms)_{it} + \beta_{21} * (Half\ Bathrooms)_{it} + \beta_{22} \\ & * (Finished\ Basement)_{it} + \sum_{j=1}^{189} \beta_{j+22} * (Census) + \varepsilon \end{aligned} \tag{1.20}$$

While the hedonic modeling technique has been routinely employed by researchers for real estate research, it is not without faults. The imperfections are spatial autocorrelation, endogeneity, and heteroscedasticity (Irwin & Bockstael, 2001). The next section describes these faults and discuss manners through which this research seeks to reduce their influence on the research results.

Hedonic Model Deficiencies

The first law of geography states that near things are more similar than far things (Tobler, 1979). As a result, spatial relationships exist between nearby residential real estate neighbors. According to Anselin and Griffith (1988), real estate research is plagued by two spatial econometric problems, spatial autocorrelation and spatial heterogeneity. Spatial autocorrelation or as Can (1990) termed, spatial dependency, describes error terms that are not independent of the explanatory variables. Geographical features of the land or unobserved peer effects associated with the residential real estate may influence the error terms in the modeling equation. Clustering standard errors with a geographic or spatially weighted variable may reduce the spatial autocorrelation within the analysis.

Endogeneity refers to the correlation between the explanatory variables or covariates and the error term. These two terms influence the dependent variable in distinct ways. Statistical problems arise when the explanatory variable, which influences the dependent variable, induces a change in the error term, which also influences the dependent variable. Irwin and Bockstael (2004) articulate an agent interaction hypothesis where the presence of spatial externalities creates endogeneity between land use decisions. Land use conversion and the decision to rezone property may be an endogenous interaction. The authors outline a series of cases where spatial externalities may influence land use conversion. Areas with community spillover effects, social desirability, critical density of amenity attraction, congestion, and pollution were all potential causes of spatial endogeneity. The use of spatial variables such as controlling for zip codes and census tracts within the hedonic regression seeks to isolate the spatial influence of the surrounding area without generating biased estimates.

Another form of endogeneity centers upon price level trends. Privately induced rezoning could be a function of price expectations where properties with higher expected sales prices have a higher likelihood of rezoning application. Were this endogeneity to occur, the coefficient of the rezone does not indicate property price appreciation, but captures localized growth trends. To reduce this concern, the model controls for new property construction in the census block group. New construction is a function of expected consumer demand. Due to the lagged duration of construction, developers building new residential real estate property invest in areas with positive demand and potentially high profits. Thus, controlling for the amount of new construction within each census block group controls for the price trend and future expectations of the rezone area.

Heteroscedasticity refers to the statistical event where the variability of the explanatory variable is unequal across the range of another explanatory variable's values. In real estate research, this event is most common with real estate age and condition. All properties age and deteriorate over time, yet some of these properties are maintained and renovated. The quality of a randomly selected sample of real estate properties has lower variability for all newly constructed properties compared to a randomly selected sample of significantly older properties. Failing to account for heteroscedasticity may result in the loss of statistical efficiency, biases in estimated standard errors, and invalid inferences (Breusch & Pagan, 1979). This research controls for the residential real estate property's age and condition with two variables: age and quality. Age is a simple calculation of the purchase date minus the construction date. The quality variable provided in the MLS dataset is a seven level continuous variable where one indicates the highest quality and seven represents the lowest quality of residential real estate.

General Data Cleaning

The data for this research are cleaned similar to other real estate research. To eliminate extreme sales price outliers, residential real estate properties which sold in the top or bottom 5% of the dataset are removed. Additionally, the smallest 1% and properties larger than 99% according to living square footage are deleted from the data. Properties with an unusually large number of bedrooms or bathrooms are removed from the dataset (Zahirovic-Herbert & Gibler, 2014). Distressed residential real estate such as foreclosures, bank owned, short-sales, and REOs sell at reduced prices and may bias estimates (Forgey, Rutherford, & VanBuskirk, 1994). To eliminate the potential for bias, these real estate observations are removed. The dataset is restricted to only one municipal county to reduce the variance in zoning procedures, tax rates, and other governmental externalities.

This chapter describes the two data methods this research employs to determine the influence of a private rezone on residential real estate and whether the change from non-residential zoning to residential zoning influences nearby residential real estate prices. The next chapter presents the results from the model and discusses the findings.

CHAPTER 5

RESULTS & DISCUSSION

This chapter begins with a description of the data used for the empirical study and is followed by the two statistical modeling techniques: propensity score matching and hedonic regression. Within each modeling technique section there is a discussion regarding the implications of the results of this research for various stakeholders. All of the tables and figures referenced in this chapter can be found after the appendix section.

Data Description

The data for this study are obtained from two sources. Privately induced rezoning data are provided through the City of Atlanta's *open data portal* maintained by the Department of Planning and Community Development. The initial dataset contains 1,014 rezones in Fulton County from 2002 to 2017. Unfortunately, not all of the rezones are complete and municipal docket information may be missing. Observations with missing information are removed from the research. The complete municipal docket provides the date of the privately induced rezone application and the date for which the rezone is approved.

There were 444 usable privately induced rezones with complete information. Table 1.2 illustrates the initial zone type and its new zone classification after rezone. Table 1.3 shows the *from-zone* by its ultimate *to-zone* end use function. Of the 444 rezones, 48.2% are classified with a non-residential end use function. Non-residential functions include commercially and industrially zoned property. The second largest percentage of rezones are initially classified as residential. Residential rezoning constituted 47.1% of the dataset. The remaining balance of

rezoned properties, 4.7%, are initially zoned for mixed use functions. Mixed use properties consist of residential and commercial operations.

Residential zones maintain the highest destination rezone within the dataset, 46.2%. While mixed use zones does not constitute a large percentage of the initial zones, mixed use zones are commonly the destination rezone at 38.7%. The lowest classification for privately induced rezoning is non-residential, 15.1%. The majority of the rezones newly classified as non-residential originate as non-residential zones.

Rezoned properties can be classified as their initial zone. Differing density classifications is one mechanism for this outcome. As previously referenced in the literature review section, municipalities distinguish zones in more detail than simply end use function. Residential real estate consists of single residential and multi residential. Within each single residential and multi residential there are more density demarcations. In Fulton County, there are nine different single residential zones classifications according to lot size and floor to area ratio. Also, Fulton County recognizes fourteen different types of multi residential zones. Again, this distinction centers upon lot size and floor to area ratio. This research collapses the densities within each end use function. Density classifications are not unique to single residential or multi residential real estate; commercial and industrial real estate maintain different density classes as well. As a result of changes to density, a rezoned property can be classified as changing to its initial zone type.

Grouping by end use functionality is the second mechanism for a privately induced rezoned property to be classified as its initial zone. There can be multiple zone types within each end use function. For example, the non-residential real estate classification includes commercial and industrial property. The new zone classification is listed as its initial zone type, since the commercial zone changes to an industrial zone and both are within the non-residential grouping.

The second dataset contains the transactional residential real estate prices and property characteristics. These data are made available by MLS. This dataset includes 477,000 residential real estate properties from 1987 to 2014 in the Metro-Atlanta region of Georgia. Residential real estate properties outside of the research time period are excluded from the analysis. Moreover, this research removes outliers and cleans the data according to prior real estate research (Smith, Gibler, & Zahirovic-Herbert, 2016).

After aligning for the intersecting time period between the two datasets and removing MLS data outside of Fulton County, the dataset encompasses 39,220 MLS transactions. Descriptive statistics, Table 1.4 provides more detailed information regarding the transactional dataset. The overall mean sales price of properties within the dataset was $260,877 with an average 104 days on the market. The average size of residential real estate was 2,234 square feet with an average lot size of 0.4 acres. On average, residential real estate was 30.7 years of age with an average quality rating of 2.49, where one equaled the highest quality rating. Almost half of the residential real estate properties in the dataset had a deck or patio and only 37.9% contained finished basements. There were 3.8 bedrooms and 2.5 bathrooms within the average residential real estate transaction.

While 14,328 MLS transactions occurred within two miles of a privately induced rezone, the majority of these transactions did not occur within the necessary 365-day period starting on the date of rezone application. There were 1,035 residential real estate transactions occurring within two miles of a privately induced rezone and within the 365-day period. The average distance from a privately induced rezone is 7,743.9 feet or 1.46 miles.

The datasets are joined in ESRI ArcMap 10.3.1 using latitude and longitude coordinates. The MLS transactional data and the rezone data aligned to the same coordinate system.

Specifically, the geographic coordinate system assigned to these data was NAD 1983 with the Georgia West FIPS 1002_Feet state plane coordinate system. Figure 1.3 illustrates the plotted rezoned parcels and the residential real estate data points. In this image, the dark green dots indicate the MLS transaction. The yellow polygons are the rezoned properties and the red dots are the centroid points for the rezones. Linear distances within 10,560 feet or two miles of the centroid point were calculated for each MLS transaction. All subsequent statistical methods were calculated in Stata 15.1.

Prior to the interpretation of the coefficient effects, academic literature may provide potential rationale for the influence of nearby property externalities. Holding all other factors equal, an increase to the supply of residential real estate in an area may reduce the price of existing real estate. This detrimental price effect may be magnified by the perceptional influence of 'new' property for consumers. Consumers value newer property and interior designs when compared with older property and outdated interiors.

When a property undergoes construction or redevelopment through a privately induced rezone, uncertainty is injected into the marketplace. Higher uncertainty correlates to lower price levels to compensate consumers for the additional market risk. The uncertainty of development with some construction or redevelopment projects may be manifest through lower residential real estate prices in the surrounding community. Akin to uncertainty in the market, an undesirable zone type may detrimentally influence the property price of surrounding real estate. Homogenous communities demand price premiums. Moreover, zones allowing for non-conforming property uses may reduce the prices of surrounding residential real estate.

While redevelopment and the specific future use of a zone may be unknown, capital investment to improve depressed structures increases the value of a community. The renewal of

old or dilapidated structures may remove blight from a community and signal positive trends to potential residential real estate buyers. This positive externality may lead to price appreciation within the surrounding real estate marketplace.

Propensity Score Matching

As a result of increased computing power and more accessible geospatial data, the propensity score matching technique has grown in popularity among real estate researchers over the last decade. The technique uses a quasi-experimental design to mimic the conditions of a randomized controlled trial, where observational data are classified as treated or not treated. After classification, the technique matches treated observations against non-treated observations using a nearest-neighbor approach to determine if there is an effect of the treatment on a dependent variable. This research explores the influence of a privately induced rezone on residential real estate price across five distances ranging from 0.75 miles to 2 miles. Each successive model increases the distance by 0.25 miles with the last increase in distance 0.5 miles.

Results

The results of all five propensity score models can be found in Table 1.5. All of the models indicate a significant relationship between a privately induced rezone and residential real estate price. At the closest distance, Model 1, residential real estate properties may be detrimentally influenced by negative externalities such as construction uncertainty, residential real estate supply shocks, or incompatible property types. Model 2, distance of 1.0 mile, has the largest coefficient effect at 26.36%. However, the effect of the privately induced rezoning diminishes in magnitude as distance increases. At the farthest distance, two miles, the influence of privately induced rezoning falls to 16.18%.

Discussion

These results indicate that privately induced property rezoning may influence surrounding residential real estate prices. However, readers should note that the physical act of rezoning may be less influential than the actual development of the property. Property development or rehabilitation may generate positive signals to consumers and potential residential real estate purchasers, thereby influencing higher residential real estate bids. Furthermore, the propensity score matching technique does not differentiate between the type of rezoning. The following model provides more detail on the influence of rezone classification.

Hedonic Regression

The hedonic regression is a common statistical method used in residential real estate research. In this research, the hedonic regression controls for spatial characteristics as well as property specific traits and the variable of interest. The observations are the residential real estate properties surrounding rezoned properties. The variables of interest in this model are the classifications of rezoning.

Results

In total, there are five fixed effects models with clustered standard errors. Each model differs by the linear distance between the center of the rezone and the residential real estate property. Successive models add 0.25 or one quarter mile to the linear distance. The fixed effects model considers those properties within each ring of distance treated by the privately induced rezone. As the distance function increases, more observations with a rezone treatment are captured by the model. Table 1.6 provides the number of MLS observations per ring of linear distance.

The full results of the five hedonic models is found in Table 1.7. All of the hedonic models have a R^2 value greater than 0.8. For each model, a rezone from a residential zone to a residential zone (R to R) increases the surrounding property value of residential real estate. Yet, there is a difference in the coefficient effect according to the linear distance associated with the residential real estate property. Residential real estate properties within 0.75 miles of a privately induced residential rezone experience the smallest price appreciation, 8.31% compared to all other linear distances. The largest increase in residential real estate price occurs in Model 3 which controls for properties located within 1.25 miles from a privately induced residential rezone. The coefficient effect increases from Model 1 to Model 3, but declines in Model 4 and Model 5. This finding seems to indicate there is a negative externality association with proximity to the rezone. Construction uncertainty may reduce the price of nearby residential real estate property prices. However, with declines in coefficient estimates in Model 4 and Model 5, the influence of a privately induced residential rezone seems to degrade as distance increases.

All of the models estimate that a privately induced rezone from a residential real estate zone to a non-residential real estate zone reduce the surrounding residential real estate property prices. The largest effects are closest to the property rezone at 0.75 and 1.0 miles. Model 1 and Model 2 estimated a residential real estate price decline of 21.26%. The distance and subsequent coefficient of the non-residential rezone variable behaves inversely to the selling price of the residential real estate. As distance increases, the negative coefficient decreases.

The transition from residential to non-residential real estate end use functions through the privately induced non-residential rezone creates a heterogeneously zoned community. This divergent property type functions differently from residential real estate and produces a negative externality upon the surrounding residential real estate. Depending on the end use function of the

non-residential real estate, the community may experience more traffic, noise, or pollution. According to the data, these negative externalities seem to spill over into the local community.

Only in Model 1 is the coefficient for a privately induced residential zone to a mixed use zone statistically significant. At the distance of 0.75 miles, this rezone reduces nearby residential real estate prices by 13.15%. Generally, mixed use property is a combination of residential and commercial real estate end use functions. The residential property component of the mixed use zone partially aligns with the existing residential community; however, the addition of non-residential real estate functions may negatively influence the nearby residential real estate property values.

The progression of these three variables in Model 1 is of interest. As the privately induced rezone deviates from residential real estate functions, the rezone's influence on the surrounding residential community becomes more negative. Figure 1.4 provides a graphical depiction of a residential function continuum by zone type. The most residential function is on the right side of the continuum, while the left most side of the continuum presents the least amount of residential function. Mixed use zones are the center point bridging the divide between non-residential and residential real estate. At 0.75 miles, rezoning to residential real estate provides a positive externality to the local residential community. Privately induced rezoning to mixed use zones negatively impacts the local residential community, but not as much as privately induced rezones to non-residential end use functions.

As non-residential real estate zones are rezoned to residential real estate zones, Models 1, 2, and 3 indicate positive price appreciation with significant test statistic values. The strength of the effect and its significance level decline as distance from the rezone increases. Similar to the discussion above, privately induced rezoning of property to homogenous community types may

lead to price appreciation. The shift from non-residential end use functions to residential end use functions is a positive benefit for the localized residential real estate community.

In addition to the influence of property type on the surrounding community, redevelopment may contribute to positive externalities in the real estate marketplace. In all of the models, privately induced non-residential rezones to non-residential zones are associated with positive and significant gains to the surrounding residential real estate properties. Similar results are observed in other housing literature. Non-residential real estate end use functions are capitalized in the residential real estate marketplace as a disamenity. The replacement of an existing disamenity provides a benefits to the local community (Schwartz, Ellen, Voicu, & Schill, 2006). In their research, the redevelopment of low-income housing yields significant and robust spillover effects. In this research, the redevelopment of local non-residential property increases local residential real estate prices from 43.48% to 64.21% depending on the distance from the rezoned property. Closer properties experience higher price appreciation compared with more distant properties, while controlling for all other factors.

The final rezone transition explored within this research is the change from non-residential to mixed use. In all of the models, this privately induced zoning conversion detrimentally influenced the surrounding price of residential real estate from -12.98 to -21.18%. Interestingly, the closest properties are not the most detrimentally influenced by this zoning change. The positive externality spillover seen in the previous non-residential to non-residential rezone may be counteracting some of the negative externality from the mixed use rezone.

Generally, non-residential real estate converted to mixed use real estate represent large buildings with many residential units and commercial activity on the first floor benefiting from pedestrian foot-traffic. Mixed use properties may significantly increase the supply of residential

real estate in the localized marketplace. This influx of new residential units may place downward pressure on the price of older residential real estate in the surrounding area. This downward pressure is reflected in the negative coefficient estimates calculated by all five models. As distance from the rezone increases, the negative externality from a privately induced rezone declines.

While the other covariates within the models are not the overall focus of this research, their sign and significance levels re estimated according to Sirmans et al. (2006). The variable to control for the total amount of new construction by block group is not significant in any of the models. The variable which controls for the size of the privately induced rezone is not significant in the models as well. The remaining two variables without significance are a binary variable indicating whether the residential real estate is a corner lot property and a variable signaling the number of bedrooms. While the lack of significance on the variable for the number of bedrooms may be startling to some, real estate researchers understand the hedonic model operates by holding all other covariates constant. By setting the square footage of a residential property to a constant value and increasing the amount of bedrooms, the size of every room in the property decreases. While not measured in the dataset, there is a parallel effect of room size and residential real estate price. Both operate in the same direction; an increase in room size may be associated with an increase in residential real estate price.

Unfortunately, the sample size for privately induced rezoning from mixed use to other forms of real estate zone is too small for reliable estimates. They are omitted from this research, but remain a continued topic of interest for additional study.

Additional Modeling

The research within these chapters does not constitute the entirety of the variables and models developed for this essay. Additional variables and models tested other facets and research questions for these data. These additional model results are not illustrated within this chapter for two reasons. First, there is the lack of statistically significant for the coefficients of interest. In some cases, the additional variables produce no tangible difference in coefficient effect size but utilized more parameters. The parsimonious models are chosen over the models with extraneous variables. Second, some of the draft models exhibit a lower model fit once compared with the presented models.

The test of a time decay effect of a privately-induced rezone on residential real estate price is one example of additional modeling. The continuous variable, measured in days, begins after an adjacent property is rezoned and captures the period of days until the sale date. However, this variable is not statistically significant, whether coded as a variable in whole days or in logarithmic form. As a result, it is removed from the final model.

Similar to the time decay concept, this research attempts to model the distance decay of residential real estate prices using a ring approach. Instead of modeling distance with expanding circles, which encapsulates the smaller distances, the research uses a ring-based approach. An initial circle at 0.75 miles are followed by rings of 0.25 miles. Each ring contains only those residential real estate properties within the specified distance. Unfortunately, the sample size for the rings is not large enough to properly conduct the fixed effects analysis and the former circle method was used.

During the research process, there is a recommendation to control for the overall price trend of the residential real estate market using the S&P/Case-Shiller GA-Atlanta Home Price

Index. The seasonally adjusted index is obtained from the Federal Reserve Bank of St. Louis, FRED database. The month and year in which the residential real estate property sold is matched to the month and year value of the home price index. Table 1.8 provides the hedonic regression results with the inclusion of the home price index. While, the home price index variable is significant within all distance models, its resulting coefficient estimate remains negligible. Moreover, the home price index exerts little influence on the coefficients of interest within the five hedonic regression models. These findings indicate that the existing models correctly accounts for the price trends within the residential real estate marketplace.

Discussion

Through comprehensive zoning, municipal leaders and urban planners organize and shape the development of their local community. As this research confirms, there are residential real estate marketplace externalities associated with privately induced rezoning. It may be beneficial to municipal leaders and urban planners to evaluate the potential change in rezone and assess its potential influence on the local residential real estate marketplace.

The total effects of a privately induced rezoning fall into four categories. The first category centers upon the rezone's end use function. Privately induced rezoning for homogenous residential communities may lead to price appreciation for the surrounding area. Heterogeneous change may detrimentally influence residential real estate prices. The disamenity of incompatible property types such as pure industrial or commercial use, may lower consumer utility within a neighborhood and reduce the price of residential real estate.

The second category is the uncertainty of new construction or rehabilitation triggered by the rezone. Rezones and the ensuing construction may lead to unknown development within the community. As a result, future community property owners may lower the offer price for

surrounding residential real estate property. While this effect only lasts for the duration of the construction period, its influence may harm the localized marketplace and should be a concern for municipal leaders and urban planners.

While construction and its uncertainty may be cause for concern in the short term, the redevelopment of antiquated or dilapidated property may be beneficial to the surrounding real estate. The infusion of capital improvement funds increases the desirability of area and may positively influence residential real estate prices. However, upward residential price shocks may promote the negative externalities associated with gentrification. The cost of residential real estate and the rental rate for that localized housing stock increase concomitantly. As these prices continue to rise, the existing population may not have the income to afford continued residence in the community. Municipal leaders and urban planners must weigh the positive externalities of redevelopment against the detrimental influence of rental rate increases.

The fourth category guiding the total effects of privately induced rezoning concentrate on the supply of residential real estate. The supply of residential real estate is directly controlled through zoning. Without offsetting increases in residential real estate demand, large increases to the housing stock may place downward pressure on residential real estate prices. Conversely, the removal of residential real estate for other property types may increase the price of residential real estate, holding the demand for housing stock constant.

CHAPTER 6

CONCLUSION

Zoning is an important municipal function which governs the type of development and regulates the end use function of real estate. The spatial structure of cities and towns are directly linked to the zoning ordinances and comprehensive plans promulgated by the governing entities. Originally, zoning provided relief to property owners as new technology and shifting migratory patterns altered the location of industry and commercial interests. Over the last hundred years, zoning has evolved from those early days as a risk-mitigating ordinance to its function now as a comprehensive municipal planning tool.

Since the vast majority of urban centers have zoning ordinances, the future of zoning will revolve upon rezoning opposed to the creation of newly zoned property. In the United States, municipalities maintain thousands of zoning boards, which may oversee the rezone of tens of thousands of properties annually. This research provides evidence that privately induced rezoning influences residential real estate prices. These influences are not limited to the rezoned property or its direct neighbors, but can be empirically observed at a distance of two miles. Even though the magnitude of the influence degrades over distance, privately induced rezoning creates housing externalities.

Recommendations

Municipal leaders and urban planning administrators must weigh the benefits of private rezoning against the potential negative externalities. To better achieve this balance between new

private development and lower residential real estate price volatility, this research provides three final recommendations.

Consider the compatibility of property types and the end use function of the newly rezoned property as it relates to the surrounding community. Incompatible land uses, such as a change from a residential zone to a non-residential zone, are associated with residential real estate price declines. The disamenities associated with non-residential real estate may reduce the overall consumer utility for residents in the community, thereby generating the observed downward pressure on residential real estate prices. Maintaining residential uniformity within an area allows for the benefits of redevelopment to be capitalized through higher residential real estate prices.

The second recommendation internalizes the supply and demand function of the localized real estate market into the rezone application. Unless migratory patterns indicate sufficient residential demand, an influx of new residential property may detrimentally impact surrounding residential real estate prices. The conversion of non-residential zones to mixed use zones generally denotes the addition of many new residential properties, either in the form of condominium or apartment units. To a certain extent, these supply shocks can be controlled with zoning. Municipal boards may restrict the number of rezoning applications from a specific zoning type in any given year. This restriction may reduce the negative price effects of supply oriented shocks to residential real estate prices.

The final recommendation involves knowledge and transparency. While zoning board notes and meetings are open to the public, the majority of local residents do not actively participate in the rezoning process. The uncertainty of construction and redevelopment of a newly rezoned property may negatively influence consumers as they purchase residential real

estate. Promoting the end use function of the rezoned property may reduce uncertainty and mitigate its negative influence on consumers.

Limitations

Similar to all academic research pursuits, there are limitations to this empirical study. The first limitation is the rolling panel dataset used for this study. By definition, two residential real estate properties are not exactly alike. The geospatial difference between the two properties forces statistical methodologies to control for their internal and external characteristics as well as their spatial dependence. Some research uses repeat sales datasets to account for this modeling challenge. Repeat sales datasets match the same property across time periods. Assuming the property did not undergo renovations or rehabilitation, the change in price between two time periods can be associated with the desired variable of interest. The downsides to these types of datasets is not described here, but repeat sales datasets claim to remove omitted variable bias from the statistical models. Ultimately, the validity and strength of the modeling within a rolling panel dataset is only as good as its control variables.

The lack of neighboring sales transactions is another dataset limitation. In real estate assessment datasets, researchers have assessed values for each property by year. The structure of these municipal assessment data easily lends to difference-in-difference models. In the current research, the rolling-panel dataset may have only a few observations for a single rezone depending on its location.

A further limitation of this dataset is the lack of knowledge about the future land use of the rezoned property. Ideally, this research controls for the future use of rezoned property with an estimated construction or rehabilitation value. This additional data provides for a more detailed analysis and better control for the nuanced price changes associated with rezoning.

Future Research

The influence of rezoning on residential real estate prices will remain of great interest to municipal leaders and urban planners. Future research will test these findings against the influence of publically induced rezoning on residential real estate prices. Moreover, future research will explore the probabilistic function of a property being rezoned and the associated factors which may increase the likelihood of a rezone approval. Lastly, future research will investigate the influence of rezoning to mixed use zones with respect to localized gentrification.

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Appendix A: Required Items for Rezoning in Fulton County, GA

ITEM 1. PREAPPLICATION REVIEW MEETING AND FORM:

Prior to submitting an application, all applicants are required to meet with a current planner who will review the applicant's proposal and site plan and complete a Pre-Application Review Form. No pre-application review meeting will be held on the day of the filing deadline. Applicants are required to bring the site plan and tax parcel identification number(s) to the meeting. Call 404-612-7400 to make an appointment.

ITEM 2. SITE PLAN CHECKLIST:

The site plan checklist (Form F) details the minimum requirements for site plans as specified by Article 28.5.2. of the Zoning Resolution. Prior to submitting an application, a review of the site plan and sign-off by Plan Review on Form F is required.

ITEM 3. APPLICATION FORM:

Original and notarized signatures of the property owner(s) and applicant(s) or a notarized statement by the applicant as to ownership are required. If a contract is used in lieu of the owner's signature, the signature on the contract must be an original and the contract must be valid for the duration of the rezoning process. See the application form for additional details.

ITEM 4. LEGAL DESCRIPTION:

The legal description must be a metes and bounds description of the property that establishes a point of beginning and gives directions (bounds) and distances (metes) of property lines. If the property consists of more than one parcel, all parcels must be combined into one legal description.

ITEM 5. DEED:

A copy of the deed which matches the applicant's name or a copy of the letter indicating a closing and the recordation of a new deed.

ITEM 6. LETTER OF INTENT:

The Letter of Intent should state the requested rezoning and use permit(s) and should include factual details about the proposed use(s), such as number and square footages of buildings, number of residential units, minimum heated floor area of residential units, number of fixed seats in places of worship, number of employees and beds in assisted living facilities, personal care homes and nursing homes, number of employees and students in day care facilities, number of classrooms and number of students in schools, hours of operation, and number and use of playing fields. If concurrent variances are requested, the Letter of Intent should clearly state the requested variances and include explanations of hardships and any other reasons why the development standards cannot be met. If a rezoning request is for a CUP, NUP or MIX district, the Letter of Intent should detail the proposed development standards.

ITEM 7. SITE PLAN:

Site plans must meet the minimum requirements specified by Article 28.5.2. of the Fulton County Zoning Resolution. Refer to Site Plan Checklist (Form F).

ITEM 8. ENVIRONMENTAL SITE ANALYSIS (ESA):

All rezoning and/or use permit applications must include an Environmental Site Analysis (ESA) identifying environmental conditions on the site to determine if the proposed use may be considered environmentally adverse. Refer to Environmental Site Analysis (Form A) for specific instructions.

ITEM 9. TRANSPARENCY:

An 8-1/2" x 11" clear black & white transparency of the site plan is required.

ITEM 10. IMPACT ANALYSIS:

All rezoning applications must include an Impact Analysis (Form B). An Impact Analysis is not required for Use Permits.

ITEM 11. DISCLOSURE FORM:

If the owner, applicant and/or applicant's representative has made a campaign contribution to any member of the Board of Commissioners for $250.00 or more within the past 2 years, Sections 1 through 4 of the Disclosure Form (Form C) must be completed. If no contributions have been made, No should be circled and Section 4 of the form completed.

ITEM 12. PUBLIC PARTICIPATION PLAN:

The Public Participation Plan is to ensure that applicants pursue early and effective public participation in conjunction with their petitions, ensure that the citizens of Fulton County have an adequate opportunity to learn about petitions that may affect them, and to ensure ongoing communication between applicants, adjoining property owners, environmentally stressed communities, community associations and other organizations, elected officials and County staff. Applicants are required to submit a Public Participation Plan (Form D) at the time of the filing of the rezoning/use permit application.

ITEM 13. PUBLIC PARTICIPATION PLAN REPORT:

A Public Participation Plan Report must be completed on Form E and filed no later than 7 days before the Board of Commissioners hearing.

OTHER DOCUMENTS THAT MAY BE REQUIRED:

ITEM 14. ADJACENT PROPERTY OWNER LIST.

If the subject property is within a quarter mile of an adjacent county, the petitioner must furnish the names and addresses of all property owners in the adjacent county that are within a quarter mile of the subject property.

ITEM 15. TRAFFIC IMPACT STUDY:

When a project equals or exceeds the thresholds listed below, a traffic impact study must be submitted. The traffic impact study shall be prepared by a qualified traffic engineer or transportation planner in accordance with professional practices and the guidelines available in the Department of Public Works.

ITEM 16. METROPOLITAN RIVER PROTECTION:

If the property is within 2,000 linear feet of the natural riverbank of the Chattahoochee River, it is part of the Chattahoochee River Corridor and subject to a Metropolitan River Protection Act Review. Applicants must complete the appropriate letter/form and submit it with all rezoning/use permit applications. The letter/form is available from the Department of Public Works.

ITEM 17. DEVELOPMENT OF REGIONAL IMPACT (DRI):

The Department of Community Affairs (DCA) has formulated development thresholds as listed below. When a development meets or exceeds the thresholds, the Atlanta Regional Commission (ARC) and the Georgia Regional Transportation Authority (GRTA) shall review the project concurrently. Applicants shall first file the rezoning/use permit request with Fulton County. After the ARC/GRTA findings are complete, the rezoning/use permit will be placed on the next available agenda. It is the applicant's responsibility to contact and follow all ARC and GRTA review procedures. For details visit the ARC at

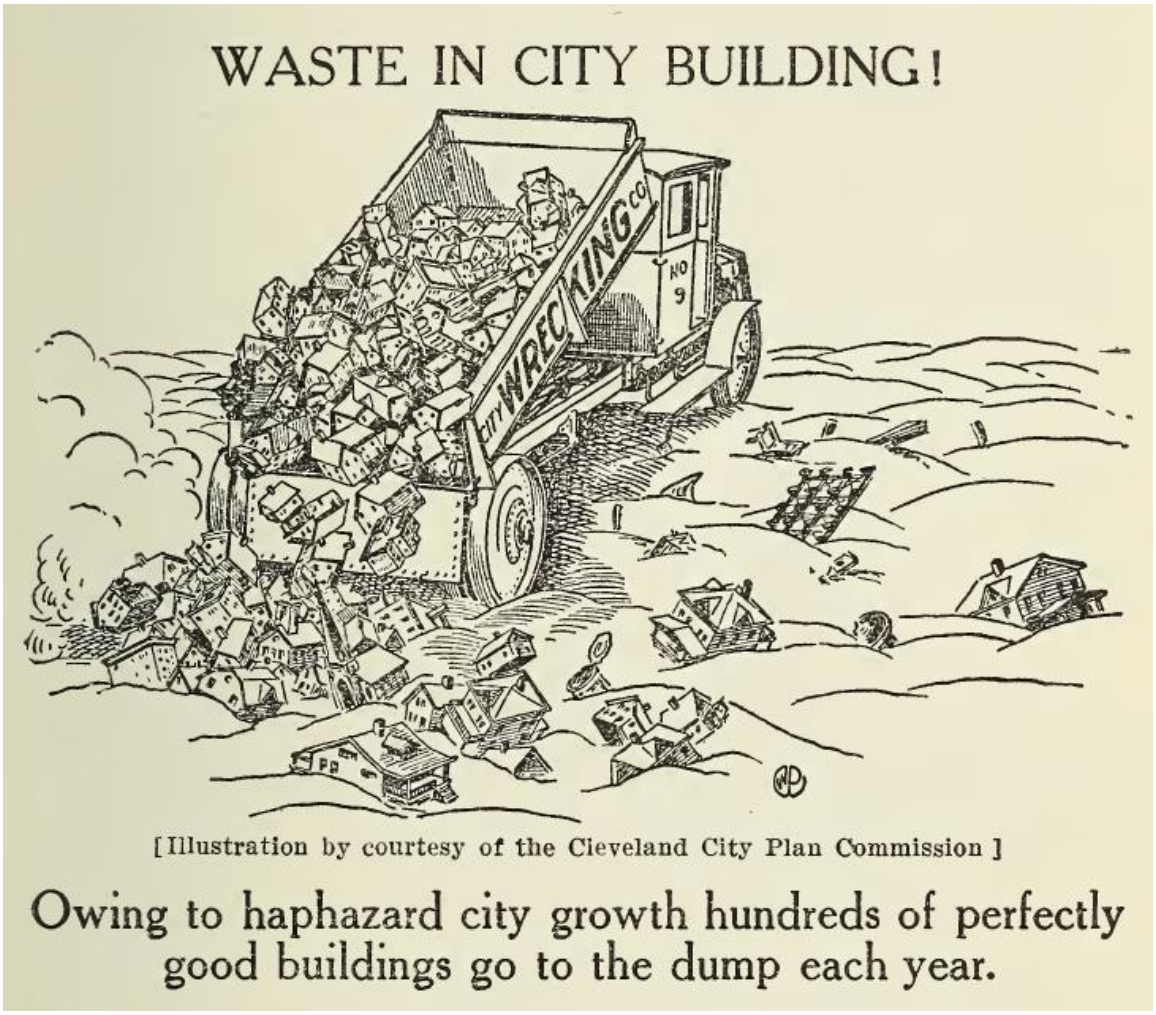
www.atlantaregional.com and GRTA at www.grta.org/dri/home.htm or call ARC or GRTA at 404-463-3000.

ITEM 18. ENVIRONMENTAL IMPACT REPORT:

Any rezoning to M-1A, M-1 or M-2 or specific use categories identified in Article 19.4 of the Zoning Resolution, as may be deemed environmentally adverse, shall include an Environmental Impact Report as part of the rezoning/use permit process.

ITEM 19. NOISE STUDY REPORT:

Any residential rezoning/use permit located within 1,000 feet of an expressway, within 3,000 feet of an active rail line, or within 5 miles of the Hartsfield-Jackson International Airport boundary shall include a noise study report.



Appendix B: Waste in City Building

Within the government-issued pamphlet regarding zoning, the authors provided a picture to illustrate the need for municipalities to institute zoning ordinances. (Department of Commerce, 1926, p. 3)

Table 1.1: Hedonic Regression Variables of Interest

Full Name of Variable	Abbreviated Name
Residential to Residential	R to R
Residential to Non-Residential	R to NR
Residential to Mixed Use	R to M
Non-Residential to Residential	NR to R
Non-Residential to Non-Residential	NR to NR
Non-Residential to Mixed Use	NR to M

Table 1.2: Initial Zone Classification & Rezone Classification

Rezone From	Rezone To					
	Commercial	Residential	Multi Residential	Mixed Use	Industrial	
Commercial	25	6	9	92	2	134
Residential	10	13	62	11	1	97
Multi Residential	9	8	72	22	1	112
Mixed Use	8	1	1	10	1	21
Industrial	5	8	25	37	5	80
Total	57	36	169	172	10	444

Table 1.3: Number of Rezones by End Use

Rezone From	Rezone To			
	Residential	Non-Residential	Mixed Use	Totals
Residential	155	21	33	209
Non Residential	48	37	129	214
Mixed Use	2	9	10	21
Totals	205	67	172	444

Table 1.4: Descriptive Statistics

Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Distance from Rezone	1,035	7743.876	2352.581	304.5485	10558.97
Size of Rezone	14,328	1,132.25	1,383.01	140.60	9,376.15
Sales Price	39,220	$260,878	$158,242	$20,000	$677,500
Days on Market	39,220	104.00	140.41	1.00	2,111.00
Acres	39,220	0.40	0.38	0.01	5
Age	39,220	30.68	25.91	2	114
Living Space (sq ft)	39,220	2,234.33	902.52	794	5922
Quality	39,220	2.49	1.08	1	7
Bathrooms	39,220	2.48	0.98	1	5
Half Bathrooms	39,220	0.55	0.54	0	2
Basement Bathroom	39,220	0.23	0.42	0	1
Finished Basement	39,220	0.38	0.49	0	1
Bedrooms	39,220	3.80	1.01	1	7
Fireplaces	39,220	1.05	0.77	0	10
Deck or Patio	39,220	0.50	0.50	0	1
Back Yard	39,220	0.67	0.47	0	1
Sprinklers	39,220	0.04	0.21	0	1
Clubhouse	39,220	0.07	0.25	0	1
Association	39,220	0.41	0.49	0	1
Corner Lot	39,220	0.24	0.43	0	1

Table 1.5: Propensity Score Matching Results

	Model 1	Model 2	Model 3	Model 4	Model 5
Distance (in Miles)	0.75	1	1.25	1.5	2
Binary Rezone (1= yes)	0.212***	0.234***	0.198***	0.158***	0.150***
	-0.0691	-0.0591	-0.0436	-0.0349	-0.0246
New Construction (in 00s)	0.00076	-0.00222	0.105**	-0.0042	-0.019
	-0.0653	-0.0684	-0.0454	-0.0361	-0.026
Quality	-0.141***	-0.205***	-0.186***	-0.205***	-0.198***
	-0.0305	-0.0252	-0.0187	-0.0148	-0.0109
Acres (log)	0.0474	0.113**	0.0107	0.0351	0.00373
	-0.0641	-0.0493	-0.0395	-0.032	-0.0226
Age (log)	0.137***	0.0478	0.0782**	0.0514*	0.0301*
	-0.0472	-0.0444	-0.0335	-0.0268	-0.0169
Size of Rezone (log)	1.013***	0.835***	0.842***	0.734***	0.859***
	-0.148	-0.132	-0.0917	-0.0757	-0.0517

Living Space (log)	0.0431	0.135***	0.0940***	0.0753***	0.0758***
	-0.042	-0.0357	-0.0284	-0.0208	-0.0152
Deck or Patio	0.0237	0.114*	0.115**	0.130***	0.182***
	-0.0752	-0.0631	-0.046	-0.0374	-0.0266
Basement Bathroom	0.143	0.119	-0.0628	0.134**	0.0763*
	-0.119	-0.112	-0.08	-0.0628	-0.0437
Association	0.143	0.192**	0.193***	0.202***	0.143***
	-0.101	-0.0862	-0.0722	-0.0581	-0.0411
Clubhouse	0.0994	-0.036	-0.17	0.0329	0.145**
	-0.189	-0.162	-0.141	-0.0995	-0.0706
Corner Lot	-0.0468	0.0944	0.143	0.107	0.0212
	-0.135	-0.123	-0.0959	-0.0818	-0.0567
Sprinkler	0.093	0.17	0.12	0.0311	0.105*
	-0.182	-0.144	-0.0948	-0.0932	-0.0629
Back Yard	0.306***	0.196***	0.185***	0.276***	0.240***
	-0.0761	-0.0643	-0.0477	-0.0379	-0.0266
Bedrooms	-0.0875	-0.161***	-0.168***	-0.135***	-0.116***
	-0.0553	-0.0435	-0.0343	-0.028	-0.0197
Bathrooms	0.238***	0.0989*	0.173***	0.147***	0.114***
	-0.0698	-0.0594	-0.0439	-0.0363	-0.025
Half Bathrooms	0.0531	0.0468	0.00386	0.0372	0.0018
	-0.0818	-0.0697	-0.049	-0.0401	-0.029
Finished Basement	-0.148	0.0953	0.186***	0.0618	0.0927***
	-0.0945	-0.081	-0.0559	-0.0477	-0.032
Constant	4.037***	6.270***	5.803***	6.731***	5.804***
	-1.058	-0.949	-0.669	-0.546	-0.374
Observations	236	360	626	972	2,070
R-squared	0.589	0.585	0.546	0.535	0.523

Table 1.6: Rezoned Properties within Distances

Linear Distance (in Miles)	Number of MLS Observations
<0.75	106
<1.00	156
<1.25	285
<1.50	445
<2.00	1,035

Table 1.7: Hedonic Regression Results

Model	Model 1	Model 2	Model 3	Model 4	Model 5
Distance	0.75	1	1.25	1.5	2
Residential to Residential	0.0798***	0.276***	0.345***	0.258***	0.168***
	-0.0302	-0.0242	-0.0191	-0.019	-0.0413
Residential to Non-Residential	-0.239***	-0.239***	-0.199***	-0.178***	-0.177***
	-0.0647	-0.0647	-0.0571	-0.0554	-0.0553
Residential to Mixed Use	-0.141***	-0.11	-0.0329	0.00836	0.0989
	-0.0521	-0.0679	-0.113	-0.122	-0.121
Non-Residential to Residential	0.282***	0.285***	0.229**	0.190*	0.201*
	-0.068	-0.0679	-0.0905	-0.111	-0.111
Non-Residential to Non-Residential	0.496***	0.493***	0.479***	0.465***	0.361***
	-0.0368	-0.0427	-0.0376	-0.0391	-0.0587
Non-Residential to Mixed Use	-0.219***	-0.238***	-0.233***	-0.180***	-0.139**
	-0.0700	-0.0643	-0.0766	-0.0571	-0.0599
New Construction (in 000s)	-0.0173	-0.0155	-0.016	-0.0176	-0.0248
	-0.0451	-0.0454	-0.0451	-0.0445	-0.045
Quality	-0.0505***	-0.0504***	-0.0504***	-0.0505***	-0.0502***
	-0.00551	-0.00549	-0.0055	-0.00552	-0.00557
Acres (log)	0.0601***	0.0601***	0.0602***	0.0604***	0.0607***
	-0.00628	-0.00625	-0.00619	-0.00617	-0.00612
Age (log)	-0.0561***	-0.0563***	-0.0564***	-0.0564***	-0.0570***
	-0.0126	-0.0125	-0.0124	-0.0123	-0.0121
Size of Rezone (log)	0.0104	0.0104	0.0108	0.0113	0.0111
	-0.00751	-0.0075	-0.00738	-0.00718	-0.00754
Living Space (log)	0.469***	0.469***	0.468***	0.468***	0.470***
	-0.0259	-0.0259	-0.026	-0.0259	-0.0256
Fireplaces	0.0561***	0.0563***	0.0563***	0.0559***	0.0557***
	-0.00607	-0.00605	-0.00604	-0.00601	-0.00593
Deck or Patio	0.0484***	0.0482***	0.0484***	0.0486***	0.0481***
	-0.00946	-0.00941	-0.0095	-0.00959	-0.00942
Basement Bathroom	0.0243***	0.0243***	0.0240***	0.0237***	0.0238***
	-0.00747	-0.00745	-0.00744	-0.00741	-0.00746
Association	0.0804***	0.0805***	0.0806***	0.0804***	0.0803***

	-0.0131	-0.0131	-0.0131	-0.0131	-0.0131
Clubhouse	0.0591***	0.0592***	0.0590***	0.0592***	0.0595***
	-0.0194	-0.0194	-0.0194	-0.0194	-0.0194
Corner Lot	0.00565	0.00551	0.0056	0.00555	0.00563
	-0.00534	-0.00532	-0.00533	-0.00532	-0.00534
Sprinkler	0.0459***	0.0462***	0.0462***	0.0462***	0.0472***
	-0.0154	-0.0154	-0.0154	-0.0154	-0.0156
Back Yard	0.0396***	0.0396***	0.0394***	0.0395***	0.0396***
	-0.00632	-0.00632	-0.00625	-0.00628	-0.00629
Bedrooms	0.0046	0.00461	0.00477	0.00493	0.00453
	-0.00471	-0.00471	-0.00473	-0.00476	-0.00475
Bathrooms	0.0902***	0.0901***	0.0903***	0.0902***	0.0897***
	-0.0064	-0.00639	-0.00638	-0.0064	-0.0064
Half Bathrooms	0.0275***	0.0275***	0.0275***	0.0275***	0.0270***
	-0.00484	-0.00482	-0.00479	-0.00479	-0.00471
Finished Basement	0.0750***	0.0752***	0.0750***	0.0753***	0.0757***
	-0.00568	-0.00566	-0.00569	-0.00561	-0.00543
Constant	9.399***	9.402***	9.405***	9.402***	9.395***
	-0.209	-0.209	-0.209	-0.209	-0.213
Observations	39,220	39,220	39,220	39,220	39,220
R-squared	0.824	0.824	0.824	0.824	0.825

Table 1.8: Hedonic Regression Results with Home Price Index

Model	Model 1	Model 2	Model 3	Model 4	Model 5
Distance	0.75	1	1.25	1.5	2
Residential to Residential	0.0803***	0.276***	0.344***	0.257***	0.168***
	-0.0301	-0.0241	-0.0191	-0.019	-0.0414
Residential to Non-Residential	-0.241***	-0.241***	-0.201***	-0.179***	-0.178***
	-0.0648	-0.0649	-0.0572	-0.0554	-0.0553
Residential to Mixed Use	-0.141***	-0.111	-0.0333	0.0079	0.0986
	-0.0521	-0.068	-0.113	-0.122	-0.121
Non-Residential to Residential	0.282***	0.285***	0.229**	0.190*	0.201*
	-0.0675	-0.0676	-0.0902	-0.111	-0.111
Non-Residential to Non-Residential	0.496***	0.493***	0.478***	0.466***	0.361***
	-0.0368	-0.0427	-0.0376	-0.0391	-0.0587

Non-Residential to Mixed Use	-0.218***	-0.237***	-0.233***	-0.180***	-0.139**
	-0.0700	-0.0642	-0.0765	-0.057	-0.0599
New Construction (in 000s)	-0.0167	-0.0149	-0.0154	-0.017	-0.0242
	-0.0448	-0.0452	-0.0449	-0.0443	-0.0447
Quality (Best=1)	-0.0505***	-0.0504***	-0.0505***	-0.0505***	-0.0503***
	-0.00551	-0.00549	-0.0055	-0.00552	-0.00557
Acres (log)	0.0601***	0.0600***	0.0601***	0.0604***	0.0606***
	-0.0063	-0.00626	-0.0062	-0.00618	-0.00613
Age (log)	-0.0562***	-0.0563***	-0.0564***	-0.0564***	-0.0570***
	-0.0126	-0.0125	-0.0124	-0.0123	-0.0121
Size of Rezone (log)	0.0105	0.0105	0.0108	0.0114	0.0111
	-0.00749	-0.00748	-0.00736	-0.00715	-0.00752
Living Space (log)	0.469***	0.469***	0.468***	0.468***	0.470***
	-0.0259	-0.026	-0.026	-0.0259	-0.0257
Fireplaces	0.0561***	0.0562***	0.0563***	0.0559***	0.0556***
	-0.00607	-0.00606	-0.00605	-0.00601	-0.00594
Deck or Patio	0.0485***	0.0482***	0.0485***	0.0486***	0.0481***
	-0.00946	-0.00941	-0.0095	-0.00959	-0.00942
Basement Bathroom	0.0243***	0.0243***	0.0240***	0.0237***	0.0238***
	-0.00745	-0.00744	-0.00743	-0.0074	-0.00744
Association	0.0804***	0.0805***	0.0806***	0.0805***	0.0803***
	-0.0131	-0.0132	-0.0131	-0.0131	-0.0131
Clubhouse	0.0590***	0.0591***	0.0589***	0.0591***	0.0594***
	-0.0194	-0.0194	-0.0194	-0.0194	-0.0193
Corner Lot	0.0057	0.00557	0.00565	0.0056	0.00568
	-0.00532	-0.0053	-0.00531	-0.0053	-0.00532
Sprinkler	0.0460***	0.0463***	0.0462***	0.0462***	0.0472***
	-0.0153	-0.0153	-0.0154	-0.0154	-0.0156
Back Yard	0.0396***	0.0397***	0.0394***	0.0395***	0.0396***
	-0.00635	-0.00635	-0.00628	-0.00631	-0.00632
Bedrooms	0.00469	0.0047	0.00486	0.00501	0.00461
	-0.0047	-0.00471	-0.00473	-0.00475	-0.00474
Bathrooms	0.0902***	0.0901***	0.0903***	0.0902***	0.0897***
	-0.00641	-0.0064	-0.00639	-0.00641	-0.00641
Half Bathrooms	0.0276***	0.0276***	0.0275***	0.0275***	0.0270***
	-0.00484	-0.00482	-0.00479	-0.00479	-0.00471
Finished Basement	0.0749***	0.0752***	0.0750***	0.0752***	0.0756***

	-0.00569	-0.00567	-0.00569	-0.00562	-0.00544
Atlanta Home Price Index	0.00460*	0.00459*	0.00454*	0.00457*	0.00452*
	-0.00241	-0.0024	-0.0024	-0.00241	-0.00238
Constant	8.874***	8.877***	8.886***	8.880***	8.878***
	-0.306	-0.304	-0.304	-0.305	-0.306
Observations	39,220	39,220	39,220	39,220	39,220
R-squared	0.824	0.824	0.824	0.824	0.825

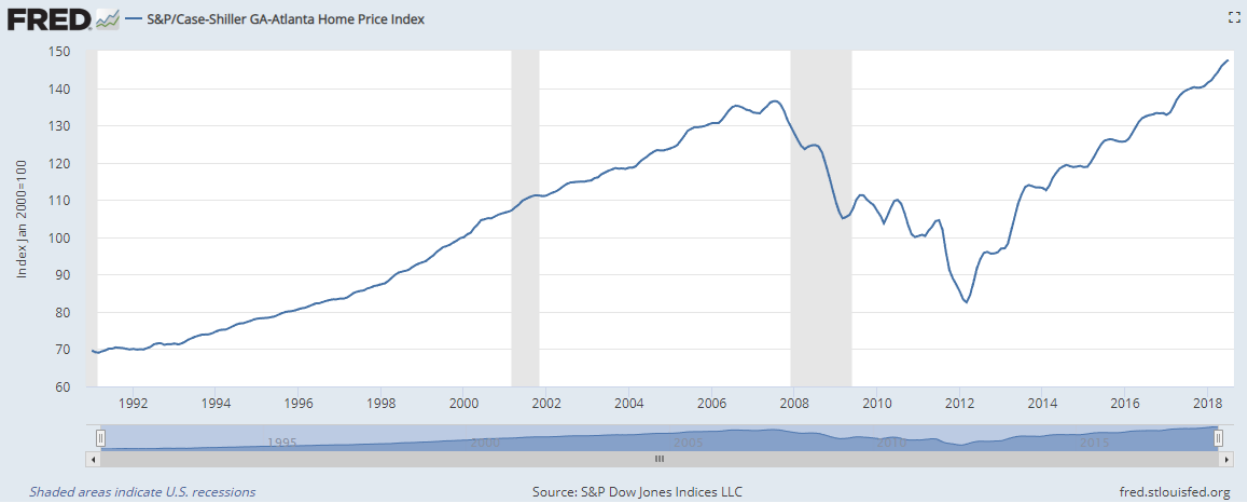


Figure 1.1: The Case Shiller Atlanta, GA Home Price Index. Residential real estate prices for the Atlanta, Georgia metro area from 1991 to 2018. Retrieved from Federal Reserve Bank of St. Louis.

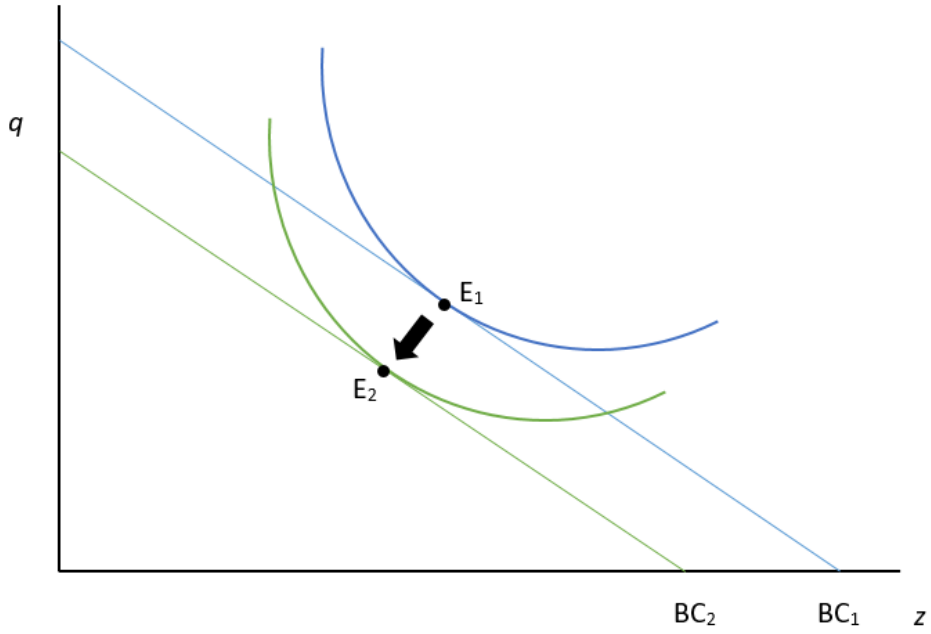


Figure 1.2: Budget Constraint. This graph of a hypothetical budget constraint illustrates the consequences of obtaining additional information for consumers. As information costs increase, the purchasing power shifts from E1 to E2.

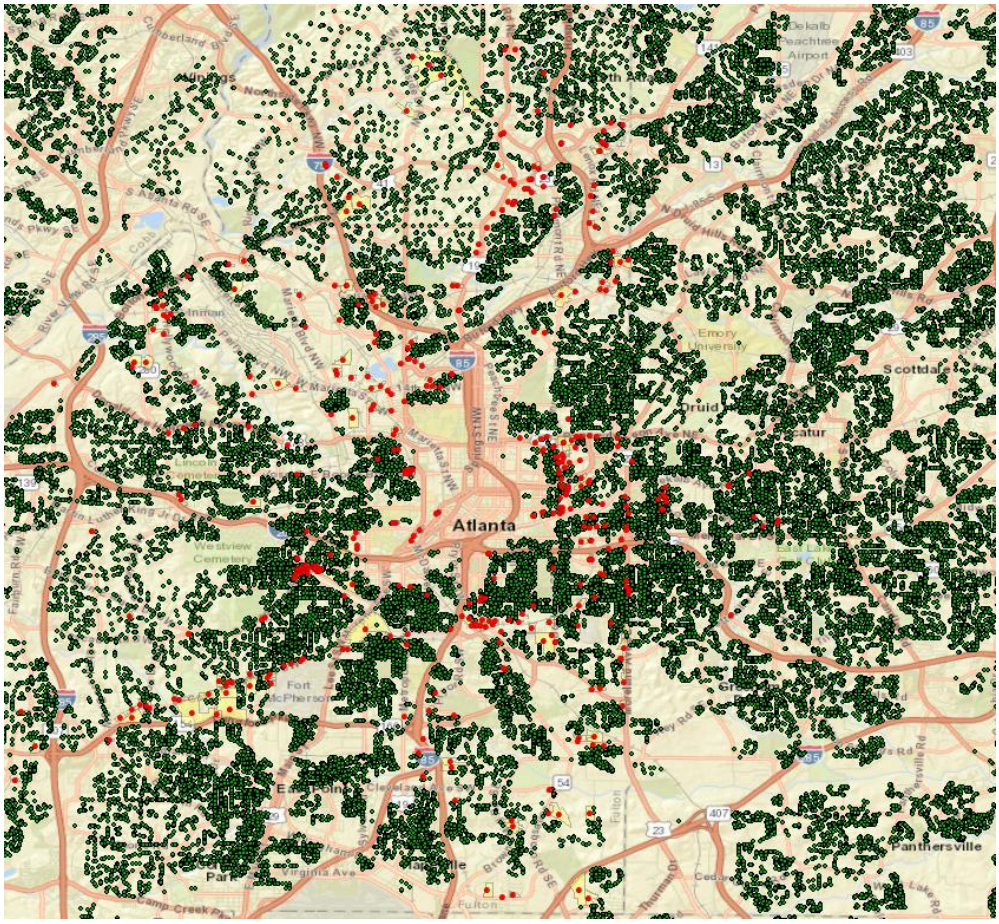


Figure 1.3: ArcGIS Map of Data Points. This map is generated within ArcGIS. The green dots represent MLS observations and the red dots are center points for the yellow rezones. Distance calculations are recorded between the red and green dots.

Figure 1.4: Property Function Continuum. The property function continuum provides a directional relationship between each of the three property types. According to this image, residential real estate end use functions differ from non-residential end use functions the most.

ESSAY 2: The Influence of Publicly Induced Rezoning on Residential Real Estate Prices

CHAPTER 1

INTRODUCTION TO PUBLIC REZONING

The municipal power to rezone districts within the confines of the municipality's border is a relatively new government function. This function, promoted by early urban and city planners of the 20th century, drastically changed the course of urban development for all future generations. Zoning "is the division of local government area into districts which are subject to different regulations regarding the use of land and the height and bulk of buildings which are allowable" (Cullingworth, 2002, p. 52). Conventional property zoning consists of five different zone types: single- and multi-family residential, commercial, industrial, and mixed use. Mixed use zoning is a combination of residential and commercial end use functions. However, municipal governments can enact non-traditional forms of zoning, one of which is called overlay zoning. Overlay zoning adjoins to the conventional zones and serves to incentivize private action. This essay describes the history of these overlay zones and relates their effects on residential real estate prices in Fulton County, Georgia. Furthermore, this essay empirically tests the influence of a municipal zone overlay on residential real estate prices and connects it to local housing policy.

Zoning represents an important area of housing policy research and directly influences the physical development of the municipality. Municipal zoning authority has been labeled "the most important local regulatory power" (Briffault, 1990, p. 3). Zoning influences one of the most valuable consumer assets, the personal dwelling (Hilber & Robert-Nicoud, 2013; Huang & Tang, 2012; Ohls et al., 1974). For example, municipal zoning which limits residential housing supply

can artificially increase the prices of residential real estate (Katz & Rosen, 1987). Moreover, the owner-occupied personal dwelling represents 66% of total household wealth for the bottom fourth-fifths of US households (Wolff, 1998). Municipal powers that can modify or influence the price of the personal dwelling must be further explored to promote housing policy efficiency and to ensure consumers are protected from residential real estate price fluctuations attributable to municipal intervention.

Municipal zoning policies influence residential real estate prices through a change in the market's equilibrium supply and demand level (Katz & Rosen, 1987). The equilibrium supply and demand level is set by consumer demand and investment supply. Conventional zoning influences the quantity supplied of housing or the end-use development. However, conventional zoning may not address the distinctiveness or current condition of a particular district (Fitzgerald & Leigh, 2002). Conventional zoning may prevent redevelopment, restrict the supply of developable land, and may impose exclusionary regulations to zone out certain population groups (Blair & Carroll, 2008). Under these circumstances, the municipality may elect to attach additional zones over the existing zone designation. These additional zones are called overlay zones. Overly zoning "is a zoning district which is applied over one or more previously established zoning districts, establishing additional or stricter standards and criteria for covered properties" (American Planning Association, 2007). Overlay zoning can be used to incentivize specific private developers, protect wetlands, or preserve historical buildings (Gravin, 2001). These zones are explicitly designed to meet local community objectives, such as those contributing to the health, welfare and safety of the residing populace.

Overlay zoning ordinances follow the legal standards set by conventional zoning. The Appellate Division of New York's Supreme Court ruled that overlay zoning falls within the

discretionary power of the local municipality in *Zartman v. Reisem* (Robinson, 1981). "If the Board's decision, based upon sufficient evidence, is consistent with the values which the municipality sought to preserve in the special district involved, the Board's action is not arbitrary or capricious" (*Zartman v. Reisem*, 1977). Overlay zone ordinances follow a basic structure. The ordinance identifies the purpose and goals of the additional zoning with specific identification of detailed rules and regulations for those structures falling within the bounds of the overlaid district. Failure to abide by set standards for the creation of an overlay zone may result in legal challenges. Such challenges occurred in Arizona, where the court struck down a specific overlay zone in *Jachimek v. City of Phoenix*. Phoenix created an overlay zone and required a special use permit for all commercial structures in the zone. This additional permit requirement violated the uniform and equal treatment of property types (*Jachimek v. City of Phoenix*, 1991). The court declared the overlay zoning ordinance invalid and forced its removal.

Tax allocation districts, also called tax increment financing (TIF), promote public interests of the community by incentivizing private developers to develop vacant or under-utilized land. Tax allocation districts may issue bonds or earmark specific tax receipts for investment or other improvements in the district (Invest Atlanta, 2017). In theory, the focused development in the district increases property values and the district generates more tax revenue to pay for the bonds or replace the lost revenue from the specific tax earmark. Before reviewing an example where a tax allocation district functions according to theory, one must understand municipal tax nomenclature. Municipal tax rates are calculated using millage rates. The Latin derivation, millage, is a term meaning thousandth. One mill equals one thousandth; thus, a 5 mill tax rate equals five hundred dollars per one hundred thousand dollars of property value.

In a fictitious tax allocation district example, assume the taxable assets of a district are $500 million and the millage rate for the town is 20 mills. The total municipal tax generated in this district amounts to $10 million. The municipality enacts a tax allocation district by obtaining a bond with annual debt service of $500,000. The bond proceeds are invested in the tax allocation district and combine with private funds, which ultimately results in the district-wide appreciation of taxable assets to $550 million. At the same millage rate, the municipality receives $11 million in total tax revenue. After subtracting the annual debt service of the bond, the municipality earns $10.5 million of additional revenue and the district has more infrastructure, services, and economic activity.

Overlay zones promote market efficiency between developers and municipal planners (Blakely & Leigh, 2016). Developers locate buildings according to market demand rather than where planners hope buildings should be located. Yet, planners provide geographic guidelines for their intended area of development. These efficiencies help promote development in a region, which may spur overall real estate price appreciation. Residential real estate price appreciation contributes to local homeowner wealth in the community. Consumer consumption theory indicates that permanent changes or the perception of permanent changes in a household's wealth induces a change in consumption in the same direction (Cooper & Dynan, 2016). Thus, appreciation of residential real estate prices increases real GDP growth (Bostic et al., 2009). Municipal efforts to increase residential real estate prices may lead to more local wealth and spending in the community. The enhanced commercial activity flows back to the community through overall financial well-being.

In addition to enhanced residential real estate prices, the local community could experience increased commercial and industrial activity. "Business development is an essential

component of local economic development planning because the creation, attraction, and retention of business activities builds and maintains a healthy local economy" (Blakely & Leigh, 2016, p. 265). Neither commercial nor industrial activity contribute to the student population attending local public schools, yet both forms of business supply tax dollars to the local municipal government. The education population distinction is important, since education consumes half of a municipality's budget (Oates, 1969). Increases in commercial and industrial activity enhance the local tax base, but do not exacerbate municipal expenditures.

Tax overlay districts have the potential to increase social and financial welfare for a region. These overlay districts leverage municipal investments by combining public money with private funds to generate substantial economic development and commercial activity in the district. However, the quantitative influence on the residential marketplace of tax overlay districts outside of the overlay zone remains largely unexplored. This research seeks to fill the gap in the literature by empirically quantifying the influence of overlay zoning on nearby residential real estate prices that are outside of the overlay zone.

Introduction to Theory

The theory of revealed preferences is the foundation for this research. Revealed preferences, which has sometimes been referred to as hedonic modeling, was formalized by Rosen (1974). Rosen's framework described products in terms of objective and measurable characteristics or attributes. Transactional pricing data and a description of each residential real estate's characteristics provide the basis for the hedonic price function. While locational theory dictates that no two properties are exactly the same, the hedonic model allows real estate researchers to estimate the effects of differentiating property characteristics. Rosen described real

estate property value in terms of utility. Properties that contribute to more consumer utility are more highly valued than properties with less utility bearing characteristics.

Utility generating attributes are called amenities in real estate literature. Amenities increase the price of residential real estate, while dis-amenities lower its value. Amenities and dis-amenities can be internal characteristics of the property or external factors outside of the property's control. An internal amenity associated with residential real estate is an additional bathroom, which increases the price of the property by 13-18% (Sirmans et al., 2005). Nearby polluting industries were found to be an external dis-amenity, resulting in a 9% decrease in the price of residential real estate (Palmquist et al., 1997).

Consumers purchase goods and services that maximize their highest indifference curve tangent to their amount of available resources (Follain & Jimenez, 1985). This consumer activity is considered utility maximization theory. Under this theory, consumers value characteristics and attributes differently, yet pay the same price. Under the assumption of finite resources, the discrepancies between utility and price shift consumers to sacrifice some attributes to maximize others. Moreover, consumers cannot separate the bundles of attributes associated with different real estate properties. For example, a consumer cannot purchase two bathrooms from one property, three bedrooms from another, and combine these purchases into a third property.

From a methodological perspective, this research utilizes two separate quantitative procedures: propensity score matching and fixed effects modeling. Sample selection bias and causal inference may occur in observational datasets, since these data are non-experimental (Dehejia & Wahba, 2002). To reduce bias in non-experimental causal studies, the propensity score matching procedure imitates statistical characteristics of a randomized trial design (Austin, 2011). Chapter 4 describes these statistical procedures in greater detail.

Research Questions

This research focuses on the development incentives and planning aspects of overlay zoning, specifically an overlay zone called tax allocation district (TAD). The Georgia Redevelopment Powers Law Act granted counties and municipalities the authority to create tax allocation districts (Reshwan, 2006). The city of Atlanta, Georgia introduced four separate tax allocation districts in 2006. The intent of these overlay districts was to revitalize each community and increase the public welfare of the district. A detailed discussion of each tax allocation district overlay zone with its unique objectives can be found in Chapter 2. This research empirically calculates the influence of each tax allocation district on residential real estate prices surrounding the overlay district. Does publicly induced overlay zoning influence residential real estate prices at 0.75, 1.0, 1.25, 1.5, and 2.0 miles? To calculate any potential spillover effects, residential real estate surrounding the tax allocation district are measured at the specified intervals starting at three-quarters of a mile. Differences in results between each individual tax allocation district are compared against their initially planned objectives. This comparison may provide additional information to policy makers, municipal leaders, and the community activists.

Uniqueness & Importance of Research

Greenbaum and Landers (2014) conducted a review of the literature on the effectiveness of tax increment financing within the tax overlay zone. Over the last six decades, municipalities enacted TIF programs in almost every state. There are currently over 10,000 TADs nationally (D. Merriman, Qiao, & Zhao, 2018). Much of the literature surrounding the effectiveness of TIFs centers upon economic development of the TIF region and property price appreciation within the tax overlay zone. Dye, Merriman, and Goulde (2014) explored the influence of the Great Recession on property growth rates within tax increment financing districts in Illinois and

Nebraska. The authors used tax assessor data with a fixed effects regression with interaction variables to account for pre- and post-recession time periods. This dissertation essay differs from the previous study as it uses a transactional dataset. A disadvantage of tax-assessor data is that the assessor collects information only relevant to the set of housing characteristics needed to calculate its value (Thorsnes, 2002).

Since TIF programs use the incremental tax revenue generated from growth in property values to fund the expenses of the program, research into program sustainability is important. Research into TIF property price trends indicates property price appreciation for properties within TIF boundaries. Using a structural probit model, J. E. Anderson (1990) calculated TIF cities experience greater property value appreciation than non-TIF adopting cities. With a panel dataset of Indiana cities, Man and Rosentraub (1998) observed an 11% increase in property prices between pre-TIF and post-TIF using a maximum likelihood probit estimation technique. Smith (2009) identified similar appreciation of commercial property as a result of TIF programs with a two stage regression model incorporating the inverse Mill's ratio and the propensity score model. While these research papers describe the influence of TIF programs on growth of property values within the designed TIF area, they fail to explore potential spillover effects resulting from the implementation of the TIF in the surrounding community. Following the housing externality theory outlined by Rossi-Hansberg, Sarte, and Owens III (2010) and Rosen (1974), this dissertation fills the gap in the literature and quantifies the potential spillover effects that may result from TIF programs.

Tax allocation districts or tax increment financing is an important research topic for the obligation of the debt falls to the citizens of the community. Failure to generate adequate growth reduces the disposable tax revenue to the detriment of the municipality's residents. Citing risk of

development growth, California abandoned the use of tax increment financing for development (Diamond, 2014). Yet, many municipalities still employ this development tool. Additional research into potential property growth and the influence of external effects may help municipal leaders and policy makers.

Progression of Essay

Chapter 2 of this essay describes the academic literature of tax allocation districts. In addition, a section is dedicated to the programmatic details of the four TADs plans. The theoretical grounding for this empirical work is found in Chapter 3, while Chapter 4 presents methodology and statistical procedures. A discussion of the results and their implications is written in Chapter 5. Chapter 6, which is the final chapter for this essay concludes the discussion of tax allocation districts. References and appendices follow the conclusion.

CHAPTER 2

PUBLIC REZONING LITERATURE REVIEW

Urban planners and elected leaders strategically plan for the municipality's future. Over the last century, urban and municipal planning has grown in scope and depth. Today, municipalities plan to increase residential well-being and to spur economic development. The first aspect, residential well-being, seeks to expand municipal services to those in the district, while the second consideration, economic development, attempts to provide quality jobs for the residing population. Community stability is an important component of residential well-being and economic development. Consistent tax codes, building ordinances, and development regulations help reduce market uncertainty and encourage growth. Zoning is an integral aspect of municipal power, which influences community stability and future development. In addition, zoning can promote economic and commercial development within a community (Blakely & Leigh, 2016).

The overlay zone described in this essay requires incremental revenue for the TAD program to succeed. To understand the market dynamic of incremental revenues and the importance of the TAD program, one must understand the municipal tax digest. In essence, local revenues depend significantly on real property valuations and the associated tax rate (Lucy & Fisher, 2000). According to Lucy and Fisher, the value of real property fluctuates with supply and demand. Price shocks associated with the market equilibrium can detrimentally impact local revenues. However, municipal efforts to encourage demand may increase the local tax digest. These efforts can align with other characteristics of the municipal plan. For example, southern

California municipalities enacted a transit-oriented overlay development plan to decrease traffic congestion and promote greater economic development along the transit corridor (Boarnet & Crane, 1998).

This chapter describes the municipal power of zoning and connects it to overlay zoning districts enacted in the state of Georgia. This chapter explores the previous research on the spillover effects of TAD programs on property prices and their influence on economic development. Furthermore, this chapter surveys the previous literature on the evaluation of residential real estate prices. It describes the specific internal and external characteristics used to generate a correctly specified hedonic regression model for residential real estate research.

History of TADs & TIFs

Municipal policies shape the future development of the district. For example, failure to finance a sewer proposal may result in greater reliance on private septic tanks and dissuade industry from locating within the jurisdiction (Lucy & Fisher, 2000). Lower local employment alters the geographic distribution of households. Similar to a sewer example, municipal zoning influences the distribution of available land for development and changes the future structure of district (Blakely & Leigh, 2016). While conventional zoning regulates the end-use function of land, a new form of zoning called overlay zoning promotes municipal objectives with greater flexibility. Overlay zones are useful tools for municipal governments when the conventional zoning or development ordinances fail to address a specific condition or problem in the community (Fitzgerald & Leigh, 2002).

An overlay zone is “a special zoning district that is placed over the existing zoning base, thereby superseding, modifying, or supplementing its requirements” (Blakely & Leigh, 2016, p. 242). Under the pretext of brevity, this essay describes one form of overlay zone, a tax allocation

district (TAD). Tax allocation districts, which are known as tax increment financing (TIFs) outside of Georgia, were first used in California in 1952 (Man & Rosentraub, 1998).[2] Originally, TADs were used to raise the local percentage match required by the federal urban renewal program without accessing the municipality's debt allowances (Davidson, 1978). Their general use did not expand until the 1970s; however, by the 1990s almost all states adopted some form of TAD legislation (Forgey, 1993). Tax allocation districts are popular because municipalities do not lose current revenues and elected leaders can pursue an agenda of urban development (Smith, 2009).

While each TAD has specific goals outlined in the redevelopment plan, the basic premise of a TAD is to grow the economic foundation of an area by investing in outdated public services or infrastructure. The growth of the economic development contributes to the tax revenues of the municipality, which are used to pay for the initial investment in public services. Within a TAD, the investment to upgrade municipal infrastructure routinely comes from a bond offering. A program to upgrade the local infrastructure is one strategy to attract commercial and industrial development within the local community (Blakely & Bradshaw, 2002). The combination of public and private development funds results in upward price pressure for land and buildings within the TAD region. As prices move upward, the taxing authority earns more revenue, which is used to finance the debt service. Figure 2.1 from Smith (2009) illustrates the Tax Allocation District process in an environment of declining property assessment values. In this figure, the municipality holds constant the declining assessment value at the inception of the tax allocation district. At this funding level, the municipality covers all of its expenditures. The bond costs are paid with the incremental revenue generated from the economic development. Incremental tax

[2] For reader clarity, all tax increment financing (TIF) literature and references have been renamed as tax allocation districts (TADs).

gains in excess of the debt service fund additional operations and services for the municipality. Moreover, the debt service is term-limited. Once the bond matures, all of the incremental tax revenues revert to the municipality.

In Georgia, municipal TAD authority originated from the Redevelopment Powers Law (Redevelopment Powers, 1985). According to the law's legislative finding and purpose statement, it is in the public's interest to redevelop economically and socially depressed areas to improve economic and social conditions. Moreover, the legislative purpose statement cites that the provision of these additional municipal powers results in a more effective partnership with private entities. Section eight of the statute describes the process to create a TAD in Georgia. The local redevelopment agency develops a plan to be submitted to the local legislative body for adoption. This plan itemizes the boundaries of the TAD and specifies the estimated tax allocation increment base or any ad valorem property taxes used in the calculation of the tax allocation increment. The plan enumerates the use of external funds such as bonds and describes repayment terms. Another component of the redevelopment plan contains findings that the TAD area has not witnessed growth and development through private endeavors. Municipal officials must reasonably infer that growth prospects are not likely to occur without public intervention. This requirement is referenced in the literature as the 'but-for' requirement and it is explained later in this chapter. Lastly, the redevelopment plan provides an anticipated value of improvement as a result of the TAD overlay zone.

TADs of Study

Since 1986, there were 64 TAD-authorizing jurisdictions in Georgia. Currently, 58 TADs are in operation in over 31 jurisdictions (Brown, 2011). This research explores four specific TADs enacted in 2006. Each TAD contains its own geographic boundary, economic focus, and

development plan. The four overlay districts, which are explained in the next section are Metropolitan Parkway, Stadium, Hollowell/Martin Luther King, and Campbellton.

Metropolitan Parkway

According to a report written by the Atlanta Development Authority, the Metropolitan Parkway TAD was designed to promote balanced economic growth by revitalizing a collection of neighborhoods to capture new development in mixed use, commercial and residential investment (Atlanta Development Authority, 2006b). The TAD overlay zone functions to generate public-private partnerships that invest in physical redevelopment and create new construction within the area. In addition to overall redevelopment, key priorities of the TAD were to increase employment opportunities for residents, attract state and federal funding, and to maximize the tax revenue potential of the area. The Metropolitan Parkway TAD covers 1,023 acres or 1.60 square miles of land along the southwest region of Atlanta. Figure 2.2 illustrates the specific boundaries of the TAD.

To align with the requirements outlined in statute for the creation of a TAD, the area must exhibit several of the following conditions: deterioration and obsolescence of structures, predominance of defective or inadequate street layout or traffic flow, faulty lot layout, detrimental condition of infrastructure which impairs community growth, underutilization of lots, and substantial percentage of aged structures. Moreover, the statute can be satisfied if the "current area condition is less desirable than the redevelopment of the area" (Atlanta Development Authority, 2006b, p. 9). According to the TAD documentation, the Metropolitan Parkway TAD contains buildings of significant age and deterioration, inefficient site use and density, inadequate parking, congested interior and residential streets, and low employment opportunities and retail market outlets for residents. The commercial rental rates within the TAD

were below adjacent neighboring districts, which exacerbated the underutilization of developable land. In 2006, 35.6% of the total assessed value of property within the TAD was tax-exempt property. The high percentage of non-revenue generating property attributed to the municipality's strained local revenue.

The comprehensive plan for Metropolitan Parkway was to create a retail and mixed use corridor with adjacent residential housing. Municipal planners desired new construction of condominiums, apartments, town homes, live/work properties, along with single family detached dwellings. To support all ages of living, assisted and senior living properties were planned to be constructed alongside conventional residential development. Retail development would represent a mix of chain stores, bars, and restaurants, as well as recreational venues such as movie theaters and bowling alleys. Municipal planners sought to expand grocery, pharmacy, bank and other community support commercial services. The plan called for the use of 'pocket parks,' which are small areas of preserved green space to enhance the appeal and desirability of the community.

Total private development within the TAD area was projected to be extensive. Municipal planners believed the area could experience 675,000 and 100,000 square feet of retail and office development, respectively. The TAD area could support 500 new townhomes, 1,200 new multi-family rentals, and 500 new multi-family condominiums. However, these private investments required improvement of the existing infrastructure. Planners identified $29 million of public improvements for the area. The majority of these funds were dedicated to sidewalk and streetscapes. To facilitate the pocket park objective, the municipality would be required to invest in park and trail infrastructure. Overall, the Metropolitan Parkway project would issue $85,249,153 in tax-increment financed bonds from 2010-2026.

Stadium Neighborhood

Projected against a backdrop of urban population growth in Atlanta Georgia, the Stadium Neighborhood TAD sought to redress an area plagued by disinvestment and considerable vacant land (Atlanta Development Authority, 2006d). The area experienced a reduction in the number of single-family residential housing stock since annual demolitions outpaced new infill construction. To combat this negative trend, municipal leaders sought to create a TAD to spur economic development and to generate new opportunities for residents.

The goal of this TAD was to create a public-private partnership to develop real estate within the district. Municipal planners intend to use TAD bond proceeds to construct parking decks on public land. These parking decks would replace the surface parking lots and would allow for their redevelopment into mixed use properties. In addition, the shift from surface parking to multi-story parking decks increased land density and usage. Overall, the TAD region comprised 361 acres and 623 individual property parcels, see Figure 2.3 for the specific TAD boundaries. Over fifteen years, municipal planners estimated $1.2 billion of new private capital could be invested in the district. The creation of new office, service industries, and retail would provide new employment opportunities for district residents.

Due to the economic conditions of the area, the Stadium Neighborhood district qualified for a TAD designation under the Georgia Redevelopment Powers Law. From 1990-2000, the population of the area declined and placed downward pressure on land and property values. The TAD region had a disproportionate share of properties valued at less than $100,000. Additionally, the median income of residents in the TAD was 53% of the Atlanta median income at $22,545. Half of all residents in the district reported household income of less than $25,000.

Almost 40% of households were headed by single parents and the college attainment rate in the TAD district was half of the attainment rate in the city.

There were three overarching goals to the Stadium Neighborhood TAD: 1) create a healthy community and increase the quality of life, 2) expand economic prospects for residents, and 3) enhance existing and develop new physical infrastructure. Attracting private partners remained vital to the TAD's successfully attainment of their three goals. The private development was projected to stabilize property values and create demand for additional expansion. The comprehensive plan stated that redevelopment in this area "should have positive indirect benefits to the greater Atlanta area by improving the environment in this major tourist location of the city" (Atlanta Development Authority, 2006d, p. 8).

Over the ten-year period from 2010-2020, the Stadium Neighborhood TAD plan called for the private development of 260,000 and 300,000 square feet of retail and hotel space with an additional 260,000 square feet of office space. Municipal planners estimated private developers could construct 3,630 additional units of residential property. The majority of these units would be low- and mid-rise residential apartments. The total estimated market value of the private investment amounted to $1.2 billion. Combining these market valuations with the prevailing municipal tax rates generated a potential cumulative increase in tax revenue of $157 million. Municipal planners allocated $150 million for the construction of parking decks with up to 10,000 spaces and another $7 million in streetscape improvements.

Hollowell/Martin Luther King Jr. Drive

The city identified the area surrounding Hollowell Parkway and Martin Luther King Jr. Drive in need of support and revitalization. Municipal planners contrasted a resurgence of mixed use, commercial, and residential development within the city against Hollowell Parkway and

Martin Luther King Jr. Drive's lack of redevelopment. Municipal planners believed public support and collaboration with private developers would promote equitable growth in Hollowell Parkway and Martin Luther King Jr. Drive. In addition, it may allow these districts to participate in the economic expansion and the increased commercial activity enjoyed by the city. Community residents expressed a vision for supportive neighborhoods with low crime and many opportunities for growth. Residents called for good quality schools, safe access to transit facilities, and a diverse neighborhood of physical resources (Atlanta Development Authority, 2006a). Residents wanted to improve the image of the area and promote the preservation of the community's natural resources.

The Hollowell TAD area is more geographically separated than the other TAD districts within this study. Figure 2.4 presents the boundaries for this tax allocation district. The main section of the TAD along Highway 285 comprises the bulk of the acreage. Within this area, medium density land uses would be located adjacent to commercial and mixed used zones. The four pockets of land south of Interstate-20 form the Martin Luther King Jr. Drive redevelopment. According to the TAD plan, these four pockets promote mixed use development. In total, this TAD covers 886 acres of land or 1.38 square miles.

Municipal planners were able to apply the criteria for the imposition of a TAD under the Georgia Redevelopment Powers Law. Within this TAD area, the majority of retail buildings were constructed between 25 and 50 years ago with only minor repairs to date. The planners deemed the commercial design and layout along the Hollowell Parkway and M.L. King Jr. Drive to be inefficient and unattractive to current standards. Parking in the area was inadequate to generate the necessary consumer demand for additional commercial activity. As a result of poor consumer demand, commercial rental rates were depressed in the district, which lowered overall

land values and densities. Traffic engineers described congested access and poor levels of egress within the district. The traffic stress upon feeder and radial roadways reduced the appeal of the community for new construction. In addition to the structural infrastructure issues, the district was characterized with under-developed land and low opportunities for local employment. From a municipal taxing perspective, 42% of all appraised land within the district was tax exempt. This exempt land represents a loss to the local municipality of $21 million annually (Atlanta Development Authority, 2006a). Efforts to expand the taxable value of property within the district may increase the amount of municipal revenue available for community services and related infrastructure initiatives.

The TAD redevelopment plan recommends increasing the land-use density along several of the core neighborhood gateways. Neighborhood gateways designate the community's entrance and are pivotal to the revitalization of the community. In addition to increased density, the redevelopment plan proposes more mixed use development to expand retail options for community residents. There are two Metropolitan Atlanta Rapid Transit Authority (MARTA) stations along Martin Luther King Jr. Drive that represent significant opportunities for transit-oriented development within the TAD redevelopment project. Transit-oriented development combines retail and commercial services with medium- to high-density multi-family housing using pedestrian-friendly train systems (Federal Transit Administration, 2018). TOD projects increase the amenity appeal of the neighborhood which leads to higher property prices (Bartholomew & Ewing, 2011).

It is anticipated that the Hollowell/M.L. King TAD redevelopment program generates 450,000 square feet of new retail development and 80,000 square feet of new office space. Additionally, the plan estimates the district can support 300,000 square feet of new industrial

development. For new residential development, municipal planners believe private investors will develop 990 new townhomes and 3,175 new multi-family units. The estimated market value of these taxable real improvements is projected to be $534.899 million. However, this new private construction remains predicated upon an initial public investment of funds to enhance existing infrastructure in the TAD community.

There are seven categories of public investment totaling $13.481 million. The largest funded category is streetscape projects for $8.3 million. Other categories include new parks, pathways, trails, roadway improvements, land assemblages, new public facilities, and improvements to water, sewer, and transportation infrastructure. From 2010 to 2030, municipal planners estimate this project will issue $101.8 million in bonds, which are expected to be fully supported by the incremental tax revenues generated by the new district construction.

Campbellton Road

The Campbellton TAD is the last TAD redevelopment project analyzed for this research. Similar to the other TADs, the intent for this district was to catalyze the investment environment and to attract regional growth. Municipal planners endeavored to enhance the appeal of the commercial property and expand employment opportunities for local residents by "competing aggressively for new development opportunities that might otherwise locate outside of the City" (Atlanta Development Authority, 2006c, p. 2). To achieve these goals, municipal planners pursued effective public-private partnerships. The Campbellton TAD boundary is less condensed than the first two TADs described in this essay, yet more consolidated than the Hollowell/M.L. King TAD. Figure 2.5 presents the boundaries for the Campbellton TAD. The TAD covers 1,433 acres consisting of 585 parcels of individual property with a market value of $347.698 million. Annual foregone tax revenue in the TAD amounted to $4.6 million.

Municipal planners estimate that new private developers could inject $1.8 billion of capital into the region by 2020. This historically underserved district could benefit from the creation of new jobs, shopping centers, recreation centers, and amenity based entertainment venues. Improved pedestrian access and the establishment of new public assembling spaces could advance the area as well. The addition of new residents and visitors in the area represent new customers for existing local businesses which may increase property values for commercial and retail space.

The Campbellton Road district qualified for the TAD overlay under the Georgia Redevelopment Powers Law because of the area's demographic and economic plight. The Campbellton district has a declining population with historical and projected growth rates lagging the growth rates in the City of Atlanta. The median household income of residents was 68% of the median income of the city and 44% of households reported income less than $25,000. Single-parent households are 40% of the district compared with 24% of households in the city. In addition, district residents have substantially lower levels of college education attainment (14%) compared to city residents (35%). Property values were lower and older in the TAD district compared to the city and district residents were more likely to rent than be classified as homeowners.

The Campbellton Road TAD endeavors to increase economic opportunities for residents and create healthy neighborhoods with strong support services. Municipal planners expected to attract public-private partnerships to inject private investment in the district for retail and residential development. From 2010 to 2020, the TAD plan estimated 985,000 and 1.66 million square feet of new retail and office development. The district supported an additional 900,000 square feet of new research park construction. For residential development, the plan estimated

450 new single family dwellings, 1,500 new townhomes, 2,950 new multi-family/condominium units, and 150 new senior housing units. The total market value of this construction amounted to $1.874 billion. At the prevailing tax rates, municipal planners believe the TAD generates $224.7 million in cumulative incremental tax revenues from 2010 to 2020.

To initiate the private development of the area, municipal leaders plan to invest public funds into the TAD area. Twenty percent of the public funding for the district are dedicated to infrastructure redevelopment. Within the TAD area, municipal planners envision public investment in infrastructure, green space, transportation improvements from $38 to 72 million. The TAD redevelopment plan allocates an additional $144 to 178 million for "project specific infrastructure/pre-development assistance" (Atlanta Development Authority, 2006c, p. 51). Total public investment in the TAD range from $182 million to $250 million.

Research on TADs

Recently, TADs have come under attack for their use of tax revenues for redevelopment purposes instead of social issues like education (Lefcoe & Swenson, 2014). California discontinued the use of tax increment financing in 2012 (Smith, 2009). In North Carolina, a tax increment financing project to create an entertainment district resulted in an economic failure and obligated the municipality to dedicate 13% of its annual operating revenue to pay for the annual bond service (Jolley & Klatt, 2015). Recent evidence indicates tax increment financing programs may not be as effective at curbing poverty and economic malaise as originally thought (Swenson, 2014). The next section of this literature review describes the research evidence on the influence of tax increment financing on real estate property values.

Since 1978, research on the influence of tax allocation districts has been conducted for municipal leaders, community organizations and for public policy analysis in almost every state.

While some of the research can be linked to self-serving consulting interests (Weber & O'Neill-Kohl, 2013), prior research can be grouped into two specific categories: financial effectiveness of the program and the program's influence on economic development.

Financial Effectiveness

Greenbaum and Landers (2014) conducted a review of the literature on the effectiveness of tax increment financing. TAD research has four general characteristics: 1) it examines the extent of blight to show that projects conform to their legislation, 2) it accounts for socioeconomic conditions of the TAD area, 3) it utilizes a control for the counterfactual conditions had the zone not been designated as a TAD, and 4) it may use Heckman selection correction or propensity scores to statistically evaluate the program's effectiveness. The literature controlled for factors that could influence the TAD selection such as previous district growth trends and socioeconomic factors. The authors reported that "papers examining property value outcomes generally found some positive outcomes in the TAD districts" (Greenbaum & Landers, 2014, p. 659).

In Michigan, the use of a TAD resulted in higher property value growth compared with non-TAD cities (Anderson, 1990). Owner-occupied residential real estate experienced positive growth from the implementation of a TAD in Indiana (Man & Rosentraub, 1998). Commercial properties within TAD boundaries displayed higher rates of appreciation in Chicago, Illinois (Smith, 2006, 2009). Public services offered to businesses within TAD zones were capitalized into the property value over time (Carroll, 2008). Thus, increases to public services may correlate to higher property prices for businesses.

While the research on the effectiveness of TADs is generally positive, there are some exceptions. In one study, industrial property values increased when surrounded by mixed use

TADs, but declined in property value when surrounded by other industrial properties (Weber, Bhatta, & Merriman, 2003). In Wisconsin, TADs neither lead to significant increases in property values for residential and manufacturing property nor improvements in local economic development (Merriman, Skidmore, & Kashian, 2011). Municipalities adopting TAD public policies experienced slower property growth than non-adopting cities (Dye & Merriman, 2000). In a repeat-sales dataset, proximity to an industrial TAD negatively influenced residential real estate prices, while proximity to commercial or residential TADs increased appreciation rates (Weber, Bhatta, & Merriman, 2007).

Another aspect of program effectiveness centered on a potential zero-sum development scenario. In theory, the amount of development may be fixed at some constant level. Thus, the development within one district may come at the expense of development in a surrounding district. Under this theory, private development may be substituted in one district without a TAD for another district with a TAD (Dye & Merriman, 2003). The overall region receives no additional development as smaller municipalities compete for the same private investments.

Economic Development

For a public municipality, many of the choices related to economic development are made by private companies (Blair & Carroll, 2008). The decision to locate a business and bring employment opportunities to a region is the decision of the private company; however, public officials have tools to attract and incentivize businesses to locate within their borders. While many of these tools go beyond the scope of this paper, the imposition of a TAD can provide the requisite incentive for businesses to operate within a community. Positive outcomes or spillovers in economic terms encourage additional production and services for consumers. Industrial and

commercially focused TADs result in high positive spillover effects and additional development (DeBoer, McNamara, & Gebremedhin, 1992).

While the local characteristics of the TAD and the socioeconomic condition of the region matter, local employment is positively associated with TAD adoption (Man, 1999). Industrially oriented TADs were more likely to increase employment than retail TADs (Byrne, 2010). In addition, Byrne found that TAD policies increase the employment levels within the TAD area, but reduce employment outside of the district (2010). Using a panel dataset at the census block-group level for Chicago Illinois, Lester (2014) found no evidence that the imposition of a TAD resulted in higher economic benefits for residents. These results confirmed similar findings that TAD adoption resulted in a negative municipal growth rate in Chicago during the 1990s (Dye & Merriman, 2000).

There is a contrarian view to the positive results of a TAD on a business. Property values and property rents appreciate in parallel. Higher rents translate to higher business costs for commercial or industrial tenants. These costs could drive down profits and reduce the earning power for businesses within the TAD. For property-owner businesses, these firms may not be financially prepared for the increases in property taxes associated with the higher value of the property (Weber & O'Neill-Kohl, 2013). The lack of preparation may result in accounting losses in the economic short term with the eventual closure of the business in the economic long run.

Endogeneity

Endogeneity concerns were present across the literature. There may be unobserved factors that could cause a particular region to be zoned as a TAD and that could cause TAD areas to grow faster than non-TAD areas (Merriman et al., 2011). In addition, communities may self-select or be pre-disposed for TAD overlay zoning. Moreover, endogeneity exists between the

probability that a property is located within a TAD and the property's value (Carroll, 2008). TAD communities exhibit higher mean vacancy rates, older buildings, and contain lower household income residents (Byrne, 2006). Another theory dictates that communities with higher property and population growth rates may be more likely to use TAD programs because there is a lower perceived risk associated with paying the debt service (Anderson, 1990). This research may avoid some of this endogeneity concern since the residential real estate properties in focus are outside of the TAD boundaries.

The counterfactual test, known as the 'but for' test in the literature, is another problem in TAD research (Carroll, 2008; Lester, 2014; Persky, Felsenstein, & Wiewel, 1997). Under the Georgia Redevelopment Powers Law, officials assume that the TAD area would not experience any development *but for* the imposition of the overlay zoning. However, this assumption cannot always hold. Development may occur in a region without the use of TAD policies and increased public expenditures. TAD research must account for the baseline level of development within the designated region. This research controls for the baseline development through the use of a construction variable. Other TAD research must quantified deviations in the trajectory of development attributable to the TAD policy (Greenbaum & Landers, 2014). "Failing to correct for self-selection bias and endogeneity in TAD implementation resulted in a downward-biased regression coefficient. The absence of corrections for self-selection bias and endogeneity might lead to underestimation of the impact of TAD." (Carroll, 2008, p. 27) Greenbaum and Landers (2014) recommend using Heckman selection correction or propensity scores to address the selection bias issues of TAD research. Smith (2009) used a propensity score technique to attenuate the endogeneity bias of the TAD assignment. He controlled for neighborhood characteristics and predicted TAD assignment instead of applying the known location of the

property as a control variable. Similarly, Lester (2014) accounted for selection bias by predicting the likelihood of the TAD policy treatment on each of the observations. The interrupted time-series research design created a difference-in-difference estimation technique, which employed a propensity score weighting procedure to predict TAD treatment against observable covariates. Moreover, research must establish a trend line to analyze the TAD region prior to the policy. Accounting for the previously established trend line, may promote more accurate estimates compared to statistical models that fail to control for the previous direction of real estate values.

Evaluating Residential Real Estate

Academic researchers evaluated real estate prices using statistical techniques that compared various property characteristics against the price of the property. The goal of these statistical techniques was to generate true estimates for the market price for an individual property. Even though this approach has been used by researchers for decades, recent advances in geo-spatial modeling and greater access to data have expanded the precision of model estimates. Now, researchers can incorporate intrinsic and external property characteristics into statistical modeling procedures.

Intrinsic Characteristics

Intrinsic characteristics of real estate focus upon the innate features of the property. Sirmans et al. (2006) completed a meta-analysis of the most commonly used real estate property features in real estate research. They reviewed only single family dwellings and controlled for statistical model type and specification. Of all the literature reviewed, the authors cited nine common features: 1) square footage, 2) lot size, 3) age, 4) bedrooms, 5) bathrooms, 6) garage, 7) swimming pool, 8) fireplace, and 9) air conditioning. This research utilizes all of the features

highlighted by Sirmans et al. except for air conditioning, garage, and swimming pool since they are not available in the dataset. The next section outlines the intrinsic real estate features.

Researchers define the amount of square footage within a real estate property as the value of livable space within the dwelling. Livable space excludes garages and below-grade basement space, even if the spaces are heated and finished. However, enclosed porches with heating as well as finished attic space with a minimum of seven feet of clearance are included in the total square footage value.

Lot size denotes the total area of the parcel of land in square feet. The taxing municipality maintains the boundaries of the lot using metes and bounds, which can be obtained from a plat diagram or comprehensive map. While a lot can be any geometric shape, by definition, it must be continuous. To calculate real estate lot size, total the combined area within the designed metes and bounds. For square lots, the frontage of the property squared is the total lot area.

Residential property age identifies the length of time from the sale date to the date of the property's construction. Newly constructed property has been associated with a transaction price premium (Rubin, 1993). Consumers may prefer more recently constructed properties or require a lower price to be compensated for a dwelling's increased age. Northcraft and Neale (1987) documented a consumer response connecting property age to a lower transaction price. "Since the house is not new, its price had to be lower than the listing price. Since it is a 9-year old house, a deduction of $10,000 seems reasonable" (p. 91). Historically, an additional year of property age reduces the transaction price of the property, holding all other factors constant (Sirmans et al., 2006). In addition to the influence on the residential real estate transaction price, age may serve as a substitute for property condition. The age of a structure and its condition are positively correlated. Wilhelmsson (2008) observed that maintenance could reduce the negative

effect of property age by 13%. In statistical modeling, exclusion of maintenance from the model has little impact on the estimated property prices. However, omitting dwelling age from the model induces bias into estimated coefficients (Knight & Sirmans, 1996).

The number of bedrooms and bathrooms are intrinsic features of residential real estate property, which contribute to the overall valuation of the property. Controlling for all other factors, properties with more bedrooms and bathrooms sell for higher prices compared to properties with less bedrooms and bathrooms (Sirmans et al., 2006). These intrinsic features enhance the utility of the residential real estate for the owner, which results in a greater willingness to pay for the property. A bedroom must have a window for egress and a door which can be closed. According to the Real Estate Standards Organization (RESO), a bathroom must contain a sink, toilet, bathtub or shower (Real Estate Standards Organization, 2016).

The presence of a fireplace influences the residential real estate valuation. A fireplace is an intrinsic feature defined as a fire chamber with a chimney and proper ventilation. While a fireplace may not be valued for its utility, it serves as a social barometer denoting wealth or status for the owners (Lawrence, 1989). These features that appeal to social taste or provide signals of wealth can lead to residential real estate price appreciation (Gibler & Nelson, 2003).

Real estate research uses the intrinsic features described above in hedonic regression models (Rosen, 1974; Sirmans et al., 2006; Sirmans et al., 2005). However, intrinsic features fail to accurately estimate residential real estate prices. Externalities, defined as neighborhood peer effects, influence residential real estate prices. The following section describes the influence of externalities on residential real estate prices.

Extrinsic Characteristics

There are two common external factors that can influence the price of residential real estate. These factors are consumption-based factors or perceived influence from nearby structures or functions. To obtain stable and reliable estimates, researchers must use a complete range of neighborhood characteristics (Cheshire & Sheppard, 1995). Traditional real estate research analysis using panel data assumes consumers combine the positive and negative characteristics of the extrinsic environment into the regression model. In addition, consumers have a theoretical assumption of perfect information (Rosen, 1974). Chapter 3 describes the theory of this research in greater detail.

Community amenities and the neighborhood conditions shape the overall attractiveness of residential real estate properties (Bartik & Smith, 1987). Community amenities embody a diverse range of goods and services. Glaeser et al. (2001) portrayed four necessary amenities for urban appeal and future development. The area must contain a rich diversity of services or consumer goods such as restaurants, theaters, and social destinations. The physical aesthetic and quality of the landscape is the second crucial amenity. The urban area must provide high quality public services such as education. The final amenity is transportation speed. Residents must have the ability to travel to employment centers as well as recreational opportunities with relative ease. The authors argued that residential real estate prices were higher in regions that contained all four of these critical amenities compared to regions without the four amenities.

Retail variety and commercial activity within a district enhanced the value of the urban landscape for a consumer (Öner, 2017) In addition, there was a correlation to the consumption of leisure goods and services with disposable income (Andersson & Andersson, 2006). As such, consumers with more disposable income received greater utility for districts with greater

services. These consumers would be more willing to pay residential property premiums for greater access to retail activity (Song & Sohn, 2007). However, there was a consumer threshold for commercial activity. Residential real estate surrounding small scale commercial property were associated with higher prices, but large scale commercial activity reduced residential real estate prices (Stull, 1975). Thus, consumers may value small amounts of commercial activity, but find fault with the additional congestion and noise from large amounts of commercial activity (Burnell, 1985).

External amenities influence residential real estate prices. A desirable view of Lake Erie increased residential real estate prices by 90% (Bond, Seiler, & Seiler, 2002). Correspondingly, research associated water view residential real estate in New Zealand with price premiums (Bourassa et al., 2005). The magnitude of the water view price premium was related to its geographical supply in the local region. Lower supply of residential properties with a water view induced higher price premiums for the positive amenity.

Consumers, who perceive an amenity has a positive influence on health or a healthy lifestyle, were willing to pay a premium for the residential real estate. Consumers were more likely to pay premiums for high quality local resources such as air quality (Boyle & Kiel, 2001), drinking water quality (Leggett & Bockstael, 2000), and distance from perceived toxic sites (de Vor & de Groot, 2011). In the opposing scenario, consumers expect significant price discounts for low quality local resources or nearby co-location of toxic sites. While toxic waste sites represent an extreme form of undesirable land use, all undesirable land uses are negatively associated with residential real estate prices (Farber, 1998).

The consumer perception of a dis-amenity or an undesirable land use function can be tied to its respective municipal zone. In Canada, residential real estate prices were detrimentally

influenced by natural gas industrial facilities and infrastructure (Boxall et al., 2005). The subsequent development of industry from the industrial zone classification created a level of concern on behalf of consumers for pollution and its related health implications. Other industrial activities that detrimentally influenced residential real estate prices were large-scale hog operations (Palmquist et al., 1997), shale gas development (Muehlenbachs et al., 2012), and landfill waste management (Ready, 2010). Similar research connected real estate location to another perceived health influencer. Gawande and Jenkins-Smith (2001) observed that real estate property prices near nuclear material shipping lanes were lower when compared to similar properties that were distantly located from nuclear material shipping lanes. High voltage electricity transmission lines, defined as 69,000 volts or more, reduced residential real estate prices compared to similar properties not co-located near high voltage lines (Hamilton & Schwann, 1995).

Potentially beneficial externalities were associated with price premiums. Access to green space or undeveloped open land was another area of housing externality research. Parks and preserved open space land increased the price of nearby residential real estate (Crompton, 2000). Significant residential real estate price premiums were observed for park and housing co-location, even after accounting for spatial autocorrelation (Conway et al., 2010). As a result of comprehensive planning initiatives, municipalities had high levels of development control within their district. These local governments preserved land in an undeveloped state. These permanently preserved open spaces increased residential real estate prices more than potentially developable open spaces (Geoghegan, 2002).

One of the most impactful real estate externalities was education. Consumers demand high quality education and were willing to pay real estate premiums for the service. Black (1999)

was the first to calculate the residential real estate price premium for quality local schools. Consumers would pay 2.5% more for a residential real estate property for a 5% increase in local elementary school test scores. Other research has confirmed these results and has found that a one standard deviation increase in school quality was associated with a 4% increase in residential real estate prices (Nguyen-Hoang & Yinger, 2011).

Crime represented a dis-amenity, which has been negatively associated with residential real estate prices because of out-migration (Cullen & Levitt, 1999). Holding supply constant, as demand for real estate falls, the price of the local properties must fall to remain in market equilibrium. Reductions in crime led to increases in property prices (Pope & Pope, 2012). The physical development of the neighborhood has an influence on crime rates. Nearby development of casinos and their connotation of crime negatively influenced property prices (Buck, Hakim, et al., 1991). Robbery and aggravated assault crimes were the most impactful types of crimes on residential real estate prices (Ihlanfeldt & Mayock, 2010). Higher levels of these types of crimes were associated with lower residential property prices, while controlling for spatial autocorrelation and housing characteristics.

The local infrastructure and the quality of the transportation system influenced residential real estate prices. Residential real estate within immediate walking distance to feeder bus transit routes were associated with price premiums (Munoz-Raskin, 2010). In addition, railway investments, which increased transportation access to a neighborhood, correlated to higher price premiums for the properties in the neighborhood (Mohammad et al., 2013). The frequency of the train schedule played a role in the value of the property. A doubling of the frequency led to an increase in real estate price of 3.5% (Debrezion et al., 2006). In addition to the physical transportation assets such as bus lines, train tracks, and highway infrastructure, the perception of

transportation access created an externality for residential real estate prices. Higher perceived levels of transportation were correlated with higher residential real estate prices (Cordera et al., 2018).

As chapter two illustrates, residential real estate valuations are influenced by internal and external characteristics, which are capitalized by consumers into the purchase price of the property. The next chapter describes hedonic price theory. This theory underpins much of residential real estate research.

CHAPTER 3

HEDONIC PRICE THEORY

The application of a theory is paramount for rigorous academic research. Theory is the structure which guides the analysis, model specification, and may indicate the sign direction for future estimated coefficients. The theory for this research essay aligns with many other real estate papers for it utilizes the revealed preference theory or hedonic price theory developed by Rosen (1974). This theory has been used to explore a wide range of research topics such as the capital benefits of natural ecosystems (Costanza et al., 1997) to market share and firm profitability (E. W. Anderson et al., 1994). In the housing literature, Rosen's hedonic price theory was the foundation for research on residential real estate prices and school quality (Black, 1999), environment benefits (Freeman III, 1979), health risks (Farber, 1998), and industrial activity (de Vor & de Groot, 2011).

The basis for Rosen's (1974) seminal work begins with a discussion of product differentiation and the intrinsic value of goods. Heterogeneous products and services include distinctive attributes which consumers value differently. One of the fundamental assumptions of this theory is the notion of value. Value equals the total amount of utility-bearing attributes or characteristics associated with the good or service. The concept of *utility* came from Daniel Bernoulli's 1738 essay.

> The determination of the value of an item must not be based on its price, but rather on the utility it yields. The price of the item is dependent only on the thing itself and is equal for everyone; the utility, however, is dependent on the particular circumstances of the person making the estimate. (Bernoulli, 1954, p. 24)

In this passage, Bernoulli distinguished between the price and the utility for a good. One may consider the utility of a good to be the item's personal usefulness or benefit. Normally, the usefulness or benefit is asymmetrical for all consumers. Conversely, the price of the good remains equal for all consumers and represents the monetary cost to acquire the good. The notion of utility persists within a real estate context. For example, Consumer X earns *q* utility for purchasing a residential real estate property with a water view; however, Consumer Z earns *p* utility for the same water view property. Holding the price constant, the consumers would pay the same price for the water front property, but experience different levels of utility from the ownership of the property. Relaxing the assumption of constant property price, if $p > q$, Consumer Z may be willing to pay more for the water view property than Consumer X. Allowing different price levels for the same good aligns the price per unit of utility for each consumer.

Buyers and sellers interact within a multi-dimensional plane and create a competitive equilibrium according to Rosen's (1974) hedonic model. Objective features characterize each good such that $z = (z_1, z_2, \ldots, z_n)$ where z_i measures the i^{th} characteristic of the good. Sellers present an extensive range of goods with different features. Buyers have complete autonomy to purchase their most desired goods within their budget constraint. In addition, the market under hedonic price theory is assumed to be in equilibrium, which denotes that supply and demand of goods are equal.

Another assumption of the hedonic price theory involves the exchange of goods in the marketplace. The theory simplifies any large geographic real estate area to a single marketplace for housing purchase or sale. In addition, there are no resale or secondhand transactions and there is no market branding. Producers cannot use advertising to induce sales or create price premiums

for their products. Thus, consumers purchase the most inexpensive identical goods. Another major assumption of the theory stipulates that goods cannot be separated into its various components or subunits. In his article, Rosen (1974) used the example that a twelve-foot vehicle does not equal two six-foot vehicles. Freeman III (1979) used a grocery store analogy to explain the hedonic model. In his grocery store, filled grocery carts line the aisles instead of individual items. Consumers cannot purchase individual items, but must purchase these filled grocery carts. Theses bundled grocery carts cannot be separated and its individual contents represent the internal features of the overall basket of purchased goods. Different prices between the grocery carts reveals a function of prices for each of the individual goods, even though the goods cannot be separated. It is through this function that transaction prices in residential real estate can reveal an estimated value for a particular aspect or feature of the residential property.

Consumers maximize their utility throughout the exchange of goods; "No individual can improve his position, and all optimum choices are feasible" (Rosen, 1974, p. 35). However, there are assumptions built into the utility maximization assertion. Consumers are expected to be rational and only engage in transactions that provide the most intrinsic utility for each expenditure. Consumers are assumed to have limited resources with limited incomes or assets. In addition, consumers have strict cardinal preference orders for their preference of goods and services. Cardinal preference order conveys a preference pattern for goods such that if good *a* is preferred to good *b* and good *b* is preferred to good *c*, then *a* is preferred to *c*. The consumer is willing to pay the most for good *a*.

The aspect of price is the final assumption of the utility maximization model. Consumers must engage in a series of tradeoffs and choose alternative goods within their limited budget. Consumers apportion funds in order to align the marginal utility of the next dollar to the potential

utility lost from the consumption of that dollar. There are no other bundles of goods for consumers to gain additional utility, thus consumer satisfy Equation 2.1.

$$\frac{\mu x}{px} = \frac{\mu y}{py} = \cdots = \frac{\mu z}{pz} \quad (2.1)$$

The consumer's marginal willingness to pay for each of the bundle's features equates to the marginal implicit price of the feature. In real estate research, this function integrates location and time into the good's bundle of innate features.

There are two steps for the hedonic model technique. The first step develops the implicit prices of the characteristics by the hedonic price function. In the second step, the observed covariates regress against the implicit price to estimate an overall demand function for consumers. In real estate research, the sales price of the property is described by a function of its innate characteristics, neighborhood externalities, and location effects, Equation 2.2. Vector C describes the physical attributes of the residential real estate, the vector N represents a vector of the real estate's neighborhood peer effects, and Z defines the location of the real estate.

$$\text{Price}_{(it)} = \delta C_{it} + \gamma N_{it} + \zeta Z_{it} + \varepsilon_{it};\ t=1, \ldots T \quad (2.2)$$

This equation describes the hedonic or implicit price function for the sales price of residential real estate property at time period t using the three vectors. The equation may be either linear or non-linear. If linear, the implicit prices are constant for individuals, yet if the equation is not linear, the implicit price for the next unit of the specific characteristic relies upon the quantity of the characteristic. This function provides an estimated price for any property with known characteristics. Differentiating Equation 2.2 provides the estimated increase in housing price to purchase the new housing bundle with an additional N_k unit, Equation 2.3.

$$\frac{dp}{dN_k} = pN_k\ (N_k) \quad (2.3)$$

The hedonic price theory received the pseudonym *revealed preferences theory* as it relies upon transactional data to create the underlying price functions. Freeman III et al. (2014) explained the revealed preferences theory as a "take-it-or leave-it" scenario (p. 24). The transaction price illustrates only those events where consumers reveal their level of utility and *take* the purchase. Relating this theory to a housing context, the difference in purchase price of two mostly identical residential real estate properties that differs by one additional bedroom would reveal the utility or price of the additional bedroom for the location at that period of time.

Omitted Variable Bias

Even though this methodology has been extensively implemented for real estate research, omitted variable bias remains one of its main weaknesses. Regardless of the number of control variables, all externalities cannot be modeled into the functional form of the equation. There are two forms of omitted variable bias in this research, neighborhood level effects and time dependent effects.

In efforts to reduce the first level of omitted variable bias, this research employs clustered standard errors at the zip code level of geography and utilizes census tract dummy variables with the model. Clustering standard errors on the zip code may reduce the serial correlation of the unobserved locational effects present within the analysis. Including dummy variables at the census tract effectively calculates the mean residential real estate valuation within each tract. These dummies align unobserved covariates within the boundary and attempt to reduce the omitted variable bias associated with neighborhood peer effects.

The second level of omitted variable bias was time effects and neighborhood trends. Over time, consumer preferences may change; thus, consumers may have different levels of utility during the study's observed time period. This research follows (Diewert, 2003) and fixes

consumer utility across all time periods. Moreover, the meta-analysis conducted by Sirmans et al. (2006) provided a list of non-time dependent housing characteristics. These housing characteristics were adopted into this research framework.

Some may hypothesize that a TAD overlay zone is not an endogenous event but occurs as a result of current economic conditions and a municipal call for redevelopment. This argument is known as the 'but for' test in TAD research (Carroll, 2008; Lester, 2014; Persky et al., 1997). According to most legislation, municipal officials must assume that the TAD area would not experience any development *but for* the imposition of the overlay zoning. Therefore, TAD research must account for a baseline level of development and the expected construction within each TAD overlay region. This research controls for new home construction within each block group to generate a baseline level of development prior to the imposition of the TAD. Developers engaged in new construction signal that new construction in the neighborhood is profitable with prices trending upward. The construction may model the increased future expectations for investment profitability in the area. With this added control variable, the hedonic model reduces the influence of the neighborhood trend and captures the change in the imposition of the TAD on residential real estate prices. The next chapter describes the statistical methods employed to reduce concerns of endogeneity.

Other Theoretical Considerations

Other theoretical considerations remain within this methodology. Hedonic price theory assumes that consumers have complete and perfect information. Perfect information means that consumer can correctly identify and appropriately value all nearby externalities associated with a real estate transaction. The prevalence of perfect information in marketplace transactions has been challenged as an incorrect assumption (Stigler, 1961; Stiglitz, 2000). However, the theory

also assumes there is a cost to obtain information, which is a more realistic assumption. The slope of the marginal cost to gain the next level of information is positive and increasing. More detailed information leads to higher costs for consumers (Stiglitz, 2000).

Holding the budget constraint and purchase price for the good constant, a higher total cost for information reduces the ability to purchase the ideal good and shifts the consumer to a lower consumption curve, Figure 2.6. In this illustration, budget constraint line BC_1 contains an informational level of *x* and this line depicts the amount of consumer resources, *q* and *z*, available at *x* level of information. An indifference curve provides a hypothetical consumption level of goods *q* and *z* at point E_1. An increase in the information level from *x* to *y* reduces the overall budget constraint by the tangible cost to achieve *y* level of information. Thus, the budget constraint shifts leftward and the consumer lies at a lower indifference curve tangent to BC_2 at E_2. The cost for a greater level of information reduced the consumer's purchasing power of goods *q* and *z*. This thought experiment illustrates that more information regarding residential real estate property characteristics results in a tradeoff in the amount of final consumption.

Since individual levels of information are not available at the person level, this research adopts the Arrow-Debreu model for commodities. Arrow-Debreu commodities are precisely defined goods, where additional information no longer increases the satisfaction of the consumers (Geanakoplos, 1989).

This chapter describes the foundational theory of the dissertation. For more information regarding economic basis for the theory, see Follain and Jimenez (1985), who provide an extensive account of the hedonic price theory and relate its application to housing research. The next chapter explains the dataset and methodology used for this research.

CHAPTER 4

METHODOLOGY

While some contend that zoning coincides with market uses and does not modify land use functions (Wallace, 1988), others claim zoning adjusts the physical properties of the neighborhood. The built environment influences consumer behavior (Boarnet & Crane, 2001) and land-use policies can influence the built environment (Cao et al., 2007). The imposition of a TAD may be the result of the physical environment and may influence a subsequent change in development trajectory for the district. Statistical methods must account for unobserved covariates as the same unobserved factors that influence residential real estate price appreciation could influence the location of a TAD district (Cameron & Trivedi, 2005). Hedonic price theory regression estimates a consumer's implicit price function, but the failure to account for the TAD selection may result with inaccurate estimates (Butsic et al., 2011).

Propensity Score Matching

The propensity score matching model reduces bias in the estimation of treatment effects with observational data (Rosenbaum & Rubin, 1983). The matching technique "exploits heterogeneity in the zoning status across parcels and provides potentially unbiased estimates of the treatment effect even if the zoning board selects parcels . . . in a non-random fashion" (Butsic et al., 2011, p. 5). Matching provides minimal functional form restrictions in estimation, yet requires correctly specified covariates.

This research aligns the propensity score matching (PSM) technique and notation of Rosenbaum and Rubin (1983). The PSM technique begins with a comparison of causal effects

between r_{1i} and r_{01}, where only one of these variables receives a treatment. Treatment in this research is location and proximity to the imposition of a TAD. The PSM analysis models the location and proximity to a TAD as an endogenous decision to the purchase of residential real estate property. Residential real estate properties that fall within a TAD area or are within a specified distance to the TAD are matched against similar residential properties outside of the specified area. The stable unit-treatment represents the assumption that r_{ti} represents unit *i* with treatment *t* (Rubin, 1986). Thus, Equation 2.4 is the random sample estimated from the population, where the estimated quantity is the average treatment effect.

$$E(r_1) - E(r_0) \quad (2.4)$$

The treatment variable $z_i=1$ if the observation *i* is apportioned to the experimental treatment, proximity to a TAD overlay zone. Conversely, $z_i=0$ if the observation is in the control group. The variable x_i is a vector of characteristics or covariates for the MLS residential real estate property observation. Equation 2.5 is the individual causal effect, where Y_i is the potential outcome under the treatment or the control group.

$$Y_i(1) - Y_i(0) \quad (2.5)$$

The PSM convention promotes direct comparison through balancing scores. This matching structure compares the outcomes of nearby residential real estate to TADs to real estate properties distant from the overlay districts. Since the experiment is randomized, the treatment observations do not differ systematically from the control observations (Rosenbaum & Rubin, 1983). The normal convention used in this technique is to balance the treatment and control groups for better comparisons. Balancing represents a function to align the conditional distribution of the observed covariates for the treated and untreated groups. "A balancing score is an unbiased estimate of the treatment effect at that value, and consequently pair matching, sub

classification and covariance adjustment on a balancing score can produce unbiased estimates of the average treatment effect" (Rosenbaum & Rubin, 1983, p. 42). The propensity score is the function e(x) illustrating the probability that z =1 given a vector of covariates, Equation 2.6.

$$e(x) = pr\ (z=1|x) \tag{2.6}$$

The average treatment effect on the treated (ATT) can only be identified if the outcomes of each *i,* do not differ in the absence of treatment, Equation 2.7. The sum of the expected value of the assignment of the treatment group and control group equals zero. The treatment assignment, ie the group to which observation z_i is assigned, is considered strongly ignorable and the ATT can be interpreted.

$$E(z(0)|r_i=1) - (E(z(0)|r_i=0) = 0) \tag{2.7}$$

In this research, Y denotes the price outcome of residential real estate property that is either within the designated proximity to a nearby TAD overlay zone or outside of that region. The average treatment effect for the treated sample is Equation 2.8, where N is the total number of observations in the sample.

$$\tau_{ATT} = \frac{1}{Nz} \sum_{i=1}^{N} (Y_i(1|z_i = 1) - (Y_i(0|z_i = 1) \tag{2.8}$$

There is a fundamental problem of causal inference. The observations account for only one potential outcome. There is no counterfactual observation. For those properties in the treatment group, a price observation does not exist for the same property as a non-treated observation. Simply, since the variable was treated, researchers have no price data had the property not received treatment.

The PSM technique models a random sample with treated and untreated groups (Butsic et al., 2011). The treated and untreated groups must be unconfounded according to Equation 2.9. The expected value of r_i given *x* covariates when assigned to the treated group must equal the

same probability for r_i given those same covariates for its inclusion to the control group. Thus, groups are matched to align the covariate distribution, which remains identical regardless of the designation as a treated or untreated group.

$$E[r_i|x, z(1), z(0)= pr[r_i|x]] \quad (2.9)$$

Each individual observation *i* has an assignment value of treatment that was determined by the covariates of *i*, Equation 2.10, and that strictly ranged between zero and one, Equation 2.11.

$$z_i = pr[r_i|x_i] \quad (2.10)$$

$$0 < pr\ (z=1|x) < 1 \quad (2.11)$$

Does the imposition of a TAD overlay zone influence residential real estate transaction prices outside of the TAD area boundary at 0.75, 1.0, 1.25, 1.5, and 2.0 miles? Using two separate models, this research tests for the average treatment effect of the treated for each distance. Covariates for each model are identical to promote comparison between the spatial differences. In addition to distance, time is another restriction placed upon the treatment variable. The date of each residential real estate property sale, RE_{sale}, is restricted to a 365-day period of time before and after the imposition of the TAD overlay zone. Equations 2.12 through 2.16 provide the formula for the creation of the treatment groups for each distance period.

$TAD = TAD_{Adopted} < RE_{sale} < 365;\ TAD_{Adopted} = +/-365$ days; i-TAD < 0.75 miles (2.12)

$TAD = TAD_{Adopted} < RE_{sale} < 365;\ TAD_{Adopted} = +/-365$ days; i-TAD < 1.0 miles (2.13)

$TAD = TAD_{Adopted} < RE_{sale} < 365;\ TAD_{Adopted} = +/-365$ days; i-TAD < 1.25 miles (2.14)

$TAD = TAD_{Adopted} < RE_{sale} < 365;\ TAD_{Adopted} = +/-365$ days; i-TAD < 1.5 miles (2.15)

$TAD = TAD_{Adopted} < RE_{sale} < 365;\ TAD_{Adopted} = +/-365$ days; i-TAD < 2.0 miles (2.16)

Since the municipality held community meetings and forums on the potential imposition of an overlay district in these communities, residential real estate prices may have deviated from their historical trend. To capture the change in trend, the larger time period prior to the imposition of the TAD overlay zone was used. However, it is noted that this period of time is marked with greater uncertainty regarding the future overlay district.

The outcome model of the paired matching PSM technique, a logit treatment model is used to conduct the conditionality. The natural log of the outcome variable price was used to obtain stronger best-fit statistics. The covariates of the equation following commonly used observed characteristics in real estate research and were outlined in the second chapter literature review.

Fixed Effects

While the propensity score model can quantify the price influence of a binary zone change on a nearby residential real estate transaction, the model cannot disentangle the nuances between the different economic initiatives or the influence of residential real estate distance to the TAD overlay zone. Another research question this paper seeks to answer separates the different economic initiatives of the TAD. Does the municipality's expectation for a particular type of development lead to higher residential real estate price appreciation? In addition, this research quantifies the effects on residential real estate price for properties located outside of the TAD area but within the designated distances of 0.75, 1.0, 1.25, 1.5, and 2.0 miles. This paper uses a fixed effects model to achieve this research goal.

The fixed effects model follows the Rosen (1974) hedonic technique, Equation 2.17.

$$\ln(p_i) = \beta X_i + \varepsilon_i \qquad (2.17)$$

In this equation, the natural log of the price of a real estate transaction is regressed against its vector of explanatory variables with a normally distributed error with a mean of zero. Since residential real estate is influenced by its internal characteristics, C, as well as its neighborhood characteristic, N, Equation 2.17 can be expanded into Equation 2.18. The vector Z denotes the specific zoning variables associated with the residential real estate.

$$\ln(p_i) = \delta C_i + \gamma N_i + \varsigma Z_i + \varepsilon_i \quad (2.18)$$

Real estate transactions are influenced by the business cycle. Recessions lead to lower real estate prices compared to expansionary periods. Additionally, inflation rates reduce the value of a single dollar across time. To account for this correlation and diminished purchasing power, the hedonic model incorporated time dependence, Equation 2.19.

$$\ln(p_{it}) = \delta C_{it} + \gamma N_{it} + \varsigma Z_{it} + \varepsilon_{it} \; ; \; t = 1, \ldots T. \quad (2.19)$$

Again, this research conforms to the time invariant consumer utility hypothesis promoted by Diewert (2003) and confirmed in real estate research by Sirmans et al. (2006).

When residuals are independent and identically distributed, standard errors are unbiased in hedonic regressions. However, when the residuals exhibit observational correlation, the standard errors can be biased. Lower standard errors overestimate the significance levels of the model, while overinflated standard errors improperly force the researcher to fail to reject the null hypothesis. Neighborhoods may correlate across years as a function of their underlying unobserved covariates and create time-series dependence (Wooldridge, 2010). Neighborhood correlation may violate the assumption of independence where the asymptotic variance of the estimated coefficient is $\frac{\sigma_\varepsilon^2}{\sigma_X^2 NT}$. Clustered standard errors reduce the influence of independence violation. However, the number of clusters must be greater than ten for the procedure to estimate the true standard error (Petersen, 2009).

The hedonic analysis takes the functional form of Equation 2.20. The log of the price is the dependent variable, which is modeled with the covariates on the right side of the equation. The variables of interest are the respective distance vectors and distance rings of MLS properties near the TAD overlay zone. The beta coefficient on these variables represents the expected percentage change in price for a one unit change in the variable. The fixed effects model incorporates a spatial variable, census tract, to account for spatial autocorrelation. Spatial autocorrelation is explained further in the next section. The fixed effects model clustered standard errors at the zip code level to observational correlation. The remaining list of covariates are the observed characteristics of the residential real estate.

$$
\begin{aligned}
ln(Price)_{it} = {} & \beta_0 + \beta_1 * (Distance\ Vector)_{it} + \beta_2 * (New\ Construction)_{it} + \beta_3 \\
& * (\ln(Acres))_{it} + \beta_4 * (\ln(Zone\ Size))_{it} + \beta_5 * (\ln(Living\ Space))_{it} + \beta_6 \\
& * (Fireplaces)_{it} + \beta_7 * (Deck\ or\ Patio)_{it} + \beta_8 * (Basement\ Bath)_{it} + \beta_9 \\
& * (Association)_{it} + \beta_{10} * (Clubhouse)_{it} + \beta_{11} * (Corner\ Lot)_{it} + \beta_{12} \\
& * (Sprinklers)_{it} + \beta_{13} * (Back\ Yard)_{it} + \beta_{14} * (Bedrooms)_{it} + \beta_{15} \\
& * (Bathrooms)_{it} + \beta_{16} * (Half\ Bathrooms)_{it} + \beta_{17} \\
& * (Finished\ Basement)_{it} + \sum_{j=1}^{184} \beta_{j+17} * (Census) + \varepsilon \qquad (2.20)
\end{aligned}
$$

While the hedonic modeling technique has been routinely employed by researchers for real estate research, it is not without faults. These imperfections are spatial autocorrelation, endogeneity, and heteroscedasticity (Irwin & Bockstael, 2001). The next section describes these faults and discuss manners through which this research seeks to reduce their influence on the research results.

Hedonic Model Deficiencies

The first law of geography states that near things are more similar than far things (Tobler, 1979). As a result, spatial relationships exist between nearby residential real estate neighbors. According to Anselin and Griffith (1988), real estate research is plagued by two spatial econometric problems, spatial autocorrelation and spatial heterogeneity. Spatial autocorrelation or as Can (1990) termed, spatial dependency, describes error terms that are not independent of the explanatory variables. Geographical features of the land or unobserved peer effects associated with the residential real estate may influence the error terms in the modeling equation. Clustering standard errors with a geographic or spatially weighted variable may reduce the spatial autocorrelation within the analysis.

Endogeneity refers to the correlation between the explanatory variables or covariates and the error term. These two terms influence the dependent variable in distinct ways. Statistical problems arise when the explanatory variable, which influences the dependent variable, induces a change in the error term, which also influences the dependent variable. Irwin and Bockstael (2004) articulate an agent interaction hypothesis where the presence of spatial externalities creates endogeneity between land use decisions. Land use conversion and the decision to rezone property may be an endogenous interaction. The authors outline a series of cases where spatial externalities may influence land use conversion. Areas with community spillover effects, social desirability, critical density of amenity attraction, congestion, and pollution were all potential causes of spatial endogeneity. The use of spatial variables such as controlling for zip codes and census tracts within the hedonic regression seeks to isolate the spatial influence of the surrounding area without generating biased estimates.

Another form of endogeneity centers upon price level trends. TAD overlay zoning could be a function of price expectations where districts with higher growth expectations have a higher likelihood of being zoned as a TAD. Were this endogeneity to occur, the coefficient of the rezone would not indicate property price appreciation, but would capture localized growth trends. To reduce this concern, the model controls for new property construction in the census block group. New construction is a function of expected consumer demand. Due to the lagged duration of construction, developers building new residential real estate property invest in areas with positive demand and potentially high profits. Thus, controlling for the amount of new construction within each census block group controls for the price trend and future expectations of the rezone area.

Heteroscedasticity refers to the statistical event where the variability of the explanatory variable is unequal across the range of another explanatory variable's values. In real estate research, this event is most common with real estate age and condition. All properties age and deteriorate over time, yet some of these properties are maintained and renovated. The quality of a randomly selected sample of real estate properties has lower variability for all newly constructed properties compared to a randomly selected sample of significantly older properties. Failing to account for heteroscedasticity may result in the loss of statistical efficiency, biases in estimated standard errors, and invalid inferences (Breusch & Pagan, 1979). This research controls for the residential real estate property's age and condition with two variables: age and quality. Age is a simple calculation of the purchase date minus the construction date. The quality variable provided in the MLS dataset is a seven level continuous variable where one indicates the highest quality and seven represents the lowest quality of residential real estate.

General Data Cleaning

The data for this research is cleaned similar to other real estate research. To eliminate extreme sales price outliers, residential real estate properties which sold in the top or bottom 5% of the dataset were removed. Additionally, the smallest 1% and largest 99% of the residential real estate properties according to living square footage were deleted from the data. Properties with an unusually large numbers of bedrooms or bathrooms were clean out of the data (Zahirovic-Herbert & Gibler, 2014). Distressed residential real estate such as foreclosures, bank owned, short-sales, and ROEs sell at reduced prices and may bias estimates (Forgey et al., 1994). To eliminate the potential for bias, these real estate observations were removed. To reduce the variance in zoning procedures, tax rates, and other governmental externalities, the dataset was restricted to only one municipal county.

This chapter described the two data methods that this research employs to determine the influence of a private rezone on residential real estate and whether the change from non-residential zoning to residential zoning influences nearby residential real estate prices. The next chapter describes the results from the model and discuss findings.

CHAPTER 5

RESULTS & DISCUSSION

This chapter begins with a description of the data used for the empirical study and is followed by the two statistical modeling techniques: propensity score matching and hedonic regression. Within each modeling technique section is a discussion regarding the implications of the results of this research for various stakeholders. All of the tables and figures referenced in this chapter can be found after the appendix section.

Data Description

The data for this study were obtained from two sources. Publicly induced rezoning data were provided through the City of Atlanta's *open data portal* maintained by the Department of Planning and Community Development. The initial dataset contained ten public rezones in Fulton County from 1998 to 2006. To reduce any potential omitted variable bias with respect to time, only the four publicly induced rezones from 2006 were used for this research. The other publicly induced rezones were removed from the empirical analysis. Table 2.1 provides selected characteristics about each individual TAD overlay zone.

The second dataset contained the transactional residential real estate prices and property characteristics. These data were made available by MLS. This dataset included 477,000 residential real estate properties from 1987 to 2014 in the metro-Atlanta region of Georgia. Residential real estate properties outside of the research time period were excluded from the analysis. Moreover, this research removed outliers and cleaned the data according to prior real estate research (Smith, Gibler, & Zahirovic-Herbert, 2016).

After aligning for the intersecting time period between the two datasets and removing MLS data outside of Fulton County, the dataset contained 39,220 MLS residential real estate transactions. In this research, the four TAD overlay zones were geographically co-located in Atlanta. To reduce unobserved variable bias with the spatial heterogeneity of real estate data, the MLS dataset was further refined to exclude all residential real estate properties in excess of five miles from the nearest TAD. This distance restriction ensured all MLS properties were located in the city of Atlanta region and were distant from other previously implemented TAD development projects in the region. All residential real estate located inside of the TAD overlay zone were removed from the dataset. After these refinements, there were MLS 13,617 observations within the dataset.

Table 2.2 provides an illustration of the number of MLS property transactions by distance from each TAD by TAD overlay. It is important to note that these residential real estate properties sold within a designated time period from the final approval of the TAD overlay zone. The municipal process to enact an overlay zone is time-consuming. During this time, consumers revise their expected probability that a publicly induced overlay zone will be enacted. To capture a consumer's ability to 'price-in' future expectations concerning the residential real estate marketplace surrounding a TAD overlay zone, this empirical analysis stated that all properties sold one year before or one year after the TAD overlay zone were influenced by the municipal decision to impose the zone. The Campbellton TAD has the largest number of surrounding residential real estate properties across all distances. The Metropolitan Parkway TAD has the fewest number of residential real estate property transactions at the farthest distance of two miles; however, the Hollowell/Martin Luther King Jr. Dr. TAD has the fewest number of residential real estate property transactions at the closest distance, .75 miles.

Descriptive statistics, Table 2.3, provides more detailed information regarding the transactional MLS dataset. The overall mean sales price of properties within the dataset was $173,092 with an average 115 days on the market. The average size of residential real estate was 1,663 square feet with an average lot size of 0.29 acres. On average, residential real estate was 48.5 years of age with an average quality rating of 2.69, where a quality rating of one equaled the highest quality rating. Almost half of the residential real estate properties in the dataset had a deck or patio and only 24% contained finished basements. There were 3.3 bedrooms and 1.97 bathrooms within the average residential real estate transaction.

The datasets are joined in ESRI ArcMap 10.3.1 using latitude and longitude coordinates. The MLS transactional data and the rezone data aligned to the same coordinate system. Specifically, the geographic coordinate system assigned to these data is NAD 1983 with the Georgia West FIPS 1002_Feet state plane coordinate system. Figure 2.7 illustrates the plotted publicly induced overlay zones and the residential real estate data points. In this image, the green dots indicate the MLS residential real estate transaction. The yellow polygons are the TAD overlay zones. Distance measurement calculations were made from the green dots to the nearest edge of the yellow polygon. Linear distances within 26,400 feet or five miles of the outermost point of the nearest TAD zone were calculated for each MLS transaction. All of the following statistical calculations used Stata 15.1.

Prior to the interpretation of the coefficient effects, academic literature may provide potential rationale for the influence of nearby property externalities. Holding all other factors equal, an increase to the supply of residential real estate in an area can reduce the price of existing real estate. This detrimental price effect could be magnified by the perceptional

influence of ‘new’ property for consumers. Consumers highly value newer property and interior designs when compared with older property and outdated interiors.

When a property undergoes construction or redevelopment through a publicly induced rezone, uncertainty is injected into the marketplace. Higher uncertainty correlates to lower price levels to compensate consumers for the additional market risk. The uncertainty of development with some construction or redevelopment projects may be manifested through lower residential real estate prices in the surrounding community. Akin to uncertainty in the market, an undesirable zone type can detrimentally influence the property price of surrounding real estate. Homogenous communities demand price premiums. Moreover, zones allowing for non-conforming property uses may reduce the prices of surrounding residential real estate.

While redevelopment and the specific future use of a TAD overlay zone may be unknown, capital investment to improve depressed structures increases the value of the nearby community. The redevelopment and renewal of old or dilapidated structures may remove blight from a community and signal positive trends to potential residential real estate buyers. This positive externality may lead to price appreciation within the surrounding real estate marketplace.

Propensity Score Matching

As a result of increased computing power and more accessible geospatial data, the propensity score matching technique has grown in popularity among real estate researchers over the last decade. The technique uses a quasi-experimental design to mimic the conditions of a randomized controlled trial, where observational data are classified as treated or not treated. After classification, the technique matches treated observations against non-treated observations using a nearest-neighbor approach to determine if there is an effect of the treatment on a

dependent variable. This research explored the influence of a publicly induced overlay zone on residential real estate price across five distances ranging from 0.75 miles to 2 miles. Each successive model increases the distance by 0.25 miles with the last increase in distance 0.5 miles.

Results

The results of all five propensity score models can be found in Table 2.4. All of the models indicate a significant relationship between a publicly induced overlay zone and residential real estate price. At the closest distance, Model 1, residential real estate properties may be detrimentally influenced by negative externalities such as construction uncertainty, residential real estate supply shocks, or incompatible property types. The largest effect was found in Model 5, where distance was two miles. Additional propensity score matching models were calculated for distance rings surrounding the initial three quarter mile distance from a TAD overlay zone. These results can be found in Table 2.5. Similar to the original propensity score matching models, the ring models illustrate increasing coefficients.

Discussion

These results indicate that publicly induced TAD overlay zoning may influence surrounding residential real estate prices. Yet, readers should note that the physical act of imposing a TAD may be less influential than the actual development of the property. Property development or rehabilitation may generate positive signals to consumers and potential residential real estate purchasers, thereby influencing higher residential real estate bids. Every TAD contains public infrastructure spending projects. These public expenditures may also provide a positive signal to consumers and contribute to higher residential real estate offers or increased consumer demand. However, the propensity score matching technique did not

differentiate between the type internal characteristics of each TAD overlay zone. The following models provides more detail on the influence of rezone classification.

Hedonic Regression

The hedonic regression is a common statistical method used in residential real estate research. In this research, the hedonic regression controls for spatial characteristics as well as property specific traits and the variable of interest. The observations are the residential real estate properties surrounding the TAD overlay zone. The variables of interest in this model are the distances from the TAD overlay zone and the TAD characteristics.

Results

In total, there are five original fixed effects models with clustered standard errors. Each model differs by the linear distance between the outermost point of the TAD overlay zone and the nearest residential real estate property. Successive models add 0.25 or one quarter mile to the linear distance. The last distance model adds 0.5 miles to the previous distance. The fixed effects model considers those properties within each circle of distance treated by the publicly induced rezone. As the distance function increases, more observations within a rezone treatment are captured by the model. In Models 1 through 5, the quarter mile distances exclude the residential real estate properties found within the previous distance model.

The full results of these hedonic models can be found in Table 2.6. All of the hedonic models had a R^2 value greater than 0.75. In Model 1, the fixed effects regression used a binary variable to quantify the spillover effects from the publicly induced rezone. At three quarters of a mile distance from the TAD overlay zone, residential real estate prices were associated with prices increases of 12.3%. Model 2 incorporated all of the residential real estate transaction from Model 1 and increased the distance from the nearest TAD overlay zone by 0.25 miles. The

binary variable signaling spillover effects from the TAD overlay zone associated residential property transaction prices with a 15.4% increase compared with similar properties outside of the one-mile distance. This price appreciation increased for each of the five fixed effects regression models to reach 19.5% in Model 5. However, the growth of the residential real estate price appreciation declined with each successive increase in distance.

To further disentangle the spillover effect of a publicly induced TAD overlay zone on nearby residential real estate prices, Models 6 through 9 distinguish the distance location of residential real estate properties by adding rings around the initial distance of 0.75 miles, Table 2.7. Model 6 regresses a binary variable signaling distance from the nearest publicly induced TAD overlay zone at 0.75 to 1.0 miles with the inclusion of the properties near the TAD by 0.75 miles. The associated spillover effect for the distance within 0.75 miles coefficient is similar to the results obtained in Model 1; however, the ring distance is not significant. Model 7 tests MLS residential real estate transactions with distance from 1 mile to 1.25 miles including both of the previous distances as controls. The spillover effect and ring distances dummy variables are statistical significant in Model 7. The lack of statistical significance with the additional distance ring variable in Model 8 indicates an inverse relationship with distance from the TAD overlay zone and the price externality from the TAD overlay zone. As distance increases, the price externality decreases.

The results in Model 8 indicates that the effects from the TAD overlay rezone are not significant at distances beyond 1.25 miles. However, Model 5 of Table 2.6 presents a significant coefficient on the two-mile binary variable, demonstrating a significant effect of a publicly induced rezone at two miles. These seemingly conflicting results can be reconciled through a better understanding of the models being tested. In Model 5, all of the MLS properties within the

two-mile radius are used for the hedonic regression, while only those properties located at the specified distances are grouped in Model 8. The volume of MLS properties and statistical significance from the closer MLS properties may be inducing the significance levels in Model 5.

Another facet of this research tests the proposed development within the publicly induced rezone. Unfortunately, the variables illustrating the different characteristics of each TAD are not statistically discernible from zero. With some exception, the TAD overlay zones are similar in construction. The lack of quantitative difference could have reduced the model's ability to produce significant results. Furthermore, the characteristic aspects of each TAD are obtained from initial planning board dockets. Any deviation from the comprehensive plans could have changed the influence of redevelopment on consumer expectations.

While the other covariates within the models are not the focus of this research, their sign and significance levels aligned with other real estate literature (Sirmans et al., 2006). The variable to control for the total amount of new construction by block group is not significant in any of the models. The only other variable without significance is a variable indicating the number of bedrooms within each residential real estate property. Real estate research has observed the lack of significance on this variable before. It is a mechanism of the hedonic model. The hedonic model operates by holding all other covariates constant. By setting the square footage of a residential property to a constant value and increasing the amount of bedrooms, the size of every room in the property decreases. While not measured in the dataset, there is a parallel effect of room size and residential real estate price. Both operate in the same direction; an increase in room size may be associated with an increase in residential real estate price. Smaller room sizes reduce the overall price a consumer may be willing to pay for the residential real estate property.

Discussion

Through zoning, municipal leaders and urban planners organize and shape the development of their local community. As this research confirmed, there are residential real estate marketplace externalities associated with publicly induced TAD overlay zoning. It may be beneficial to municipal leaders and urban planners to evaluate the potential spillover effects and assess the shock on the local residential real estate marketplace. There are a few policy implications regarding the use of TAD overlay zones. The next paragraphs outline those implications and suggest remedies to mitigate their detrimental influence.

The empirical results of this research indicate price appreciation for the surrounding residential real estate property. While positive price appreciation is beneficial to homeowners, non-owner residents in the surrounding community may be detrimentally impacted through rising rental costs. The increase in residential real estate prices reduces the supply of low cost housing options for low income residents (Desmond, 2018). The lack of affordable housing may induce changes in the migratory patterns for specific socioeconomic groups. A rapid change in residential real estate price within an urban context is called gentrification. Municipal officials and urban planners must be cognizant of the effects of gentrification on residential real estate prices and the labor force. Gentrification can significantly increase the cost of rent in a community. In addition, it can transform the local workforce composition. Due to the high cost of housing, the supply of lower-wage workers may fall, which may negatively affect local employers.

A second consideration for municipal leaders and urban planners is the debt mechanism through which TAD overlay zones initiate public redevelopment. In each of the four TADs explored in this research, the municipal authority borrowed tens of millions of dollars to finance

public improvement projects. The municipality pays the annual debt service of these bonds financed from general municipal revenue. In theory, the growth in property values resulting from the enhanced public infrastructure may translate to higher tax revenue; however, real estate market shocks disassociated with the localized economic trends of the region may prevent the necessary tax revenue from materializing. The economic recession of the last decade remains an excellent example of an adverse market shock which may reduce the probability that the municipality recoups the annual debt service costs through additional tax revenues.

Spending future municipal revenues *today* increases the financing risk of a municipality. Deviations from the expected revenue forecast could bring deleterious impacts to the local community through reduced public services or deferred maintenance. The annual bond service costs of the debt remain contractual obligations. The municipality and its residents are required to pay the funds regardless of macroeconomic conditions or changes to the expected amount of new construction. A TAD overlay zone failed in the City of Roanoke Rapids, North Carolina because the municipal revenues of the project did not meet expectations and the required debt service payments (Parker, 2013). The city had an additional $21.5 million in bonded debt without offsetting revenue. Ultimately, the residents were forced to pay more through taxes or accept fewer municipal services.

A theoretical concern with the use of Tax Allocation Districts centers upon the role of government. This research provided evidence of a price externality and TAD spillover effect as a result of a TAD overlay zone. Should municipal governments have the authority to manipulate residential real estate prices through additional TAD overlay zones? While government's role in society is not a major focus of this research, municipal residents have the right to question their government's ability to select 'winning' districts. To compound matters, the entire district would

be forced to pay for the bond's annual debt service if the TAD's revenues failed to meet expectations. Thus, a project benefitting a localized portion of the community may be the burden of all residents. For this reason alone, the use of TAD policy for economic development should be fully scrutinized and vetted by the community and municipal officials.

CHAPTER 6

CONCLUSION

Zoning is an important municipal function which governs the type of development and regulates the end use function of real estate. The spatial structure of cities and towns are directly linked to the zoning ordinances and comprehensive plans promulgated by the governing entities. Recently, municipalities adopted a new tool called overlay zoning to specifically target economic or cultural aspects of redevelopment. Tax allocation districts, a form of overlay zoning, are explicitly designed to meet local community objectives, such as those contributing to the health, welfare and safety of the residing populace.

Tax allocation districts, promote public interests of the community by incentivizing private developers to develop vacant or under-utilized land. Tax allocation districts may issue bonds or earmark specific tax receipts for investment or other public improvements in the district. In theory, the focused redevelopment in the district increases property values and the district generates more tax revenue to pay for the bonds. This research provided evidence of a TAD spillover effect on surrounding residential real estate prices. It was beyond the scope of this research to calculate if the increase in residential real estate price and the additional tax revenue therein generated enough new municipal revenue to offset the cost of the TAD debt.

Recommendations

Municipal leaders and urban planning administrators must weigh the benefits of publicly induced overlay zoning against the potential negative externalities. This research provides final recommendations to enhance the discussion of publicly induced TAD overlay zoning prior to its

implementation. The goal of these recommendations is to balance new private development from a TAD against residential real estate price volatility. Additionally, these recommendations discuss the inherent risks associated with the utilization of TAD redevelopment.

The first recommendation for municipal leaders and urban planning officials is to monitor the forces of gentrification in the localized economy. Gentrification is the rapid price appreciation of residential real estate prices. Rampant price growth negatively affects the property market, supply of labor, and the culture of the community. High property values lead to high rental rates for non-owner residents. Existing businesses may experience a dwindling supply of labor or may be required to pay higher salaries to compensate employees for the higher cost of housing. In either case, the profitability of business operations declines. However, there are strategies to help protect the labor force composition.

Publicly induced TAD overlay zone redevelopment is a long process through which the community members draft a comprehensive plan for the district. To maintain an adequate supply of labor across all income levels, TAD comprehensive plans should incorporate a diversity of affordable residential real estate property. This mixture of new residential real estate may reduce the rental price pressure associated with gentrification. Moreover, low income residents may have the opportunity to remain housed in the local community, preserving some of its culture.

The second recommendation involves the debt financing mechanism associated with TAD overlay zoning and the reliance of future revenues to pay annual debt service. Since the municipality obligates residents to pay interest and principal costs, financial projections of future revenues should be conservative. Lower financial projections reduce the amount of debt the TAD can legally issue. A lower amount of issued debt corresponds to a reduction in public infrastructure investments. Yet, if an external macroeconomic factor prevented new construction

from occurring or redevelopment was less than anticipated, local residents would have a lower bond interest obligation.

Prior to the imposition of a new TAD overlay district, municipal leaders and urban planners should create contingency funding procedures. These procedures would limit resident exposure to large tax increases and protect the financial health of the municipality. Additionally, the issuance of bonds would be contingent upon third party contractual agreements of redevelopment. The municipality could begin debt issuance after a specified percentage of contractual developmental contracts are reached. The use of these financially related milestones could reduce the overall risk of the indebted project.

Another recommendation for municipal leaders and urban planners is the use of tranche debt financing. Since TAD overlay zones require incremental tax revenues for sustainability, issuing debt in multiple sequences may reduce the inherent risks associated with single issue debt issuance. Additional forecasting after the deployment of the first round of municipal capital can estimate the actual amount of incremental revenue. This information would provide more accurate estimates of the municipality's ability to cover the annual debt service costs. Were debt payments to exceed tax revenue projections, future debt issuance could be reduced or canceled entirely. This gradual approach to TAD public financing could reduce the overall financing risks associated with the initial bond indebtedness and the municipal hope that incremental revenues cover debt servicing costs.

Limitations

Similar to all academic research pursuits, there are limitations to this empirical study. The first limitation is the rolling panel dataset used for this study. By definition, two residential real estate properties are not exactly alike. The geospatial difference between the two properties

forces statistical methodologies to control for their internal and external characteristics as well as their spatial dependence. Some research uses repeat sales datasets to account for this modeling challenge. Repeat sales datasets match the same property across time periods. Assuming the property did not undergo renovations or rehabilitation, the change in price between two time periods can be associated with the desired variable of interest. The downsides to these types of datasets is not described here, but repeat sales datasets claim to remove omitted variable bias from the statistical models. Ultimately, the validity and strength of the modeling within a rolling panel dataset is only as good as its control variables.

The lack of neighboring sales transactions is another dataset limitation. In real estate assessment datasets, researchers have assessed values for each property by year. The structure of these municipal assessment data easily lends to difference-in-difference models. In the current research, the rolling-panel dataset may have only a few observations for a single rezone depending on its location.

Another limitation of this research was the use of a continuous zone for the TAD region. Ideally, the TAD region would be segmented by conventional zone in addition to the overlay zone. This information would help control for the residential real estate externalities associated with end use function and property type.

Future Research

Municipal leaders and urban planners will always seek to improve districts within their community. As a result, the externalities associated with TAD overlay zones should remain of great interest over the coming decades. Future research will test the duration of the spillover effects. Do the residential real estate price gains observed in this research remain constant over time or does the appreciation decline? There are important revenue implications for this research

question as the municipal debt service obligated by the TAD generally persists for twenty-five years. Another future research question could explore the factors related to the successful or unsuccessful deployment of TADs around the nation. The research will investigate the most common characteristics associated with TAD composition and financial structure and provide information for the successful deployment of a TAD overlay zone.

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Table 2.1: Selected TAD Characteristics

	Metropolitan	Stadium	Hollowell/MLK Jr	Campbellton
Size (Acres)	895	361	886	1,433
Size (Parcels)	456	623	496	585
Residential Units	2,200	3,920	4,165	5,050
Retail Sq Ft	675,000	560,000	450,000	985,000
Office/Industrial Sq Ft	100,000	260,000	380,000	1,660,000
Public Improvements*	$29	$7	$13.5	$38
Total Bonds Planned*	$85.2	$157	$101.8	$224

* In millions

Table 2.2: Number of MLS Properties by Distance by TAD

Distance from TAD (in miles)	0.75	1.0	1.25	1.5	2.0
Metropolitan Parkway	245	277	295	325	371
Stadium	206	276	329	410	524
Hollowell/Martin Luther King Jr. Dr.	203	255	310	365	433
Campbellton	309	401	472	534	609

Table 2.3: Descriptive Statistics

Variable	N	Mean	Standard Deviation	Min	Max
Distance from Rezone	13,617	7,917.29	6,622.88	0.22	26,399.54
Size of Rezone	13,617	45,882.88	24,812.88	2,699.70	78,752.96
Sales Price	13,617	$173,092	$121,731	$ 22,000	$ 495,000
Days on Market	13,617	115	147	1	1,845
Acres	13,617	0.29	0.29	0.01	5
Age	13,617	48.47	29.36	2	114
Living Space (sq ft)	13,617	1,663	647	806	5,032
Quality	13,617	2.69	1.19	1	7
Bathrooms	13,617	1.97	0.74	1	5
Half Bathrooms	13,617	0.33	0.49	0	2
Basement Bathroom	13,617	0.11	0.31	0	1
Finished Basement	13,617	0.24	0.43	0	1
Bedrooms	13,617	3.29	0.86	1	7
Fireplaces	13,617	0.83	0.91	0	10
Deck or Patio	13,617	0.53	0.50	0	1
Back Yard	13,617	0.52	0.50	0	1
Sprinklers	13,617	0.05	0.21	0	1
Clubhouse	13,617	0.02	0.15	0	1
Association	13,617	0.14	0.35	0	1
Corner Lot	13,617	0.06	0.24	0	1

Table 2.4: Propensity Score Matching Results

	Model 1	Model 2	Model 3	Model 4	Model 5
Distance (in Miles)	0.75	1	1.25	1.5	2
Binary TAD (1= yes)	0.165***	0.181***	0.207***	0.234***	0.243***
	-0.0247	-0.0212	-0.02	-0.0191	-0.0174
New Construction (in 00s)	-0.0382	0.0266	-0.0405*	-0.0498**	-0.0353*
	-0.0289	-0.0243	-0.0225	-0.0225	-0.0204
Quality	-0.139***	-0.163***	-0.165***	-0.163***	-0.166***
	-0.0108	-0.0094	-0.0089	-0.0084	-0.00758
Acres (log)	-0.0383*	-0.0057	-0.0511***	-0.0441**	-0.0757***
	-0.0226	-0.02	-0.0184	-0.018	-0.0159
Age (log)	-0.0124	-0.0118	-0.0047	-0.0202*	0.00212
	-0.0159	-0.0135	-0.0125	-0.012	-0.0107
Living Space (log)	0.637***	0.551***	0.614***	0.621***	0.656***
	-0.0577	-0.0503	-0.0458	-0.0452	-0.0407
Fireplaces	0.145***	0.142***	0.106***	0.106***	0.120***
	-0.0161	-0.0132	-0.0123	-0.0118	-0.0112
Deck or Patio	0.151***	0.155***	0.177***	0.160***	0.148***
	-0.0266	-0.0232	-0.0215	-0.0207	-0.0189
Basement Bathroom	0.146***	0.145***	0.063	0.0742*	0.0931**
	-0.0524	-0.0435	-0.0408	-0.039	-0.0367
Association	0.235***	0.241***	0.278***	0.262***	0.245***
	-0.0436	-0.0353	-0.0341	-0.0332	-0.0308
Clubhouse	-0.0089	-0.136**	-0.0999*	-0.0955	-0.0733
	-0.0709	-0.0615	-0.0604	-0.0586	-0.0532
Corner Lot	0.107*	0.0271	0.102**	0.121**	0.101**
	-0.0622	-0.0547	-0.0516	-0.049	-0.0441
Sprinkler	0.0562	0.0903*	0.0235	0.0273	0.0171
	-0.0595	-0.0498	-0.0477	-0.0462	-0.0441
Back Yard	0.124***	0.135***	0.137***	0.142***	0.146***
	-0.0261	-0.0225	-0.0211	-0.0203	-0.0183
Bedrooms	-0.0955***	-0.128***	-0.132***	-0.115***	-0.145***
	-0.0197	-0.0161	-0.0153	-0.015	-0.0135
Bathrooms	0.0795***	0.123***	0.0996***	0.110***	0.124***
	-0.0257	-0.022	-0.0203	-0.0199	-0.0185
Half Bathrooms	-0.0409	-0.0162	0.0162	-0.0513**	-0.0214
	-0.0296	-0.0252	-0.0241	-0.0233	-0.0211
Finished Basement	0.0779**	0.0843***	0.136***	0.0948***	0.0998***
	-0.0343	-0.0292	-0.0281	-0.0269	-0.0239
Constant	7.287***	8.015***	7.527***	7.494***	7.179***
	-0.415	-0.362	-0.333	-0.325	-0.291

Observations	1,926	2,418	2,812	3,268	3,874
R-squared	0.401	0.44	0.433	0.416	0.428

Table 2.5: Propensity Score Matching Results for Rings

Model	Model 6	Model 7	Model 8
Distance (in Miles)	.075-1.0	1.0-1.25	1.25-1.5
Binary TAD (1= yes)	0.150***	0.198***	0.253***
	-0.0435	-0.0374	-0.048
New Construction (in 00s)	0.0128	-0.0578	0.0442
	-0.0458	-0.0464	-0.0719
Quality	-0.183***	-0.173***	-0.199***
	-0.0201	-0.017	-0.0221
Acres (log)	0.0554	-0.0687*	-0.0008
	-0.044	-0.0351	-0.0472
Age (log)	0.0464	-0.0294	-0.0145
	-0.0311	-0.0231	-0.031
Living Space (log)	0.547***	0.490***	0.764***
	-0.105	-0.0899	-0.113
Fireplaces	0.0967***	0.0757***	0.0338
	-0.0257	-0.0215	-0.0286
Deck or Patio	0.225***	0.0930**	0.234***
	-0.0487	-0.0405	-0.054
Basement Bathroom	0.0908	0.146**	-0.155
	-0.078	-0.0709	-0.115
Association	0.196***	0.354***	0.288***
	-0.0746	-0.0595	-0.0949
Clubhouse	0.0776	-0.143	-0.171
	-0.13	-0.112	-0.196
Corner Lot	0.288**	0.115	0.156
	-0.121	-0.0909	-0.119
Sprinkler	0.0278	0.149*	0.0323
	-0.0811	-0.0852	-0.111
Back Yard	0.0859*	0.147***	0.105**
	-0.0467	-0.04	-0.052
Bedrooms	-0.106***	-0.0941***	-0.195***
	-0.0333	-0.0279	-0.0395
Bathrooms	0.0996**	0.0613	0.184***
	-0.0452	-0.0392	-0.0543
Half Bathrooms	-0.0545	-0.051	-0.170**
	-0.0528	-0.0472	-0.0666

Finished Basement	0.0891	0.146***	0.188***
	-0.0597	-0.0525	-0.0675
Constant	8.017***	8.592***	6.820***
	-0.771	-0.65	-0.784
Observations	586	886	456
R-squared	0.443	0.368	0.486

Table 2.6: Hedonic Regression Results

	Model 1	Model 2	Model 3	Model 4	Model 5
Miles from TAD	0.75	1	1.25	1.5	2
Distance within .75 miles	0.116**				
	-0.0452				
Distance within 1 mile		0.143***			
		-0.0517			
Distance within 1.25 miles			0.165***		
			-0.0511		
Distance within 1.5 miles				0.171***	
				-0.0538	
Distance within 2.0 miles					0.178**
					-0.0675
TAD Residential Units (in 000s)	0.0129	0.0131	0.0116	0.0119	0.00799
	-0.0257	-0.0257	-0.0258	-0.0263	-0.0272
TAD Retail Sq Ft (in 0,000s)	-0.0213	-0.0212	-0.0207	-0.0219	-0.0238
	-0.017	-0.017	-0.0172	-0.017	-0.0165
TAD Office/Industrial Sq Ft (in 0,000s)	0.00606	0.00571	0.00571	0.00599	0.00746
	-0.0055	-0.00547	-0.00532	-0.00546	-0.00549
New Construction (in 000s)	0.0305	0.0274	0.0247	0.0332	0.0389
	-0.117	-0.115	-0.112	-0.117	-0.117
Quality	-.0565***	-.0566***	-.0568***	-.0568***	-.0563***
	-0.00619	-0.00614	-0.00605	-0.00614	-0.00619
Acres (log)	0.0436***	0.0438***	0.0433***	0.0437***	0.0437***
	-0.011	-0.0108	-0.0107	-0.0107	-0.0106
Age (log)	-0.0812***	-0.0814***	-0.0813***	-0.0815***	-0.0818***
	-0.011	-0.011	-0.0111	-0.0111	-0.0112
Living Space (log)	0.458***	0.459***	0.461***	0.460***	0.458***
	-0.0478	-0.0475	-0.0475	-0.0477	-0.0472
Fireplaces	0.0660***	0.0659***	0.0657***	0.0659***	0.0660***
	-0.00969	-0.00951	-0.0095	-0.00954	-0.00957

Deck or Patio	0.0855***	0.0856***	0.0853***	0.0850***	0.0852***
	-0.0125	-0.0125	-0.0124	-0.0124	-0.0123
Basement Bathroom	0.0389***	0.0387***	0.0386***	0.0388***	0.0382***
	-0.0117	-0.0114	-0.0115	-0.0114	-0.0116
Association	0.146***	0.145***	0.144***	0.144***	0.145***
	-0.0278	-0.0278	-0.028	-0.0278	-0.0272
Clubhouse	0.0444**	0.0452**	0.0431**	0.0428**	0.0424**
	-0.0175	-0.0171	-0.0178	-0.0182	-0.0177
Corner Lot	0.0654***	0.0647***	0.0648***	0.0649***	0.0664***
	-0.0135	-0.0132	-0.0133	-0.0133	-0.0135
Sprinkler	0.0478*	0.0474*	0.0482*	0.0485*	0.0485*
	-0.0256	-0.0258	-0.0257	-0.0264	-0.0261
Back Yard	0.0496***	0.0497***	0.0498***	0.0490***	0.0492***
	-0.00579	-0.00567	-0.00558	-0.00566	-0.00567
Bedrooms	-0.00497	-0.00496	-0.00501	-0.00533	-0.00548
	-0.00868	-0.00869	-0.00869	-0.00869	-0.00879
Bathrooms	0.0799***	0.0795***	0.0786***	0.0794***	0.0797***
	-0.0112	-0.0113	-0.0113	-0.0113	-0.0112
Half Bathrooms	0.0368***	0.0365***	0.0361***	0.0367***	0.0366***
	-0.0108	-0.0106	-0.0106	-0.0109	-0.0108
Finished Basement	0.0802***	0.0803***	0.0810***	0.0811***	0.0821***
	-0.0111	-0.0112	-0.0111	-0.0114	-0.0112
Constant	9.704***	9.703***	9.696***	9.707***	9.721***
	-0.341	-0.339	-0.34	-0.342	-0.339
Observations	13,617	13,617	13,617	13,617	13,617
R-squared	0.75	0.75	0.75	0.75	0.75

Table 2.7: Hedonic Regression Results for Rings

	Model 6	Model 7	Model 8
Miles from TAD	0.75	1	1.25
Distance within .75 miles	0.102**	0.153***	0.173***
	-0.0483	-0.0535	-0.0532
Ring Distance .75 to 1 mile	0.046	0.0492*	0.0497*
	-0.0275	-0.0276	-0.0278
Ring Distance 1 mile to 1.25 miles		0.160***	0.181***
		-0.0549	-0.0652
Ring Distance 1 mile to 1.5 miles			0.0925
			-0.0822
TAD Residential Units (in 000s)	0.0129	0.0116	0.0116
	-0.0257	-0.0258	-0.026
TAD Retail Sq Ft (in 000s)	-0.213	-0.207	-0.213

	-0.17	-0.173	-0.17
TAD Office/Industrial Sq Ft (in 0,000s)	0.603	0.568	0.579
	-0.553	-0.538	-0.54
New Construction (in 000s)	0.0285	0.0226	0.0261
	-0.116	-0.112	-0.114
Quality	-0.0565***	-0.0567***	-0.0567***
	-0.00624	-0.00609	-0.00611
Acres (log)	0.0437***	0.0434***	0.0437***
	-0.011	-0.0108	-0.0107
Age (log)	-0.0813***	-0.0815***	-0.0816***
	-0.011	-0.0111	-0.0111
Living Space (log)	0.458***	0.460***	0.460***
	-0.0479	-0.0476	-0.0477
Fireplaces	0.0660***	0.0658***	0.0659***
	-0.00973	-0.00948	-0.00953
Deck or Patio	0.0854***	0.0852***	0.0849***
	-0.0126	-0.0125	-0.0125
Basement Bathroom	0.0387***	0.0385***	0.0386***
	-0.0117	-0.0116	-0.0115
Association	0.147***	0.144***	0.144***
	-0.0276	-0.0279	-0.0279
Clubhouse	0.0442**	0.0428**	0.0423**
	-0.0175	-0.0177	-0.018
Corner Lot	0.0653***	0.0648***	0.0648***
	-0.0135	-0.0133	-0.0133
Sprinkler	0.0473*	0.0478*	0.0480*
	-0.0253	-0.0254	-0.0258
Back Yard	0.0497***	0.0498***	0.0494***
	-0.0058	-0.00559	-0.00577
Bedrooms	-0.00499	-0.00503	-0.00519
	-0.00863	-0.00864	-0.00861
Bathrooms	0.0798***	0.0784***	0.0787***
	-0.0112	-0.0113	-0.0114
Half Bathrooms	0.0368***	0.0361***	0.0363***
	-0.0108	-0.0106	-0.0108
Finished Basement	0.0802***	0.0810***	0.0811***
	-0.0111	-0.0111	-0.0113
Constant	9.706***	9.698***	9.704***
	-0.341	-0.34	-0.342
Observations	13,617	13,617	13,617
R-squared	0.75	0.751	0.751

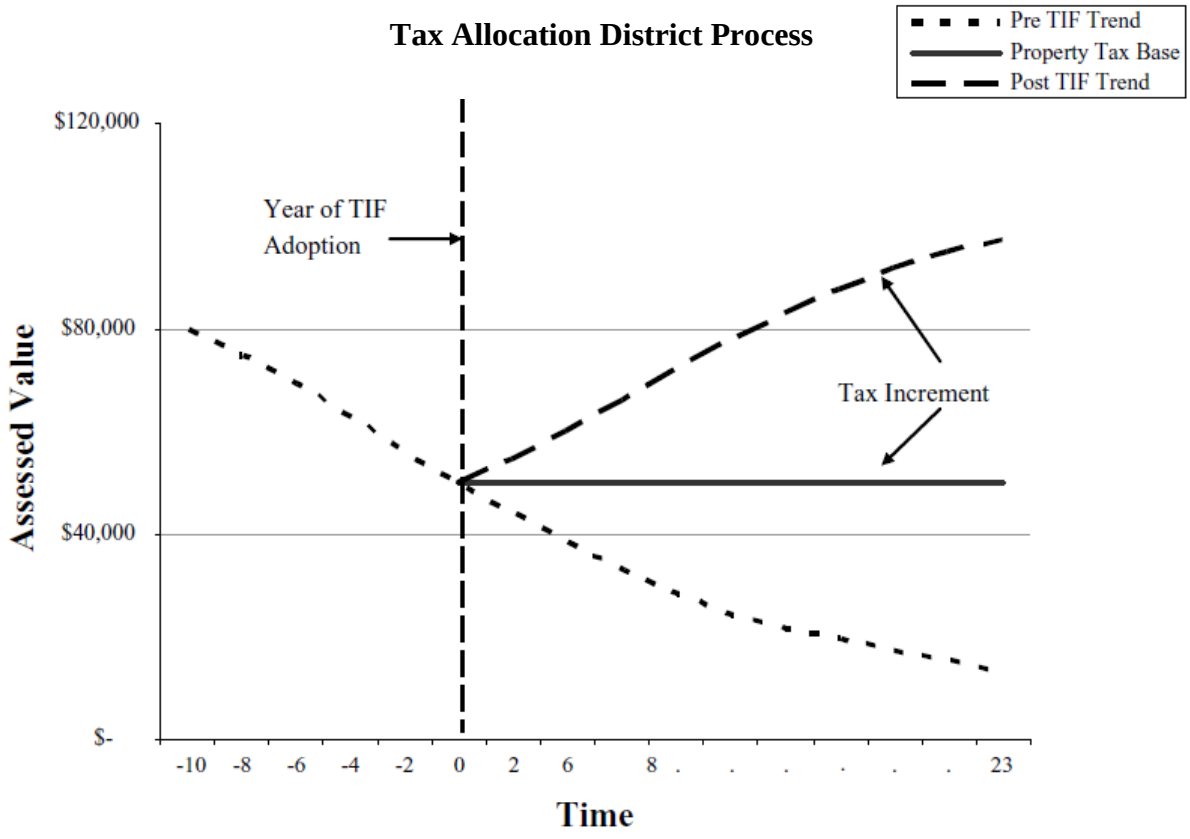

Figure 2.1: Tax Allocation District Process. Retrieved from Smith, B. C. (2009). If you promise to build it, will they come? The interaction between local economic development policy and the real estate market: Evidence from tax increment finance districts. *Real Estate Economics*, *37*(2), 209-234.

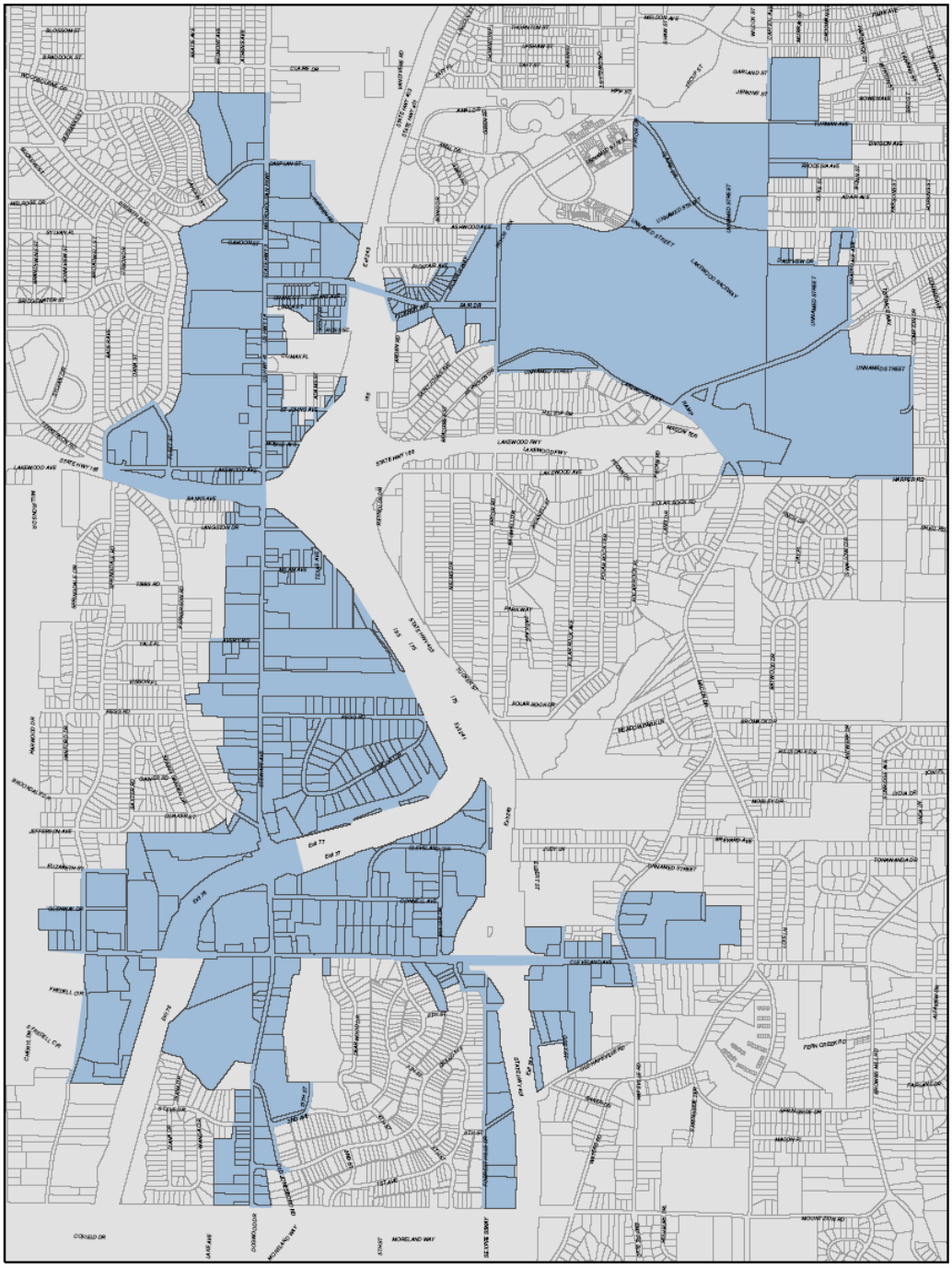

Figure 2.2: Metropolitan Parkway TAD Boundary. Retrieved from Atlanta Development Authority. (2006). *Metropolitan Parkway redevelopment plan and tax allocation district*. Retrieved from https://www.investatlanta.com/developers/opportunities-incentives/tax-allocation-district-financing/metropolitan-parkway

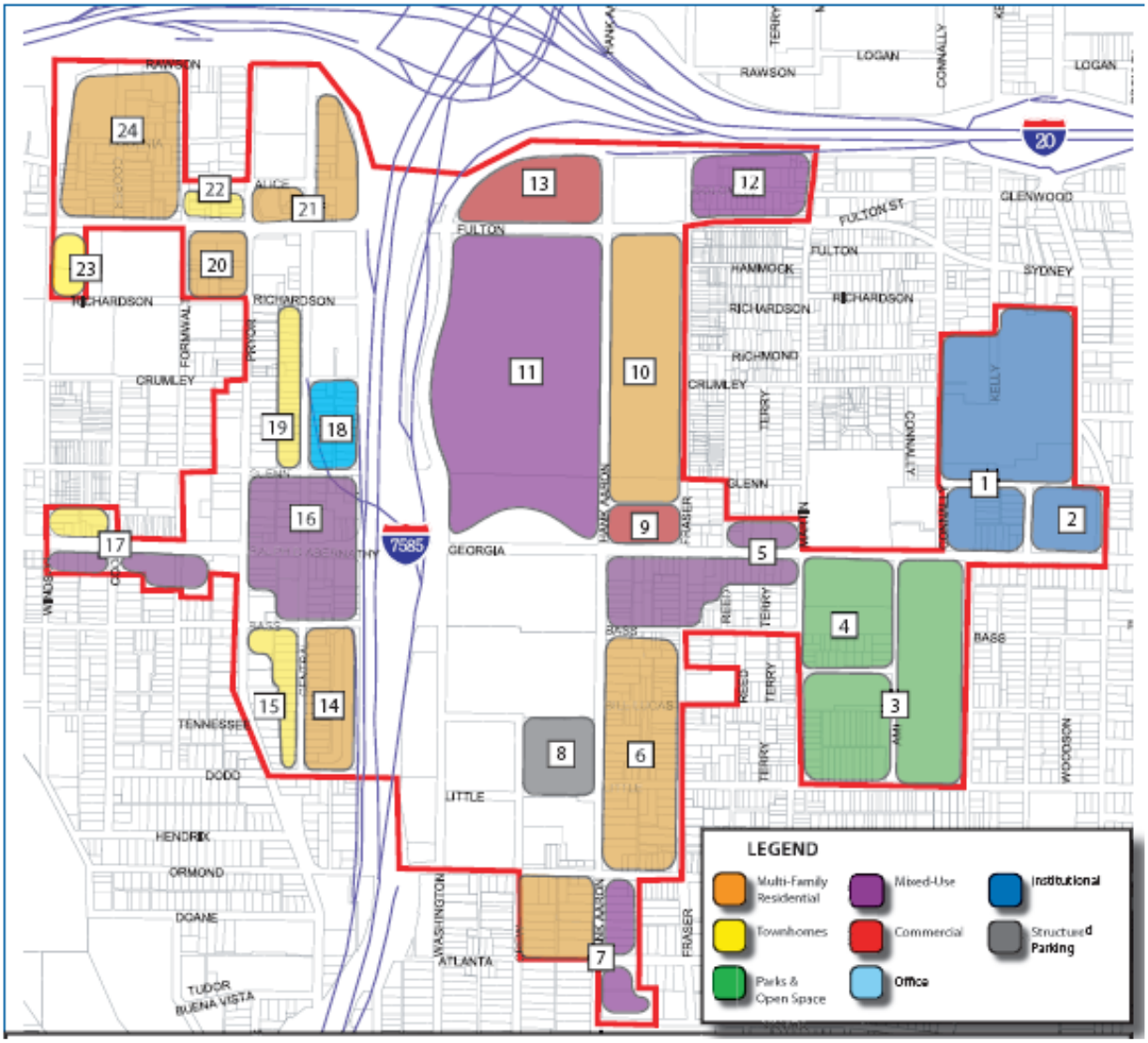

Figure 2.3: Stadium Neighborhood TAD Boundary. Retrieved from Atlanta Development Authority. (2006). *Tax allocation district redevelopment plan for the Stadium Neighborhoods tax allocation district Atlanta, Georgia*. Retrieved from https://www.investatlanta.com/developers/opportunities-incentives/tax-allocation-district-financing/stadium-area

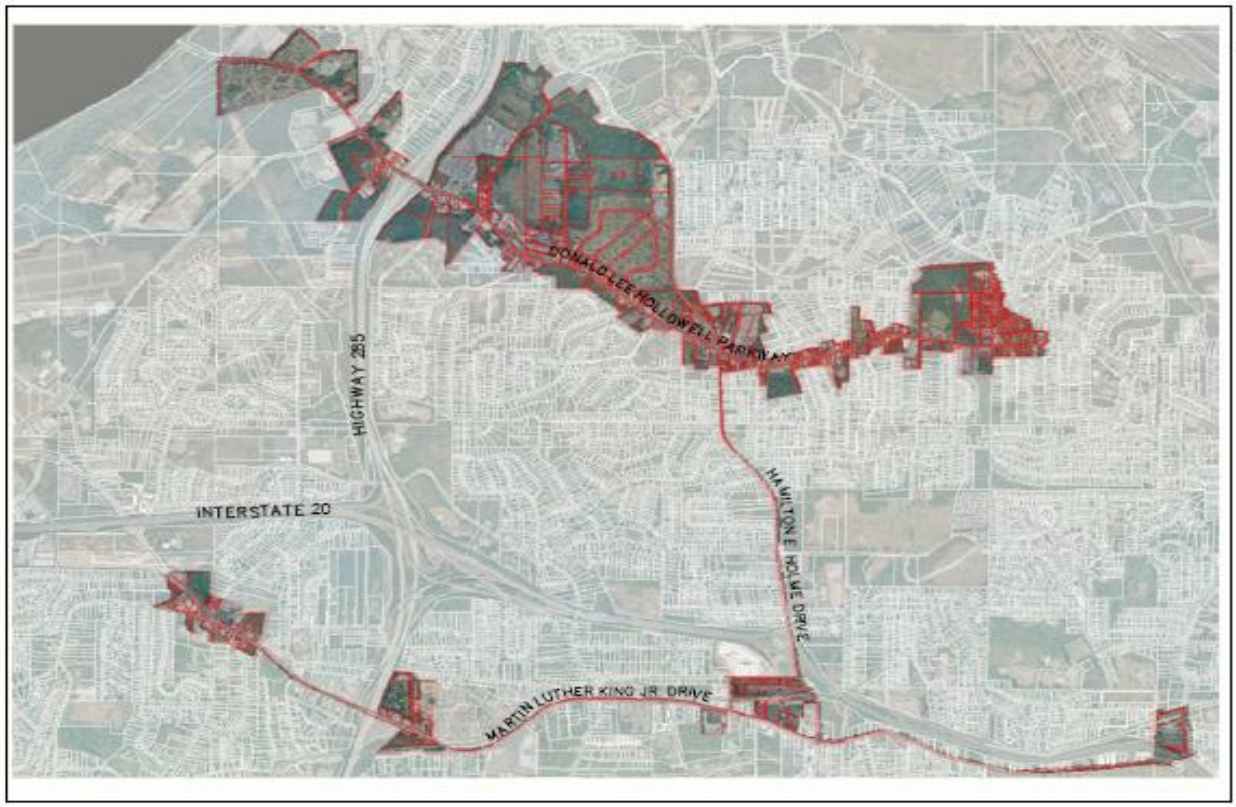

Figure 2.4: Hollowell/Martin Luther King Jr. Drive TAD Boundary. Retrieved from Atlanta Development Authority. (2006). *Hollowell/M.L. King redevelopment plan and tax allocation district*. Retrieved from https://www.investatlanta.com/developers/opportunities-incentives/tax-allocation-district-financing/hollowell-martin-luther-king

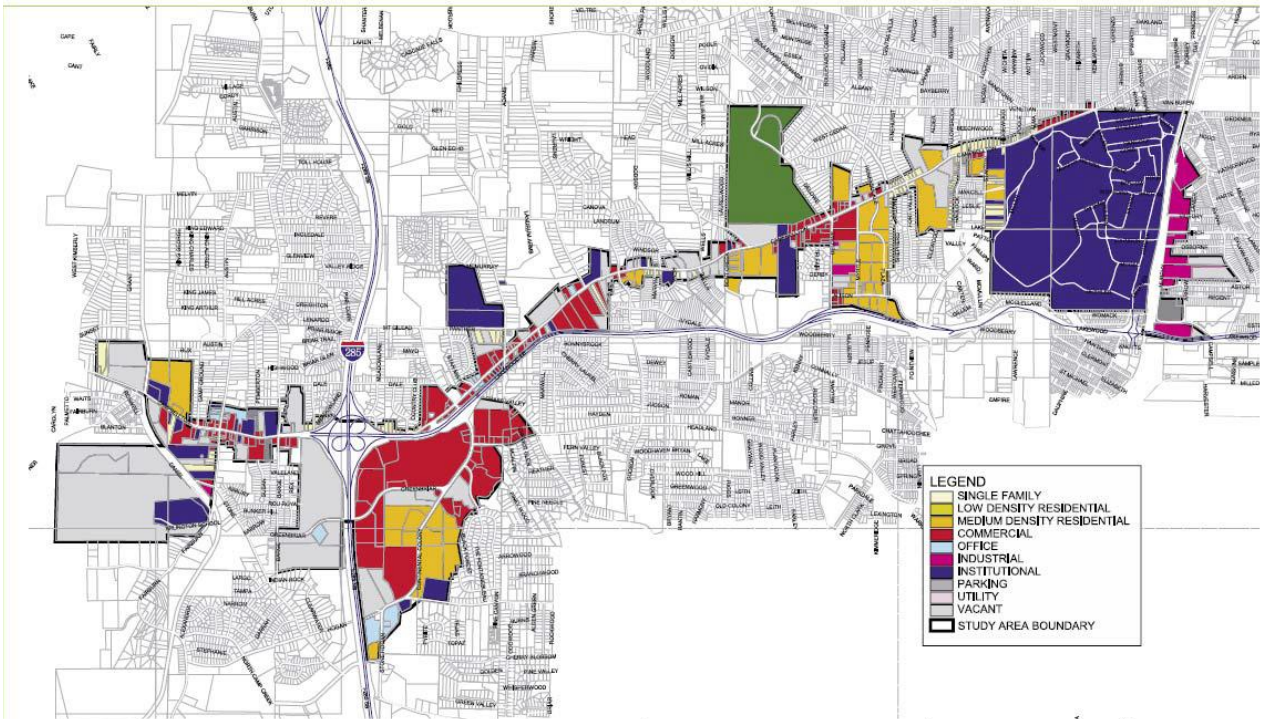

Figure 2.5: Campbellton Road TAD Boundary. Retrieved from Atlanta Development Authority. (2006). *Redevelopment plan for the Campbellton Road tax allocation district Atlanta, Georgia*. Retrieved from https://www.investatlanta.com/developers/opportunities-incentives/tax-allocation-district-financing/campbellton-road

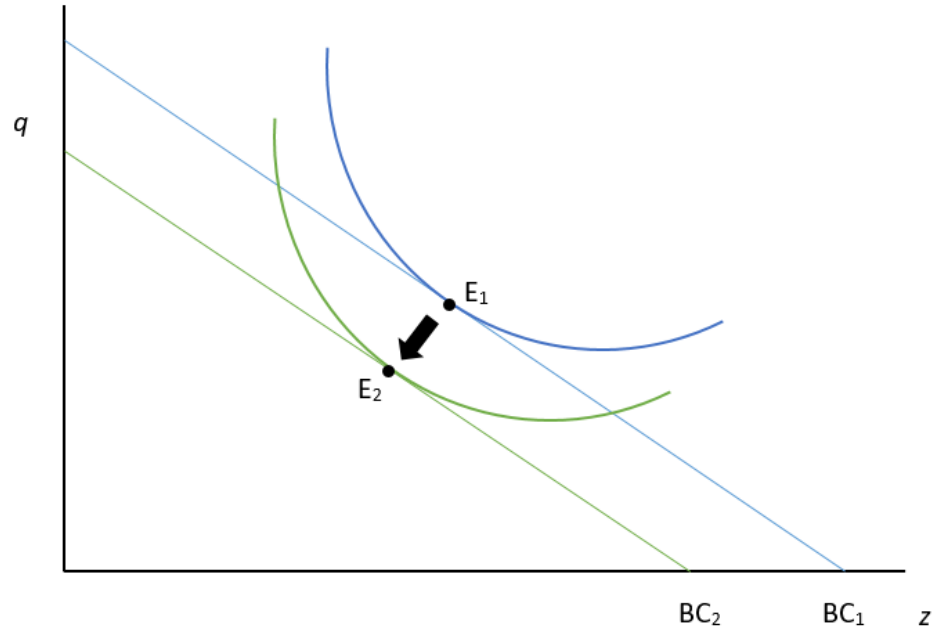

Figure 2.6: Budget Constraint. This graph of a hypothetical budget constraint illustrates the consequences of obtaining additional information for consumer's. As information costs increase, the purchasing power shifts from E1 to E2.

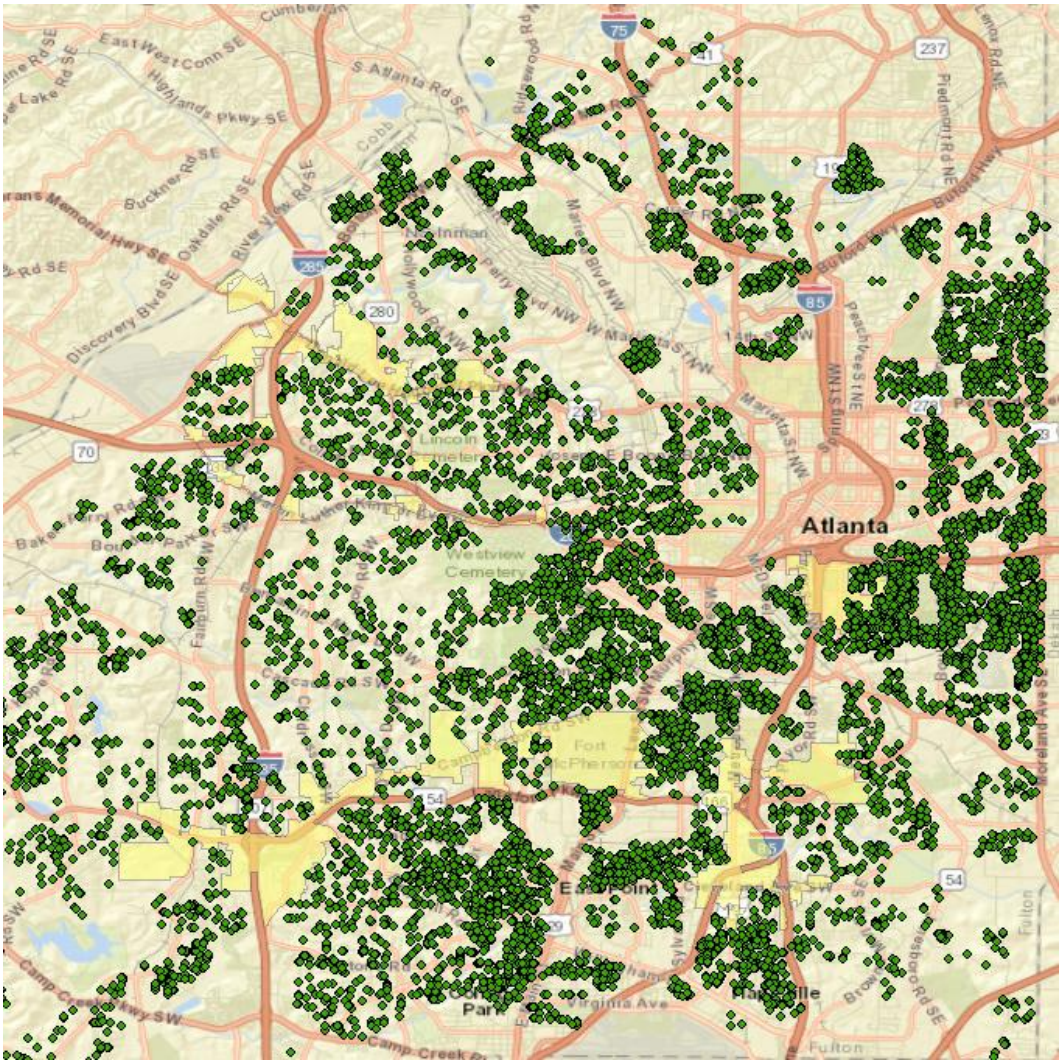

Figure 7: ArcGIS Map of Data Points. This map is generated within ArcGIS. The green dots represent MLS residential real estate observations and the yellow polygons represent the TAD overlay rezones. Distance calculations are recorded between the green dots and the nearest point of the yellow polygons.

EPILOGUE

Private & Publicly Induced Rezoning Discussion

This dissertation explores the influence of private and publicly induced rezoning on residential real estate prices at various distances. The distinction between publicly and privately induced rezoning is the nature of the entity requesting a zone change. Privately induced rezoning begins from the request of a real estate owner or developer. Publicly induced rezoning occurs at the recommendation of a municipal servant or authoritative board. In either case, this dissertation observed housing externalities or spillover effects associated with rezoning.

There are differences between the two forms of rezoning. Generally, privately induced rezoning contains only one or a few parcels of land per surrounding property at a single point in time. Conversely, all of the publicly induced overlay zones studied in this research are over 450 continuous parcels. The geographic scope of publicly induced rezoning is significantly larger than privately induced rezoning.

Another difference between the two types of rezoning is end-use functionality. The assumption in the research is that private developers seek to convert land to the most profitable use. In publicly induced rezoning, the assumption is that municipal leaders or urban planners seek to convert land to maximize social benefit. As an example, the community may benefit the most from affordable housing construction; however, that end-use property function may not be the most profitable use. The public entity might prefer to zone the land with an affordable housing end use function, whereas the private developer may prefer a more lucrative end use function for the land such as multifamily condominiums.

It is important to compare the results of the two essays to disentangle the nuanced differences between privately and publicly induced rezoning. While distance from a rezone plays an important role, the sign and significance level of the externality effects associated with privately induced rezoning primarily depends on the end use function of the new zone. Changing residential real estate zones to another form of end use detrimentally influence surrounding residential real estate prices. At the closest distance tested, 0.75 miles, the spillover effects are the greatest.

The renewal of nonresidential real estate provided the highest effect size among all zone types tested. This finding is crucial as it illustrated that redevelopment of nonresidential properties contributes to local residential real estate prices. This finding may help homeowners overcome a common misconception regarding the externality effects of nonresidential real estate in their community. This misconception has been characterized with the acronym, NIMBY, *not in my back yard*. NIMBY-ism describes the consumer's fight against most nonresidential economic development projects in their community. As the findings in essay one suggest, the redevelopment of existing nonresidential real estate may increase residential real estate prices and contribute to the growth of the community. Additionally, these implications are useful for municipal leaders and policy makers as they craft tax allocation districts and institute new overlay zones.

Essay two explores four tax allocation districts in Atlanta, GA. Combined, these four zones encompass over 3,500 acres. The results of essay two demonstrate that distance from a nearby publicly induced rezone plays a more important role than the characteristics of the rezone itself. The positive spillover effects are statistically significant only until 1.25 miles from the publicly induced rezone. The composition of the TAD overlay zones are not statistically

significant in any of the models. Essay one indicates that the type of rezoned property may influence residential real estate prices. For example, the Metropolitan Parkway and Hollowell/Martin Luther King Jr. Drive TADs are of equal acreage and parcels. The Metropolitan Parkway TAD calls for half as many residential units and only 25% of office/industrial square footage compared to the Hollowell/Martin Luther King Jr. Drive TAD. However, the Hollowell/Martin Luther King Jr. Drive TAD is projected to add only 65% of the retail square footage compared with the Metropolitan Parkway TAD. These differences in TAD comprehensive plans does not yield any statistical differences in residential real estate prices.

After analyzing the results from the two essays, the externality effects are generally larger for residential real estate property near privately induced rezones. This finding may be attributed to the speed of development. Private developers pursuing a profit motive engage in the redevelopment of newly rezoned land quickly. Contrast the private developer's speed of property redevelopment to the municipal process of TAD overlay zoning. In the TAD overlay zone, private developers must engage in the reconstruction and rehabilitation of the district. The municipal authority retains no ability to actively construct buildings. Even though the district may be zoned for a specific function or end use, the municipality cannot force a developer to immediately begin construction.

In addition to the speed of construction, the scope of redevelopment is much smaller for the private developer compared with the publicly induced rezone. The comprehensive plan for the Stadium Neighborhood TAD envisioned the private investment of $1.2 billion within the district. The Campbellton TAD was 50% higher than the Stadium Neighborhood TAD at $1.8 billion. Even if private developers agreed to fund an equal amount of construction, its completion within the community may not be realized for years to come. As a result of construction speed

and immediacy of private development, the externality effects from privately induced rezoning may be better realized as residential real estate price shocks in the localized marketplace.

Were municipal policy makers and urban planners looking to promote a TAD overlay zone within the community, they could increase the speed of construction by contracting with developers in hopes of initiating construction at the time the TAD received full authorization. In addition, TADs could benefit from the increased consumer knowledge of the redevelopment plan. Fully draft comprehensive plans are routinely circulated within the community prior to the authorization of a TAD, but the shear scope of the redevelopment package may be unfathomable or unattainable to the community member or future residents. Segmenting the TAD redevelopment plan into parcel level end use function blocks by distance may be more beneficial to potential residential real estate buyers than its current structure.

The results of these essays should be used by municipal planning board appointees. Any change in zone that deviates from the current culture and homogeneity of the neighborhood should be heavily scrutinized. The lack of consumer opposition should not be justification for the immediate passage of heterogeneous zone changes. However, not all heterogeneous zone changes are detrimental to residential real estate prices. Residential real estate prices increased as a result of a change from nonresidential to residential zones.

In a similar progression of zone planning application, municipal officials and urban planners creating a comprehensive plan for a TAD region must ensure homogenous zone formation. Currently, mixed use zones are fashionable for urban development. The commercial land use component of mixed use zones adds additional tax revenue to the municipality without straining municipal services. The results from essay one indicate negative spillover effects for residential real estate when residential or nonresidential zones are rezoned as mixed use zones.

Within the TAD comprehensive plans, thousands of square feet of new development were reserved for mixed use construction. This new construction may counteract the positive externalities associated with nonresidential redevelopment and renewal. While the additional supply of residential property may place downward pressure on housing rental prices, it may come at the expense of owner asset values.

These two essays are unique for they explore two fundamentally similar events in city planning; yet, they observe different spillover effects on local residential real estate property prices. These essays encompass the same geographic area within the same time period. No study to date has combined these two topics of privately and publicly induced rezoning into one dissertation. This dissertation fills a gap within the literature. There are many more zoning questions to ask and, ultimately, answer; yet, municipal officials and urban planners benefit from the findings of the two empirical essays and the comparative essay discussion found within this dissertation.