MIXED USE AND TRANSIT PROXIMITY PREMIUMS: DO ACCESSIBLE, MULTIPLE-USE PROPERTIES GENERATE PRICE PREMIUMS?

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by
Gina McKeever
Temple University, Fox School of Business and Management
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Review Committee:

Dr. Paul Asabere, Advisory Chair, Finance & Real Estate, Fox School of Business and Management, Temple University
Dr. Peter Chinloy, Finance & Real Estate, Fox School of Business and Management, Temple University
Dr. Connie X. Mao, Finance, Fox School of Business and Management, Temple University
Dr. Lynne Andersson, External Member, Human Resources Management, Fox School of Business and Management, Temple University

ABSTRACT

Mixed-use properties have received increased attention over the last 15 years. There are many perceived benefits of mixed-use development, such as Smart Growth, sustainable development, and urban regentrification. The increased interest in mixed-use developments in suburban, less densely populated areas appears to be motivated by changing consumer preferences and the perceived success of these developments by real estate owners, developers, and governing agencies. Real estate developers, owners and investors have asserted that the financial performance and success of mixed-use projects is better than single-use properties. There is limited data or empirical evidence, in trade publications or academic journals, which supports or disproves this assertion. This research uses data from New York City's five boroughs to empirically study the effects of a property's use-type on the financial performance of commercial projects in order to determine if a "mixed-use premium" exists. Initial findings suggest that a property with multiple uses generate between an 8.5%–17% price premium on average, though the magnitude of the premium varies from borough to borough.

Further, this research also examines the effects of transit proximity on commercial property values in Manhattan. Relevant stakeholders assume that being closer to public transportation will translate into higher market values. The existing literature is mixed, but there appears to be more evidence for a positive relationship between transit proximity and commercial property values. This study will examine the relationship between transit proximity and commercial property values. Preliminarily, adding one subway station within a 0.25 miles radius results in a 14% increase in sales price. Further, a Mixed Use-

Transit Proximity interaction variable was created which showed a positive, but non-significant relationship to commercial property values in Manhattan.

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INTRODUCTION

Mixed-use developments are growing in popularity. Developers, investors of commercial real estate, regulatory/land use planning agencies, and residents have all expressed interest in mixed-use properties, and many new development projects in urban, metropolitan, or suburban areas are comprised of more than one use-type or are otherwise considered a mixed-use development. In fact, in the current real estate environment, it is rare to see a neighborhood-retail center, shopping mall, or stand-alone office park slated for construction even in suburban areas where land is zoned or designated for a specific use-type.

Various factors contribute to the growth of mixed-use properties. Many residents are attracted to the Live Work Play lifestyle (Malizia, 2014), 18-hour and 24-hour cities (Kelly, 2013), and walkable and connected communities (Pivo and Fisher, 2011). City planners and regulatory agencies are more concerned with urban renewal, sustainable development, increasing density, increasing diversity, compact cities, Smart Growth, and New Urbanism (Burton, 2000). Developers and investors recognize the benefits of mixed-use properties including diversification of a property's income stream by relying on two or more different use types. If one market type is soft, cash flows will not abruptly stop if demand remains for other use types at the property. Additionally, if there is an increased demand for this property type, effective rents can be higher than their single-use counterparts, and one-use developments (typically office or retail) can generate demand for other types. Furthermore, in 2010 Emerging Trends (Urban Land Institute A), the mixed-use development was identified as the most attractive property type for institutional investors, and in 2018 Emerging Trends, prospects for urban and suburban mixed-use properties remain relatively high compared to other niche property types. The outlook on single-use properties such as regional malls, outlet centers, power centers, and suburban office parks and buildings is relatively poor, while the prospects for urban high street retail and lifestyle entertainment centers range from fair to excellent (Urban Land Institute B).

Most of the existing literature on mixed-use properties exists in trade publications via descriptive articles, case studies, unsubstantiated claims by developers, and advocacy work for community social and environmental objectives. Theory-based, empirical research on mixed-use properties is surprisingly sparse to date (Rabianski, Gibler, Tidwell, & Clements, 2009). One likely reason for the limited research on mixed-use properties is that there is no single, industry-accepted definition. The Urban Land Institute defines mixed-use development as a property with three or more revenue producing uses that are functionally integrated and generated from a coherent plan (Witherspoon, Abbett, & Gladstone, 1976). In an effort to articulate an industry-wide definition, the International Council of Shopping Centers, Inc. (ICSC), the National Association of Industrial and Office Properties (NAIOP), the Building Owners and Managers Association International (BOMA) and the National Multi Housing Council (NMHC) collaborated and released this definition of mixed-use:

> A mixed-use development is a real estate project with planned integration or some combination of retail, office, residential, hotel recreation or other functions. It is pedestrian-oriented and contains elements of the live-work-play environment. It maximizes space usage, has amenities and

> architectural expression and tends to mitigate traffic and sprawl. ("What Exactly is Mixed Use", 2006)

The existing literature and empirical research would thus not consider a single building containing apartments over street-level retail or office space to be genuinely mixed-use because it is comprised of only two uses and it is not a complex aggregation of land parcels and uses, though this would appear to exclude other types of mixed-use development.

Hoppenbrouwer and Louw (2005) provide a typology of mixed-use developments that can be studied or defined along four dimensions: shared premises (one non-segregated space with multiple functions), vertical (multiple uses in one building), horizontal (numerous uses on one parcel), and time (e.g., a building used as a school by day and theater at night). While most research on mixed-use developments has thus far focused on the horizontal dimension, it is critical to also understand the vertical dimension.

This study will examine mixed-use development along its vertical dimension, as each transactional data point includes the sales price of one property. Within that one property, it can be further designated as having a single use or multiple uses. If there is more than one use contained within one property that is defined as the vertical dimension of mixed use. This research will focus on the vertical dimension of mixed-use properties as each transaction reflects the sales price within one property, not an aggregate of multiple land parcels or adjacent sales. The existing research focuses on the horizontal dimension of mixed-use developments. There is scant academic research on mixed use developments in general, and an even smaller subset of research focusing on the vertical dimension of mixed-use developments.

Research Question

Various stakeholders, including developers, real estate owners/investors, and regulatory agencies believe that the financial performance of mixed-use properties is better than properties with only one use, but there is limited evidence to prove or disprove this assumption found in trade publications or academic journals. The primary goal of this paper is to address the question: Does a property with more than one use (mixed or multiple uses) attract a price premium over single-use properties?

For the purpose of this research, mixed-use will be defined as any property with more than one use. The terms mixed-use and multiple-use will be used interchangeably. The most common commercial single-use properties are multifamily (for rent apartments), retail, office, hospitality (hotel), and industrial. Examples of a mixed-use property include office over street- level retail, apartment over retail, apartment over office, hotel over retail, and condominium over retail. Industrial properties are considered single-use by default, as it is not typical to combine industrial uses with retail or office uses in the NYC market.

In order to determine if a mixed-use premium exists, this paper will consider the transaction-based value of commercial properties that have sold in the most densely populated, metropolitan area of New York City from 2015 to 2018. Additionally, the terms value and price will be interchangeable for the purpose of this paper as they are indicators of a property's financial performance and are directly related. Given NYC's reliance on its transportation system, this paper is well positioned to also address the question: Do transit proximity and transit density have a significant effect on commercial property values?

The study is structured as follows: Chapters 1–5 discuss mixed use properties, and Chapters 6–7 discuss transit proximity and their ability to generate price premiums.

CHAPTER 2

LITERATURE REVIEW

The concepts of mixed-use land development and multi-use buildings date as far back as the Greek agora and medieval market (Witherspoon, Abbett, & Gladstone, 1976). Before the advent of modern transportation, residents had to walk between home, work, and recreation, and traveling long distances was limited. The popularization of the car in the 20th century brought about the increased separation of land use; people could live further from work, businesses, and city centers because commuting became an option. Municipal leaders began designating specific uses to specific areas in order to separate living from commercial uses (working and shopping). Home buyers preferred to separate residential use from commercial use because it allowed families to avoid the negative externalities associated with commercial zones, such as traffic and noise pollution. This phenomenon gave way to suburban sprawl. Jane Jacobs (1961) revived the concept of integrating multiple uses in one area, arguing that this fostered diversity, encouraged vibrant and prosperous neighborhoods, and reduced reliance on automobiles. As preferences change, a renewed interest in mixed-use properties has seen suggested not only for urban regentrification but also for suburban development.

As mentioned above, different stakeholders perceive the benefits of mixed-use properties differently. As major cities have become more populated, the strategy of combining developmental use types has allowed developers to increase population density and maximize use of a limited area. Related topics such as the Live Work Play lifestyle, the 24-hour city, the Compact City, and New Urbanism have helped relevant stakeholders understand what drives consumer demand, the optimal location for various uses, and the overall success of mixed-use development.

These evaluations of the overall successfulness of mixed-use properties have been mixed. Kelly, Adair, McGreal and Roulac (2013), in studying the 24-hour city, found a statistically significant relationship between the 24-hour city and real rents and investment returns, particularly for office properties. Building on Kelly's work, Malizia (2014) suggested that 24-hour cities offer the Live Work Play (LWP) environment that attracts younger consumers, which by extension incorporates mixed-use development. The LWP environment can be described as compact, dense, connected, mixed-use, diverse and walkable. Malizia's work found a strong association between these LWP factors and office property performance. Burton's (2000) study of Compact Cities found that the higher density urban form may be favorable for some aspects of social relationships and harmful for others. Favorable outcomes were public transportation, reduced social segregation, and better access to community amenities, and some of the negative aspects were smaller living spaces and a lack of affordable housing.

Using a case study approach, Grant (2002) studied the effects of New Urbanism on economic vitality, social equality, and environmental quality. She found that there are more negative outcomes, specifically pollution, than benefits to mixed-use projects. Rabianski, Gibler, Tidwell and Clements (2009) reflected on the very limited empirical research into the financial performance of mixed-use projects, of which a majority of the research, listed in Table 1, has looked at the effects of mixed-use developments on surrounding home prices. These studies, which largely measure success via market demand, attempt to give insight into homebuyer preferences and address the optimal placement of mixed-use developments relative to residential developments or zones. Unfortunately, the findings were mixed and did not directly compare the success of mixed-use properties to single-use properties.

The most recent and relevant study on mixed-use properties conducted by Nakamura, Peiser and Torto (2018) designated seven major metropolitan areas as innovation centers, which they identified as hubs of mixed-use development. They compared the financial performance of commercial property types within a 0.5-mile radius and a 1-mile radius to those outside of the respective radii. Office and retail properties had higher values and returns when compared to properties outside of the radius, but there was no premium on multifamily properties within the mixed-use zone. The research question is similar to the one posed in this paper, but the definition of mixed use, data methodology, and analysis differ slightly.

Nakamura et al. (2018) and Childs, Riddiough and Triantis (1996) both measured the success and financial performance of commercial properties using surrounding commercial property values instead of surrounding residential property values (of single-family homes). Childs, Riddiough and Triantis (1996) specifically examined mixed-use redevelopment and the risks associated with assembling land parcels. There are risks associated with redeveloping and rezoning a property, but those risks are partially offset by the benefits of higher rents and higher demand. If redevelopment costs are low, developers have financial incentives to build mixed-use developments.

As mentioned above, Hoppenbrouwer and Louw (2005) defined mixed use developments along four dimensions: shared premises, vertical, horizontal, and time. While most research on mixed-use developments has thus far focused on the horizontal dimension, it is critical to understand all aspects of mixed-use properties, including both the horizontal and the vertical dimensions. The empirical research considers mixed-use properties along Hoppenbouer and Loew's (2005) horizontal dimension: multiple aggregated parcels of land containing multiple and differing uses. Hoppenbouer and Loew provide the framework by which other researchers can study mixed use properties, stating it is acceptable and important to understand mixed use properties along all dimensions. This research will empirically study mixed use developments along the vertical dimension, which is defined as more than one use contained within one property. Chapter 3 will discuss the empirical model and hypothesis.

Table 1. Mixed Use in Academic Literature

This table summarizes the most relevant academic literature on Mixed Use providing the discipline, authors, year of publication, main construction, definition of main construct, measure of the construct (data methodology) and data source.

Discipline	Authors & Year	Construct & Definition	Construct Measure	Data Source
Real Estate	Nakamura, Peiser and Torto (2018)	Examines the financial performance of commercial properties surrounding mixed-use developments. Main goal is to investigate if properties in mixed- use areas have higher financial performance than properties in non-mixed-use areas.	Panel Regression Analysis	NCREIF
Urban Planning	Koster and Rouwendal (2012)	Mixed land use and its effect on housing values. Diverse land uses in a neighborhood have a positive effect on housing pricing. Some land uses are more compatible with residential land use. Also, different users have a differing willingness to pay to be proximate to mixed-use development (multifamily renter vs. single-family homeowners.)	Hedonic Pricing Model on adjacent residential properties	Public information (Dutch)
Land Economics	Kuethe (2012)	Housing prices were higher in areas of higher land use diversity and lower in areas with lower land use fragmentation. Found no statistical significance between land use diversity and home prices.	Hedonic Pricing Model on homes in the city of Milwaukee	Milwaukee tax assessment data
Real Estate Economics	Pivo and Fisher (2011)	Walkability premium occurred in office, retail and apartment values. No premium exists for industrial properties.	OLS Regression	NCREIF, Front Seat

Table 1, continued

Discipline	Authors & Year	Construct & Definition	Construct Measure	Data Source
Urban Economics	Song and Knapp (2004)	Examines effects of mixed land uses on housing values. Found that housing values increase with proximity to public parks or neighborhood single-use properties. Also housing prices were higher in neighborhoods zoned for single-family residential use.	Hedonic Pricing Model: home pricing proximity to mixed-use development	Public information (sales transactions, tax assessments, census data, employment data)
Urban Economics	Song and Knapp (2003)	New Urbanism and its effect on housing values. This study found a potential higher housing values in New Urbanist neighborhoods (up to 15%).	Hedonic Pricing Model: New Urbanist neighborhood vs typical suburban neighborhood	Public information (sales transactions, employment data, land data)
Real Estate Economics	Childs, Riddiough and Triantis (1996)	If redevelopment costs are low, mixing land use and redevelopment has a positive effect on land value and rate of development is faster. Development sites change as marginal returns and risk changes.	Contingent claims pricing framework	
Urban Studies	Cao and Cory (1981)	Increasing industrial, commercial, multi-family and public land uses (in low doses) does not decrease surrounding home values. An optimal mix of land use can be obtained and uses do not need to be separate.	Hedonic Pricing Model	Arizona Census Tracts (1970), zoning data
Law and Economics	Lafferty and French (1978)	Residential property values increase as the amount of industrial land increases. Benefits are income generated for the city and employment opportunities	Hedonic Pricing Index	Boston Public data
Urban Studies	Burnell (1985)	Mixed land use has adverse external effects including pollution. Home values vary depending on proximity to industrial sites.	Hedonic Pricing Index	Data from Cook County, IL

CHAPTER 3

EMPIRICAL MODEL AND HYPOTHESES

As noted from the chart above, the hedonic pricing model was used in the majority of these studies to measure the financial performance of selected mixed-use properties. This technique, pioneered by Griliches (1961) and Rosen (1974), showed that heterogeneous products could be described as a bundle of measurable characteristics or independent variables. The price of a product (the dependent variable) could then be broken down into several implicit prices that could be attributed to each characteristic—these are referred to as their "hedonic" prices. The use of the hedonic pricing model emphasizes and demonstrates a buyer's marginal willingness to pay for each independent variable via the sign and magnitude of each associated coefficient.

The hedonic pricing model is particularly useful for evaluating the values of residential and commercial real estate as each property is comprised of both internal and external characteristics that determine its value. In the case of real estate, examples of internal characteristics include an asset's size, quality, and age, the quality of its amenities, etc. Independent variables in the hedonic pricing model can also be external (i.e., environmental), such as quality of location, quality of submarket within an area, average household income, density, land zoning, etc. One of the biggest drivers of real estate value is location, and the hedonic pricing model allows researchers to study the extent to which buyers value certain independent variables (Koster & Rouwendal, 2012). The purpose of this paper is to investigate how a property's expected use, either single or mixed, affects a buyer's willingness to pay for it using the hedonic pricing model.

Hedonic indices and methods are used primarily for the valuation of single-family or residential homes. Most research on mixed use properties to date uses the value of surrounding residential homes to determine the financial success of mixed-use developments, as residential home prices reflect homebuyers' willingness to pay for homes in a certain location. Cao and Cory (1981), Lafferty and French (1978), Burnell (1985), Song and Knaap (2004), and Koster and Rouwendal (2012) used this method to examine housing values surrounding mixed-use projects. These studies show a homebuyer's or resident's willingness to pay a premium to live near mixed-use properties over single-use commercial properties. Although these results provide a measurement of success via increased residential property values, it only offers the view of the resident and home-buying consumer behavior; it does not reflect the value that a commercial real estate investor, operator, or developer places on mixed-use properties. By using the hedonic pricing model on commercial real estate transactions (or trades), this paper will attempt to examine the price premium associated with mixed-use developments from a real estate investor's perspective.

With the exception of Nakamura et al. (2018), few studies have used commercial property valuation as a determinant of the success of a mixed-use property and any associated price premium. Hedonic methods are not regularly used for commercial real estate transactions due to the thinness and availability of the commercial property market and the proprietary nature of commercial real estate transactions (Fisher, Geltner, & Webb, 1994). Hoag (1980), Miles, Cole, and Guilkey (1990) and Webb, Miles, and Guilkey (1992) used the hedonic pricing model and transaction driven data as an acceptable method to derive value/returns for commercial properties and is considered as predictive as other methods of valuation. In practitioner terms, the hedonic pricing method is akin to the sales comparison approach in an appraisal where characteristics (class type, location, unit size, year built, amenities, etc.) are adjusted to derive a property's market value.

This study will use the transaction-based sales price as an indicator of financial performance. The hedonic pricing model states that the price of a property V, is a function vector of location and other specific traits Z, as shown in Equation 1.

$$V = f(Z) \quad (1)$$

This pricing model allows us to observe the implicit prices (Vzi) for each housing characteristic (Zi), specifically the number of uses of the property. The hedonic is a reduced form equation as it reflects both supply and demand effects (Asabere, 1990).

$$V = \beta 0 + \beta i Zi + \varepsilon \quad (2)$$

where value is the dependent variable, β0 is the constant, βi (i=11) are coefficients, Zi are the independent variables listed in Table 2 and ε is an error term.

Table 2. Definition of Variables

Variable	Definition
MIXEDUSE	Dummy variable indicating Multiple Use = 1, Single Use = 0
AGE	Represents the age of the property in years
BLDGSIZE	Building size in square feet
NUMBER of FLOORS	Represents the number of floors each building contains
LANDAREA	Size of the lot measured in square feet
FAR	Represents Floor to Area Ratio
STARRATING	A Costar defined metric intended to provide a national building quality rating system, which ranges from 1-5
YEAROFSALE	Year in which the property sold
BOROUGH	Dummy variables indicating the Borough the property is located. 1=Bronx 2=Staten Island 3 =Queens 4 =Brooklyn 5= Manhattan.
TDISTANCE	Represents the distance from the nearest transit (1/d)
INTEREST RATE	10-Year Treasury Yield

The hedonic model listed in Equation 2 incorporates independent variables that have a significant relationship with the dependent variable, sales price, or property value. A property's final sales price can be broken into a buyer's willingness to pay for each independent variable.

The MIXEDUSE variable is the main focus of this research. Each transaction will be coded either 0 for single use, meaning only one use-type, or 1 for multiple use, meaning more than one use type. In order to determine the dummy variable coding for MIXEDUSE, each transaction record will be broken down into its various uses. Therefore, a mixed-use property will only need to have two or more uses in order to be coded for mixed-use, i.e., retail and multifamily; hospitality, office, and retail, etc. The sign and scale of the MIXEDUSE coefficient will determine whether single-use or multiple use affects a property's price and whether there is a premium for mixed-use properties over single-use properties.

Several additional variables are included as they affect the value and price of properties. The size of a building has a direct impact on a property's sales price; thus, the BLDGSIZE variable is measured in square feet. This data is typically public record. NUMBEROFFLOORS is an intrinsic characteristic of the property that an investor might consider when acquiring a property. While this variable is related to the BLDGSIZE variable, some investors may place a premium on a high-rise building over a low-rise or mid-rise building. Number of Floors denotes an investors willingness to pay for each additional level. The AGE variable represents the original age of a property's improvements, irrespective of renovations. LOTSIZE represents the size of the land parcel (upon which the building improvements exists) in square feet. The size of the land parcel is important, but the property's zoning and density requirements are what drive land and property values. The Floor Area Ratio (FAR) represents the relationship between the total usable building area and its lot size. Properties with a higher FAR are typically denser and located in urban, metropolitan areas. Land valuation is based upon a property's FAR and the as-of-right building permissions associated with the property. Consequently, a real estate investor will consider FAR when deciding to invest in a commercial property.

In addition to age, building size, lot size, density constraints, and number of floors, asset quality has a significant impact on sales price. Newer or more recently improved buildings that contain state-of-the-art technology and are energy efficient, typically command a premium over older properties that have not been improved since original construction. Variables such as building age and asset class are intended to capture the quality of the building, but they do not account for renovations or capital improvements made to the property. Furthermore, asset class is typically reported by the seller or buyer, not a third party, non-biased entity. The STARRATING variable is meant to measure the quality of the building irrespective of its location and age. It is reported by Costar (provider of secondary data used for this study) and ranges from 1 to 5, allowing assets to be compared across the country. While a five (5) denotes newly constructed, Class A properties, a one (1) typically denotes older properties with no improvements.

This model also uses two locational characteristics to account for the physical environment, BOROUGH and TDISTANCE. The subject area for this research is New York City's (NYC) five boroughs: Bronx, Staten Island, Queens, Manhattan and Brooklyn. The BOROUGH variable will measure a buyer's marginal willingness to pay to acquire property in each borough. Each borough has unique characteristics; for example, there are material differences between investing in Manhattan versus the Bronx, Staten Island, or Queens. The Bronx, Queens and Brooklyn have pockets of suburbia where single-family homes and neighborhood retail centers still exist, Manhattan is more urban, and Staten Island is more suburban. Presumably there is a premium associated with higher quality boroughs, such as Manhattan and Brooklyn. For example, a commercial real estate investor may assign a premium to properties in Manhattan compared to properties located in Queens or Staten Island. Bender, Din, Hoesli and Laasko (1999) highlighted the importance of location as a determinant of value and attempted to quantify a qualitative characteristic using Geographic Information Systems. Bender et al. (1999) established a basis for using several locational characteristics to account for the premiums associated with the physical environment.

In addition to BOROUGH, a property's proximity to public transportation also impacts sales price in an urban area, such as New York City. Access and proximity to the subway in NYC is critical as it is the main mode of transportation to work, shop, and play in the urban metropolis. The TDISTANCE variable will capture the incremental effects of subway proximity to the sales price. This variable is calculated by taking the inverse of the distance from the subway (1/d where d is distance from the subway in miles).

Lastly, interest rates as defined by the 10-year treasury yield on the closing date, were utilized to account for macroeconomic conditions. Lending rates should have a significant impact on an investor's ability to lever an acquisition. One would expect higher rates to drive market values down.

Because mixed-use properties contain more than one use, multiple uses can be seen as a method of reducing risk via land/property use diversification. Similar to portfolio diversification in stocks and bonds or a real estate investor owning different property types in different locations, properties with multiple uses reduce its reliance on a single use and reduce the amount of space that must be absorbed by the market (Kane 2009). For example, if the retail sector is soft due to an external factor, cash flow and occupancy will more than likely decrease on single- use neighborhood retail center. If this same center had apartments above the retail component or an apartment building on the same parcel, the reduction in cash flow would be smaller given that the apartment tenants continue to pay rent.

Childs, Riddiough and Triantis (1996) found that when different uses are not highly correlated mixed-use diversification reduces risk to the developer. The work of Hartzell, Heckman and Miles (2009) found that alternative property types, such as mixed-use properties, have low correlations, and land and existing property values increase significantly as the correlation between uses decreases. Office and retail uses are more correlated to one another than they are to multifamily use, as properties used to sell goods and conduct business are not typically correlated to homes. Hence, we expect to find a positive and significant relationship between a property's use type and its value. The extent to which investors value a multiple-use property over a single-use property will be demonstrated by the magnitude and sign of the MIXEDUSE coefficient.

The model is comprised of 11 dependent variables that are assumed to have a direct and significant impact on a property's selling price. As demonstrated in Figure 1, the primary goal of this research is to use the hedonic pricing model as a method of valuing commercial properties and to specifically observe the relationship via the sign and magnitude of the MIXEDUSE coefficient. While other variables affect price and value, the purpose of this paper is to examine the effects of multiple-use development on property value. Measures for multiple use versus single use include descriptive coding, and the measure for value, the dependent variable, is the transaction price of the property.

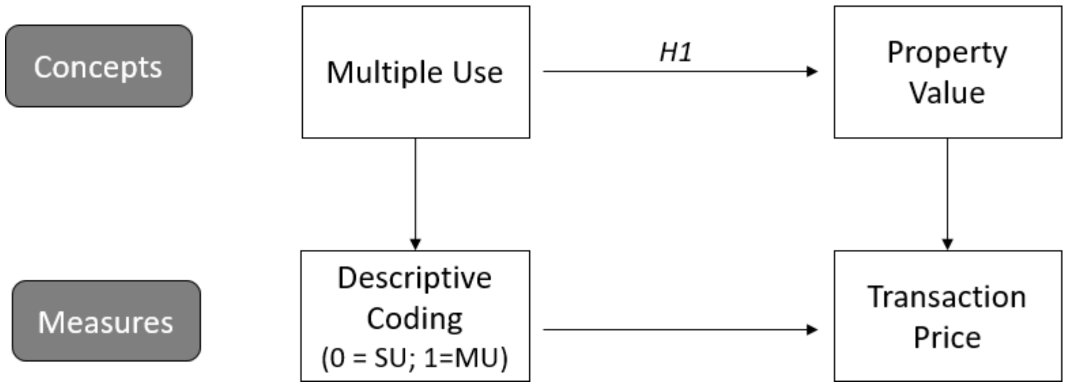

Figure 1. Conceptual Model and Proposed Measures

CHAPTER 4

DATA COLLECTION AND ANALYSIS

Data for this study will be collected from CoStar, a database that contains information on over 5 million commercial real estate properties throughout the United States. This is a comprehensive and rich database that is comprised of publicly available information, including all property sales recorded with the United States. CoStar has over 1,200 researchers who are responsible for collecting and verifying information from a variety of sources. They make approximately 47,000 calls per day to brokers, owners, developers, and other commercial real estate professional. Often data is automatically collected from free, municipal channels via artificial intelligence programs, then researchers speak to property owners, brokers, and other industry participants to verify and confirm the data. CoStar is considered the most comprehensive resource for commercial real estate data as it covers all markets (primary, secondary, tertiary) and all property types throughout the United States. The CoStar database is continuously updated with up to 5.1 million data changes per day.

In addition to individual property information, leasing information, and investment sales data, CoStar provides market data (rent, vacancy, expenses, completion and absorption) for major metro MSAs and associated submarkets. CoStar's product suite includes COMPS (sales comparables and rent comparables), Property, Investment Analysis, Real Estate Manager, Private Sale Network, Portfolio Strategy, Brokerage Applications, Tenant, Lease Analysis, Market Analytics, Risk Analysis, Advertising and Suite. CoStar allows users to ascertain virtually any information about the property including, photos, last transacted sales date and sales price, a property's true owner (not just the owning entity), asset class, rentable square feet, gross square feet, zoning, submarket location, submarket data. See Exhibit 1 for a sample of the available information in CoStar's database.

To analyze the value premium of multiple-use over single-use buildings, this study will use available sales data from CoStar's COMPS. In the sales comps section, the user can search for all property trades made within a specified area and time frame. The results will contain the information required for the variables listed in Table 2: property type, secondary property type, property description, transaction notes, age of building, size of building, size of lot, floor area ratio, Star Rating, transaction sales date, submarket and actual sales price. Distance from nearest subway stop will be collected separately using longitude and latitude, provided in Costar and public information from New York State, New York City Transit and the MTA.

New York City is the largest metropolitan statistical area (MSA) in the United States according to the 2010 US Census Bureau (www.census.gov). As a major metropolitan area NYC contains all of the elements of mixed-use developments. It is the archetypal area for mixed uses, high density, accessibility and walkability. NYC is pedestrian friendly, has aspects of the Live Work Play environment, maximizes space usage, has various amenities including parks and recreational facilities, and attempts to mitigate traffic and sprawl. Additionally, NYC is a densely populated area. The scope of this research will include data from all of NYC's five boroughs, as it will contain both multiple-use properties and single-use properties, such as the single-story bodega, the high-rise office tower, and the 15-unit multifamily walk-up.

The collected data will include all recorded property sales in New York City's five boroughs from January 2015 to December 2018. See Exhibit 2 for a map of the proposed data collection area and location map for the collected sales to date. New York City was selected for three primary reasons: (a) the author's familiarity with the market, (b) the sheer volume of real estate activity in one of the largest MSAs in the United States and (c) given the urban nature of this market there are be a healthy amount of mixed-use trades in the selected time frame. The time frame was selected as to minimize the effects of the 2008 recession on real estate investments and trading. By 2015, real estate investment and development had rebounded to normal levels.

The MIXEDUSE variable will be coded using text recognition of the following data fields in Costar: Property Type, Secondary Type, Description and Transaction Notes. The coding will denote whether a property contains the following components: Multifamily, Retail, Office, Hospitality, Industrial, or Specialty Use (includes garages) using the keywords listed in Table 3. All land sales will be excluded from the data set, as land does not contain any buildings to classify as either single or multiple use. If the fields contain the keywords in Table 3, the data will note that the property features the associated use-type. If each transaction or property contains more than one use type, it will be considered mixed-use and will be coded 1. If the property is comprised of only one use-type, it will be coded 0. From this analysis, we will be able to determine a property's use composition which is necessary for the secondary objective of this paper.

Table 3. Mixed Use Coding Keywords

This table shows keywords used to determine use type of each property. There are 5 different use-types: Multifamily, Retail, Office Hospitality, Industrial and Specialty. Costar typically provides use type within the following fields: Primary Property Type, Secondary Property Type and Property Description. If these fields contained a keyword it was then classified accordingly.

Multi-Family	Retail	Office	Hospitality	Industrial	Specialty
multi-family	retail	office	hospitality	industrial	specialty
multifamily	store		hotel	warehouse	garage
apartment	commercial				
residential					

Between January 1, 2015, and December 31, 2018, there have been 12,485 recorded arms-length transactions in NYC. Non arms-length transactions and partial interest transfers have been removed from the data set as those sales prices (or values) are not reflective of market trades. Based on the text recognition method described above, approximately 25.5% of the total 12,485 property trades are considered multiple use. Additionally, duplicates and records that are missing critical information are not included. Exhibit 3 is a proposed sample of the downloaded data that will be used for this research.

Summary Statistics

Table 4 contains summary statistics for each continuous variable. From January 2015 to December 2018, there were 12,485 observations of Sales Price with a mean of $13,000,000 and a standard deviation of $81,500,000. The minimum sales price was $46,912, and the maximum sales price was $4,100,000,000. Additionally, there were approximately 3,184 Mixed Use properties in the dataset of 12,485 transactions. Because this is a categorical variable, the summary table shows the proportion of mixed-use to single-use properties. The mean of .255 reflects the average number of multiple use (code=1) to single use (code=0) properties.

Table 4. Summary Statistics – All Observations

This table presents the summary statistics for all observations in the sample. The initial sample contains all sales transactions within Bronx, Staten Island, Queens, Brooklyn and Manhattan from January 2015 to December 2018. All data was collected from Costar.

Variable	Obs	Mean	Std.Dev.	Min	Max
Sales Price	12,485	$13,000,000	$8,160,000	$46,912	$4,100,000,000
Mixed Use	12,485	0.255	0.436	0	1
Distance from Transit (miles)	12,485	0.374	0.543	.0029	5.4
Building Size (SF)	12,485	28,154	137,985	112	8,942,176
Floor Area Ratio	11,912	2.962	3.552	.0028	97.224
Land Area (SF)	11,912	11,609	79,416	156	4,440,972
Age (years)	11,526	84	29	0	219
Interest Rate Index	12,485	.023	.004	.014	.032
Number of Floors	11,591	4	4	1	63

The mean Building Size for the sample was 28,154 square feet (sf) with a minimum size of 112 sf and maximum size of 8,942,176 sf. The average land area, also measured in square feet, was 11,608, with a minimum of 153 sf and a maximum 4,440,972 sf. The Floor Area Ratio (FAR) ranged from .0028 to 97. Buildings with extremely low FARs typically represent gas stations, which have a very small building footprint on a larger area of land. As mentioned in the previous section, this reflects the allowed density of the building. The mean Distance from public transportation is 0.374 miles and ranges from .003 to 5.4 miles. The average Age of the sample set is 84 years ranging from 0 (constructed in 2018) to 219 (constructed in 1799). Buildings in the NYC market have an average of 4 floors and ranges from 1 (single-story) to 63 stories.

Due to the categorical nature of the BOROUGH, YEAROFSALE, and STARRATING variables, they are not included in the Table 4. Dummy variables were created for each category within in each variable. As mentioned previously, the five boroughs in New York City were coded as follows: Bronx = 1, Staten Island = 2, Queens = 3, Manhattan 4, Brooklyn = 5. The selected reference borough is Manhattan, which is considered the most valuable in terms of property of the boroughs. Most transactions occurred in 2015 and decline slightly each year. As such, 2015 was set as the base level Year. As expected, most buildings have either a 2-star or 3-star rating out of 5 stars. Four-star properties were set as the base level and changing the Star Rating base level does not materially affect the results. The statistical software package used, STATA, removes observations that do not contain all relevant variables. As such the total sample size is reduced to n=10,931. Table 5 lists the summary statistics for the final sample set. The average sales price for the sample set is $14,200,000, which is slightly higher than the full data set. The remaining averages are similar to the full data set.

Table 5. Summary Statistics – Final Sample

This table shows the summary statistics for the final sample. Stata only uses observations that contain all selected variables. If a field is missing, the observation is excluded. Thus, the initial sample was further reduced to 10,931 observations.

Variable	Obs	Mean	Std.Dev.	Min	Max
Sales Price	10,931	$14,200,000	$8,530,000	$77,700	$4,100,000,000
Mixed Use	10,931	0.257	0.437	0	1
Distance from Transit (miles)	10,931	0.366	0.533	.0029	5.1
Building Size (SF)	10,931	30,830	146,742	112	8,942,176
Floor Area Ratio	10,931	3.043	3.671	.0028	97.224
Land Area (SF)	10,931	11,730	81,348	500	4,440,972
Age (years)	10,931	84	29	0	219
Interest Rate Index	10,931	.022	.004	.014	.032
Number of Floors	10,931	4	4	1	63

Exhibit 4 of the appendix contains distribution graphs for the continuous variables Sales Price, Building Size, Land Area and Floor Area Ratio to check for a normal distribution. Based on a visual check of these distribution graphs, Sales Price, Building Size, and Land Area have a positively skewed distribution, where there is a much higher frequency at the lower values. In order for multiple linear regression models to work optimally, normally distributed data is needed. These variables (Sales Price, Building Size and Land Area) will be transformed by taking the natural log. Exhibit 5 shows the transformed distribution of the aforementioned variables.

Exhibit 6 in the appendix shows two-way scatterplots of the dependent variable against the independent variables. Each relationship appears to be neither linear nor proportionate, as expected from the Collwell and Sirmans (1980) study mentioned above. Each unit of increase in the independent variable does not result in an equal change in price for all values of the independent variable. DiPasquale and Wheaton (1996) confirmed that the nature of real estate values and their characteristics are typically non-linear. In order to test if the non-linear models will be more effective, the natural log of each independent variable is taken in order to linearize the relationship.

Discussion

The hedonic pricing model is used to capture and quantify the relationship between the independent variables (see Table 2) and the dependent variable, market value of the property. Ordinary least squares (OLS) regression analysis is used to test the hypothesis. Historically, the OLS regression has been the preferred technique of data analysis when utilizing the hedonic pricing model. OLS techniques produce optimum results when the dependent variable, independent variables, and error terms are assumed to be individual and independent of each other (Dubin, Pace, & Thibodeau, 1999). Given the nature of real estate transactions, sales prices and the associated error terms are spatially dependent upon proximate sales. There are two main ways this spatial dependence occurs. First, appraisal valuations typically utilize comparable sales to determine property value. Sales comparables are properties that have similar physical characteristics, and are, ideally, located in the same neighborhood or submarket. Market values of properties rely on similar properties that are located near a subject property. The sale of one property has a direct effect on the sales price or market value of its neighboring properties. Second, the physical characteristics of buildings, specifically the exterior and façades within neighborhoods tend to be similar. This is often tied to zoning regulations and restrictions placed on the type of improvements that can be made at a property.

In order to account for the spatial dependence of a property's sales price on nearby sales, Spatial Autoregressive (SAR) models will be utilized in additional to OLS estimation techniques. SAR models use a spatial lag, similar to a time lag in the time-series literature, in which a weighing matrix is used to determine the spillover effects of one transaction on another. Using a generalized spatial two-stage least squares (gs2sls) estimator, the SAR model extends the linear regression model by accounting for spillover effects from neighboring properties (StataCorp, 2019). The use of SAR techniques will improve the accuracy of predictions made by multiple regression models (Dubin, Pace, & Thibodeau, 1999).

The dependent variable was regressed against the independent variables listed in Table 2 using the Ordinary Least Squares and Spatial Autoregressive estimation techniques. The results of the analyses can be found in Table 6, which shows Model 1 as the OLS regression and Model 2 as the SAR model. The adjusted R-squared ranges from 64.4% - 66.7% in these 2 models, which implies that the models explain approximately 64%-67% of the variability in sales price around the mean. There is only a slight difference in the adjusted R-squared of both models. The SAR model explains only 2.3% more of the variation within the data. Furthermore, the significance of each variable and magnitude of the significance are also very similar between the OLS and SAR model. The use of the SAR model accounts for the autocorrelation between each sales price, yielding less biased estimates in Model 2.

Table 6. Regression Results – All Five Boroughs

The table below presents the results of the regressions that estimate the effects of Mixed Use on sales prices in NYC. Model 1 shows the OLS regression results and Model 2 shows the results of the SAR model. All variables are as defined as Table 2. The T-statistic based on the standard error of each variable is provided in the parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(1) OLS Sales Price (ln)	**(2) SAR** Sales Price (ln)
Mixed Use	0.0543***	0.0889***
	(3.07)	(5.21)
Distant From Transit (*1/d*)	0.006***	0.005***
	(9.15)	(7.28)
Building Size (SF)	0.535***	0.422***
	(23.84)	(23.14)
Floor Area Ratio	0.000***	0.000***
	(8.04)	(7.55)
Land Area (SF)	0.245***	0.388***
	(17.80)	(21.59)
Age	0.000	-0.000
	(1.88)	(-1.50)
Interest Rate Index	-0.098	2.449
	(0.03)	(0.68)
2015 (Reference)	---	---
2016	0.062***	0.081***
	(2.80)	(3.78)
2017	0.174***	0.175***
	(7.66)	(8.01)
2018	0.181***	0.171***
	(5.06)	(4.97)
Number of Floors	-0.013***	-0.003
	(-4.28)	(-1.35)
1 Star Rating	-0.349***	-0.335***
	(-5.88)	(-5.86)
2 Star Rating	-0.265***	-0.241***
	(-5.13)	(-4.84)
3 Star Rating	-0.295***	-0.268***
	(-5.82)	(-5.47)
4 Star Rating (Reference)	---	---
5 Star Rating	-0.315***	-0.383***
	(-2.67)	(-3.38)
Bronx	-1.256***	-0.831***
	(-44.56)	(-26.73)
Staten Island	-1.579***	-0.882***
	(-30.04)	(-15.72)
Queens	-0.932***	-0.613***
	(-35.71)	(-22.17)

Table 6, continued

	(1) OLS Sales Price (ln)	(2) SAR Sales Price (ln)
Brooklyn	-0.3157*** (-4.28)	-0.645*** (-30.14)
Constant	8.889*** (69.34)	7.410*** (55.20)
Obs.	10,931	10,931
Adjusted R-squared	0.644	0.667

The variable of importance, MIXEDUSE, shows a positive relationship with property sales prices, and the result is significant at the 1% level in Model 1 and Model 2. The MIXEDUSE coefficient represents the average sales price premium of mixed-use properties over single-use properties. Because the dependent variable is in log form and the independent variable is in its original form, the coefficient in Table 6 must be exponentiated so that a percentage change can be calculated (by subtracting 1 then dividing by 100.) Using this technique for the independent variables in their original form, the MIXEDUSE coefficient shows that multiple use properties have an average 5.6% price premium based on the OLS model, and a 9.3% price premium based on the SAR model, over single-use properties. These results show that (1) multiple uses is a highly significant characteristic in determining commercial property values in NYC's five boroughs and (2) there is a considerable price premium, between 5%–9%, for properties with multiple uses.

The distance from transportation coefficient (TDISTANCE) is highly significant to 1% levels in both models. The sign of the TDISTANCE variable is positive, which is to be expected. A positive coefficient is anticipated when taking the inverse of distance, as shown in Models 1 and 2 above. The next chapter further examines the relationship between transportation proximity and commercial property values. Utilizing the same methodology to transform the coefficients into an interpretable result, a one (1) mile increase would result in a .06% and .05% increase in price in Models 1 and 2, respectively. These results show that distance from a subway station is an important characteristic in all five boroughs, but the effect is economically very small.

The building size coefficient is also highly significant to 1% levels in both models and signifies that a 1% increase in building size results in a 0.422% - 0.535% increase in sales price on average. Because the log form of this independent variable was used, coefficients can be directly interpreted from Table 6. The floor area ratio variable is significant to 1% levels in the OLS and SAR models. While the variable is positive and significant, a 1 unit increase in the FAR ratio results in 0% increase in the price. The results show that FAR is an important determinant for market value, but it does not lead to any increases on average. The land area coefficient is significant at 1% levels in both models. The sign of the coefficient is positive and the price premium ranges from 0.245% - 0.388%. These results show a nominal premium increase associated with a 1% increase in land area.

The number of floors coefficient is highly significant to 1% in the OLS model and non-significant in the SAR model. The sign of both coefficients is negative, which means that an increase of 1 floor results in a 0.03% - 1.29% lower market value on average. The negative relationship between number of floors and sales price may seem counterintuitive, but there are a few chronically nonlinear relationships in real estate (Colwell and Sirmans, 1980, Colwell and Munneke, 1997). These studies show that the relationship between number of floors and building size is not necessarily proportional. In other words, this relationship tends to be positive and linear up to a certain point, and then the marginal contribution begins to diminish. The negative coefficient for the number of floors variable shows that increasing the size of a building by going vertical or adding floors does not yield a proportionate increase in the sale price for each floor. As an example, going from 2 floors to 3 floors may yield a much higher return than would going from 40 floors to 41 floors.

The age coefficient is not significant in Model 1 or Model 2. While the coefficient is positive in Model 1 and negative in Model 2, both show that a 1% increase in building age results in 0% change in market value on average. Although, a negative coefficient would make more intuitive sense, assuming that market values tend to decline as a property ages.

As mentioned above there are 3 dummy variables: Year of Sale, Star Rating and Borough. Results for these variables can be found in Table 6. The reference level for the Year variable is 2015. All of the Year dummy variables were statistically significant relative to 2015 and the sign of the coefficient is positive. The positive sign means sales prices in 2016-2018 were higher than sales that occurred in 2015 on average. Four-star properties are the reference variable for the Star Rating variable. The Star Rating metric is meant to capture a property's asset quality. The 1-star, 2-star, 3-star and 5-star properties were significant and negative when compared to the 4-star properties. Based on the results, 4-star properties would yield the highest premium.

In addition to inverse distance from the subway, BOROUGH was used as a second locational variable. Each borough was assigned a dummy variable, and the borough of Manhattan was set as the reference level. All boroughs show statistical significance and the coefficient signs are all negative. These results demonstrate that 1) Borough location is an important characteristic in the determination of market value and 2) on average, sales prices in the Bronx, Staten Island, Queens and Brooklyn are lower when compared to

Manhattan sales prices, which makes intuitive sense. The coefficient for each borough, in order of increasing percentage change, are as follows: Brooklyn (-0.35%), Queens (-0.93%), Bronx (-1.26%) and Staten Island (-1.58%). These coefficients show that Brooklyn has the most similar prices to Manhattan and there is more disparity in price between Staten Island and Manhattan. These results elude to the notion that different boroughs have different characteristics and demand drivers which lead to differing sales prices.

Often times it is hard to quantify location within the hedonic pricing model. The Borough variable provides a means to add a quantifiable locational characteristic to the Sales Price model proposed in this paper and it also provides another means to examine mixed use, within each individual borough. The regression results in Table 6 incorporate transactional data for all of NYC's five boroughs, but each borough has its own unique characteristics which most real estate professionals consider completely different markets. The shape and composition of the urban area ranges from Manhattan, the quintessential urban area, to Staten Island, which is the quintessential suburban neighborhood. It is important to note that access to Manhattan can only be obtained via ferry or by car. There is no subway or railway line that connects the two boroughs. Brooklyn, the Bronx and Queens contain varying degrees of the urban form.

To test the robustness of the Mixed Use results above, the same model was utilized with sales price as the dependent variable and the independent variables as listed in Table 2 to run OLS regressions for each Borough. A borough by borough examination of the data will provide additional insight into the relationship between multiple use properties and market values and it should also reveal which characteristics are significant in determining market value in each borough.

Table 7. Regression Results – OLS Models for Each Borough

The table below presents the results of the OLS regressions that estimate the effects of Mixed Use on market values within each individual borough. All variables are as defined in Table 2. The T-statistic based on the standard error of each variable is provided in the parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(3)	(4)	(5)	(6)	(7)
	Bronx Sales Price (ln)	Staten Island Sales Price (ln)	Queens Sales Price (ln)	Manhattan Sales Price (ln)	Brooklyn Sales Price (ln)
Mixed Use	0.121***	-0.167**	-0.015	0.171***	0.049**
	(2.89)	(-2.00)	(-0.45)	(3.66)	(2.14)
Distant From Transit (*1/d*)	0.006***	0.008	0.005***	0.006***	0.006***
	(3.46)	(1.38)	(3.58)	(3.97)	(7.59)
Building Size (SF)	0.363***	0.476***	0.342***	0.544***	0.414***
	(8.94)	(6.52)	(9.37)	(12.13)	(13.28)
Floor Area Ratio	0.000***	-0.000	0.000***	-0.000	0.000***
	(7.16)	(-0.45)	(7.05)	(-0.27)	(5.29)
Land Area (SF)	0.503***	0.238***	0.475***	0.119**	0.354***
	(12.82)	(3.33)	(13.57)	(2.40)	(12.04)
Age	-0.002***	-0.002**	0.000	0.001	0.001**
	(-2.71)	(-1.98)	(0.50)	(1.27)	(2.02)
Interest Rate Index	1.196	-51.677***	-0.635	-1.751	6.362
	(0.16)	(-3.32)	(-0.09)	(-0.19)	(1.23)
2015 (Reference)	---	---	---	---	---
2016	0.050	-0.026	0.112**	0.017	0.096***
	(1.12)	(-0.28)	(2.55)	(0.31)	(3.18)
2017	0.295***	0.298***	0.205***	-0.031	0.233***
	(6.47)	(2.86)	(4.79)	(-0.52)	(7.83)
2018	0.289***	0.658***	0.297***	-0.025	0.195***
	(3.98)	(4.38)	(4.33)	(-0.27)	(4.02)
Number of Floors	-0.006	0.062**	-0.014*	-0.005	0.033***
	(-0.60)	(2.18)	(-1.67)	(-0.86)	(4.40)
1 Star Rating	-0.139	0.213	-0.415***	0.010	-0.250***
	(-0.89)	(0.61)	(-3.49)	(0.06)	(-2.60)
2 Star Rating	-0.077	0.481	-0.329***	-0.389***	-0.191**
	(-0.53)	(1.43)	(-2.97)	(-3.89)	(-2.17)
3 Star Rating	0.020	0.580*	-0.366***	-0.460***	-0.221**
	(0.14)	(1.70)	(-3.36)	(-4.85)	(-2.52)
4 Star Rating (Reference)	---	---	---	---	---
5 Star Rating	N/A	N/A	N/A	-0.325*	-0.279
				(-1.83)	(-1.09)
Constant	6.438***	8.322***	7.502***	10.094***	7.696***
	(24.24)	(14.15)	(31.03)	(30.86)	(41.74)
Obs.	1237	288	2258	2930	4217
Adjusted R-squared	0.763	0.7138	0.644	0.389	0.593

The results of the OLS regressions are shown in Table 7 within Models 3 (Bronx), 4 (Staten Island), 5 (Queens), 6 (Manhattan) and 7 (Brooklyn). The adjusted R-squared ranges from 38.9% - 76.3%. It appears that there is significant variation in the Manhattan data (R^2 of 39%), but the models for the other boroughs still explain a high percentage of the variation within the data (60% - 76%).

The significance and sign of the Mixed Use coefficient varies from borough to borough. The Mixed Use coefficient is significant in all boroughs except for Queens and positive in all boroughs except for Staten Island and Queens. The results in Table 7 show that having multiple uses is not a critical characteristic in determining market value in Queens. Conversely, in Staten Island an area that is considered more suburban, single-use properties generate a higher premium than multiple use property, approximately 17% higher on average. Multiple use property sales have a 13% premium over single use properties in the Bronx, 2% price premium in Queens (though the coefficient is not significant), 12.4% price premium in Manhattan and 8.5% increase in Brooklyn. The combined dataset showed statistical significance for the Mixed Use coefficient. The results in Table 7 shows that the significance (and predicted price premium) of the Mixed Use variable differs from borough to borough, which is to be expected as the boroughs are heterogenous in nature.

The Bronx OLS regression results reported that the following variables are statistically significant: Mixed Use, distance from transit, building size, floor area ratio, land area, age, 2017 and 2018. The sign for each of the significant coefficients except for age is positive. The age coefficient is negative which is to be expected. As a property ages, the sales price is expected to decrease. This borough has the highest adjusted R squared (76%).

The Staten Island OLS regression results reported that the following variables are statistically significant: Mixed Use, building size, land area, age, interest rate, 2017, 2018, number of floors and 3-star rating. Interestingly, the distance from the transit variable was not significant in Staten Island, which implies that proximity to public transportation is not critical in determining commercial real estate values in a suburban, heavily car-dependent borough. Additionally, Staten Island is the only borough in which the interest rate variable was statistically significant and negative.

The Queens OLS regression results reported that the following variables are statistically significant: distance from transit, building size, floor area ratio, land area, 2016, 2017, 2018 and 1-, 2- and 3-star rating properties. As mentioned above, the MIXEDUSE variable was not statistically significant.

The Manhattan OLS regression results reported that the following variables are statistically significant: Mixed Use, distance from transit, building size, land area and 2-, 3- and 5-star rating. This borough has the lowest adjusted R squared (39%).

The Brooklyn OLS regression results reported that the following variables are statistically significant: Mixed Use, distance from transit, building size, floor area ratio, land area, age, 2016, 2017, 2018, number of floors and 1-, 2- and 3-star rating.

Building size and land area were highly significant at the 1% level for all boroughs. The mixed use, distance from transit, 2017, and 2018 variables showed statistical significance in four out of five boroughs. Based on the regression results, building size, land area, mixed use, distance from transit, and timing of sale are critical characteristics in determining market value. Interest rate and number of floors did not appear to have a significant impact on a property's sales price. While a mixed-use premium appears to exist for boroughs that are more urban in nature, Bronx, Manhattan and Brooklyn, single use premiums seem to exist in boroughs that are more suburban, Staten Island and Queens.

Table 8. Regression Results – SAR Models for Each Borough

The table below presents the results of the Spatial Auto-Regressions that estimate the effects of Mixed Use on market values within each borough. All variables are as defined in Table 2. The T-statistic based on the standard error of each variable is provided in the parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(8)	(9)	(10)	(11)	(12)
	Bronx Sales Price (ln)	Staten Island Sales Price (ln)	Queens Sales Price (ln)	Manhattan Sales Price (ln)	Brooklyn Sales Price (ln)
Mixed Use	0.124***	-0.1701**	0.020	0.117**	0.082***
	(2.98)	(-2.08)	(0.62)	(2.58)	(3.72)
Distant From Transit (*1/d*)	0.006***	0.008	0.003**	0.004**	0.006***
	(3.54)	(1.43)	(2.27)	(2.44)	(6.74)
Building Size (SF)	0.368***	0.476***	0.333***	0.484***	0.416***
	(9.12)	(6.70)	(9.45)	(11.12)	(13.79)
Floor Area Ratio	0.000***	-0.000	0.000***	0.000	0.000***
	(6.81)	(-0.38)	(5.96)	(0.39)	(4.62)
Land Area (SF)	0.505***	0.238***	0.524***	0.282***	0.387***
	(12.97)	(3.33)	(15.39)	(5.68)	(13.62)
Age	-0.002***	-0.002**	-0.000	0.000	-0.000
	(-3.08)	(-1.76)	(-0.18)	(0.85)	(-0.13)
Interest Rate Index	1.318	-15.048***	4.543	7.430**	5.005
	(0.18)	(-3.33)	(0.63)	(2.44)	(1.00)
2015 (Reference)	---	---	---	---	---
2016	0.049	-0.024	0.152**	0.0713	0.090***
	(1.12)	(-0.27)	(3.58)	(1.32)	(3.08)
2017	0.291***	0.299***	0.197***	0.004	0.242***
	(6.44)	(2.94)	(4.78)	(0.06)	(8.40)
2018	0.289***	0.655***	0.266***	-0.079	0.214***
	(4.01)	(4.48)	(4.01)	(-0.90)	(4.57)
Number of Floors	-0.007	0.061**	-0.0180**	-0.006	0.021***
	(-0.66)	(2.20)	(-2.17)	(-1.28)	(2.93)
1 Star Rating	-0.132	0.221	-0.482***	0.056	-0.197**
	(-0.86)	(0.65)	(-4.19)	(0.37)	(-2.11)
2 Star Rating	-0.0714	0.484	-0.379***	-0.323***	-0.115
	(-0.49)	(1.48)	(-3.55)	(-3.34)	(-1.36)
3 Star Rating	0.0188	0.585*	-0.409***	-0.410***	-0.147*
	(0.13)	(1.76)	(-3.89)	(-4.47)	(-1.72)
4 Star Rating (Reference)	---	---	---	---	---

Table 8, continued

	(8)	(9)	(10)	(11)	(12)
	Bronx Sales Price (ln)	Staten Island Sales Price (ln)	Queens Sales Price (ln)	Manhattan Sales Price (ln)	Brooklyn Sales Price (ln)
5 Star Rating	N/A	N/A	N/A	-0.353**	-0.177
				(-2.06)	(-0.72)
Constant	6.269***	8.383***	6.573***	7.849***	6.700***
	(22.88)	(14.41)	(26.71)	(21.95)	(35.63)
Obs.	1237	288	2259	2930	4217
Adjusted R-squared	0.7665	0.7282	0.6660	0.4236	0.6153

SAR estimation techniques were also used to complete a borough by borough analysis of the data. As mentioned above, SAR models account for the collinearity of sales prices. Thus, the results should not differ greatly from OLS models, but instead the SAR model should provide more accurate prediction results. The results of the Spatial Autoregression can be found in Table 8. As expected, the results are similar to that of the OLS models presented in Table 7. The significance of each variable and the sign of each coefficient is marginally different. The adjusted R squared ranges between 42.4% - 76.7%, which is slightly higher than the OLS results, which ranged from 38.9% - 76.3%.

The Mixed Use variable is significant in all boroughs except Queens, similar to the OLS regression. The sign of the coefficient is positive in the Bronx, Queens, Manhattan and Brooklyn, but negative in Staten Island. The negative coefficient can be interpreted to mean that on Staten Island there is a 15.6% price premium for single use properties. The Bronx, Manhattan and Brooklyn show a 13%, 12% and 8.5% price premium for multiple use properties, respectively.

The Bronx SAR estimation results reported the following variables as having statistical significance: Mixed Use, distance from transit, building size, floor area ratio, land area, age, 2017 and 2018. The sign for each of the significant coefficients except for age is positive. The age coefficient is negative which is to be expected. This borough has the highest adjusted R squared (77%).

The Staten Island SAR results reported the following variables as having statistical significance: Mixed Use, building size, land area, age, interest rate, 2017, 2018 and number of floors. Similar to the OLS model, the distance from transit variable was not significant in Staten Island and this is the only borough in which the interest rate variable was statistically significant. The SAR results confirmed the results of the OLS regression.

The Queens OLS regression results reported the following variables as having statistical significance: distance from transit, building size, floor area ratio, land area, 2016, 2017, 2018 and 1-, 2- and 3-star rating properties. As mentioned above, the MIXEDUSE variable was not statistically significant and Queens is the only borough were the quality of the asset was statistically significant.

The Manhattan OLS regression results reported the following variables as having statistical significance: Mixed Use, distance from transit, building size, land area, 2016 and 2-, 3- and 5-star rating. While Manhattan has the lowest adjusted R squared (42.5%) of the boroughs, it is the most improved of R squared from its OLS models.

The Brooklyn SAR results reported the following variables as having statistical significance: Mixed Use, distance from transit, building size, floor area ratio, land area, 2016, 2017, 2018, number of floors and 3-star rating.

Table 9 shows the level of significance and sign of the mixed use variable and adjusted R-squared for both the OLS and SAR models. The results are similar in terms of the determinants of value and the sign of the coefficients for each borough. Using the hedonic model, consistently significant variables include Mixed Use (the coefficient of interest), distance from public transit, building size and land area.

Table 9. Results Comparison for OLS and SAR models

This table compares the results of the OLS and SAR models for each borough, specifically the adjusted R-squared for each model and the sign and significance of the variable of interest, Mixed Use. Results are similar within each borough.

	Bronx		**Staten Island**		**Queens**		**Manhattan**		**Brooklyn**	
	OLS	**SAR**	**OLS**	**SAR**	**OLS**	**SAR**	**OLS**	**SAR**	**OLS**	**SAR**
Adjusted R^2	76.3%	76.7%	71.4%	72.8%	64.4%	66.6%	38.9%	42.5%	59.3%	61.5%
Mixed Use	1% / +	1% / +	5% / -	5% / -	NS / -	NS / +	1% / +	5% / +	5% / +	1% / +

Examining all five boroughs within one dataset, the multiple use variable was highly significant and generated a price premium ranging from 5.6% – 9.3% on average, which constitutes a material difference considering the magnitude of sales prices for this market. A borough by borough study of the multiple use variable yielded slightly different results. The Mixed Use variable was not significant in the Queens models, which is expected as it contains more suburban areas and it is far from Manhattan. Commercial property prices in Staten Island are affected by multiple uses, but in a negative way. According to the results, single use properties generate an 18% premium over multiple use properties. This finding is probably due to the fully suburban nature of Staten Island. While Staten Island is proximate to Manhattan, there is limited connectivity to Manhattan which makes it a typical suburban area more akin to New Jersey.

These findings show that multiple use properties are a significant quality and generate a positive price premium over single use properties in Manhattan, Brooklyn and the Bronx. These boroughs have a more urban form where residents and investors value accessibility and the ability to live, work, play and shop within a close vicinity. The results of this study confirm the hypothesis of this paper, multiple use properties are both an important characteristic in determining market value, and there appears to be a premium associated with multiple uses.

While the above models show the effects of Mixed Use (defined as a binary event) on market values, it may be useful to consider the effect of the actual Number of Uses each property has on market values in NYC. The Number of Uses variable is defined as the number of uses each property has. An OLS regression was run using the same controls listed in Table 2, replacing Mixed Use with Number of Uses. Based on the final sample data, number of uses can be either 1 (single use), 2, 3 or 4. As Costar only identifies 6 use types, a maximum number of uses of 4 makes intuitive sense. Table 10 shows the results of considering Number of Uses as a continuous variable (Model 13) and as a categorical variable (Model 14). The effect of Number of Uses on NYC market values is similar to the effect of Mixed Use on market values. First, the variable is significant to 1% levels. Second, the magnitude of the coefficient is similar showing a 5.17% increase in market value as the number of uses increases, on average. Model 1 showed a 5.6% premium for multiple use properties. All other variables, with respect to significance and magnitude, are similar to that of the original Mixed Use model (Model 1).

Table 10. Number of Uses OLS Regressions

The table presents the results of the OLS regressions which estimate the effects of the number of uses on market values in NYC. 1 which is not displayed in the table, represents single use and is the reference level of this variable. *2, 3,* and *4* show the marginal increase of adding a use type to a property. The T-statistic based on the standard error of each variable is provided in the parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(13) Sales Price (ln)	**(14)** Sales Price (ln)
Number of Uses	0.0517*** (3.33)	
2		0.5055*** (2.80)

Table 10, continued

	(13) Sales Price (ln)	**(14)** Sales Price (ln)
3		0.0122**
		(1.94)
4		0.106
		(0.63)
Distant From Transit (*1/d*)	0.006***	0.006***
	(9.07)	(9.04)
Building Size (SF)	0.522***	0.522***
	(37.66)	(37.63)
Floor Area Ratio	0.025***	0.025***
	(6.40)	(6.50)
Land Area (SF)	0.255***	0.255***
	(18.32)	(18.27)
Age	0.000**	0.000**
	(1.92)	(1.92)
Interest Rate Index	-0.648	0.672
	(0.17)	(0.18)
2015 (Reference)	---	---
2016	0.062***	0.0625***
	(2.80)	(2.81)
2017	0.172***	0.172***
	(7.60)	(7.60)
2018	0.174***	0.174***
	(4.87)	(4.86)
Number of Floors	-0.017***	-0.017***
	(-5.44)	(-5.44)
1 Star Rating	-0.349***	-0.349***
	(-5.89)	(-5.89)
2 Star Rating	-0.261***	-0.261***
	(-5.04)	(-5.05)
3 Star Rating	-0.294***	-0.294***
	(-5.79)	(-5.79)
4 Star Rating (Reference)	---	---
5 Star Rating	-0.279***	-0.279***
	(-2.36)	(-2.36)
Bronx	-1.256***	-1.256***
	(-44.36)	(-44.31)
Staten Island	-1.575***	-1.574***
	(-29.82)	(-29.79)
Queens	-0.934***	-0.934***
	(-35.70)	(-35.64)
Manhattan (Reference)	---	---
Brooklyn	-0.7886***	-0.7886***
	(-36.81)	(-36.70)
Constant	8.856***	8.908***
	(67.60)	(69.29)
Obs.	10,931	10,931
Adjusted R-squared	0.643	0.646

Number of Uses was also considered as a categorical variable in Model 14. This will show the effects of a property having 2, 3 and 4 uses compared to having a single use property. The results in Table 10 show the Number of Uses is significant for 2 uses and 3 uses, but not 4 uses. Additionally, when compared to a single use property, a property with 2 uses looks to have a 50% premium over a single use property on average. This is a significant increase when going from single use to a two-use property. One explanation for this is that most single use properties in Manhattan are multifamily or co-operative properties, and adding a commercial component, typically retail or office, leads to a significant increase in property values. A property with 3 uses has a 1.2% premium over single use properties, on average. These findings show that properties with 2 and 3 uses have higher market values than single use and properties with 4 uses.

Because of the coding methodology, an exact concentration of each use type within a property cannot be extracted from the data. However, it can be determined if a property contains a specific use type. For example, a property with apartments over retail is coded as having 2 uses and is considered mixed use. Additionally, the property can be identified as Retail and Multifamily. Using this methodology, an OLS regression was run using the controls listed in Table 2 and each use type, Retail, Office, Multifamily, Hotel, Industrial and specialty will be the variables of interest. The variables are binary, thus the results will show the premium or discount associated with having a specific use type with a property. The results, specified in Table 11, show that having retail, office, multifamily, hotel and industrial uses within a property is significant (to 1% levels) and specialty property types appear to be non-significant. Interestingly, there are premiums associated with retail, office and hotels properties ranging from 5.5% - 56% and discounts for multifamily and industrial properties ranging from -23.2% - 27.7%. This can be interpreted to mean that there are additional costs associated with operating multifamily and industrial properties.

Table 11. OLS Type of Use

The table presents the results of the OLS regression which estimate the effects of each use type (*Retail, Office, Multifamily, Hotel, Industrial, Specialty*) on sales prices in NYC. Each use type is a binary variable, 0 if the property does not contain the use type and 1 if the property does contain the use type. The T-statistic based on the standard error of each variable is provided in the parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(15) Sales Price (ln)
Retail	0.089***
	(4.95)
Office	0.055***
	(2.16)
Multifamily	-0.277***
	(-11.85)
Hotel	0.560***
	(9.26)
Industrial	-0.232***
	(-6.72)
Specialty	-0.298
	(0.67)
Distant From Transit (*1/d*)	0.005***
	(7.71)
Building Size (SF)	0.619***
	(42.70)
Floor Area Ratio	0.000
	(0.09)
Land Area (SF)	0.160***
	(10.68)
Age	0.001***
	(4.50)
Interest Rate Index	-1.363
	(0.37)
2015 (Reference)	---
2016	0.059***
	(2.71)
2017	0.158***
	(7.12)
2018	0.163***
	(4.65)
Number of Floors	-0.012***
	(-3.73)
1 Star Rating	-0.271***
	(-4.48)
2 Star Rating	-0.221***
	(-4.35)

3 Star Rating	-0.277***
	(-5.57)
4 Star Rating (Reference)	---
5 Star Rating	-0.335***
	(-2.90)
Bronx	-1.207***
	(-44.44)
Staten Island	-1.579***
	(-30.61)
Queens	-0.905***
	(-35.28)
Manhattan (Reference)	---
Brooklyn	-0.743***
	(-35.20)
Constant	8.910***
	(68.29)
Obs.	10,931
Adjusted R-squared	0.659

Mixed use and Number of Uses appear to be significant characteristics in determining market value in NYC. There are other factors that determine the significance such as borough, number of uses and actual use type. Based on these findings, more uses is better than 1 use, but 4 uses appears to be too many. Additionally, retail, office and hotels generate a premium while multifamily and industrial properties are discounted. Thus far this study has shown that properties with multiple uses generate pricing premiums over their single use counterparts on average.

CHAPTER 5

CONCLUSIONS AND RESEARCH IMPLICATIONS

Understanding the success of mixed-use properties as measured by their financial performance is critical given the number of mixed-use developments slated for construction over the next few years (Small, 2019). Various stakeholders have different motives for studying this topic and are interested in different aspects of mixed-use development. Land use planners and regulatory agencies seek the optimal synergy of different land uses set in an optimal location. Similarly, understanding the financial viability and drivers of successful mixed-use developments are critical to land use planning and other built environment policy implications. If mixed-use developments perform better than their single-use counterparts, land use planners and officials should consider investing more of their energy into these developments and the individual elements that contribute to their success, such as higher density, more pedestrian friendly communities, better public transportation, reduced traffic congestion, mixed affordable housing with market rate housing, and safer communities.

Real estate developers, owners, and investors seek to maximize the financial performance of mixed-use properties and discover the actual demands of consumers (residents, renters and businesses) and municipalities. Real estate owners and investors target the highest and best use for the property which will yield the highest return. Developers seek to reduce risk by completing projects with minimal red tape and as quickly as possible, create the highest land density, and generate the highest present value for the finished project. They also reduce risk by owning and operating mixed-use properties to diversify their income stream and user demand.

Given the aging stock of existing buildings, the scarcity of buildable land, and changes in the retail industry, it is critical to understand the impact and financial viability of multiple-use projects over their single-use counterparts. Additionally, second- and third-tier regional malls are showing decreasing financial performance in the forms of lower rents and increased vacancy. With big box retailers like Sears and Toys-R-Us closing their doors, real estate owners and land use planning officials are looking to repurpose the land; mixed-use projects might be appropriate for this newly available space (Williams, 2018). Mixed-use developments are also a way for municipalities to utilize infill sites and large vacant properties to create new tax rateables and foster a sense of community.

The goal of this research is to determine if multiple use projects are financially profitable and help various stakeholders determine the highest and best use for raw land and existing buildings. Some real estate owners and developers believe that mixed-use properties are more profitable than single-use properties. Do developers and investors gain a financial benefit to owning/operating multiple use properties? Based on the results of this study, there appears to be a premium associated with mixed use properties. The borough-by-borough analysis gives more insight into the mixed-use premium. The urban form appears to matter when looking at the effect of multiple-use development on property values. Urban boroughs showed a positive mixed-use premium, while less urban boroughs showed no significant or a negative relationship between mixed-use properties and sales prices. This lends credence to the idea that mixed-use properties generate higher property values than single-use properties when the development is in a more “city-like” or urban environment, creating an accessible and walkable mini-city.

Land use planning officials and real estate investors hope that a mixed-use premium exists as well, but there is minimal empirical evidence to support or refute this claim. This research attempts to empirically measure the financial performance of mixed-use projects which can be used to determine land use and zoning areas, redevelopment options, and provide evidence that such developments add value to a community. This study showed that building size and land area were consistently significant in all five boroughs, along with two other variables, distance from transit and mixed use, which were highly significant in four out of five boroughs. The significance and magnitude of these variables appear dependent upon the urban form of the borough, ranging from most urban (Manhattan) to least urban (Staten Island).

The initial study showed that, on average, properties with more than one use-type generated a pricing premium over single use properties. The results also showed that proximity to a transit station had a significant impact on property values in the Bronx, Queens, Manhattan, and Brooklyn, but not in Staten Island. The remainder of the study will focus on the effect of transit proximity and transit density on commercial property values in Manhattan. Moreover, the interaction effects between mixed use and transit proximity will be examined.

PART II. TRANSIT PROXIMITY AND COMMERCIAL PROPERTY VALUES IN MANHATTAN

CHAPTER 6

INTRODUCTION

Intuitively a major metropolitan area such as New York City (NYC) is heavily reliant on its public transportation, specifically the subway system1. New York City's Metro has the most stations of all metros worldwide and is consistently within the Top 10 for longest system and busiest system (What is the Largest Metro System in the World? 2015). The majority of riders use the subway to commute to work, but it is used to reach recreational activities as well. The daily ridership during the work week is 5.4 million, and during the weekend the average ridership is 5.4 million (average of 3 million on Saturday and 2.4 million on Sunday (Introduction to Subway Ridership, n.d.). Most riders Live Work and Play within New York City's five boroughs, which appears to be a key component to the success of mixed use properties, a concept that was examined in the previous study. Another seemingly key component in the success of mixed-use properties is accessibility. In an urban, densely populated area such as Manhattan, accessibility, walkability and proximity to transit are thought to have a direct impact on commercial property values.

There are many studies that examine the impact of railway stations on both residential and commercial real estate. The extant research focuses on residential property values and land values with limited research on the impact of railway stations on commercial property values. Results of this relationship range from positive to negative and the magnitude also varies. This variation may be caused by the nature of the data, the methodology, railway studied (heavy rail versus light rail) and the measurement of railway or transit proximity (Debrezion, Pels & Rietveld 2007).

Transit proximity is generally measured by actual distance to the nearest station, but it can also be measured by walkability or accessibility. A property or station is considered walkable if it is within ¼ mile of a destination (Pivo and Fisher 2011), which is about a 5-minute walk. Outside of this ¼ mile radius, a location is considered "not walkable." Some studies have examined the changes in property value for every ¼ mile ring from the station. There are virtually no studies that examine how transit density effects commercial property values. For the purpose of this study, the impact of railway stations on commercial property values will be measured in two ways: via the actual distance measured in miles and transit station density. Transit density is defined as the number of stations within a ¼ mile of a specific location. A property with 0 subway stations within 0.25 miles has a low transit density and is considered not as accessible. Conversely, a property that has six subway stations within walking distance has a high transit density and is considered extremely accessible.

Using the same NYC data collected for the previous study, this portion of the paper will consider transit proximity as a significant characteristic in determining commercial property values especially in an urban area, such as Manhattan. The prior study used transit proximity as a control. In this study, transit proximity will be the main variable of interest and quantified both by actual distance to a subway station and the number of stations within walking distance. Properties that have a higher transit density should generate a price premium over properties with a lower transit density, as those properties are considered more accessible. The concepts of mixed use and accessibility are seemingly intertwined.

This paper will also examine the interactive effects of mixed use and walkability of transit stations on commercial property values in Manhattan.

Research Question

The primary goal of this study is to examine the effect of transit proximity on commercial property values. Does the inverse distance from a subway stations and the number of stations within walking distance effect commercial property values in Manhattan? In the previous model, inverse distance from transit was used as a control variable and the coefficient was significant and positive. The results from the previous study has preliminarily shown transit proximity to be an important characteristic in determining commercial property values in NYC's five boroughs. This study will examine data from the borough of Manhattan only, as distance from subway stations and transit density are meaningful and quantifiable characteristics. Additionally, to incorporate concepts examined in the first study, this paper aims to address the following question: Are there any significant interaction effects between multiple use properties and having at least one walkable station on commercial market values in Manhattan?

CHAPTER 7

LITERATURE REVIEW

As mentioned above, the relationship between transit proximity and real estate varies depending on the type of property studied, type of railway, methodology, etc. The current literature on the effect of transit proximity and residential home prices are mixed; some show a positive relationship (Sim, 2002), others show a negative relationship (Landis, 1995), and others still show no statistical significance (Gatzlaff & Smith, 1993). Interestingly, some studies have demonstrated a ring effect—a negative relationship up to a certain threshold that shifts to a positive relationship outside of the “disamenity” zone (Goetz, Ko, Hagar, Ton, & Matson, 2010). Using home prices as the dependent variable measures how close residents want to live to a train or light rail station. It does not give a true indication of the premiums (or costs) associated with owning and operating commercial real estate near a railway station.

Few studies examine the relationship between transit proximity and commercial property values. Table 12 summarizes the seven studies that use either commercial sales prices, rent or land value as the dependent variable. In general, the results of these studies, using the hedonic pricing model, showed an increase in land values and commercial sales price as proximity to transit decreases. The sales price premium ranged from 4.6%–23% and the rent premium ranged from 2.5%–7%.

Bollinger, Ihlandfeldt, and Bowers (1998) reported contrary findings, showing a 7% discount in office rents for properties located near MARTA stations in Atlanta. One explanation for this discrepancy is that resident and user reliance on public transportation and crime surrounding some of the specific stations were high.

Table 12. Transit Proximity and Commercial Property Values in Extant Literature

The table below provides a summary of academic articles related to transit proximity and commercial property values. Author, publication year, main construct, construct definition, construct measure and data source of each article is also provided.

Authors & Year	Construct & Definition	Construct Measure	Data Source
Cervero and Duncan, 2002	Examines light rail and CBD proximity effects on commercial land values. Land near LRT exhibited 23% premium. Land near LRT within CBD exhibited 120% premium.	Hedonic Pricing Model	Metroscan, Santa Clara County LRT
FTA, 2000	Examines proximity of transit and assessment values. 2% increase in value for every 1,000 feet	Hedonic Pricing Model	Axciom Dataquick - sample surrounding Union Station and Dupont Circle - DC Metro
Weinstein and Clower, 1999	Examines proximity of transit and sales price. 4.6% premium for retail and 22.7% premium for office over properties located beyond 0.25 mile from 14 DART stations	Input/ Output Model	NAICS ,DART
Cervero, 2003	Explores light and commuter rail proximity and land values. Retail and office properties near CBD saw highest premiums. Elsewhere, premiums were small or negative.	Hedonic Pricing Model	Metroscan, San Diego MTDB
Weinberger, 2001	Examines LRT proximity and office rent, which were 7-10% higher than office properties beyond 0.5 miles.	Hedonic Pricing Model	
Bollinger, Ihlandfeldt and Bowes, 1998	The relationship between MARTA proximity and office rents was found to be negative. Rents were discounted 7% on average.	Hedonic Pricing Model	Jamison Research, Atlanta MARTA
Benjamin and Sirmans, 1996	Apartment rents decreased approximately 2.5% for every 0.1 mile.	Hedonic Pricing Model	DC Metro

Cervero and Duncan (2002) showed a substantial premium for commercial land parcels located near a light rail station. The premium increased even further if the parcel was located near the light rail and located near a CBD. Notably, this paper found a dual effect of proximity to the CBD and public transportations systems on commercial land values. This paper measures the transit proximity effect using land values (which is substantially different from cash flowing commercial properties) and a light rail system in Santa Clara County (which is substantially different from the NYC Metro system).

Weinstein and Clower (1999), Cervero (2003), and Weinberger (2001) examined the effects of light rail station proximity on commercial property values. The light rail systems of Dallas, San Diego and Atlanta differ greatly from the heavy rail systems of New York or Washington D.C. These models incorporated distance from the Central Business District (CBD) as these railways catered to more suburban commuters. These papers examined transit proximity as a binary variable, comparing commercial property values within walking distance (0.25 miles radius) to commercial property values beyond walking distance. Retail and office properties saw the highest premiums ranging from 4.6% - 22.7%. Further, transit density is not a quantifiable variable in these cities because it is rare to have more than one station within 0.25 miles.

Only one study conducted by the Federal Transit Authority (2000) examined the effects of 'heavy' rails on commercial property values in the Washington DC area, which also has an urban or city environment. In this study, the Federal Transit Authority (FTA) chose the area surrounding two Metro stations – Union Square and Dupont Circle. Using the hedonic pricing model, the results of the study show that closer proximity to the stations yielded higher assessment values. While DC's Metro system is similar to that of the NY Metro, tax assessment values were used as the dependent variable. Assessment values are used to determine property taxes; as such, they do not always reflect full market value and are often not very accurate. The FTA found a 2% price premium exists for every 1,000 feet to the transit station.

The existing literature has documented a value premium associated with railway station proximity. It is important to note that the majority of these papers examine light rail systems, which generally connect the suburbs to the CBD. Only one paper examines commercial property values within an urban area. Due to the nature of the rail type and more suburban environment, the concept of transit density has not been used to measure transit proximity.

Using the hedonic pricing model, this study will use the concept of actual distance from the subway and transit density to examine the relationship between transit proximity and commercial property values in Manhattan. Presumably, higher accessibility via more transit stations property will increase a property's market value among other things. This research will be novel in the use of transit density and heavy rails within one of the largest metro areas in the United States.

CHAPTER 8

EMPIRICAL MODEL AND HYPOTHESIS

The hedonic price model is an acceptable method to determine the impact of various characteristics on a property's final sales price, as exhibited by the extant literature summarized in Tables 1 and 12. The hedonic pricing model assumes that a good is comprised of several characteristics, which represents a buyer's willingness to pay for each characteristic via the sign, magnitude and significance of each independent variable (Rosen, 1974.)

Similar to the previous study, Transactional Sales Price will be used as the dependent variable (V). The short form hedonic equation can be seen in Equation 2, where value (or sales price) is the dependent variable, $\beta 0$ is the constant, βi (i=11) are coefficients, Zi are the variables listed in Table 13 and ε is an error term.

Table 13. Transit Density Model - Definition of Variables

The table below defines the independent variables used in Models 16-21. Number of Stations and Inverse Distance are the two main variables used to measure Transit Proximity.

Variable	Definition
NUMBER OF STATIONS	The number of stations within a 0.25 mile radius and is denoted by 0, 1, 2, 3, 4, 5 or 6
INVDIST	Represents the inverse of distance from the nearest transit (1/d)
MIXED USE ***OR*** NUMBER of USES	Dummy variable indicating Multiple Use = 1, Single Use = 0 Continuous variable indicating the number of uses a property contains. Ranges from 1 (single use) to 4
BLDGSIZE	Building size in square feet
NUMBER of FLOORS	Represents the number of floors each building contains
LANDAREA	Size of the lot measured in square feet
FAR	Represents Floor to Area Ratio and measured in square feet
AGE	Represents the age of the property
INTERESTRATE	10-Year Treasury Yield
STARRATING	A Costar defined metric intended to provide a national building quality rating system, which ranges from 1-5
YEAROFSALE	Year in which the property sold

The main focus of this study is transit proximity. In this model, transit proximity is measured by the actual inverse distance and transit density, which is defined as the number of stations within walking distance. In this study, walkability is defined as an area that is within ¼ mile range of a given point or property. A subway station is considered walkable if it is within ¼ mile or a 5- to 7-minute walk from a property. The variable Number of Stations represents the amount of stations within ¼ mile. A property with a Number of Stations equal to 0 means there are no stations within walking distance. A property that has a Number of Stations equal to 4 means there are 4 stations within a ¼ mile of the property. The main hypothesis for this study: as the number of stations within walking distance of a property increases, the property value is also expected to increase. If transit density is a characteristic that leads to pricing premiums in Manhattan, one would expect the coefficient to be both positive and significant.

The Distance from Transit variable represents the linear distance from a property (data point) to the nearest subway station. According to rent decay theory, prices and rents decrease at an accelerated rate up to a certain distance, typically 0.5 miles. Once the proximity extends beyond this point, prices and rents decrease at a much slower rate (Al-Mosaind, Dueker, & Strathman, 1993). The INVDIST variable captures this exponential relationship between distance from public transportation and a property's sales price. Notably, the relationship between distance from the train and property values is not perfectly linear (Al-Mosaind, Dueker & Strathman, 1993). As such, this study will utilize the inverse of the calculated distance to the nearest subway station in order to account for the non-linear or exponential nature of the relationship. Mathematically, distance and the inverse of distance are equivalent. Econometrically, the inverse of distance is the most effective measure, as the relationship is not linear or proportional. Figure 2 provides visual confirmation of the relationship described above. There appears to be a steep gradient at lower distances followed by no effect on sales as distance to transit increases.

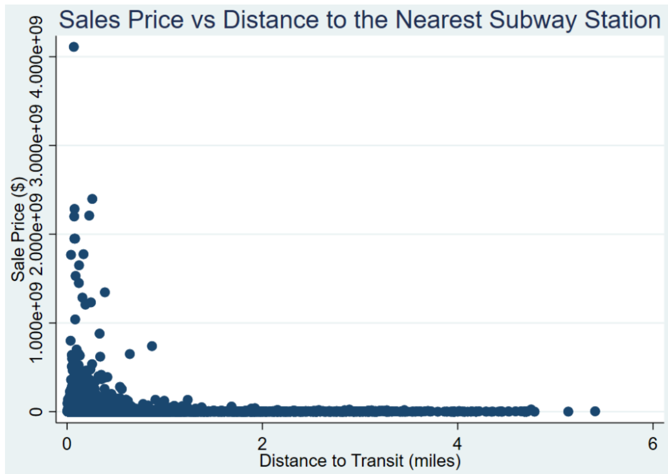

Figure 2. Sales Price and Distance from Transit

Transactional prices are expected to decrease the further away a property is from a subway station. The relationship between distance from the subway station and property prices would be negative. When taking the inverse of the distance from the subway station, the coefficient should be positive and significant if it affects commercial property values. The previous study showed that the inverse distance from the subway station was positive and significant for some boroughs. The same results are expected for this study.

The remaining variables are as described in the first study. Mixed Use or Number of Uses, Building Size, Number of Floors, Land Area, Floor Area Ration (FAR), Age, Interest Rate, Star Rating and Year of Sale are all thought to be important and significant characteristics in determining commercial property values. The Mixed Use variable shows whether a property is single-use or contains more than one use. The coefficient is expected to be positive and significant. Number of uses shows how many use types are contained within a property. Either Mixed Use or Number of Uses will be used in the model, as they both quantify uses for each property. Mixed Use is a binary variable (single use or multiple use) and Number of Uses is a continuous variable. Building Size, Number of Floors, Land Area and FAR are self-explanatory property characteristic having to do with the size and available space of a property. The coefficients are expected to be positive and significant operating under the notion that as size increases market values increase as well. Conversely, Age and Interest Rate typically show a negative relationship with property values. As a property ages, presumably without renovations, market value should decrease. Also, as the cost of debt increases, market values should also decrease.

All independent variables are continuous with the exception of Mixed Use, Star Rating and Year of Sale which are categorical variables. The Borough variable has been excluded from this model as this study contemplates data from Manhattan only. As in the previous study, Star Rating is meant to represent asset quality (as defined by Costar) and Year of Sale represents when the transaction occurred. The coefficient shows the relationship to price when compared to the reference level. For Star Rating the reference level is a 4-Star Rating and for Year of Sale the reference level is 2015.

The model is comprised of 11 independent variables that are believed to have a direct and significant impact on a property's selling price. While there are other variables that impact price and value, the primary focus of this study is the relationship between transit proximity and commercial property values in Manhattan. The main hypothesis is that Inverse Distance from Transit and Number of Stations coefficients will both be positive and significant, showing that accessibility will generate pricing premiums over properties that are less accessible via subway.

CHAPTER 9

DATA COLLECTION AND ANALYSIS

Similar to the first part of this study, the same dataset from Costar will be used for this portion of the study. Costar is a third-party database that contains information on over 5 million commercial real estate properties in the United States. The data will include all sales from January 2015 – December 2018 from the borough of Manhattan only due to its reliance on the subway system.

Costar's Sales Comparables section contains detailed information on the property and transaction details of a sale. For this study, the following variables were taken directly from Costar: building size, number of floors, land area, floor area ratio, star rating, year of sale, longitude and latitude of each sale, property description and primary use type. The mixed use variable was coded as described in Part 1 of this study, using the primary use type and detailed property description provided in Costar.

The longitude and latitude of subway entrances were downloaded from Open Data NY. There are 101 stations in the Borough of Manhattan as shown in Figure 3 below. Additionally, shape files from Open Data NY were used to calculate the number of stations within 0.25 miles of each data point using ArcGIS Desktop. Figure 4 below shows a close-up view of subway data layered over the sales that occurred in Manhattan between 2015 and 2018. To provide prospective, the blue dot in the center of Figure 4 is the 42nd Street station which is a considered a busy station.

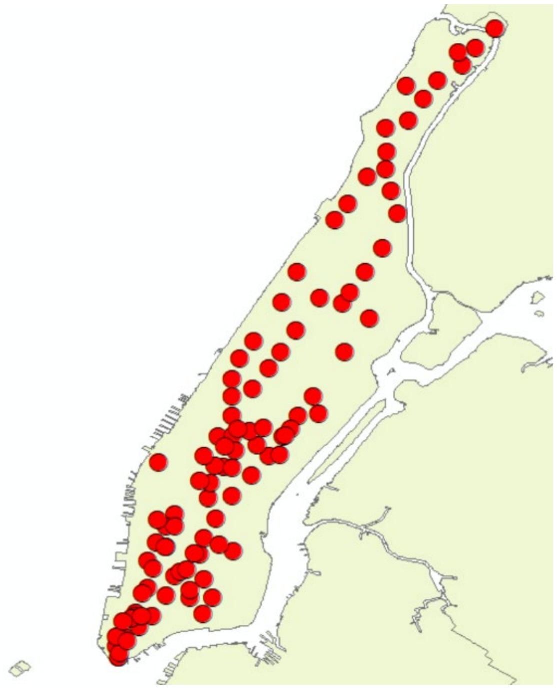

Figure 3. Manhattan Subway Stations

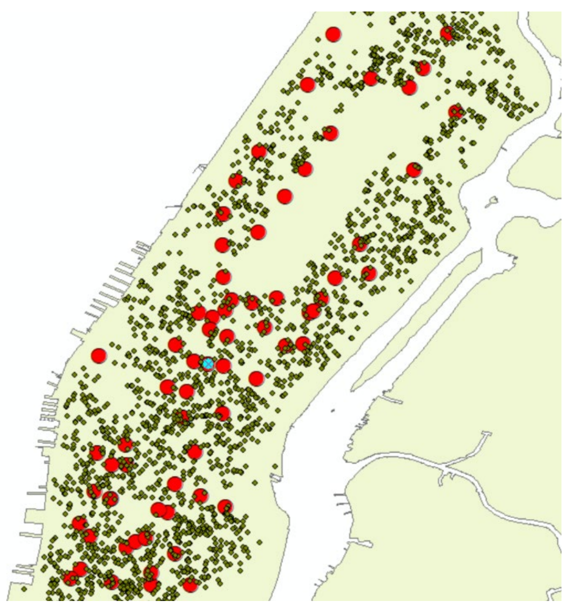

Figure 4. Manhattan Subway Stations and Data Overlay

The Number of Stations data, which was calculated via argGIS' Spatial Join tool, is summarized in Table 14. The table shows that 1,219 properties do not have a subway station within 0.25 miles of the property, 1,200 properties have 1 station within walking distance, 384 properties have 2 stations within walking distance, and even fewer have 3, 4, 5 or 6 stations within walking distance. It is important to note that per this table, 1,801 properties have at least 1 station within walking distance and is therefore considered accessible. The more stations that are located within walking distance, the more accessible a property is considered. The Station Proximity variable is a binary variable that shows if a property has 1 or more stations within walking distance (coded to 1) or if it does not have any stations within walking distance (coded to 0).

Table 14. Number of Stations Summary

This table provides a summary of the number of subway stations located within 0.25 miles of a data point. Based on this table, 1,219 properties in the sample do not have any stations within walking distance, 1,200 properties have 1 subway station within walking distance, and so on to 1 property that has 6 stations within walking distance.

Number of Stations	Frequency	Percentage	Cumulative Percentage
0	1,219	40.36%	40.36%
1	1,200	39.74%	80.10%
2	384	12.72%	92.81%
3	146	4.83%	97.65%
4	53	1.75%	99.40%
5	17	0.56%	99.97%
6	1	0.03%	100.00%

Summary Statistics

Table 15 contains summary statistics for the data within the sample model. There were 2,930 transactions that took place in the borough of Manhattan from January 2015 through December of 2018. The average sales price for the sample $38,100,000, with a minimum sales price of $270,000 and a maximum sales price of $4,100,000,000. Additionally, of the 2,930 properties in this sample, approximately 703 are mixed use. The number of uses for the buildings in Manhattan range from single use to 4 uses, with each building having an average of 1.27 uses. The average distance from the nearest subway station is 0.177 miles. The average building size is 63,000 square feet with an average lot size of 8,735 square feet. The average building age is 95 years or a majority of buildings were constructed in the 1920s.

Due to the non-linear relationship of sales price, building size, land area, and floor area ratio, the natural log will be used to transform these variables in order to create a more normal distribution and make the relationship between the dependent variable (sales price) and independent variables more linear.

Table 15. Summary Statistics

This table provides summary statistics for the final sample used for the second part of this study. The data for this study comes from commercial property sales in the borough of Manhattan only.

Variable	Obs	Mean	Std.Dev.	Min	Max
Sales Price	2,930	$38,100,000	$160,000,000	$270,000	$4,100,000,000
Mixed Use	2,930	0.240	0.4273	0	1
Number of Uses	2,930	1.27	.5236	1	4
Distance from Transit (miles)	2,930	0.177	0.106	0.0035	0.6527
Building Size (SF)	2,930	63,333	238,273	300	8,942,176
Floor Area Ratio	2,930	5.668	5.722	.0042	97.224
Land Area (SF)	2,930	8,735	53,829	500	2,755,326
Age (years)	2,930	95	30	0	219
Interest Rate Index	2,930	.022	.004	.014	.032
Number of Floors	2,930	7	7	1	63

Discussion

The hedonic pricing model is used to measure the impact of each characteristic on a property's transaction price. The dependent variable was regressed against the independent variables listed in Table 13, with Number of Stations as the main variable of interest. The model's main variables of interest are Inverse Distance and Number of stations, with either Mixed Use or Number of Uses included as a variable to quantify multiple use properties. The Ordinary Least Squares (OLS) regression analysis is the preferred technique of data analysis when using the hedonic pricing model. The OLS model produces optimal results when the dependent variable, independent variable and error terms are assumed to be individual and independent of each other (Dubin, Pace, & Thibodeau, 1999.) In the previous study, Spatial Autoregressive (SAR) techniques were used to account for the spatially dependent nature of real estate sales. The OLS results and SAR results were very similar in coefficient sign, magnitude and adjusted R-squared. Similar to the previous study, both OLS and SAR results will be presented for each model. The results for the OLS models can be found in Table 16 and the results for the SAR models in Table 17.

Table 16. OLS Regression Results – Transit Density, Transit Proximity and Commercial Property Values in Manhattan

The table below presents the results of the OLS regressions that estimate the effects of Transit Proximity on market values within Manhattan. Transit Proximity is measured by Transit Density (Number of Stations) and actual inverse distance from a subway station (Inverse Distance). All variables are as defined in Table 13. The T-statistic based on the standard error of each variable is provided in the parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(16) Sales Price (ln)	**(17)** Sales Price (ln)	**(18)** Sales Price (ln)
Mixed Use * Station Proximity			
Single Use & Poor Proximity (Reference)			---
Single Use & Good Proximity			0.0347
			(0.56)
Mixed Use & Poor Proximity			0.0518
			(0.53)
Mixed Use & Good Proximity			Omitted Collinearity
Number of Stations	0.143***	0.141***	0.138***
	(6.86)	(6.76)	(4.49)
Inverse Distance	0.004**	0.004**	0.004**
	(2.13)	(2.15)	(2.13)
Mixed Use	0.162***	---	0.166**
	(3.51)		(2.12)
Number of Uses	---	0.114***	---
		(3.03)	
Building Size (SF)	0.468***	0.432***	0.468***
	(10.26)	(9.28)	(10.26)
Floor Area Ratio	0.013**	0.024***	0.013**
	(2.14)	(3.54)	(2.14)
Land Area (SF)	0.195***	0.233***	0.194***

Table 16, continued

	(16) Sales Price (ln)	(17) Sales Price (ln)	(18) Sales Price (ln)
	(3.84)	(4.33)	(3.81)
Age	0.001	0.0004	0.001
	(0.67)	(0.53)	(0.66)
Interest Rate Index	0.889	1.362	0.922
	(0.10)	(0.15)	(0.10)
2015 (Reference)	---	---	---
2016	0.038	0.0358	0.039
	(0.68)	(0.65)	(0.70)
2017	-0.034	-0.0355	-0.032
	(-0.57)	(-0.60)	(-0.55)
2018	-0.040	-0.0476	-0.040
	(-0.45)	(-0.53)	(-0.45)
Number of Floors	-0.010*	-0.013***	-0.010*
	(-1.89)	(-2.60)	(-1.87)
1 Star Rating	0.016	0.027	0.019
	(0.10)	(0.17)	(0.12)
2 Star Rating	-0.339***	-0.330***	-0.340***
	(-3.41)	(-3.31)	(-3.42)
3 Star Rating	-0.417***	-0.407***	-0.420***
	(-4.43)	(-4.31)	(-4.45)
4 Star Rating (Reference)	---	---	---
5 Star Rating	-0.279	-0.233	-0.279
	(-1.58)	(-1.87)	(-1.58)
Constant	9.990***	9.994***	9.982***
	(31.18)	(30.66)	(31.14)
Obs.	2,930	2,930	2,930
Adjusted R-squared	0.404	0.400	0.404

The results of the OLS regression with Mixed Use can be found in Table 16, Model 16 and the OLS regression with Number of Uses can be found in Table 16, Model 17. The adjusted R-squared for both models is approximately 40%, which implies that the proposed model explains 40% of the variability around the mean. Given the number of potential variables (or characteristics) that effect commercial market values in Manhattan, 40% is a relatively high R-squared.

The main independent variables for this model are Inverse Distance and Number of Stations. The Inverse Distance coefficient, another indicator of the importance of accessibility, is both positive and significant to 5% levels. The positive coefficient is expected as this represents the inverse of distance from the nearest train station. The coefficient is very small, 0.004, which can be interpreted to mean that small changes in the inverse distance lead to large increases in sales price. The Number of Stations coefficient is also positive and significant to 1% levels. These results support the first hypothesis of this paper, market values increase as the number of walkable stations increase. The relationship appears to be both positive and highly significant, showing a 14% increase in value as the number of stations within 0.25 miles increases by one. Considering the average sales price in Manhattan is $38,100,000, a 14% premium amounts to a $5,334,000 increase (on average) per station within walking distance.

The results of the remaining variables are similar to that of the Mixed Use model in the previous study. The Mixed Use variable is positive and significant; properties with two or more uses maintain a 16% premium over properties that are single use, on average. In the OLS model that contains number of uses, the coefficient is positive and significant to 1% levels. The coefficient reflects a 11% increase, on average, for an increase in the number of uses by 1. Building Size and Land Area also have a significant impact on market values to 1% levels and Floor Area Ratio also has a significant effect on value but only to 5% levels. The building size, floor area ratio and land area coefficients are also all positive. The Age, Interest Rate and Year variables were not significant. The Number of Floors variable was significant to 10% levels and the 2-Star and 3-Star ratings were significant at 1% levels.

Overall, the number of stations and inverse distance variables proved to be both positive and significant demonstrating that in an urban environment, accessibility, via proximity to numerous subway stations and actual distance, is an important quality that has an impact on market value.

The first part of this study contemplated the effects of mixed-use properties on commercial property values. Mixed use was defined as a property containing 2 or more uses. This portion of the study contemplated the effects of transit proximity on commercial property values in Manhattan. The paper also examines the interactive effects of Mixed Use properties and Transit Proximity on commercial property values. A secondary hypothesis of this study is that mixed use properties that contain at least one subway station within walking distance has a significant and positive effect on commercial property values in Manhattan. In a regression, the coefficient term should be significant and positive if both mixed uses and good proximity have an impact on commercial property values.

As defined above, a transit station has "good" proximity if it is within walking distance of a property. A new variable, Station Proximity, was created in order to examine the interactive effect of multiple use properties that are proximate to a subway station. Station Proximity is a binary variable which shows if a property contains 1 or more subway stations within 0.25 miles or within walking distance. Based on Table 14, a property with 0 stations within 0.25 miles have been coded to 0, which is considered bad proximity, and a property that contains 1 or more stations with 0.25 miles have been coded to 1, which is considered good proximity.

The interactive term Mixed Use*Station Proximity was added to the variables used in Table 16, Model 16. The independent variables were regressed upon the dependent variable Sales Price, with the Mixed Use* Station Proximity variable. The results of this regression are shown in Table 16, Model 18. Single use properties that do not have a subway station without 0.25 miles are the reference level for this variable. As see in the results Table 16, the interactive variable are not significant but the coefficient signs are all positive. When compared to single use properties with bad proximity, all other combinations of mixed use and transit proximity have a higher value. Unfortunately, this interactive variable appears to be non-significant to the model, and the adjusted R-squared remains unchanged from the previous model at 40.4%. Adding this interactive term does not increase the explanatory power of the model.

As shown in Table 16, the results of the remaining independent variables of this model are similar to those of the previous model. Number of Stations, Building Size, Land Area and 2-Star Rating and 3-Star Rating all exhibited a positive relationship to sales price with a significance level of 1%. Inverse Distance from the Train and Mixed Use showed a positive and significant relationship to 5% levels. The magnitude and sign of the coefficients were virtually identical between Models 16 and 17.

In order to account for spatial dependence of property sales and characteristics which occurs in real estate, Spatial Autoregressions (SAR) were run with Sales Price as the dependent variable and the independent variables listed in Table 13 with either Mixed Use or Number of Uses as one of the control variables. Table 17, Model 19 shows the model with Mixed Use as the control variable and Model 20 includes Number of Uses as a control variable. As seen in the mixed-use study, the adjusted R squared increased slightly to 41.36%. This is slightly higher than the adjusted R squared of 40% in the OLS models. When using the SAR technique, Number of Stations (measure of transit density) is positive and significant in both Models 19 and 20 and Inverse Distance is also positive and significant to 5% levels. Transit proximity appears to be a significant characteristic of commercial real estate in Manhattan which yields a 7% increase as the number of stations increase. Market value also seems to be extremely sensitive to changes in actual distance from the subway station. Interestingly, Mixed use, in Model 19 is positive and only slightly significant to 1% levels and Number of Uses produced a non-significant result. This can be interpreted to mean that when Number of Uses and Mixed Uses matter less when taking to account the spatial dependence.

As with the OLS models, the SAR results in Table 17 show Building size, Floor Area Ratio, Land area and Number of Floors have the most significance, while the remaining characteristics were non-significant or only slightly significant. The main variables of interest were significant, but mixed use and number of uses were only slightly significant. Table 17, Model 21 includes Mixed Use as a control variable and the interactive term Mixed Use * Station Proximity. Number of Stations and Inverse Distance, both measures of transit proximity, are still positive and significant to 5% levels. Notably, neither the Mixed Use variable nor the Mixed Use * Station Proximity term remain significant. Model 21 also shows that Single use properties with good proximity have lower prices than single use properties with bad proximity.

Table 17. Spatial Autoregression Results – Transit Density, Transit Proximity and Commercial Property Values in Manhattan

The table below presents the results of the Spatial Auto-Regressions that estimate the effects of Transit Proximity on market values within Manhattan. As in Table 17, the main variables of interest are Number of Stations and Inverse Distance. All variables are as defined in Table 13. The T-statistic based on the standard error of each variable is provided in the parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	(19) Sales Price (ln)	**(20)** Sales Price (ln)	**(21)** Sales Price (ln)
Mixed Use * Station Proximity			
Single Use & Poor Proximity (Reference)		---	---
Single Use & Good Proximity			-0.167 (-0.26)

Table 17, continued

	(19) Sales Price (ln)	(20) Sales Price (ln)	(21) Sales Price (ln)
Mixed Use & Poor Proximity			0.006
			(0.07)
Mixed Use & Good Proximity			Omitted Collinearity
Number of Stations	0.0718***	0.0722***	0.077**
	(3.06)	(3.08)	(2.32)
Inverse Distance	0.004**	0.004**	0.004**
	(2.32)	(2.33)	(2.33)
Mixed Use	0.079*	---	0.066
	(1.80)		(0.84)
Number of Uses	---	0.042	---
		(1.18)	
Building Size (SF)	0.347***	0.318***	0.347***
	(8.09)	(7.25)	(8.09)
Floor Area Ratio	0.015***	0.025**	0.015***
	(2.70)	(2.1)	(2.69)
Land Area (SF)	0.389***	0.414***	0.194***
	(7.96)	(8.33)	(3.81)
Age	0.001*	0.001*	0.001*
	(1.81)	(1.77)	(1.81)
Interest Rate Index	.151*	.151*	.1515*
	(1.72)	(1.72)	(1.73)
2015 (Reference)	---	---	---
2016	0.104**	0.100**	0.104*
	(1.98)	(1.90)	(1.98)
2017	-0.058	-0.060	-0.058
	(-1.04)	(-1.08)	(-1.05)
2018	-0.100	-0.104	-0.100
	(-1.72)	(-1.22)	(-1.17)
Number of Floors	-0.015***	-0.018***	-0.014***
	(-3.01)	(-3.90)	(-3.01)
1 Star Rating	-0.032	-0.025	-0.031
	(-0.22)	(-0.17)	(-0.22)
2 Star Rating	-0.257***	-0.252***	-0.256***
	(-2.79)	(-2.72)	(-2.78)
3 Star Rating	-0.318***	-0.311***	-0.317**
	(-3.64)	(-3.55)	(-2.30)
4 Star Rating (Reference)	---	---	---
5 Star Rating	-0.365**	-0.328**	-0.364**
	(-2.31)	(-2.07)	(-2.30)
Constant	8.644***	8.654***	8.64***
	(23.38)	(23.25)	(23.37)
Obs.	2,930	2,930	2,930
Adjusted R-squared	0.4136	0.4138	0.4136

The findings of this study confirm the existence of transit proximity premium. There was both a positive and significant coefficient for the main variables of interest, Inverse Distance and Number of Stations. An increase in the number of stations by 1 yielded a 14% premium in sales price or market value in the OLS model and a 7% premium in the SAR models, on average. Accessibility via actual distance and transit density appears to be important characteristics of commercial real estate in Manhattan based on these reports, which support the main hypothesis of this paper. Accessibility and walkability are also considered important characteristics of mixed use properties, as was seen in the preceding study. When an interactive term for Mixed Use and Transit Density was created, the results showed a positive relationship, but it did not appear to be significant in determining commercial property values in Manhattan.

CHAPTER 10

CONCLUSIONS AND RESEARCH IMPLICATIONS

There are various motives to studying and understanding the effect of public transit on commercial real estate and the built environment. The benefits of public transit are numerous and well documented. A few of the benefits to cities include mobility, economic, environmental and public health benefits (Mohammad, Graham, Melo and Anderson, 2013.) The benefits of public transportation begin with increasing accessibility, which can lead to increased trade, employment and population density. As activity increases, land and property values can become enhanced as a result. For an area such as NYC, which is heavily reliant upon its public transportation, it is important to understand the impact subway station proximity and density have on commercial property values.

There are many empirical studies that examine the relationship between railway proximity and real estate values. The focus of most studies is residential home prices, which does not provide much insight into investment potential for commercial real estate. Examining home prices shows a home buyers willingness to live close to a railway station. Extant research that aims to examine the effects of railway stations on commercial real estate uses mostly light rail networks. The light rail system differs from heavy rail by size of network, activity of stops and the above ground (versus subterranean) location. Negative effects or costs associated with noise, pollution and traffic are limited with the subterranean subway system. This research provides empirical evidence that a transit proximity premium exists within the one of the bigger MSAs in the United States. Further, greater accessibility yields a sales price premium in the borough of Manhattan.

Real estate developers, owners, investor and planning officials alike understand the importance of accessibility and the growing demand for areas where residents can live, work and play. It has always been assumed that transit proximity translates directly into higher property values. This research provides empirical evidence which shows that more stations within walking distance and being closest to the subway indeed increases the premium of a property. While the results also showed that the interaction between multiple use and transit proximity was not a significant characteristic of sales prices in Manhattan, the relationship was positive. Properties that were single use but had at least one station within walking distance and multiple use properties that did not have a walkable subway station have a higher sales price, on average, than single use properties that do not have a walkable subway station. Single use properties that are not accessible have the lowest market values of the different groups. This finding empirically confirms what real estate investors and developers previously knew by intuition or a hunch. Planning and zoning officials can use this information when developing plans. Multiple use properties fare the best near transit stations and single use or even residential properties do not necessarily benefit as much from being near a transit station.

New York City, specifically the borough of Manhattan, is the prototype for a densely populated, urban city. The residents of Manhattan heavily rely on the subway system as a main mode of transportation. The results are clear, properties that contain multiple uses, transit density and transit proximity are highly significant in Manhattan. Will they be as significant in other major metropolitan areas? The methods and findings of this research can be used to study transit density in other major metro areas. In the future, the most successful and profitable developments will be those that have the most innovative use of existing space. In order to use space innovatively, it is important to know what characteristics of commercial properties drive market values. This study isolates the effects of multiple or mixed use properties and transit proximity on commercial market values in Manhattan.

NOTES

[1] The NYC subway system has 472 stations located throughout Manhattan, the Bronx, Queens and Brooklyn. The total annual ridership for all NYC subway stations is 1,680,060,402 in 2018, which is down from 2017's annual ridership of 1,727,366,607. (NYMTA1, n.d.) The Bronx has 68 subway stations and a 2018 annual ridership of 139,238,932. Queens has 79 subway stations and a 2018 annual ridership of 234,085,767. Manhattan has 133 subway stations and a 2018 annual ridership of 936,516,980 and Brooklyn has 162 subway stations and a 2018 annual ridership of 370,231,302 (NYMTA1, n.d.). Staten Island is serviced by the Staten Island Railway, which has 21 rail stations and an annual ridership of 4,600,000 (NYMTA2, n.d.) The Staten Island Railway does not have a direct connection to Manhattan. Commuters from Staten Island must take a ferry or drive in order to get to Manhattan. All five boroughs have a total 2018 annual ridership of 1,684,660,402. In order to appreciate the magnitude of NYC's ridership count, the total population of all five boroughs in 2010 was 8,175,133 (NY.org, 2013). New York City is a major global economic hub and is heavily reliant upon its public transportation systems. The stations link residents, visitors, and commuters alike to their destinations throughout the city.

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APPENDIX

Appendix 1 - CoStar Property Information

301 Park Ave

Waldorf Astoria New York
New York, NY 10022

Hotel Building - 225 Rooms of 1,681,000 SF Sold on 2/10/2015 for $1,950,000,000 - Research Complete

buyer

Anbang Insurance Group
c/o Robert Barone
6 Jian Guo Meng Wai St
Chaoyang District Beijing 100022

seller

Hilton Worldwide Holdings, Inc.
c/o Christian Charnaux
7930 Jones Branch Dr
McLean, VA 22102
(703) 883-1000

vital data

Escrow/Contract:	**130 days**	Sale Price:	**$1,950,000,000**
Sale Date:	**2/10/2015**	Status:	**Confirmed**
Days on Market:	**127 days**	Building SF:	**1,681,000 SF**
Exchange:	**Yes**	Price/SF:	**$1,160.02**
Conditions:	**1031 Exchange, Condo Conversion**	Pro Forma Cap Rate:	**-**
Land Area SF:	**81,340**	Actual Cap Rate:	**3.00%**
Acres:	**1.87**	Price/Room:	**$8,666,667.00**
$/SF Land Gross:	**$23,973.57**	No Rooms:	**225**
Year Built, Age:	**1931 Age: 84**	Down Pmnt:	**$100,000,000**
Parking Spaces:	**-**	Pct Down:	**5.1%**
Parking Ratio:	**-**	Doc No:	**2015000062955**
FAR	**20.67**	Trans Tax:	**$7,167,316**
Lot Dimensions:	**200x405**	Corner:	**No**
Frontage:	**-**	Zoning:	**C5-2.5**
Comp ID:	**3229031**	No Tenants:	**23**
		Percent Improved:	**58.6%**
		Submarket:	**Plaza District**
		Map Page:	**-**
		Parcel No:	**1304-9001**
		Property Type:	**Hospitality**

income expense data

Estimated Expenses	- Taxes	**$21,787,072**
	- Operating Expenses	**$213,031,047**
	Total Expenses	**$234,818,119**
Estimated Net Income	Net Operating Income	**$58,500,000**

Listing Broker

Eastdil Secured, LLC
40 W 57th St
New York, NY 10019
(212) 315-7200
Mark Schoenholtz, Lawrence Wolfe

- Debt Service - Capital Expenditure Cash Flow	**Buyer Broker** **No Buyer Broker on Deal**
financing	prior sale
	Date/Doc No: **10/24/2007** Sale Price: **-** CompID: **2512719**

Comps Statistics

	Low	Average	Median	High	Cou
Sale Price	$1,950,000,000	$1,950,000,000	$1,950,000,000	$1,950,000,000	
Building Size	1,681,000 SF	1,681,000 SF	1,681,000 SF	1,681,000 SF	
Price per SF	$1,160.02	$1,160.02	$1,160.02	$1,160.02	
Actual Cap Rate	3.00%	3.00%	3.00%	3.00%	
# of Rooms	225	225	225	225	
Price per Room	$8,666,667	$8,666,667	$8,666,667	$8,666,667	
Days on Market	127	127	127	127	
Sale Price to Asking Price Ratio	-	-	-	-	

Totals

Sold Transactions **Total Sales Volume:** **$1,950,000,000** **Total Sales Transactions:**

Survey Criteria

basic criteria: Sale Date - **1/1/2015 - 3/31/2015**; Sale Status - **Under Contract/Pending, Sold**; Return and Search on Portfolio Sales as Individual Properties - **Yes**

geography criteria: County - **Manhattan, NY**

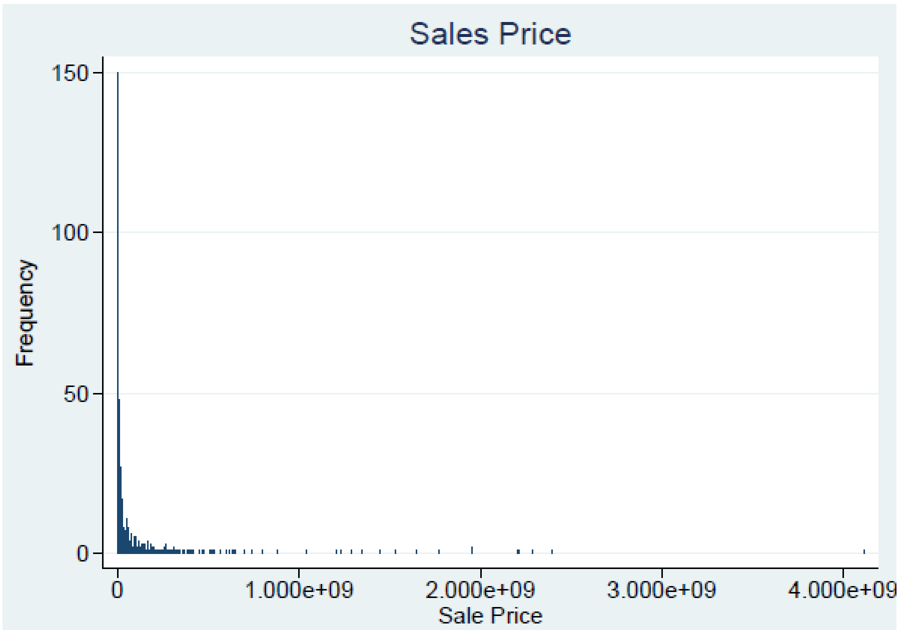
Appendix 2 - Area of Study

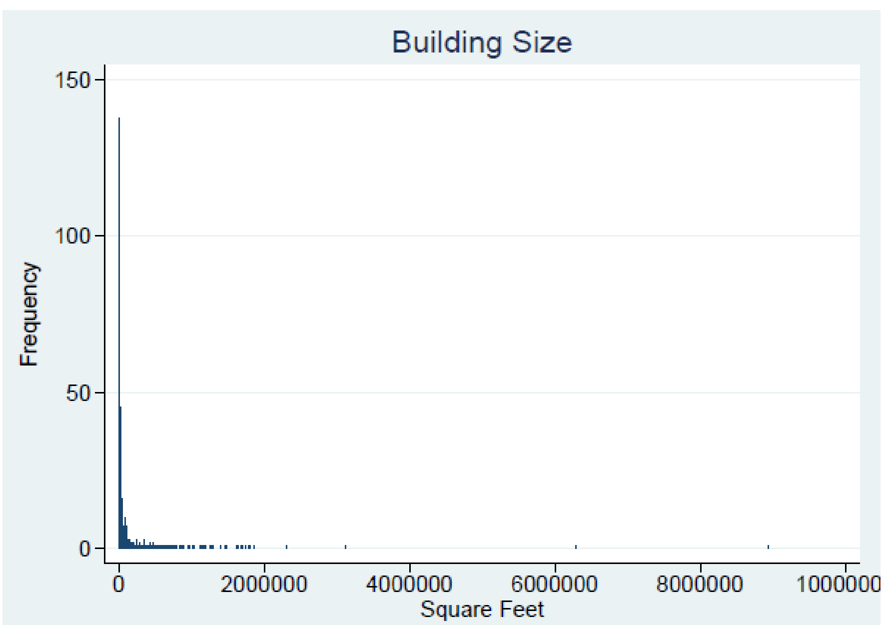
Source:
https://upload.wikimedia.org/wikipedia/commons/thumb/5/5a/New_York_City_District_Map.png/1200px-New_York_City_District_Map.png

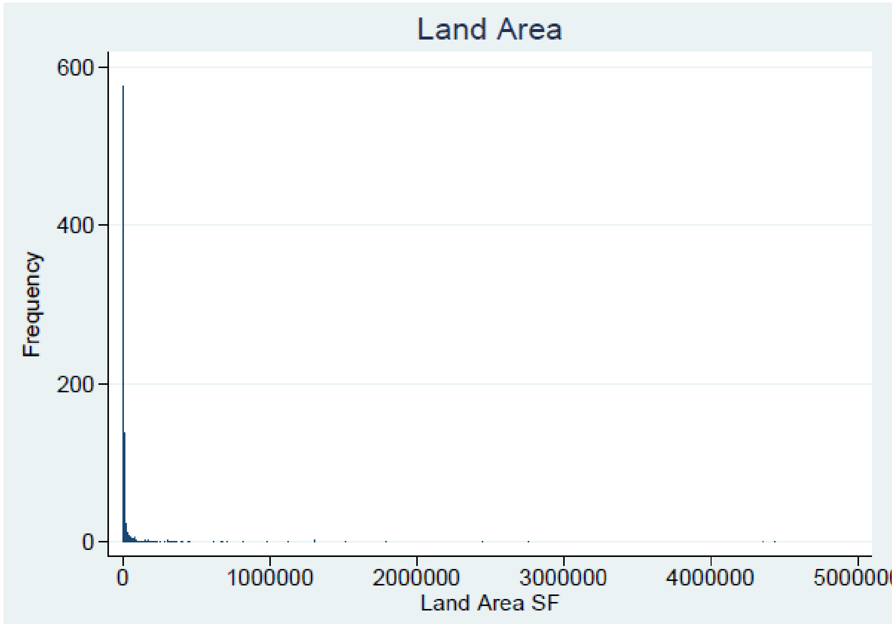
Appendix 3 - Sample CoStar Data

Property #	Age	Bldg SF	Description Text	MIXEDUSE	FAR	Lot Size	Property Address	Property Name	PropertyType	Sale Date	Sale Price	Secondary Type	Star Rating	Submarket Name	Year Built
1	46	1,484,325	* A/K/A 126 West 42nd Street & 101 West 41st Street * Emergency generator * Outdoor public plaza * Indoor pedestrian plaza/atrium * Security service * DAS being installedâ€and Internet Service Providers: Sidera/Lightpath, Verizon, Pilot and Spectrum. * Equinox and Whole Foods Retail space in 1095 Avenue of the Americas can be combined with retail space at 120 W 42nd Street. Note that	1	25.06	59,241	1095 Avenue of the Americas,	Salesforce Tower	Office	1/15/2015	$2,200,000,000		4 Star	Penn Plaza/Garment	1972
2	87	1,681,000	This world-famous hotel in a subtle Art Deco style has both office and professional space. The 625-foot towers have a separate entrance on East 50th Street, and there is an additional entrance to the hotel on Lexington Avenue.	1	20.67	81,339	301 Park Ave	Waldorf Astoria New York	Hospitality	2/10/2015	$1,950,000,000	Hotel	4 Star	Plaza District	1931
3	8	1,109,028	11 Times Square is the newest addition to the impressive cluster of corporate headquarters in the Times Square District. Located at the gateway to the new "New 42nd Street," the 1,000,000 square foot monolith will rise as a majestic symbol of 21st century modernity and style. This newly constructed, class A office tower, occupying the southeast corner of 42nd Street and 8th Avenue, will capture the imagination and spirit of the renaissance that transformed Manhattan's Midtown West into one of New York's most dynamic business districts. Designed by Fox & Fowel Architects, PC, New York's Premier office building architect, 11 Times Square will serve as an exciting monument to the future. The 35 story, sculptural office tower will be elegantly sheathed in a state of the art aluminum and glass curtain wall. Perched high above the city, a rooftop atrium and telecommunications tower will crown the shimmering building. At street level, passersby will be drawn 11 Times Square's expansive entrances, which will feature	0	29.26	37,897	11 Times Sq	Eleven X	Office	2/11/2015	$630,000,000		5 Star	Times Square	2010
4	55	474,951		0	10.19	46,609	790 7th Ave	1652 Broadway	Hospitality	2/13/2015	$535,000,000	Hotel	3 Star	Columbus Circle	1963
5	35	1,192,893	180 Maiden Lane is a 41 story soaring glass tower with unprecedented panoramic views of the New York Harbor, the Statue of Liberty, the South Street Seaport, midtown and the East River. Located in the heart of the financial and insurance districts, the building is within easy reach of Wall Street, the retail and dining amenities of the South Street Seaport, the 1,2,3,4,5,A,C,J,Z subway lines, the Whitehall Terminal (Staten Island Ferry) and FDR River Drive. This building was awarded an Energy Star label in 2012 for its operating efficiency. In 2014, this building was awarded LEED certification by the U.S. Green Building Council. Wired Certified Platinum This building has been Wired Certified Platinum. Wired Certified Platinum means a building is best in class across all features of connectivity that matter most to tenants: number and quality of internet service providers, redundancy and resiliency of telecom infrastructure, ease of installation and capacity to readily support new telecom services. The bu	1	24.60	48,787	180 Maiden Ln	Continental Center	Office	1/7/2015	$470,000,000		4 Star	Financial District	1983
6	108	356,330	This building was awarded an Energy Star label in 2016(83) and 2017(84) for its operating efficiency. Wired Certified Platinum This building has been Wired Certified Platinum. Wired Certified Platinum means a building is best in class across all features of connectivity that matter most to tenants: number and quality of internet service providers, redundancy and resiliency of telecom infrastructure, ease of installation and capacity to readily support new telecom services. The building can support current and future tenants with the most stringent technology requirements. Internet Service Providers available: Verizon-Fiber, Time Warner Cable-Fiber, Rainbow Broadband-Fixed Wireless, Zayo Group-Fiber, Lightower-Fiber, Verizon-Copper	0	24.06	14,810	315 Park Ave S (Part of Portfoli	The Remington Rand Bldg	Office	1/8/2015	$360,000,000		4 Star	Gramercy Park	1910
7	53	156,000	Building Features: * Prime A Columbus Circle location * Class A, boutique asset * Access to conference room and cafeteria. * Electronic card key security system at reception * 24 hour access & security * Full concierge * Internal stairway * Central Park views *Nonprofit Center with shared amenities	0	6.93	22,498	1865 Broadway	American Bible Society Bldg	Office	1/30/2015	$300,000,000		3 Star	Columbus Circle	1965
8	118	152,236		0	6.44	26,571	82 Mercer St, Retail	Office Condo	Office	1/13/2015	$284,235,000		3 Star	Soho	1900

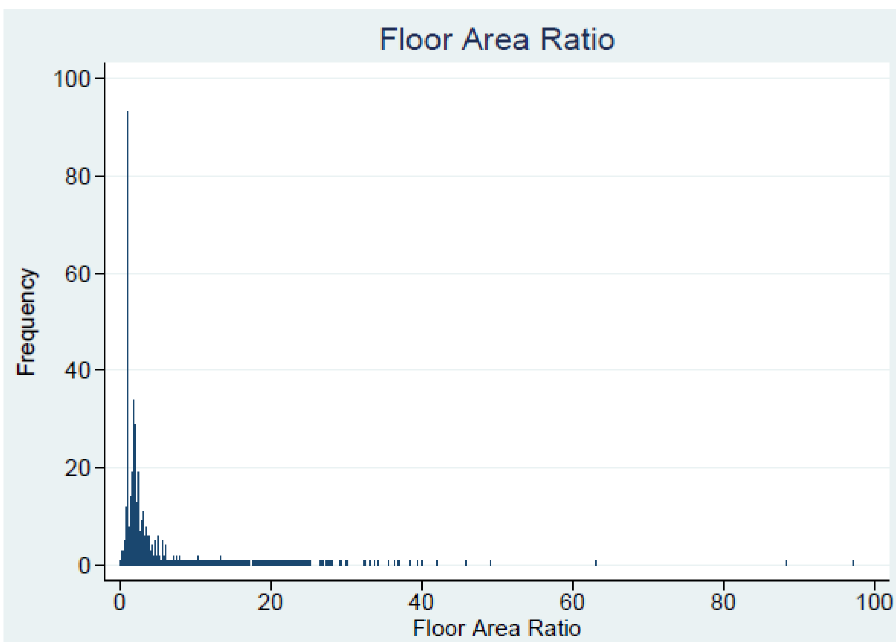
Appendix 4
Distribution Graph





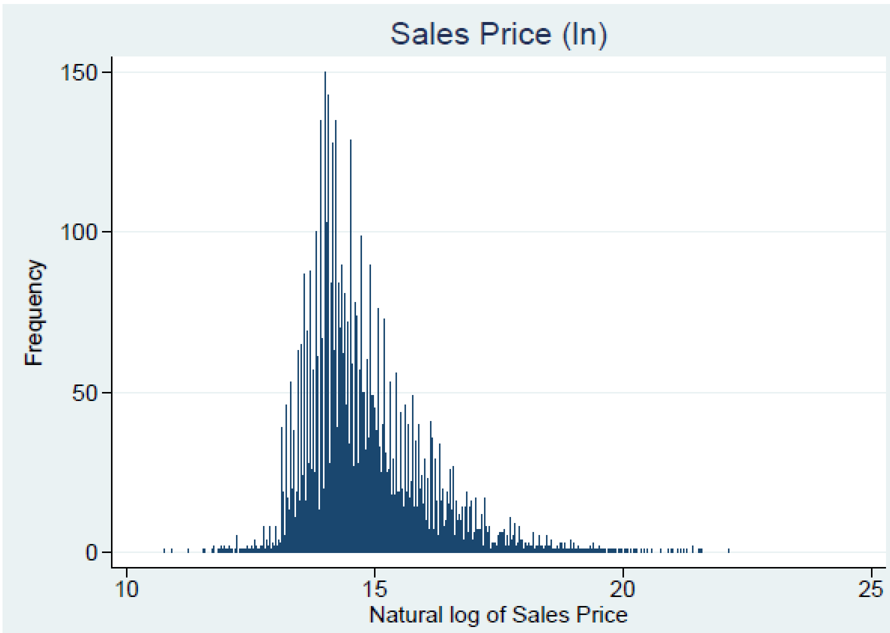


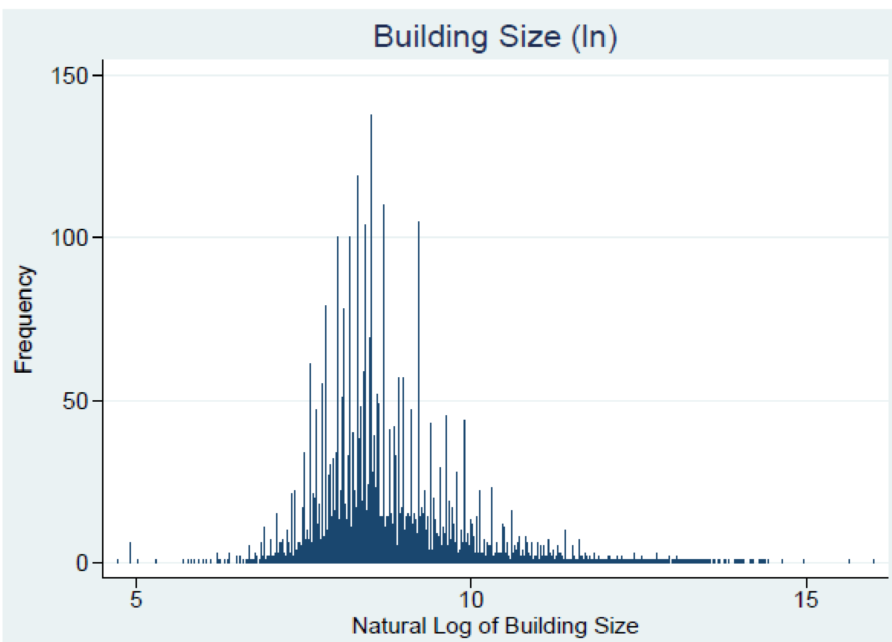
Land Area
600
400
200
0
Frequency
0
1000000
2000000
3000000
4000000
5000000
Land Area SF

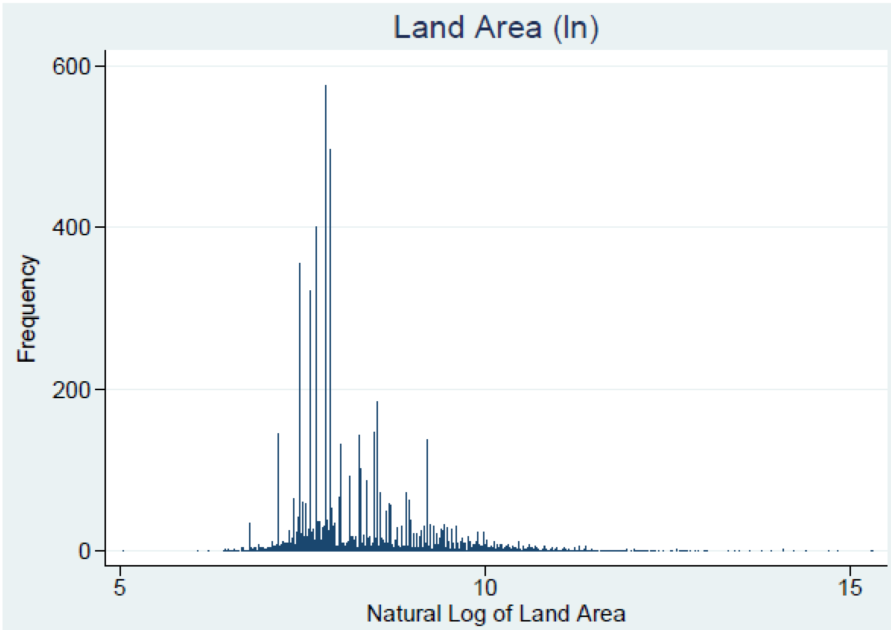


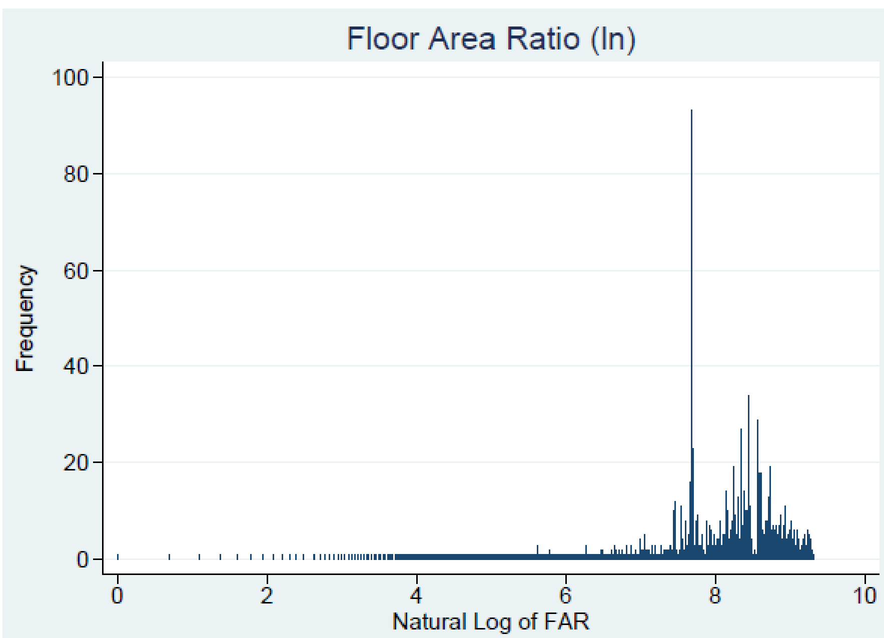
Floor Area Ratio
100
80
60
40
20
0
Frequency
0
20
40
60
80
100
Floor Area Ratio

Appendix 5
Transformed Variables






Land Area (ln)
600
400
200
0
Frequency
5
10
15
Natural Log of Land Area


Floor Area Ratio (ln)
100
80
60
40
20
0
Frequency
0
2
4
6
8
10
Natural Log of FAR

Appendix 6
Two Way Scatter Plot