THE IMPLEMENTATION OF URBAN GROWTH BOUNDARY AND ITS EFFECTS ON LOCAL HOUSING AFFORDABILITY: PORTLAND, OREGON, AS A CASE STUDY

By

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To my beloved parents

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LIST OF ABBREVIATIONS

CNT	Center for Neighborhood Technology
CTD	Center for Transit-Oriented Development
DLCD	Department of Land Conversation and Development
HOI	Housing Opportunity Index
H + T Index	Housing and Transportation Housing Affordability Index
HUD	U.S. Department of Housing and Urban Development
IGA	Intergovernmental Agreement
LCDC	Land Conservation and Development Commission
LUBA	Land Use Board of Appeals
NAHB	National Association of Home Builders
TDR	Transfer of Development Rights
UA	Urbanized Area
UGA	Urban Growth Area
UGB	Urban Growth Boundary
USA	Urban Service Area

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Since 1958 in the United States, Urban Growth Boundary (UGB) has been adopted as an important growth management tool that aims to prevent urban sprawl and preserve the natural environment on the city's outskirts. The UGB is an invisible line drawn around the city, which indicates the developable areas and farmland. It compellingly controls the future urban development inside the boundary and favors higher density development, public transit and walk-able urban spaces in city area.

After the implementation of UGBs nationwide, there are increasing concerns on this mandate growth management tool and the local housing affordability. Based on some facts and previous studies, the boundary constrains the supply of land and changes the urban development pattern, which tends to increase housing prices. The purpose of this thesis explores the price effects of the UGB—constrains land supply and changes urban development pattern, on Portland's housing affordability. As to Portland, the city adopted UGB in 1979 under the legislation and management of the state government. Due to the unique implementation statue and urban development pattern,

Portland has been a classic UGB city for researches and a perfect research object for my study.

Therefore, this research is aimed to explore the relationship between the implementation of the Portland's and local housing affordability. It reviews all the important previous studies on Portland's UGB and housing affordability, and describes their arguments, methodologies and limitations. Both theoretical and statistical methods are adopted in this study. In the analysis and results chapter, prices trend analysis and Spearman correlation coefficient are used to explore the relationship between land and housing prices between 1984 and 2009. Moreover, a regression model was conducted to tests the price effects of the UGB on median housing prices among 35 major urbanized areas in 2000, as well as the other nine independent variables. In conclusion, the results showed that the UGB did not contribute to the median housing prices of the urbanized areas, and the best median housing prices regression model consisted of median household income, job density, median commute time, which has a highest adjusted R square. The final part of the study provides the explanations for the result and discusses the limitations of the research.

CHAPTER 1
INTRODUCTION

Problem Statement

Nowadays, more and more cities and counties have adopted some form of Urban Growth Boundary (UGB) in their comprehensive planning, which is a compelling requirement of local or state government. The growth boundary services as an important growth management tool that intends to curb suburban or “leap-frog” development, protect farm and forest land, and encourage redevelop of the inner-city. Compared to traditional growth management method, UGB intends to encourage higher density development, public transit and walk-able urban spaces in city area. Moreover, there are concerns on this mandate growth management tool that the boundary might constrain the future supply of land and affect the housing market, which was supported by many previous studies (Downs, 2004). This kind of mandate growth management and planning tool may result in higher housing prices, leading to lower local housing affordability. The relationship between the boundary and housing affordability is controversial and unclear.

This study aims to explore the relationship between UGB and housing affordability in Portland, Oregon, and find out whether the implementation of UGB tends to lower the housing affordability in the city. If there is a certain relationship between these two research objects, this study would also answer how significant this relationship is, based on the statistical analysis.

Urban Growth Boundary and Housing Affordability

As mentioned above, the research question is to explore the relationship between growth boundary and housing affordability. More importantly, it is necessary to introduce these two concepts and define them for the following study.

Urban Growth Boundary

A typical Urban Growth Boundary is an invisible "line" or "boundary" drawn around the city area, which separates the developable lands for future urbanization from farm and forest land. Inside this boundary, the land can be used for future urban development; however, on the other side of the boundary, the land is preserved and not able to be used for urban development for certain period of time, for example, 20 years. According to Staley et al. (1999), there are at least 6 goals of the growth boundary:

- "preserve open and farmland;
- minimize the use of land generally by reducing lot sizes and increasing residential density;
- reduce infrastructure costs by encouraging urban revitalization, infill, and compact development;
- clearly separate urban and rural uses;
- ensure the orderly transition of land from rural to urban uses; and
- promote a sense of unified community."

Normally, the adoption of the growth boundary is under the planning requirement of local or state-level government. For instance, in United States, Only Oregon and Washington have very aggressive state legislation, which requires all the counties and cities to adopt growth boundaries (Anderson, 1999). In most of the cases, the boundary should leave enough land supply to accommodate future urban development, such as for residential, industrial and commercial uses, etc. In Oregon, according to the state laws, all cities are required to have a 20-year supply of land for future development within their growth boundary areas (Anderson, 1999). Moreover, these cities also need to review the boundary area every 5 years to ensure there is a sufficient supply of land for the future. The size of the boundary is critical in the adoption and expansion process: if too much land is included in the boundary, the boundary might not effectively manage the urban growth; if the supply of land is less than the future demand, the land prices would be pushed up.

To be effective, in the practical implementation process, the UGB can be adopted in several different forms, such as urban service area (USA), urban growth area (UGA) and urban demarcation lines, etc. These planning tools have similar goals which control the future urban development and encourage compact development. However, unlike traditional UGBs that control the supply of land, the urban service area manages the expansion of the urban infrastructure, such as water, electricity, sewer, etc., and is defined as an "infrastructure management tool". The expansion decision of urban infrastructure is "made in orderly intervals and coordinated with land use decisions (Warken, 2003)".

In addition, there are several alternative planning tools of UGB, such as Intergovernmental Agreement (IGA) in Boulder County, Colorado, Transfer of Development Rights (TDR) program in Lancaster County, Pennsylvania. According to the definition provided by Anderson (1999), the goal of the IGAs are to "represent binding agreements between the parties, creating a contractual obligation to comply with them". While TDR is a type of zoning ordinance that allows the owners of property located in low-density development or conservation use zone to sell the development rights to other owners (Roddewing & Inghram, 1987).

In sum, in this study, the UGB is defined as a "land supply management tool" that controls the future supply of developable land. The concept of UGB is used consistently throughout the whole paper.

Housing Affordability

Generally speaking, housing affordability measures the ability to afford a housing unit based on one household or family annual income level. It is a relationship between housing price and annual income. Traditionally, according to the standard provided by the U.S. Department of Housing and Urban Development (HUD), the house market is considered as affordable only if households pay less than 30% of their annual incomes for housing.

Recently, a more comprehensive approach has been created to test housing affordability—the Housing and Transportation Index. This index is derived from the evidence that transportation cost is the second largest household cost after housing—and stated that the combined portions of the cost of housing and transportation should be not exceed 45 percent of a household's annual income (Center for Transit-Oriented Development and Center for Neighborhood Technology, 2006). This approach will be elaborated in the following Analysis and Results Chapter. In this study, both of the "30%" and "45%" standards are applied to test the housing affordability.

Why Portland as A Case Study

In this research, Portland is the case study used to demonstrate and explore the effects of UGB on local housing affordability. Based on the facts and statistical analysis of Portland, I will not only represent the qualitative description of the effects of the boundary on housing, but also test the significance of UGB on housing affordability in a quantitative way. Compared to other UGB cities in the US, Portland has some unique characteristics to be an ideal research object for this thesis.

First, the state of Oregon is one of three states in which the UGB is mandated, with the others consisting of Washington and Tennessee. The efficiency of the implementation of this planning tool is ensured by the mandate power from the state-level. To some extent, the mandated planning process makes it easier for researchers to gather “evidence” of the effects of the UGB in the city, such as changed development pattern, constrain supply of land, etc.

Second, Portland has been well known for its Urban Growth Boundary planning policy for more than 30 years since it adopted the UGB back in 1979. As mentioned before, the growth boundary is focused on achieving the “long-term” goals of compact development. Even after the boundary was implemented, the effects of UGB on the city still need a certain time period to emerge. The size of the boundary is critical issue: if it contains more land than future needs, then the future urban growth is not effectively contained; if it accommodates less land than needed, there will not be enough land for the future urban growth and population. When the boundary in Portland was originally created, the boundary was drawn slightly large and with little scientific data supported (Anderson, 1999). It makes the boundary less effective in controlling urban growth. Since then, the boundary in Portland was little expanded.

Third, the existence of abundant and available data resources is another main reason that Portland is popular choice for urban growth management study. Portland has attracted much attention from government officials, research institutes, and many scholars in urban studies since the city adopted the UGB in the late 1970s. The city has become a textbook-example for state or local governments who intend to adopt UGBs as growth management tools in their jurisdiction.

As has been stated above, these are the main reasons and advantages that I also choose Portland in my research.

Overview of the Thesis

The most important purpose of this thesis is to answer the question—what are the effects caused by implementation of UGB on local housing affordability? The main body of the paper consists of qualitative description and quantitative analysis chapters to find out the answer to this issue. In Chapter 4-“Analysis and Results”, prices trend and correlation analysis between land and housing prices, and a median housing prices multiple regression model will be conducted, in order to test the following hypotheses.

Hypothesis 1. Due to the UGB constrain on the supply of land, the trends of land prices and land share in the Portland metropolitan area should be higher than other metropolitan areas without UGBs in United States. Since land prices have a significant impact on housing prices, the housing prices in Portland should be also higher. In addition, the Spearman Correlation Coefficient should supports the argument that the land and housing prices in Portland are highly correlated.

Hypothesis 2. Besides affecting the land prices, the UGBs also tend to change the urban development patterns, such as higher-density development, high redevelopment and infill development rate of the inner-city, etc. The regression model takes into account all of the factors that contribute to housing prices to measure the price effects of different predictors on the median housing prices among 35 urbanized areas. The result of the regression analysis should demonstrate the exact price effects of the UGB on the median housing prices.

The whole thesis is structured in six chapters. Chapter 1 is the brief introduction of the research topics, objectives, questions and hypothesis. Chapter 2 first reviews the boundary adoption history and planning administration of UGB in Portland. Then it presents all the important theoretical debates and statistical analysis done by previous studies, focusing on UGB and housing affordability in Portland. Chapter 3 provides the details about the statistical analysis methodology. Chapter 4 demonstrates the analysis and the results in these two methods. Chapter 5 discusses the results of the analysis and the limitations of the research. The last chapter draws the conclusion for the research questions and makes recommendations from a planning perspective.

CHAPTER 2
LITERATURE REVIEW

This chapter presents the adoption history, and the implementation status of UGB in Portland, such as the managing authority, planning administration, planning policies, etc. Following that, the next part discusses the conflicts between growth management and housing affordability, which is fundamental information to link the UGB in Portland with local housing affordability issue. The third part is the most essential in the literature review which is the answer to my research questions provided by previous researchers. It will be divided into two sections that demonstrate the arguments, methodologies and limitations in the previous debates and statistical analysis done by other major researchers. The theoretical debates focus on the relationship between the UGB, land prices and housing prices, while the statistical analysis concentrate on multiple regression of Portland's housing affordability that concludes all the factors contributing to housing prices. All the previous studies in each section will be reviewed in chronological order.

The Implementation of UGB in Portland

Since the UGB was adopted by State government in 1979, it has been implemented as one important part of the statewide land-use planning program in Portland for more than three decades. The purpose of a growth management tool is to contain the urban development within a certain boundary and to prevent sprawl. Today, The UGB in Portland is considered as one of the most successful cases of managing urban growth in the nation, mainly because of its long implementation history and the mandated administration from Oregon State.

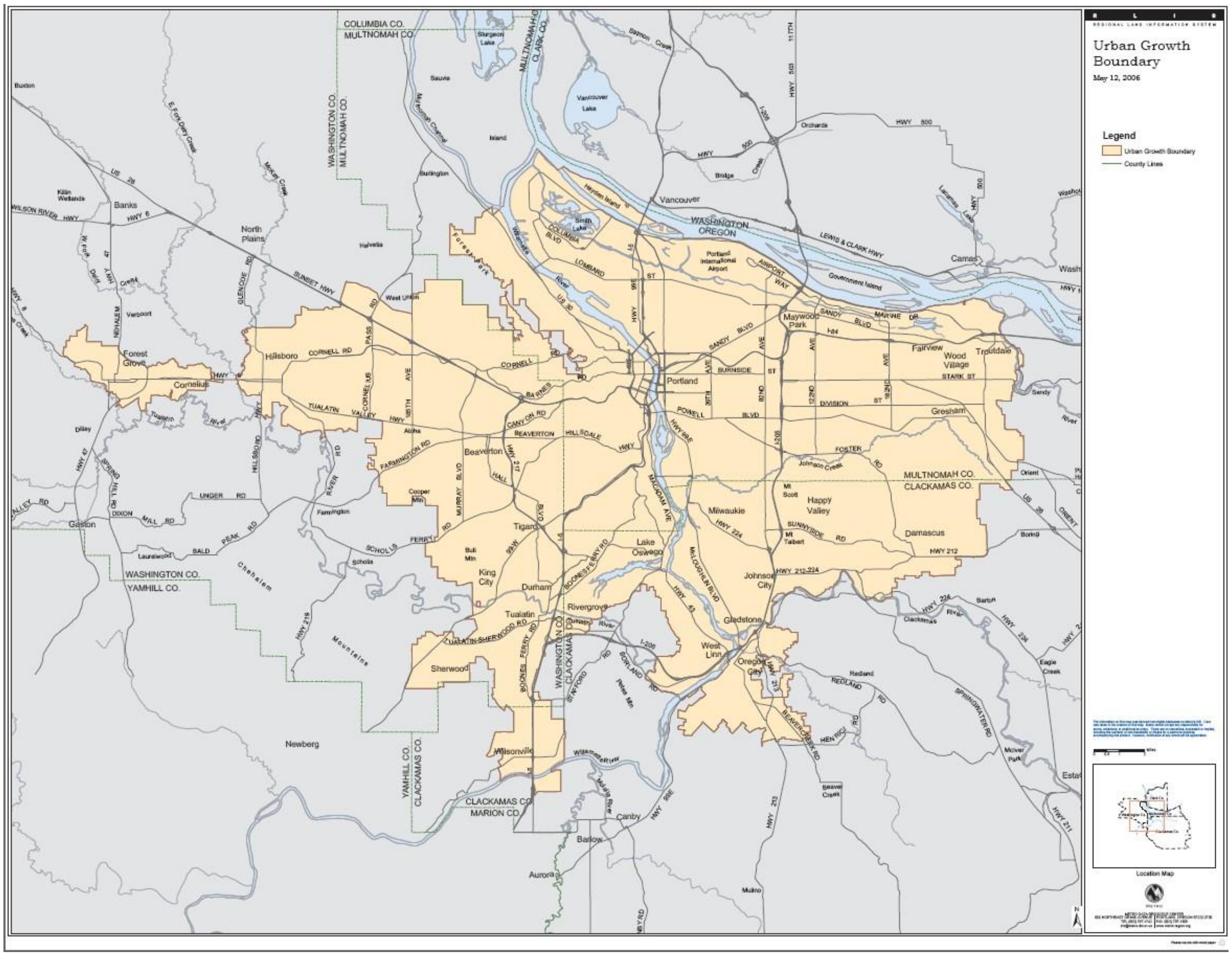


Figure 2-1. Map of the urban growth boundary as of May 2006. (Source: http://library.oregonmetro.gov/files/ugbmap0506.pdf. Last accessed January, 2011)

Adoption History of UGB in Portland

Oregon State required all the cities within the state to adopt the urban growth boundary in 1979. However, the state actually has begun to work on urban growth management and planning administration issues from the early 1970s. Before the growth boundary adoption in 1979, Oregon State began its efforts to control the urban growth and development in the late 1960s.

In 1969, “Senate Bill 100” was adopted by the Oregon State Legislature, which required every city and county in the state to have a comprehensive land use planning that meets state's standards (Oregon Government, 2010). Due to the lack of effective enforcement in this bill, most of the cities and counties refused to develop such plans. Later in 1973, the Governor Tom McCall gave a famous speech to legislature and campaigned across the state to appeal for a statewide land use planning program. As a result, on the same year, "Senate Bill 100" was approved, and it created Land Conservation and Development Commission (LCDC), the Department of Land Conservation and Development (DLCD) and statewide protection for farm and forest land. The task for LCDC, assisted by DLCD, were: adopts "state land-use goals and implements rules, assures local plan compliance with the goals, coordinates state and local planning, and manages the coastal zone program (LCDC, 2010)". The Statewide Planning Goals are the fundamental planning ordinances in Oregon, between state and local governments. According to the official Statewide Planning Goals statements, the UGB "shall be established to identify and separate urbanizable land from rural land (Oregon Government, 2010)", which apply to all cities in the state. More importantly, its enforcement from the state is one of the main reasons that assure efficiency of planning policies at the local level.

Under this system, all the cities are required to submit their proposed UGBs to the LCDC and the LCDC will verify them according to the planning ordinances in the statewide planning goals (Oates, 2006). In 1979, Metro--a regional government, was created by Portland-area voters, which is the first metropolitan council in the United States (Oregon Government, 2010). It is responsible for the management of the urban growth boundary for the Portland metropolitan area—Multnomah, Clackamas, and Washington Counties.

Planning Administration

As mentioned above, the Metro is one of the 240 UGB jurisdictions in Oregon, which directly manages the urban growth boundary in the Portland metropolitan area (The Oregon Encyclopedia, 2011). According to the information on Metro's official website, Metro has some specific land-use planning powers including:

- "coordination between regional and local comprehensive plans in adopting a regional urban growth boundary;
- requiring consistency of local comprehensive plans with statewide and regional planning goals;
- planning for activities of metropolitan significance including (but not limited to) transportation, water quality, air quality and solid waste."

According to Oregon State Law, the UGB in Portland Metropolitan region is required to contain 20-year of supply of land for the future residential development inside the boundary. The Metro Council is responsible for reviewing the supply of land for the future use every five years, if necessary, expand the boundary. The UGB in Portland was originally approved to include 15.8% more land than expected to be development for 20 year (Nelson & Moore, 1993). However, since the first approval in 1981, the boundary has been expanded for more than thirty times, for example, 3,500 acres in1998, 380 acres in 1999, and 1,956 acres in 2004; however, most of these expansions were less than 20 acres. The biggest expansion of UGB in history was recorded in 2002, which was 18,867 acres, providing "38,657 housing units and 2,671 acres for additional jobs" (Metro, 2011).

In addition, according to the planning procedures in Oregon, if Portland intends to expand its boundary, it must notify the state and hold hearings. The expansion application filed by local government will be handed to Land Use Board of Appeals by the state government (LUBA).

Dispute Resolution

In Oregon's planning process, he state has established a series of procedures to solve disputes arose between specific landowners and planning ordinances. First, the dispute should be considered at the local level, before a hearing officer. After the hearing, the decision made by the officer may be appealed to the local government's city or board of county commissioners. At the same time, a second appeal may be handed to a special review board under the Land Use Board of Appeals (LUBA). LUBA is serviced as an exclusive jurisdiction to review any land use decision made by the local government, special district or state agency (Anderson, 1999). And the final decision would be made by state's circuit courts. Before LUBA was created, the land use appeals were reviewed by LCDC and the circuit court. The establishment of LUBA is to "simplify the appeal process, speed resolution of land use disputes and provide consistent interpretation of state and local land use laws" (Oregon Government, 2010).

Moreover, compared to the slow and costly regular appealing processes handled by LUBA, the landowners can turn to alternative resolution like mediation and arbitration which are reviewed by LCDC. These also are the very common dispute resolution methods in the Oregon State. In the mediation methods, the mediators are chosen by both parties to handle the local land use dispute, whose service fees are paid by the LCDC.

Unintended Effect of UGB

During the implementation of the UGB in Portland, an unintended side effect occurred in the boundary expansion process—"Hobby" Farmers. The "Hobby" Farmers, which is a new interest group, consisted of non-commercial farmers. According to the Staley and Mildner's (1999) "Urban-Growth Boundaries and Housing Affordability" study, they stated that "by planting a field of Christmas trees or a large patch of strawberries, these landowners have been able to get rural homebuilding permits under the exemption for farmers". These new houses built by theses farmers on some rural large parcels seem to create exurban sprawl outside the boundary. The exurban development mainly occurred on the exception areas which are pre-commitment to urban use or limited usefulness for farm and forest land (Knaap & Nelson, 1992). On the other hand, the farmers group strongly oppose to the expansion of the UGBs, worrying the future expanded urban development will destroy the quality of their lives in the rural areas. The normal expansion process of the UGBs is interfered by these farmers, which leads to constrain the supply of land more scarcely. It is the least the city planners want to see in the UGB's implementation process.

The Conflicts between Growth Management and Housing Affordability

After the adoption of UGBs nationwide, there have been increasing concerns regarding the relationship between growth management and local housing affordability. Some scholars claim there are conflicts arising between growth boundaries and housing affordability, which causes the local housing market to be less affordable. This section will discuss these conflicts, which services as an overview of the relationship between UGBs and housing affordability.

In the dissertation "Myths & Facts: About Growth Management", Morrill and Hodge (1991) analyzed myths regarding growth management and housing affordability. They argued that contradictory to the common understanding, the fact is that the increased housing prices is not resulted from the demand of newcomers in the city or the higher construction cost, but the reduction of land supply caused by growth management. For example, from 1983 to 1990, the construction cost in Seattle rose 16% while the housing price rose roughly 60% (Morrill & Hodge, 1991). In comparing the demand of newcomers and construction cost, they concluded that the growth management "inherently reduces the economically available supply of land, therefore raising its costs and the costs of houses on it (Morrill & Hodge, 1991)". Nevertheless, the limitations in their study included that their arguments were not presented in detail and lacked sufficient data to support.

On the other hand, Gerrit Knaap and Lewis Hopkins (2001) considered UGBs as an instrument of inventory control that concentrates on when UGB should be expanded and by how much to mitigate its prices pressure on housing market. If UGBs are implemented successfully to manage the growth, the supply of land must be constrained by the boundary for promoting higher density development. Since the land value is a main cost in the housing cost, the UGB should be expanded before the land value is being pushing up too much which causes significant impact on the housing price (Knaap & Hopkins, 2001). The ideal and simple solution is to know when to expand the boundary and how much land it should include. In the real world, the time frame of expansion and the amount of land that should be included are almost impossible to predict. However, they insisted that the UGBs tend to constrain the land supply and push up the land value, which eventually affects the housing affordability. In addition, Knaap and Hopkins' (2001) research provided three possible logical methods to avoid the negative impacts caused by UGB—lead-time, safety-stock, and market-factor inventory. These methods explained the “when and how much” problem in different time periods during the expansion decision-making process.

Nelson et al. (2002) studied the link between growth management and housing affordability. They explained that the market demand, instead of land constrains caused by growth management tools, is the primary determinant of housing prices. Furthermore, Nelson et al. (2002) believed that both the traditional land use regulations (i.e., zoning, low-density-only development, etc), and growth management policies can raise the price of housing, mainly by constraining the supply of land. In their understanding, the effects of UGB in Portland suggested that UGBs can affect land values, however, their impacts on the housing affordability is still in dispute (Nelson, 2002).

A recent study done by Quigley and Rosenthal (2005) reviewed and analyzed the previous researches on the effects of growth management on the price of housing. They criticized that most of the previous studies ignored the “endogeneity” of regulation and price, and the “complexity of local policymaking and regulatory behavior” (Quigley & Rosenthal, 2005). In their perspective, a systematic and national measurement of land use regulations should be developed and a regulatory survey should be conducted to collect the local-level regulatory information.

In summary, these previous academic studies showed that UGBs tend to constrain the supply of land and then increase the land prices. In regards to housing prices, to some extent, the increased land prices will lead to higher housing prices inevitably. However, the exact magnitude and impacts caused by the UGBs on housing affordability remain uncertain.

Theoretical and Statistical Analysis of Portland's UGB and Housing Affordability Issue

The last section of this chapter reviews previous studies of Portland's UGB and the housing affordability issue, which will be introduced in two small parts—theoretical debates and statistical analysis.

Theoretical Debates in Previous Studies

The following debates on the effects of the UGB on Portland's housing affordability focus on the theoretical evidence provided in the previous studies. Besides the theoretical debates, some related simple statistical analyses are showed to support their arguments, such as demographic, housing or economic data, etc. I will start by describing the conflicts between the UGBs and housing affordability at the state level.

In the article written by Knaap and Nelson (1999), they reviewed the statewide land use planning program in Oregon and then focused on the implementation of the UGBs at the local level, from the political and planning perspectives. They believed that after the establishment of UGBs in Oregon, the UGBs appeared to affect the land value by providing the information about when the boundary will be expanded and by how much (Knaap & Nelson, 1992). In the housing market in Oregon, state law requires the local governments to meet minimum development density, which facilitates the construction of multiple-family units. These requirements actually increase the potential supply of housing in the cities. However, according to Knaap and Nelson's (1992) research, little evidence exist to suggest that neither UGBs have constrained the supply of developable land and housing nor have resulted in more affordable housing market due to the higher-density development in the city.

Staley and Mildner (1999) studied the effects of the UGB on Portland's housing market in four categories: housing cost and prices, housing density, development land and infill development, and consumer choices. Based on the housing prices and income level analysis, in 1999, Portland was ranked among the 10% of the least affordable housing market in the nation and on the West Coast (Staley & Mildner, 1999). Secondly, the average housing density increased from five homes per acre to eight homes per acre, and the living quality decreased due to the shrinking size of average house unit (Staley & Mildner, 1999). Since the boundary constrained the supply of land inside the boundary, the city had to develop vacant land (infill) and redevelop the existing properties within the boundary, which led to higher construction cost and higher housing prices (Staley & Mildner, 1999). Staley and Mildner (1999) concluded that the Portland's UGB certainly contributed to higher housing costs, whereas the magnitude was uncertain.

The same year, Staley, Mildner and Edgens (1999) conducted another study of Portland's UGB and housing affordability issue. They emphasized that the amount of vacant land has decreased from 75,000 acres in 1985 to less than 55,000 in 1999, and the Portland metropolitan area would face an 8,590 housing units deficit even with the achieved densities recommended in the Metro 2040 Plan (Staley et al., 1999). As a result, the housing prices increased significantly after 1990, for example, the housing prices in 1994 was approximately 140% of the housing prices in 1985 (Staley et al.,1999). In addition, Staley et al. (1999) observed that the UGB had pushed investment inward, and forced higher-density and inner-city development. Because of pressure from different special-interest groups, such as environmental activists, zeroexpansion advocates, etc., the expansion of the UGB proved difficult, which further increased housing costs. Due to these issues, the UGB in Portland tended to constrain the supply of land and housing, which lowered local housing affordability.

In another study, Goodstein and Phillips (2000) discussed the impacts of the UGB in Portland on residential development patterns, focusing on rising land values and increased housing density. They argued that the land values have risen after the adoption of the UGB and the average lot size of new residential development decreased 13.5% and 20% respectively in Clackamas and Multnomah counties between 1991 to 1995 (Goodstein & Phillips, 2000). During the same time period, Portland also experienced high rate of redevelopment and infill development, which consisted of 29% of residential development, much higher than 1980s (Goodstein &Phillips, 2000). Furthermore, besides smaller lot sizes, the trend towards higher density caused by the UGB led to smaller yards, fewer open space and less privacy in new housing development. In comparing the median housing prices in the Portland metropolitan area to other western metropolitan areas, the results showed that the median housing price increased almost 70% during 1991 to 1996 (Table 2-1). However, due to other explanations, such as increased demands of the market, speculative influences, etc., the increase in land values and housing density did not necessarily indicate that the UGB led to increased housing prices in Portland. To weigh all other factors, they conducted a regression model to test price effects of the UGB on Portland’s housing prices, which will be discussed in the statistical analysis chapter.

Table 2-1. Median housing prices in major western metropolitan areas

Metropolitan Areas	1991	1993	1996	%Changed
San Francisco	$275,000	280,000	289,000	5.09%
San Diego	171,000	163,000	165,000	-3.90%
Seattle	135,000	140,000	153,000	14.33%
Salt Lake City	85,000	102,000	146,000	71.46%
Portland	85,000	108,000	144,000	69.41%
Sacramento	145,000	140,000	135,000	-6.90%
Denver	90,000	101,000	130,000	44.44%
Las Vegas	97,000	117,000	123,000	26.80%
Phoenix	85,000	109,000	120,000	41.18%

Source: Goodstein and Philips, 2000.

Squires (2002) studied the data from the U.S. Census and Metro, and claimed the UGB in Portland has slowed down the sprawling of the urbanized area and increased the population density. For example, the population (per sq. mile) totaled 4,517 in 1950, 2,940 in 1980 and 3,167 in 1994, at the meanwhile, the area (sq. miles) is 114 in 1950, 349 in 1980 and 388 in 1990. The UGB in Portland also created a dual land market—inside and outside the growth boundary. The land outside the boundary lost its speculative value, which is limited to agricultural use, while the land inside the boundary remained or even gained speculative value. They also observed that the new housing development density increased, while the average new lot size for housing development decreased from 12,800 square feet in 1978 down to 6,200 square foot in 1998 (Squires, 2002). These are all the direct and indirect effects of the UGB on the housing prices, which intended to lower the housing affordability in Portland.

These are the critical comments about the effects of Portland's UGB on local housing affordability; however, the 1000 Friends of Oregon group held a different opinion regarding housing prices. They believed that the housing prices in Portland are similar to, or lower than comparable cities, which is considered as an affordable housing market for renters and buyers (1000 Friends of Oregon, 1999). As a response to the constrain of the supply of land caused by the UGB, the 1000 Friends of Oregon (1999) claimed that the price of land is a small portion of the housing prices, and the rapidly increasing housing prices in 1990s was mainly result from the economic upturn, but not the UGB. Taking Los Angeles as a comparable case, the housing prices in Los Angeles cost $30,000 more than in the Portland region, which indicates relatively unlimited land supply could not assure more affordable housing (1000 Friends of Oregon, 1999). The shrinking average lot size was not caused by the UGB, but mainly resulted from the demands from local people, as the age and families in Portland continued to get younger and smaller. The Statewide Planning Program in Oregon, including the UGB in Portland, created a more affordable housing market for the local people, by reducing the amount of property taxes and infrastructure paid by every homebuyer.

Contrast to the above studies, Jun, Myung-Jin (2004) focused on the effects of Portland's UGB on the urban development patterns, based on Census data from 1980 to 2000. He compared the urban development pattern in Portland to other 31 metropolitan areas for the following variables: urbanized population, urbanized area, population density in urbanized area, employment in central city, housing units in the urbanized area, auto and transit users and mean commute time (Table 2-2). The results showed that Portland did not appear to have less suburbanization, higher infill development or decreased auto use, compared to other metropolitan areas (Jun, 2004). Furthermore, he conducted a housing supply regression model to examine what factors affected the location of new housing and whether the UGB affected the urban residential development pattern. The most important result of the analysis indicated that the UGB variable was not statistically significant in both 1990 and 2000 models.

Therefore, he concluded that the location of new housing is not affected by the UGB variable (Jun, 2004).

Table 2-2. Percentage change of six variables of urban development pattern in Portland, 1980-2000 (Jun, 2004).

Variables	Percentage changed, 1980-2000	Rank (out of 32)
Urbanized Population (000s)	54.3	8
Urbanized Area (square miles)	35.8	9
Population Density	13.6	15
Employment in central city	70.8	6
Housing units in urbanized area	54.4	16
Auto users	69.9	12
Public transit users	26.1	11
Mean comminuting time	14.5	15

Source: U.S. Bureau of Census, STF3, 1980 and 2000, (Jun, 2004).

In summary, most of the previous studies observed that the UGB tended to increase the land value, mainly because of its constrain of supply of land and preference for higher-density development. Moreover, the urban development pattern was also changed by the implementation of the UGB, such as higher redevelopment and infill development rate, increased housing density, etc. Demonstrated in the above discussion, all these observed direct or indirect effects caused by the UGB, seemed to lower the housing affordability in Portland. However, the exact magnitude of the UGB's impacts is unclear and not well supported by statistical analysis.

Statistical Analysis—Indicators and Regression Models

In above theoretical analysis, the conclusions about effects of the UGB on Portland's housing affordability are lack of statistical analysis to support. To answer the question whether the UGB affects the housing prices and by how much, I will study the previous statistical researches, which include simple indicators and several multiple regression models. The indicators demonstrates the ranking of Portland's housing affordability among major metropolitan areas, while the regression model shows that whether the UGB in Portland contribute significantly to housing prices, as well as the factors that contributes to housing prices most.

Indicators—HOI and H+T Affordability Index

The first indicator is the Housing Opportunity Index (HOI) provided by National Association of Home Builders (NAHB). The HOI, that includes local median income and housing cost, is defined as the share of housing prices that would have been affordable to median family income, based on the standard mortgage underwriting criteria (NAHB, 2011). According to the information from the websites of NAHB, the data of median family income of metropolitan areas are collected from Department of Housing and Urban Development (HUD) and the data of housing costs are from Core logic. To be consistent with the conventional assumption in the lending market, the NAHB assumes that “a family can afford to spend 28% of its gross income on housing (NAHB, 2011)”. In the national HOI ranking, the Portland metropolitan area ranked the 181st among 226 metropolitan areas. Moreover, between 1999 and 2002, 2006 and 2010, the ranking range of Portland’s HOI was from 127th to 198th in the nation. However, in the year 2003-2006, the housing affordability of Portland dramatically ranked 65th to 109th, which was the highest ranking ever recorded (NAHB, 2011). The reason of these sudden changes was unclear. Concluded from the above the data, the housing market in Portland is considered unaffordable, approximately 180th among more than 200 metropolitan areas.

Later, Center for Neighborhood Technology (CNT) developed another affordability index—Housing and Transportation Affordability Index (H+T Index).Since the transportation cost is the second largest expenditure after housing of one family, CNT included the transportation cost into the affordability calculation. Therefore, H+T Affordability Index is calculated as the total expenditure of housing and transportation cost dividing annual household income. As the transportation cost, it was calculated by a complicated model (Figure 2-2), which includes not only the cost of commute to and from work, but also the daily travel cost (CNT, 2011). Furthermore, the transportation cost is highly related to location, characteristics of the neighborhood and urban form. According to the basic urban economics theory—"prices adjust to ensure locational equilibrium (Sullivan, 2009, p.28)", the transportation cost is directly related to the housing location that it is the trade-off between the distance to work and housing prices or rent. Compared to the traditional "30%" standard, the H+T Affordability Index defined that the total expenditure less than 45% of the income is considered as affordable. In addition, the index covers 80% of the total population, 337 metropolitan areas and 161,000 neighborhoods (CNT, 2011). It is important to note that the H+T Affordability Indexes of the metropolitan areas are based on neighborhood scale.

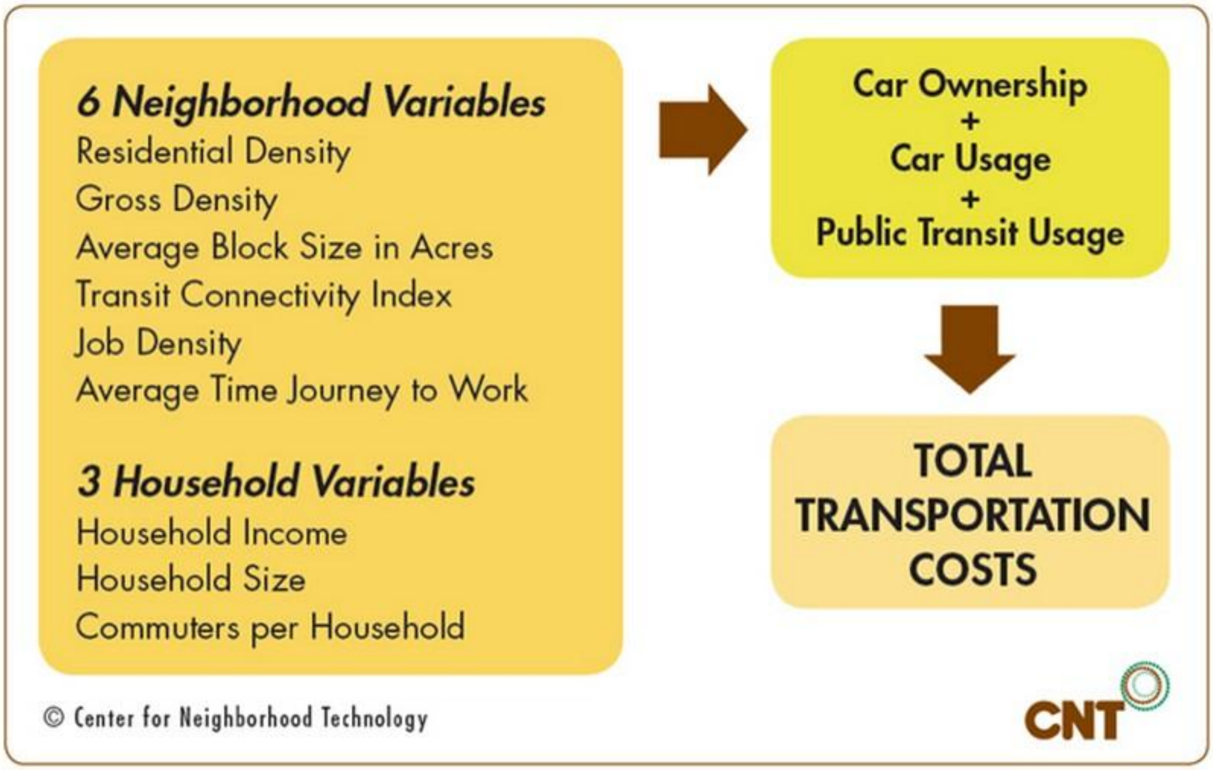
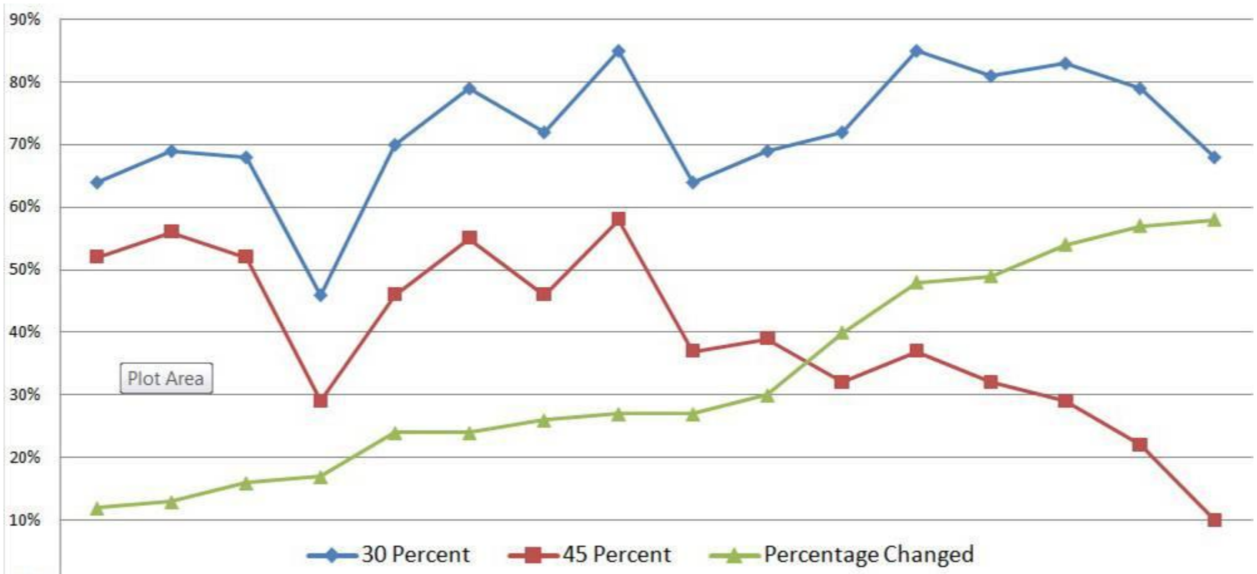


Figure 2-2. The estimated model of total transportation cost in the H+T Affordability Index. (Source: http://htaindex.cnt.org/method.php. Last accessed January, 2011. Edited by Author)

According to the H+T Community Profiles (CNT, 2011), 69% and 39% of the selected communities are considered as affordable respectively, based on the "30%" and "45%" standards. Only sixty-four percent and thirty-seven percent of Portland's communities are considered affordable based on the same standard, which are both lower than the national average percentages. Among the selective 14 metropolitan areas, Portland ranked 14th and 9th in these two different affordability standards, and it is not considered as an affordable housing market. More importantly, the percentages of affordable communities in all the metropolitan areas decreased when the affordability index takes account of the transportation cost. The percentage changed between "30%" and "45%" standards indicates that in certain cities, the transportation cost caused more significant impacts on local housing affordability, for example, Charleston, Duluth-Superior, Daytona Beach, etc. Showed in Figure 2-3, Boston, Washington D.C. and Chicago have a relative high and stable housing market than other metropolitan areas, while Portland's housing affordability index is slightly lower than the national average level.



Boston, MA-NH	Washington, DC-MD-VA-WV	Chicago, IL	Los Angeles-Long Beach, CA	Hartford, CT	Houston, TX	Cleveland-Lorain-Elyria, OH	Des Moines, IA	Portlan-Vancouver, OR-WA	National Overview	Pittsburgh, PA	Birmingham, AL	Oklahoma City, OK	Charleston, WV	Duluth-Superior, MN-WI	Daytona Beach, FL
64%	69%	68%	46%	70%	79%	72%	85%	64%	69%	72%	85%	81%	83%	79%	68%
52%	56%	52%	29%	46%	55%	46%	58%	37%	39%	32%	37%	32%	29%	22%	10%
12%	13%	16%	17%	24%	24%	26%	27%	27%	30%	40%	48%	49%	54%	57%	58%

Figure 2-3. Percentages of communities considered affordable using "30%" standard and "45%" H+T Affordability Indexes of major metropolitan areas. (Source: http://htaindex.cnt.org/metro-profiles.php. Created and edit by author)

The Figure 2-4 illustrates the locations of affordable communities in the Portland Metropolitan area. The icon "1", "2" and "3" in the map stand for main city of counties in the metropolitan area, Portland, Cedar Hills in Washington County, Troutdale in Multnomah County and Clackamas County. As seen in the figure, most of the neighborhoods located in the Portland City area are considered as affordable, based on both standards.

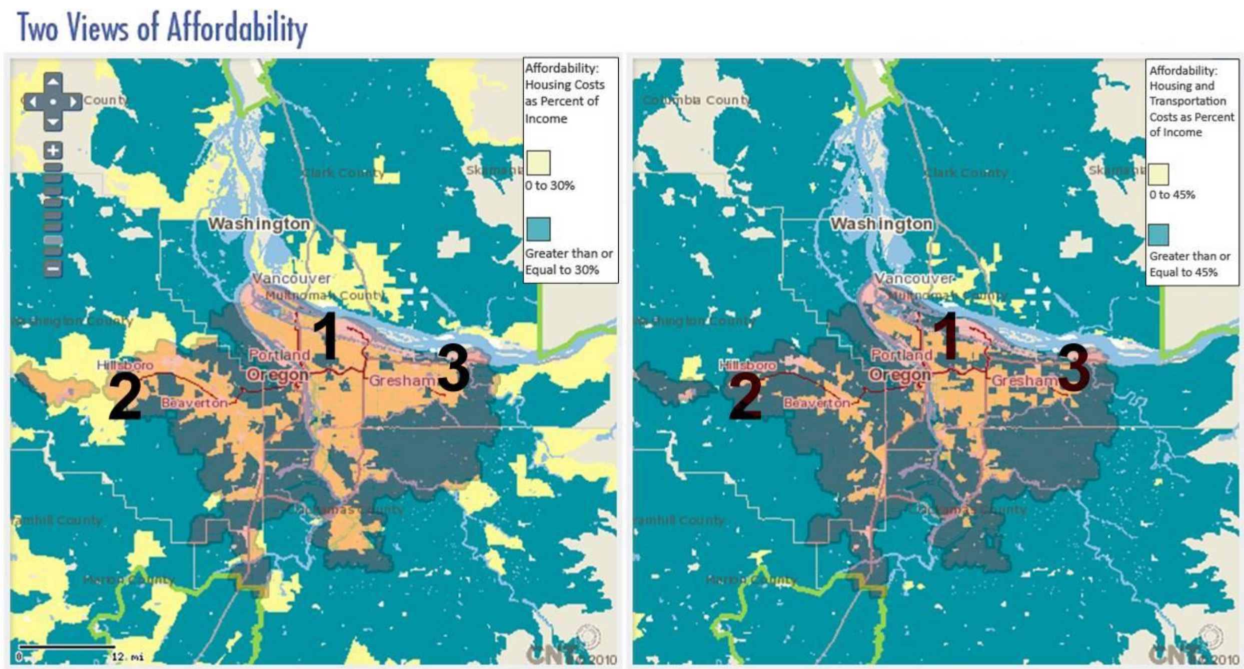


Figure 2-4. Map of the locations of affordable communities in Portland Metropolitan Area under “30%” and “45%” Standards. (Source: http://htaindex.cnt.org/metro-profiles.php. Last accessed January, 2011. Edited by author)

In sum, HOI showed that Portland’s housing market is not considered as affordable, far lower than the national average level; while the “30%” and H+T Affordability Index analysis held the opinion that the Portland’s housing affordability is approximately at the national average level. However, compared to HOI analysis, the results of the H+T Affordability Index is more comprehensive and reliable that it contains transportation cost which is another crucial factor that contributing to the housing affordability.

Multiple regression models

Besides the housing cost, annual income and transportation cost variables mentioned above, I will review the previous Portland’s housing affordability regression model, which take into account of the price effects of all other factors on local housing affordability. Though all housing affordability models focused on the Portland UGB and the housing affordability issues therein, the studies were conducted in different ways, mainly limited by available data and the conducting date of the research. The results provided us with the statistical analysis of effects of Portland's UGB on housing affordability from different perspectives.

Started from 1985, Gerrit Knaap conducted a regression model to analyze the effects of the UGB on residential land values in the metropolitan Portland area (Clackamas, Multnomah and Washington Counties). The data consisted of all the "arm's-length" residential land transactions within the Portland's Urban Growth Boundary in the fiscal year 1980. The selective variables captured the influences on the residential land values, including characteristics of the transaction, physical features of the land, constrains of the zoning, etc., while a dummy variable was used to indicate the relationship of the parcels of land to the UGB (Knaap, 1985). In this model, the dependent variable was the sales price divided by the number acres in the sale. From the results of the analysis, Knaap concluded that the land values varied significantly across Clackamas and Washington Counties, and it were lower outside the UGBs of these two counties, while the land values remained the same in Multnomah County. However, lack of additional information, the model did not test for the mechanism how the UGB caused impacts on the land values, for example, on the values of land in the urban zones, of the land within 300 feet of a sewer line, etc.(Knaap, 1985). In addition, Knaap only tested the relationship between the location of land parcels to the UGB of Portland, but not focusing on the housing affordability.

Alkadi (1996) used a hedonic model to conduct a time-series analysis to test the relationship between housing prices and the UGB in Washington County of the Portland metropolitan area. The dependent variable was the sales prices of individual houses in Washington County before and after the adoption of Portland's UGB, and 29 independent variables were included in the housing prices model, collected from supply-demand, accessibility factors, public service, structure and site factors of housing transactions, etc. during 1978 to 1990. UGB was adopted as a dummy variable with UGB = 1 indicating the house was sold after the implementation of the UGB in Portland—October, 1980, and TIME variable indicated the exact time of the house sold, from January 1978 = 1 to December 1990 =156 (Alkadi, 1996). According to the statistical results, Alkadi (1996) concluded that there was no relationship between housing prices and the implementation of the UGB, whereas the increase rate of housing prices was found to be less after the implement of the UGB than before. It is important to note that the distance of sale to the UGB was the only variable tested to be related with a higher increase rate in housing prices.

Following the previous theoretical debate, Goodstein and Phillips (2000) used a regression model to test the price effects of all the factors on the Portland's housing prices, which was a cross-sectional analysis among 37 major cities throughout the country from 1991 to 1996. The model contained 9 independent variables which reflected the supply-and-demand sides and speculation in the housing market. The estimation of the price effects of the UGB was represented as a proxy variable in the regression model. Comparing the predicted median housing prices to the Portland actual median housing prices, the results demonstrated that the UGB has probably slightly increased the median housing prices in Portland, approximately less than $10,000(Goodstein & Phillips, 2000). They concluded that the increased housing prices during the study period mainly resulted from the rapid employment and income growth.

Two years later, their conclusions were supported by another study conducted by Anthony Downs. Compared to previous Portland's housing affordability regression models, Downs (2002) conducted a more comprehensive regression to test price effects of 25 key independent variables on the dependent variable—percentage increases in home prices during various time periods. There were five time periods in the regression models, 1990 to 2000, 1990 to 1994, 1990 to 1996, 1994 to 2000 and 1996 to 2000, which were selected due to the available home prices data (Downs, 2002). In the analysis process, the first step was to run the regression with all the variables, which aimed to find out the variables that were statistically significant to the dependent variable. In the second step, these statistically significant variables would be included into the "best" regression models for each time period. More importantly, once the "best" models were developed, the UGB dummy variable would be also included into each of the model to test the price effects of the UGB in five different time periods. In the results, after the dummy variables were included, the adjusted R square values of three time periods (1990-1994, 1990-1996, and 1990-2000) rose significantly, while the adjusted R square values of the other two time periods (1994-2000 and 1996-2000) dropped (Downs, 2002). Downs (2002) concluded that the UGB only had significant impacts on the increasing housing prices from 1990 to 1994, but not during other time periods between 1990 and 2000. He also gave the explanation that only in the time period 1990-1994, the job and income growth rate increased rapidly, as well as the home prices, and the estimated 20-year land supply did mitigate the UGB's constraining impacts on the housing market.

In the same year, Fischel (2002) reviewed the studies conducted by Downs (2002), Goodstein and Phillips (2000), and Knaap and Nelson (1992) and made his own comments and opinions. Downs, Goodstein and Phillips had the similar conclusion that the rapid rose in housing prices during early 1990s was mainly attributable to rapid job and income growth rather than the constrain of the UGB, while Knaap and Nelson reached a different conclusion (Fischel, 2002). He provides the explanation that the densities within the UGB had been increased due to the statewide growth management requirements before the implementation of the UGB. As a result, the potential housing supply in late 1980s was high enough for the future increasing housing demand.

Myung-Jin Jun (2006) used a hedonic prices regression analysis to assess the mean housing prices in the Portland metropolitan area in the year 1990 and 2000, which took account of the building structure, housing market and accessibility factors. Similarly, the UGB was presented as a dummy variable. The results of the regression model showed that the UGB variable had no significant effect on the housing prices, inside or out the growth boundary areas in years 1990 and 2000 (Jun, 2006). However, further research questions were generated by the results in that the research should also consider the relationship between land values, housing density and housing prices, because these variables are highly correlated (Jun, 2006).

Grout et al. (2009) conducted a regression discontinuity design to explore the price effects of Portland's UGB on the vacant land prices. The data of the samples were the undeveloped parcels of land which were located in and around the Portland's Urban

Growth Boundary, and the distance to the UGB variable was measured as negative values inside the UGB and positive value outside the boundary (Grout et al., 2009). The whole study area was divided into 12 sections which indicated the different locations of the vacant parcels in or around the UGB. The results demonstrated that only the vacant land in Western Portland was significantly influenced by the distance to the UGB variable, which created a discontinuity point within Portland's UGB. However, other vacant land within the Portland's UGB did not appear to be affected by the UGB variable, so there were not sufficient evidence to establish any relationship between the implementation of the UGB and the vacant land values.

Summary of Previous Studies on Portland's Issue

The above studies explored and analyzed the relationship between Portland's UGB and local housing affordability issue both qualitatively and quantitatively. Though their research designs are not exactly the same, most of the studies reached the similar conclusion that the implementation of Portland's UGB did not seem to affect the local housing affordability.

In the theoretical analysis section, most of the researchers insisted that the implementation of Portland's UGB constrain the supply of land for future urban development, which tends to increase urban density, redevelopment and in-fill development rate, and eventually could push up the land prices. Even if the boundary contains 20-year supply of land for future development and encourages higher density, Portland still could have a housing deficit in 2040 (Staley et al., 1999). There are the main theoretical opinions presented by previous studies that Portland's UGB definitely caused price effects on local housing market.

However, the results of previous statistical studies reached the different conclusion that Portland's UGB did not affect local housing prices. On the contrary, housing prices were affected by the growth in income and employment opportunities. Due to the fact that the statistical analyses were adopted in different years between the time periods from 1985 to 2009, these studies had different research design and limitations, such as different available data, research time frame, methodology, dependent and independent variables, etc. In the studies adopted in early years, the Portland's UGB was tested to have slightly affected the land prices and housing prices. However, in the later studies, with more available data and comprehensive research design, the conclusion was that the UGB in Portland did not contribute to increasing local housing prices.

CHAPTER 3
METHODOLOGY

The literature review from the previous chapter provided background information demonstrating the controversial relationship between UGB and housing affordability. Based on the previous arguments, the growth boundary intends to push up land prices and change urban development patterns, which leads to lower housing affordability. This study used both qualitative and quantitative analysis to test two research hypotheses. As mentioned before, the two research hypotheses are: (1) Due to the UGB constrain on the supply of land, the trends of land prices and land share in the Portland metropolitan area should be higher than other metropolitan areas without UGBs in United States. Since land prices have a significant impact on housing prices, the housing prices in Portland should be also higher. In addition, the land and housing prices in Portland are highly correlated; (2) besides affecting the land prices, the UGBs also tend to change the urban development patterns, such as higher-density development, high redevelopment and infill development rate of the inner-city, etc. The regression model takes into account all of the factors that contribute to housing prices to measure the price effects of different predictors on the median housing prices among 35 urbanized areas.

The details in these two statistic analysis are not similar. The former one is to test the correlation between land prices and housing prices in major metropolitan areas in America; while the latter one is a multiple regression model of median housing prices among major cities.

Correlation between Land Prices and Housing Prices

In this method, the correlation analysis consists of depictive analysis of trends in land prices, housing prices, percentage of land share in housing prices, and a Spearman correlation analysis between the two, based on a dataset of 10 major metropolitan areas. The purpose of this analysis is to provide clear answers for the following research questions:

- According to the trends analysis from 1984 to 2009, are the land prices and the percentage of land share (the proportion of land prices in the housing prices) higher in Portland than other 10 metropolitan areas without the control of the UGB and their average trend?
- Are the housing prices higher in Portland than other 10 places, as well as their average trend?
- Based on the results of the Spearman correlation, is the significance of the correlation coefficient value higher in Portland than other metropolitan areas without the UGB?

Data Source and Study Area

The data about land prices and housing prices of different major metropolitan areas are assessed from the of Lincoln Institute of Land Policy, which contains the information about land, structure and housing prices back from 1984 to 2009, quarterly. The recorded housing prices come from real estate transactions, however, the land prices are rarely recorded due to most of direct land sales are occurred in built up areas and new suburban development areas (Lincoln Institute of Land Policy, 2010).Therefore, the land prices are calculated by residual method—housing prices subtracted the cost of structure and the percentage of land share was land prices dividing housing prices. The area of focus for this method was the metropolitan area of the city due to all the data from Lincoln Institute of Land Policy are collected within this boundary. However, due to some metropolitan areas contain many non-densely developed or undeveloped lands, the tested results intend to enhance the gap between Portland and other metropolitan areas. There are 10 comparable metropolitan areas used in the analysis (Table 3-1), which have he similar population size as Portland metropolitan area, but without UGBs.

Table 3-1. List of the metropolitan areas for the prices trend analysis and Spearman Correlation

Name of Metropolitan Areas	Total Population (000s)
Portland, OR	2,265,223
Average of 10 Metropolitan Area	2,323,848
Cincinnati, OH	1,979,202
Cleveland, OH	2,945,831
Indianapolis, IN	1,607,486
Milwaukee, WI	1,689,572
Phoenix, AZ	3,251,876
Pittsburgh, PA	2,358,695
San Antonio, TX	1,592,383
San Diego, CA	2,813,833
St. Louis, MO	2,603,607
Tampa, FL	2,395,997

Source: U.S. Bureau of Census, Census 2000.

Prices Trends Analysis and Spearman Correlation Coefficient

To answer the above questions, I will use the line charts which show the trends of land prices, percentage of land share and housing prices to find out the relationship between land and housing prices among these 11 major metropolitan areas. Moreover, the Spearman Correlation Coefficient was adopted to test the significant level between the land and housing prices. The line charts give a qualitative description of the prices and land share trends, while the correlation coefficient provide more quantitative analysis for land and housing prices. Finally, I ranked these metropolitan areas according to their value of significance in the statistical result.

Median Housing Prices Regression Model

Compared to the first method that focused on the correlation between land and housing, this multiple regression model will consider all the factors that contributed to housing prices, which is a more comprehensive model. The purpose of this regression is to provide answers to these research questions:

- According to the results of correlation coefficient, are all the selected independent variables statistically significant to the median housing prices?
- Followed the first two questions, which variables are statically significant in the regression model and contributing to median housing prices most? Is the UGB variable causing impacts on the median housing prices? If not, is the UGB variable correlated to some of the independent variables, such as housing density, population density, median commute time, etc?
- Based on the statistical results of the regression model, the best median housing prices model with the highest “adjusted r square” will be discussed and explained.

Data Source and Study Area

In the regression, the dependent variable is the median housing prices of major cities in the states and 9 predictors are considered in the model. Most of the data are downloaded from the “Census 2000” from the website of U.S. Census Bureau. The basic of the data will be described in the following section. The sample size of the cities is 35, and the cities names are listed in detail in Table 3-2. Among these 35 samples, 10 cities have adopted some forms of growth boundary planning tools, such as urban service area, intergovernmental agreement, etc.

Table 3-2. List of the urbanized areas in the multiple regression model.

Location/ Urbanized Areas	West Coast (6)	Southwest (7)	Midwest (11)	Southeast (4)	East Coast (7)
UGB ("1")	Portland, OR San Jose, CA Seattle, WA	Boulder, CO Denver, CO	Twins Cities, MI Lexington, KY	Memphis, TN	Miami, FL Virginia Beach, VA
UGO ("0")	Los Angeles, CA San Diego, CA San Francisco, CA	Dallas, TX Houston, TX Phoenix, AZ Salt Lake City, UT San Antonio, TX	Buffalo, NY Chicago, IL Cincinnati, OH Cleveland, OH Detroit, MI Indianapolis, IN Milwaukee, WI Pittsburgh, PA St. Louis, MO	Atlanta, GA Charlotte, NC Tampa, FL	Baltimore, MD Boston, MA New York, NY Philadelphia, PA Washington DC

Source: Edited by author.

To be noticed, differently from the prices trend analysis, the research area in the analysis in not metropolitan area, but the boundary of urbanized area (UA) of each city. Defining the study area among different cities is essential to the accuracy of the final results. A metropolitan area, according to the definition made by U.S. Census, is a substantial central nucleus, surrounded by the adjacent areas which have highly economic linkages with the central nucleus; while the urbanized area is referred to a central city and its surrounding highly built-up areas (Greene and Pick, 2006).The reason I choose urbanized area to be the study area is because the metropolitan area contains many not highly built-up areas surrounding the central cities, which intends to affect the final results of some predictors. More importantly, to the cities controlled by growth boundary, the metropolitan area contains many areas outside the boundary which are not built-up, mainly farmland and forestland. In addition, the city boundary is also not an ideal study area due to it only consists of the central city, ignoring some thickly developed areas around the central cities without the control of UGB.

Variables in the Regression Model

This multiple regression model is cross-sectional that it integrates the median housing prices of 35 urbanized areas in year 2000, which consisted of 9 independent variables (Table 3-3). All the variables were gathered from “census 2000” database of the U.S. Bureau of Census and modified for the statistical purposes. To be noticed, in the model, the UGB variable is represented as a dummy variable that “0” stands for negative-cities with no growth boundary, and “1” stands for positive-city with growth boundary.

The purposes of the model aimed to explore the price effects of each independent variable on the median housing prices of the urbanized areas, especially focusing on the price effects caused by the implementation of the UGB.

Table 3-3. List of variables in the median housing prices regression model.

Variables	Expected Sign	Data Measurement
MHP, Median Housing Prices		Interval
AHS, Average Household Size	+	Interval
HD, Housing Density(per square miles)	+	Interval
JD, Job Density	+	Interval
MCT, Mean Commute time(per person)	-	Interval
MHI, Median Annual Household Income	+	Interval
PD, Population Density(per square miles)	+	Interval
UGB, UGB Dummy	+	Ordinal
UR, Unemployment Rate	-	Ratio
VD, Vehicle Density(per square miles)	+	Interval

Source: Edited by author.

CHAPTER 4
ANALYSIS AND RESULTS

This chapter presents two statistical analyses of the price effects of the Urban Growth Boundary (UGB) on Portland's housing affordability: price trend analysis to determine correlation between land prices and housing prices and the regression analysis to determine the prices effects of the UGB on the median housing prices through a regression analysis. These two methods are both cross-sectional analyses, comparing the Portland metropolitan area or urbanized area to other metropolitan area or urbanized areas in the United States. Furthermore, the second part in this chapter discusses the above two statistical analyses of the UGB's price effects in Portland presented and provides explanations for their results. The limitations of each method and the recommendations to improve the research also will be discussed.

Correlation between Land and Housing Prices

This method concentrated on the relationship between land prices and housing prices. According to the theoretical discussion in Literature Review Chapter, Portland's UGB intends to affect housing prices by constraining the supply of land and increasing the density of development. There are two parts in this analysis process. First, the trends of land prices, land shares (the percentage of land prices in housing prices) and housing prices in Portland and 10 other metropolitan areas without UGBs. Second, the Spearman Correlation Coefficient is used to explore the significance level between land and housing prices in these areas.

Prices Trends Analysis

Figure 4-1 and 4-2 show the trends of land prices and land share for the Portland metropolitan area and 10 metropolitan areas without the control of a UGB between 1984 and 2009.

As demonstrated in Figure 4-1, except for Phoenix, Portland and San Diego, the remaining metropolitan areas had similar land prices trends between 1984 and 2003. However, among these metropolitan areas, the land prices in Milwaukee and Tampa increased faster than the other six metropolitan areas between 2004 and 2008. Obviously, the land prices in San Diego were not comparable to the other metropolitan areas because it remained much higher than all other areas during the whole time period. Between 1984 and 1989 in Portland, the land prices trend was almost identical to the other areas, excluding Phoenix and San Diego; the prices began to increase beyond those from the other eights areas and the average of the 10 metropolitan areas after 1990, and following this trends for the rest of the time period. Portland and Phoenix had similar land price trends between 1990 and 2007, but the land prices in Phoenix dropped significantly after the economic downturn in 2007. Except for extremely high land prices in San Diego, the Figure 4-1 illustrates that the land prices in Portland continued growing and remained in a higher position even during the economic crisis from 2007 to 2009.

Again in the land share trends, San Diego had a much higher land share percentage than all other metropolitan areas; the value was more than 60% during the whole time period and peaked at about 82% in 2006. However, higher land prices were not necessarily associated with higher land share. The land share percentage trends were below 40% of the housing prices in the remaining metropolitan areas, excluding

Phoenix and Portland. Notable among these low land share metropolitan areas, Tampa exceeded 40% after 2000 and peaked at about 58% in 2005. After that, it dropped dramatically to 12 % in 2009. The land share in Portland continued increasing steadily and exceeded 40% in 1990, peaking at 62% in 2006. In 2007, due to the economic crisis, the land share in Portland dropped to 46%, higher than all the other metropolitan areas (except San Diego) and the average of these areas.

As seen in Figure 4-3, the housing prices trends of these 11 metropolitan areas illustrated a pattern similar to the land prices trends. San Diego was still leading among all the metropolitan areas with much higher housing prices from 1984 to 2009. The other areas had a similar growth pattern in that the housing prices increased slowly but steadily over time, whereas housing prices in Portland started to grow faster from 1990, peaking at $ 384,404 in 2007. Even though the housing prices in Phoenix were higher than Portland between 2004 and 2007, Phoenix prices dropped dramatically during the economic crisis to the point where they were, much lower than those in Portland by 2009. Similar to the land price trend, the housing prices in Portland grew constantly and remained at a higher level than other metropolitan areas during the whole time period, except for San Diego and Phoenix.

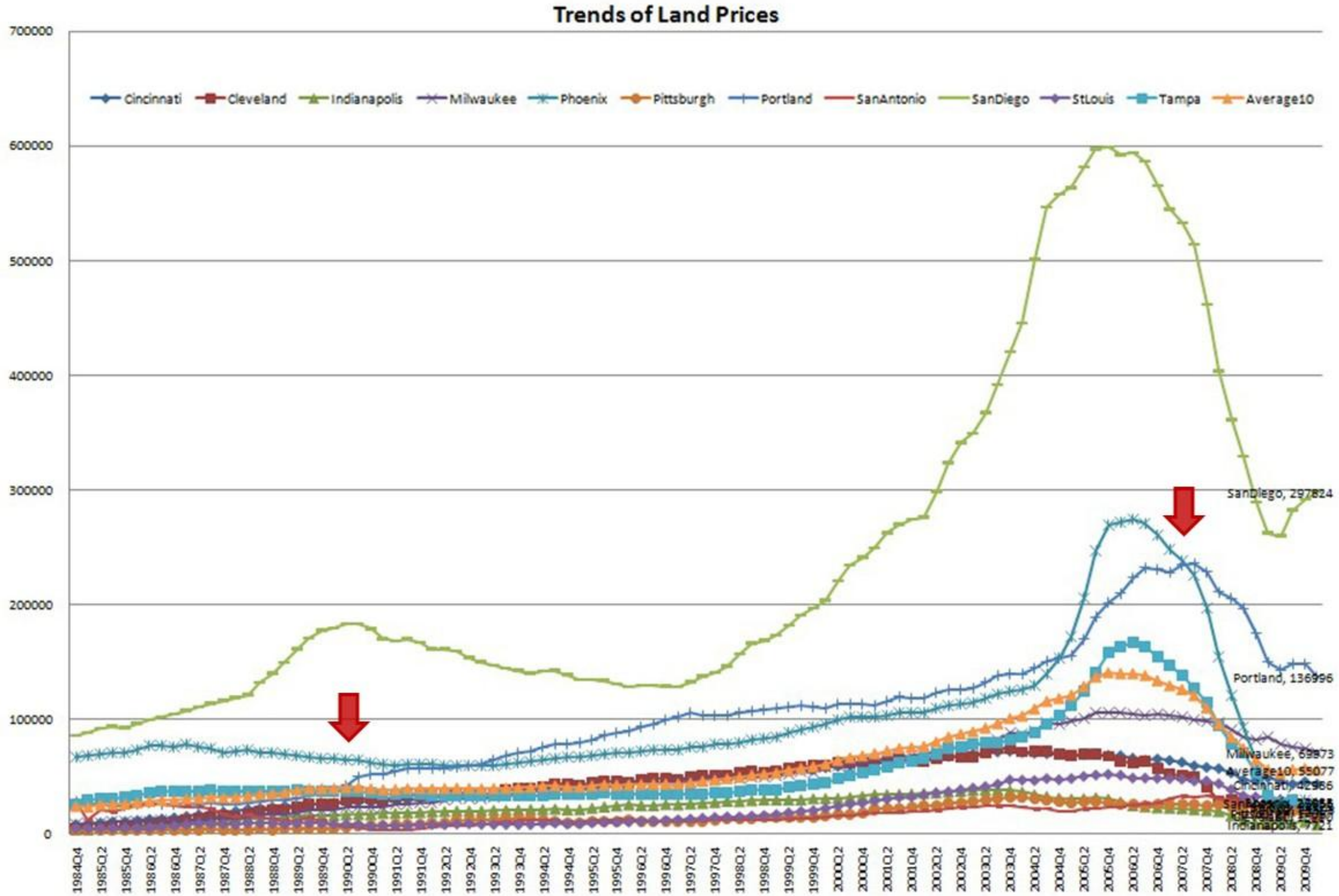


Figure 4-1. Trends of land prices of 11 metropolitan areas. (Source: Lincoln Institute of Land Policy. Edited by author)

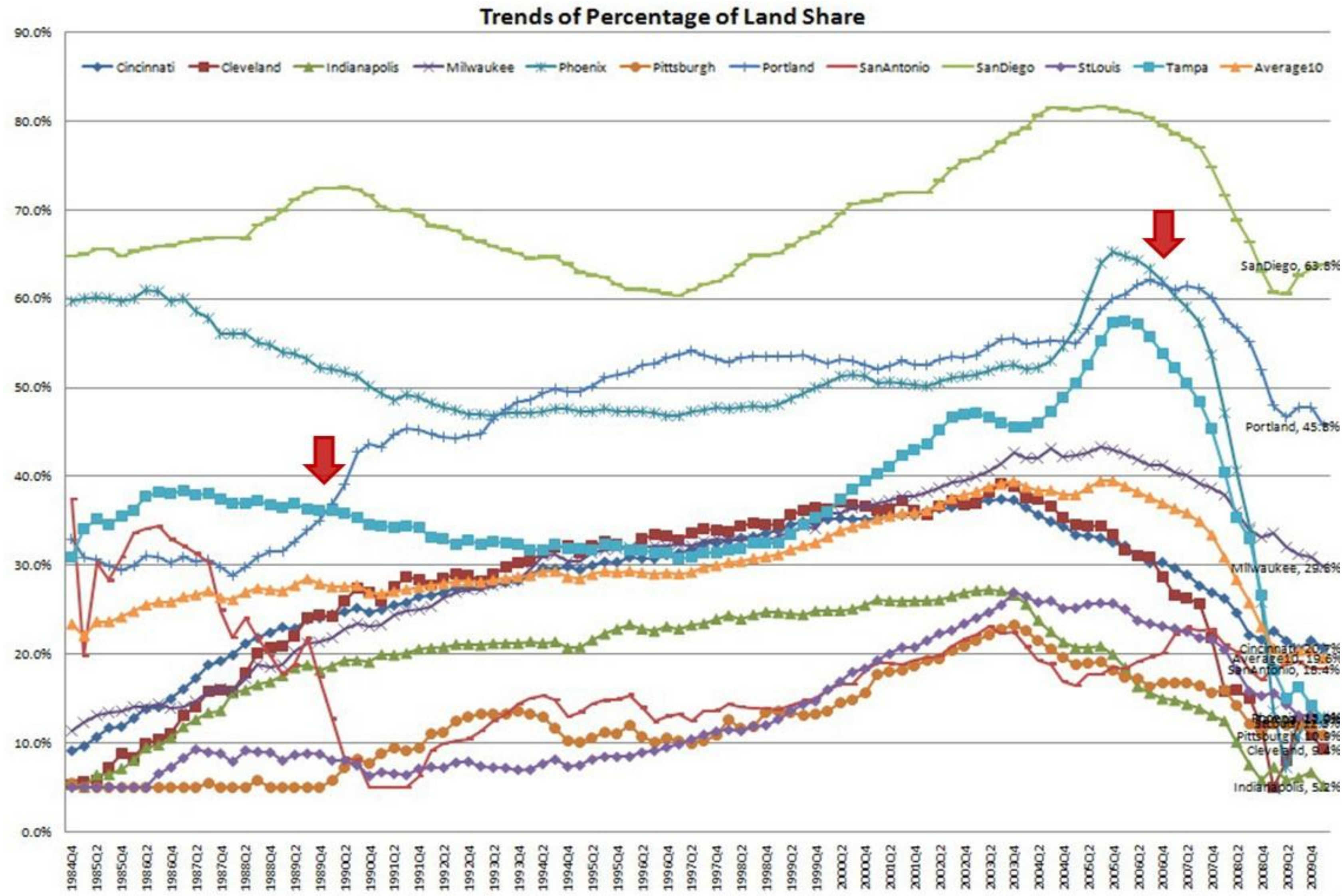


Figure 4-2. Trends of percentage of land share of 11 metropolitan areas. (Source: Lincoln Institute of Land Policy. Edited by author)

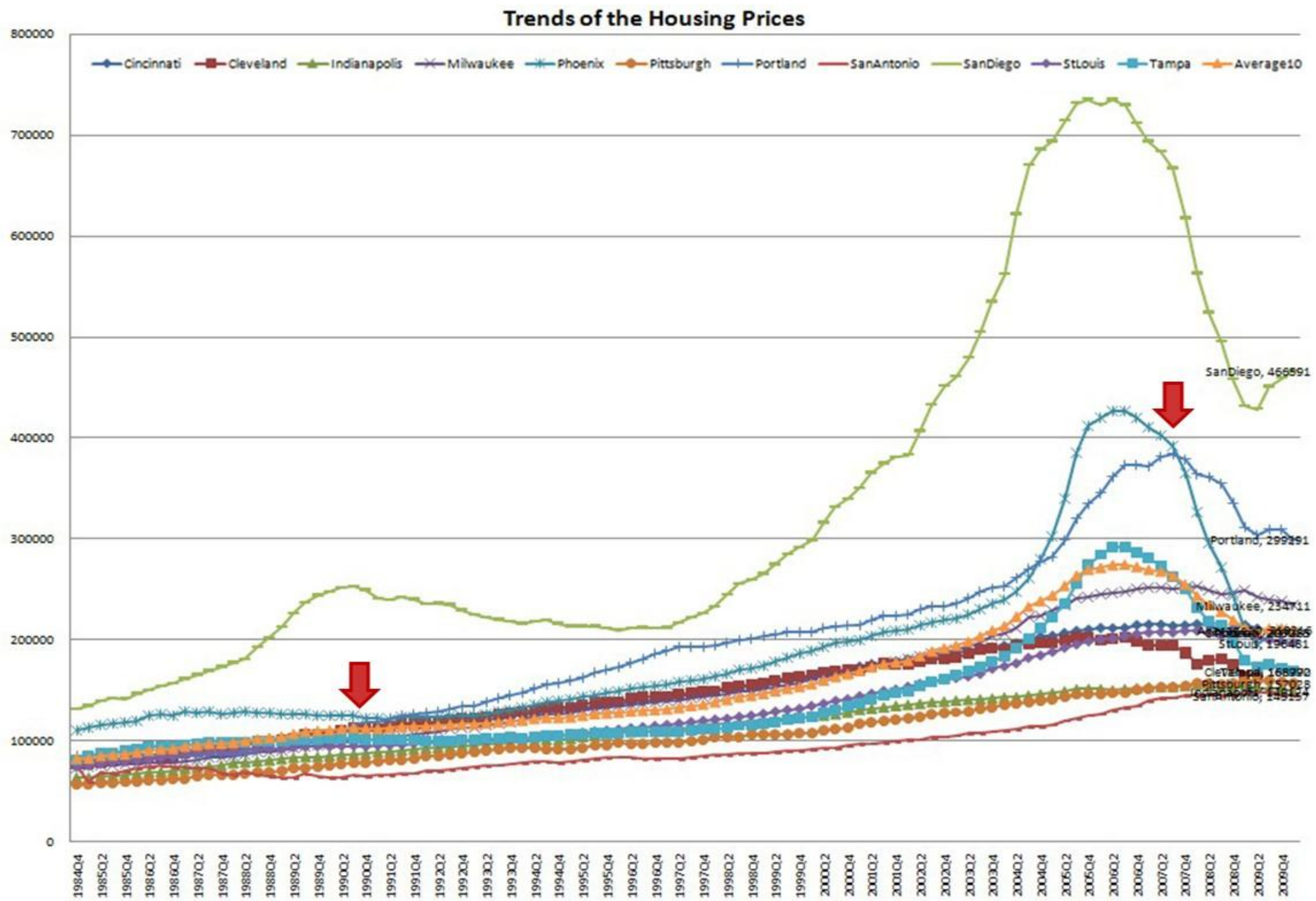


Figure 4-3. Trends of housing prices of 11 metropolitan areas. (Source: Lincoln Institute of Land Policy. Edited by author)

Spearman Correlation Coefficient

The above price trends analysis illustrated that there was a certain relationship between land and housing prices. Therefore, the Spearman Correlation Coefficient was utilized to measure the correlation between land and housing prices in each metropolitan area. The results of the Spearman two-tail tests, as seen in Table 4-1, indicated that land and housing prices in each metropolitan area were significantly correlated to each other.

Table 4-1. Ranking of the Spearman Correlation Coefficient of 10 metropolitan areas.

Name of Metropolitan Areas	Spearman Correlation Coefficient (Sig. at 0.01 level)	Ranking
Portland, OR	.997	1
San Diego, CA	.992	2
Milwaukee, WI	.988	3
St. Louis, MO	.927	4
Pittsburgh, PA	.917	5
Cincinnati, OH	.890	6
Cleveland, OH	.803	7
Phoenix, AZ	.752	8
San Antonio, TX	.701	9
Tampa, FL	.685	10
Indianapolis, IN	.548	11

Source: Lincoln Institution of Land Policy, edited by author.

The Spearman Correlation Coefficient is “a commonly used measure of the size of an effect and that value of ±.1 represent a small effect, ±.3 is a medium effect and ±.5 is a large effect” (Field, 2005, p.111). In the results presented in Table 4-1, the coefficients were all larger than + .5, indicating that land prices had a large effect on housing prices in all the metropolitan areas. Portland, San Diego and Milwaukee had the highest coefficients among the metropolitan areas (close to + 1), whereas the coefficient for Indianapolis was just slightly higher than + .5. Portland had the highest coefficient among all the areas at 0.997. Though Phoenix and Portland had similar patterns for land and housing price trends, the Phoenix coefficient was 0.752. This value was much less than 0.997 and ranked at 8th among all the metropolitan areas.

In summary, land prices, land shares and housing prices in Portland grew faster than other metropolitan areas after 1990 and remained at a high level even during the economic downturn. Only San Diego had a higher land prices, land shares and housing prices than Portland during the whole time period. Moreover, based on the results of the Spearman two-tail tests, these two metropolitan areas had almost the same coefficient values—0.997 in Portland and 0.992 in San Diego. However, there is no evidence showed that the rapid growth of the land and housing prices in Portland was caused by the UGB.

Median Housing Prices Regression Model

Compared to the correlation analysis between land prices and housing prices, this regression model is more comprehensive and accurate statistical method that it aims to measure the price effects of eight other independent variables besides UGB dummy variable, on the median housing prices among 35 urbanized areas. The first part of the analysis is to find out which independent variables are statistically significant to the median housing prices. In the second part, based on the results of the regression model, the best models to measure the median housing prices will be explained in detail.

Correlation Coefficient and Scatter Plot Analysis

Before presenting the best median housing prices regression models, the relationship between dependent variable and each of the independent variables were tested to see if they were statistically significant to the median housing prices (Table 4-2). Since the interval or ratio data were not normally distributed, the Spearman

Correlation Coefficient was used in the test, which is a non-parametric test and its rejection zone is less than 0.05.

Table 4-2. Correlation coefficients of dependent variable and independent variables in the regression model.

Independent Variables	Sig. (two-tail test, at 0.01 level)	Correlation coefficient
AHS, Average Household Size	.198	(.223)
HD, Housing Density(per square miles)	.002	.496
JD, Job Density	.001	.552
MCT, Mean Commute time(per person)	.029	.368
MHI, Median Household Income (annually)	.000	.780
PD, Population Density(per square miles)	.001	.535
UGB, UGB Dummy	.314	(.175)
UR, Unemployment Rate	.148	(-.250)
VD, Vehicle Density(per square miles)	.000	.615

Source: U.S. Bureau of Census, “2000 Census”, edit by author.

The results of the Spearman tests indicated that only the average household size, UGB and unemployment rate were not statistically significant to the median housing prices—dependent variable. The significance of the coefficients of these three variables was larger than 0.05, which meant that there is no relationship between median housing prices and average household size, UGB and unemployment rate. Furthermore, as seen in Figure 4-4, 4-5 and 4-6, the dispersion of median housing prices and these three variables did not illustrate any correlation in the scatter plots maps. These results indicated that the UGB variables were not correlated to the median housing prices in the regression model. In addition, the straight line in the scatter plots indicated the mean values of the all the sample point, but not necessarily indicating any linear relationship between the tested two variables.

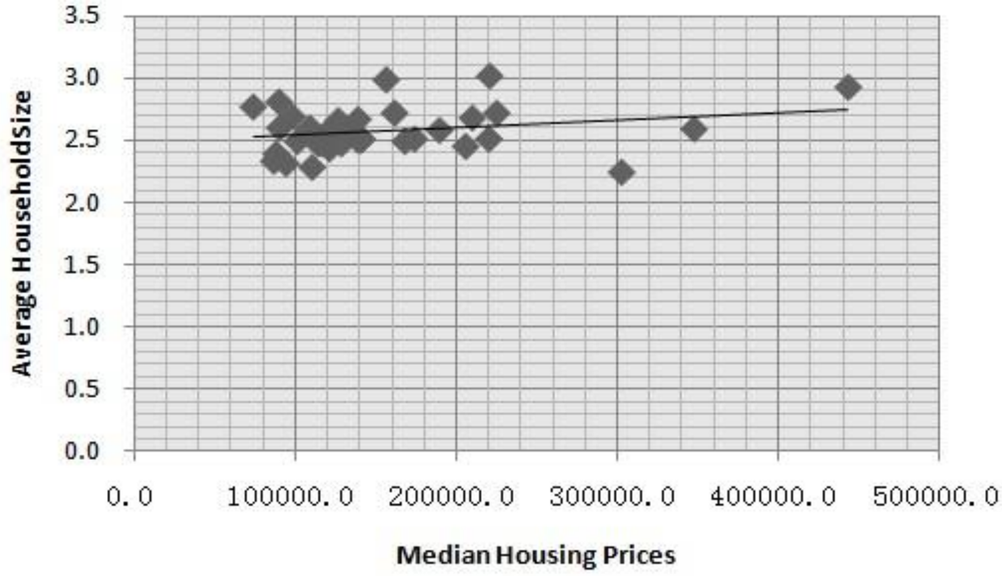


Figure 4-4. The scatter plot of median housing prices and average household size. (Source: U.S. Bureau of Census, “2000 Census”. Edit by author)

Figure 4-5. The scatter plot of median housing prices and UGB dummy variable. (Source: U.S. Bureau of Census, “2000 Census”. Edit by author)

Figure 4-6. The scatter plot of median housing prices and unemployment rate. (Source: U.S. Bureau of Census, “2000 Census”. Edit by author)

On the other hand, six independent variables in the model were statistically significant to the dependent variable. The coefficients of job density, median annual household income, population density and vehicle density were larger than 0.5, which indicated that these variables had strong positive effects on median housing prices. The coefficients of housing density and mean commute time indicated these two variables had medium effects on median housing prices. The median household income and the vehicle density variables had the highest coefficients among all the variables, 0.780 and 0.615 respectively; while the coefficient of median commutes time was 0.368, which was the lowest value. In addition, the scatter plots of median household income and mean commute time also confirmed their correlations with median housing prices (Figure 4-7 and 4-8).

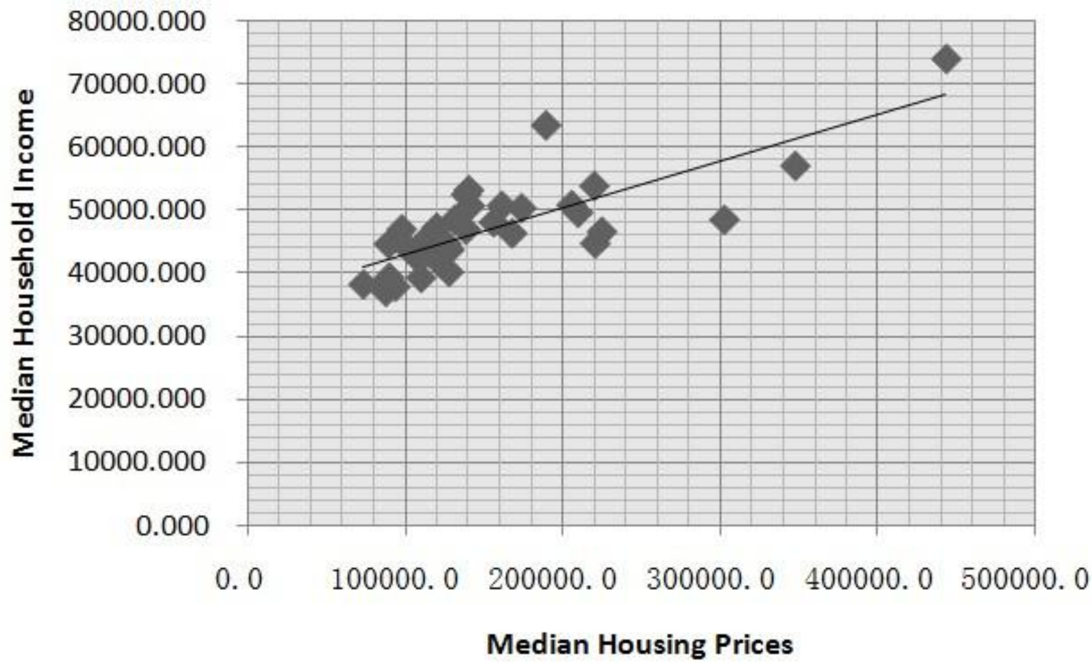


Figure 4-7. The scatter plot of median housing prices and median household income. (Source: U.S. Bureau of Census, "2000 Census". Edit by author)

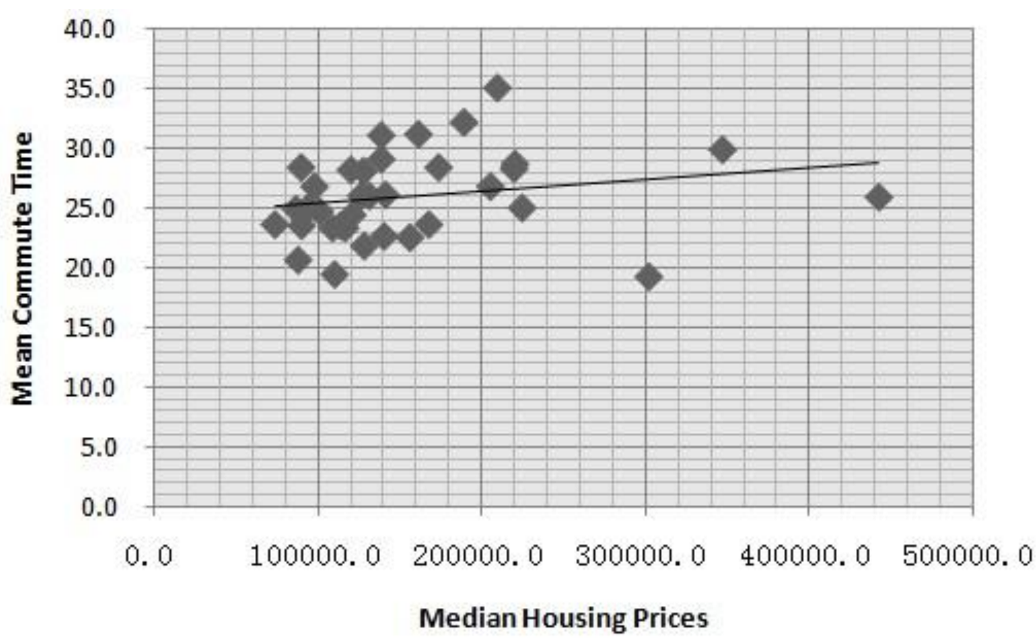


Figure 4-8. The scatter plot of median housing prices and mean commute time. (Source: U.S. Bureau of Census, "2000 Census". Edit by author)

The coefficients of housing density, job density and population density had very close significance value, 0.496, 0.552 and 0.535 respectively. Moreover, the scatter plots also illustrated that these three independent variables and the dependent variable had a very similar dispersion pattern (Figure 4-10, 4-11 and 4-12), which showed that these variables were highly correlated to each other. In addition, the dispersion of median housing prices and vehicle density in the scatter plot also showed similar pattern (Figure 4-9). This kind of similarity might result in collinearity problems in the following regression analysis.

Figure 4-9. The scatter plot of median housing prices and vehicle density. (Source: U.S. Bureau of Census, “2000 Census”. Edit by author)

Figure 4-10. The scatter plot of median housing prices and housing density. (Source: U.S. Bureau of Census, “2000 Census”. Edit by author)

Figure 4-11. The scatter plot of median housing prices and job density. (Source: U.S. Bureau of Census, “2000 Census”. Edit by author)

Figure 4-12. The scatter plot of median housing prices and population density. (Source: U.S. Bureau of Census, “2000 Census”. Edit by author)

Median Housing Prices Regression Models

As discussed above, the similarity of the dispersion between vehicle density, housing density, job density and population density would cause collinearity problems in the regression analysis, which would lower the credibility of the median housing prices model. If a model contained two of more of the above four variables, the VIF would be larger than 10 in the regression results, which indicated two or more variables in the model were highly correlated. To avoid the coollinearity issues in the regression models, there were four different regression models generated to measure the housing prices in these 35 urbanized areas, which consisted of three independent variables and a constant. Among these four regression models, the same variables in four models were median household income and mean commute time. The different variable was one of the four variables— vehicle density, housing density, job density and population density. These four median housing prices models are:

- Median Housing Prices=a1*(Median Household Income) + a2*(Vehicle Density)+ a3*(Mean Commute time)+ a4*(UGB Dummy)+ b(Constant).
- Median Housing Prices=a1*(Median Household Income) + a2*(Housing Density)+ a3*(Mean Commute time)+ a4*(UGB Dummy)+ b(Constant).
- Median Housing Prices=a1*(Median Household Income) + a2*(Job Density)+ a3*(Mean Commute time)+ a4*(UGB Dummy)+ b(Constant).
- Median Housing Prices=a1*(Median Household Income) + a2*(Population Density)+ a3*(Mean Commute time)+ a4*(UGB Dummy)+ b(Constant).

The following four tables showed detailed information about the median housing prices models with four different independent variables—vehicle density (Table 4-3), housing density (Table 4-4), job density (Table 4-5) and population density (Table 4-6). As demonstrated in the tables, the median household income had coefficients ranging from 0.617 to 0.708, which indicated a large positive effect on the median housing prices, while the mean commute time had a medium negative effect on the median housing prices, ranging from -0.259 to -0.195. All four density variables had a positive effect on the housing prices with close coefficient values. Furthermore, the vehicle and job densities showed large effects on median housing prices (greater than 0.50), while housing and population densities had medium effects (close to 0.50).

In the regression models, median household income was the most crucial variable s in measuring the median housing prices, which had a highest R square change, approximately 0.61, while the R square change of the mean commute time ranged from 0.031 to 0.052. Among all four density variables, the vehicle density had a highest R square change(0.190) in the regression model, followed by job density at 0.187. As to the median housing prices regression model, all four models had a very close adjusted R square value, approximately 0.810, which could explain about 81% of the housing prices cases. The job density-median housing prices model had a highest adjusted R square value at 0.831.

The UGB variable is not statistically significant in all four models and it tends to lower the adjusted R square of the regression, approximately by -0.005. In the models, in spite of the effects caused by the UGB, the coefficient of the median household income and density variables remained almost the same, while mean commute time variable was affected much significantly. For example, in Table 4-3, the results of the vehicle density housing prices model indicated that the mean commute time variable was not statistically significant due to the influence of the UGB variable.

Table 4-3. Summary of the vehicle density-median housing prices regression model

Model	Independent Variables	Sig. (Two-Tail Test)	Coefficient	Adjusted R square	R square change
VD-1	Constant	.000		.597	.609
	Median Household Income	.000	.780		
VD-2	Constant			.786	.190
	Median Household Income	.000	.543		
	Vehicle Density	.000	.496		
VD-3	Constant			.813	.031
	Median Household Income	.000	.617		
	Vehicle Density	.000	.516		
	Mean Commute time	.024	-.195		
VD-4	Constant			.807	-.005
	Median Household Income	.000	.614		
	Vehicle Density	.000	.512		
	Mean Commute time	.053	-.188		
	UGB	.863	.015		

Source: Generated by SPSS, edited by author.

Table 4-4. Summary of the housing density-median housing prices regression model

Model	Independent Variables	Sig. (Two-Tail Test)	Coefficient	Adjusted R square	R square change
HD-1	Constant	.000		.597	.609
	Median Household Income	.000	.780		
HD-2	Constant			.768	.173
	Median Household Income	.000	.653		
	Housing Density	.000	.434		
HD_3	Constant			.816	.051
	Median Household Income	.000	.748		
	Housing Density	.000	.485		
	Mean Commute time	.004	-.256		
HD-4	Constant			.810	-.006
	Median Household Income	.000	.746		
	Housing Density	.000	.483		
	Mean Commute time	.013	-.250		
	UGB	.901	.011		

Source: Generated by SPSS, edited by author.

Table 4-5. Summary of the job density-median housing prices regression model

Model	Independent Variables	Sig. (Two-Tail Test)	Coefficient	Adjusted R square	R square change
JD-1	Constant	.003		.597	.609
	Median Household Income	.000	.780		
JD-2	Constant			.783	.187
	Median Household Income	.000	.604		
	Job Density	.000	.467		
JD-3	Constant			.831	.050
	Median Household Income	.000	.694		
	Job Density	.000	.516		
	Mean Commute time	.003	-.253		
JD-4	Constant			.826	-.005
	Median Household Income	.000	.694		
	Job Density	.000	.516		
	Mean Commute time	.013	-.239		
	UGB	.731	0.28		

Source: Generated by SPSS, edited by author.

Table 4-6. Summary of the population density-median housing prices regression model

Model	Independent Variables	Sig. (Two-Tail Test)	Coefficient	Adjusted R square	R square change
PD-1	Constant	.000		.597	.609
	Median Household Income	.000	.780		
PD-2	Constant			.759	.165
	Median Household Income	.000	.618		
	Population Density	.000	.438		
PD-3	Constant	.004		.809	.052
	Median Household Income	.000	.708		
	Population Density	.000	.493		
	Mean Commute time	.005	-.259		
PD-4	Constant	.004		.804	-.005
	Median Household Income	.000	.698		
	Population Density	.000	.485		
	Mean Commute time	.19	-.238		
	UGB	.626	.42		

Source: Generated by SPSS, edited by author.

In sum, the best median housing prices regression model is, a1*(Median Household Income) + a2*(Job Density) + a3*(Mean Commute time) + b (Constant), which was able to explain about 83% of the housing prices cases. The most significant variables were the median household income and job density, which had a large positive price effects on the median housing prices. In addition, the R square change of the median household income was 0.609, which was much higher than job density (0.165) in the model. The UGB variables are not statistically significant and affects other independent variables in the models, which tend to lower the adjusted R square in each model.

The Price Effects of the UGB Variable

The above results of regression analysis showed that the UGB variable is not statistically significant in any of the four density models, which indicated that the UGB variable had no direct price effects on median housing prices among 35 urbanized areas. However, as showed above, the UGB variable would slightly affect price effects of other independent variables in the models, such as housing density, job density, mean commute time, median household income, population density, etc., which might cause indirectly price effects on median housing price. As showed in Table 4-7, all the correlation coefficients were larger than 0.05, which indicated that there were no correlation between the UGB variable and any of the independent variables in the models. Therefore, the implementation of the UGB had no direct or indirect price effects on the median housing prices in year 2000.

Table 4-7. Correlation coefficients of the UGB dummy variable and other independent variables in the regression model

Independent Variables	Sig. (two-tail test, at 0.01 level)	Correlation coefficient
HD, Housing Density(per square miles)	.234	.207
JD, Job Density	.219	.213
MCT, Mean Commute time(per person)	.064	-.316
MHI, Median Household Income (annually)	.775	.050
PD, Population Density(per square miles)	.264	.194
VD, Vehicle Density(per square miles)	.056	.326

Source: U.S. Bureau of Census, “2000 Census”, edit by author.

CHAPTER 5
DISCUSSION

This part draws the summaries of both the statistical analysis which are correlation analysis between land prices and housing prices, and median housing prices regression model. In the summary, the results of the analysis will be discussed and explained in detail. In addition, the limitations of the analysis and the recommendations for improvements of each method will be presented in the following paragraphs.

Summary of the Correlation Analysis

The prices trends and correlation analysis were aimed to test the first hypothesis—due to the supply of land constrained by the UGB, Portland had higher land prices and housing prices than other metropolitan areas since the adoption of the UGB in 1979, and the land prices are highly correlated with the housing prices. The results demonstrated that the land prices, percentage of land share and housing prices in Portland remained at a high level among the selected metropolitan areas during the whole study period, except for the San Diego and Phoenix metropolitan areas. Portland land prices, land shares and housing prices began to grow much faster than other metropolitan areas since 1990, and dropped less significantly than other areas during the economic downturn that started from 2007. The main reason of the faster growth of the housing prices in Portland was result from the rapid growth in income and employment, which was also supported by Downs' (2002) research. Moreover, the correlation coefficient of land prices and housing prices of Portland had the highest significant value among all the selected metropolitan areas, which indicated that the land prices were highly correlated with housing prices. However, the correlation coefficient of San Diego was almost the same to Portland, 0.992 in San Diego and 0.997 in Portland.

In the early 1990s, the land prices, land share and housing prices in Portland started to grow faster than most of the selective metropolitan areas, approximately 10 years after the establishment of the UGB. However, there is little evidence to establish any relationship between the repaid growth in housing prices and the implementation of the UGB.

Inconsistent Prices Trends of San Diego and Phoenix

In 1984, land and housing prices in San Diego were higher than those in Portland, approximately 40% (higher). After that, San Diego's land and housing prices kept growing steadily and experienced a significant increase between 1997 and 2006, approximately 400%. The increase was mainly resulted from an economic upturn—rapid growth in population, employment and business. During the same time period, Portland's land and housing prices also grew steadily, but less dramatically. During the economic downturn, the land and housing prices in San Diego also dropped severely, which closed the gap with Portland. However, land and housing prices in San Diego were still about 200% and 150% of Portland in 2009. As to the land share, Portland experienced a more significant growth than San Diego between 1984 and 2006. In 2009, the land share in San Diego was still about 130% of Portland's. In addition, the correlation coefficients of these two metropolitan areas had an almost the same correlation value.

Though Phoenix has high prices trends similar to Portland, there were some differences worth mentioning in the Phoenix's prices and land share trends. Land and housing prices were stable between 1984 and 2004, while land and housing prices in Portland grew steadily. Between 2004 and 2006, Phoenix land and housing prices experienced a suddenly increase, after that, the land and housing prices dropped to a significantly level in 2009. The land and housing prices in Portland also experienced an increase and decrease during the same time period, but less significantly, and remained at a high level in 2009. In addition, the land share in Phoenix continued dropping from 1984 to 2004, and then after experiencing a sudden increase from 2004, the land share dropped dramatically to a low level (23%) among all the metropolitan areas in the economic downturn. However, the land share in Portland was growing steadily during almost the whole time period, and dropped slightly to 45.8% during the economic downturn.

In sum, without the establishment of the UGB, San Diego had a higher land prices, land shares and housing prices than Portland, which is strongly contradicted the hypothesis. One explanation for these results is that San Diego and Phoenix are the most populous areas among the eleven selective metropolitan areas, and they have a much stronger demand in the housing market. There was also no evidence showed that the prices trends and the correlation between land and housing prices were resulted from the implementation of the UGB. Without further information or analysis, it is difficult to conclude that the UGB affected the land prices, land shares and housing prices trends in Portland.

Limitations of the Correlation Study

In this cross-sectional prices trends analysis, the samples size—total number of metropolitan areas, is not large enough to provide strong evidence that the metropolitan area with UGB has a higher land prices, land shares and housing prices, which should be expanded to include more metropolitan areas, with or without the control of the UGB.

More importantly, unlike the UGB in Portland established within the boundary of the metropolitan area, most of the UGBs area established within the boundaries of other municipalities. Therefore, due to other metropolitan area contain many non-highly built up areas, it is important to note that the metropolitan study area intend to enhance the gap between the metropolitan area with or without UGBs, which lowers the credibility and accuracy of the analysis results.

The results did prove that there were higher prices trends and higher correlation between land prices and housing prices in the Portland metropolitan area than other metropolitan area, however, it provided little evidence that all these results were resulted from the implementation of the UGB. It is completely possible that the higher prices trends in Portland had nothing to do with the implementation of the UGB, which could be the result of increased household income, increased employment opportunities, economics upturn, market inflation, etc. Unless other factors that contribute to the housing prices were included in this analysis, it is difficult to state that the higher prices trends and correlation coefficient of Portland were caused by the implementation of the UGB. In addition, as mentioned in Chapter 3, the land prices are calculated by housing prices subtracting the construction cost, which leads to increasing the correlation coefficient between land and housing prices.

Summary of the Regression Analysis

The results of the correlation coefficient analysis demonstrated that only six independent variables were statistically significant to the median housing prices (Table 4-8), and the UGB dummy had no direct price effects on median housing prices. All these independent variables had positive large price effects on the dependent variable, whereas the mean commute time variable had a negative medium effect on the median housing prices. Furthermore, vehicle density, housing density, job density and population density variables are highly correlated, which caused a very high VIF (much greater than 10) value in the models. Therefore, there were four regression models with these four density variables. The best model consisted of median household income, job density, mean commute, which have the highest adjusted R square value, approximately 0.83. In this model, the R square changes contributed by these three variables are about 0.61, 0.19 and 0.05 respectively. After including the UGB into these four models, it tends to lower the adjusted R square of each model. In addition, the UGB dummy variable also did not have any correlation with the six independent variables that were statistically significant to the median housing prices, which indicated that the UGB variable had no indirect price effect on median housing prices. It is important to note that, at least in 2000, the UGBs did not affect the urban development pattern, such as housing density, population density, median commute time, etc, which is contradictory to the hypotheses.

Table 5-1. Summary of the correlation coefficients of independent variables in the regression model

Independent Variables	Correlation Status	Tested Sign	Effect
AHS, Average Household Size	Uncorrelated	Uncorrelated	--
HD, Housing Density	Correlated	+	Large
JD, Job Density	Correlated	+	Large
MCT, Mean Commute time	Correlated	-	Large
MHI, Median Household Income	Correlated	+	Large
PD, Population Density	Correlated	+	Large
UGB, UGB Dummy	Uncorrelated	Uncorrelated	--
UR, Unemployment Rate	Uncorrelated	Uncorrelated	--
VD, Vehicle Density	Correlated	+	Large

Source: Analyzed in SPSS, edit by author.

Uncorrelated Independent Variables in the Model

The three uncorrelated independent variables are average household size, unemployment rate and the UGB dummy. The average household size indicates the average people within one household. Among 35 urbanized areas, the mean, range and standard variance of average household size are 2.57, 0.78 and 0.18, which indicates that there are no huge differences between each urbanized area.

The mean, range and standard variance of the unemployment rate are 0.054, 0.041 and 0.01, which indicates that the difference of unemployment rate in each urbanized area is very little. Moreover, in 2000, the housing market in each urbanized area was very stable and the unemployment rate was low. However, for certain years, the unemployment rate is related to the housing prices, for example, in the Goodstein and Philips' (2000) study mentioned in the Literature Review chapter. If the study time period of the regression model extended to multiple years, the unemployment rate would have had a larger price effect on the median housing prices.

As to the UGB dummy variable, there are several factors that influence its price effects on the median housing prices. First, there are different forms of UGBs adopted in different states, which do not have exact the same effects as the one in Portland, for example, the IGA in Colorado or urban service area in Tallahassee. Moreover, in the implementation process, some of UGBs in other states do not have such strong management enforcement and legislation at the state level, while only Oregon, Washington, and Tennessee requires the cities to establish UGBs. Third, the UGBs need a certain amount of time to take effects after the adoption. In the case of Portland, after approximately 10 years, the land and housing prices started to growth faster than before at 1990. For other urbanized areas with UGBs, the implementation history of the

UGBs did not have such a long time period as Portland’s which had a 30 year implementation history, which also intended to lower the prices effect of the UGB. Lastly, under the state law, the Portland is requires have a 20-year supply of land for future urban development within its growth boundary area to help mitigate the price pressures of the UGB on the land and housing prices. The vacant land in the boundary should be sufficient for the future development until 2020. In addition, in the Portland’s UGB history, there have been several times of expansions to accommodate more land into the boundary area.

Results of the Regression Model

In the final regression models, the most important independent variable is the median household income. Even without other variables, the median household income model is able to explain about 61% of the all the housing prices samples. The results indicated that the higher median household income in one urbanized area is accomplished the higher median housing prices.

Though four density variables are highly correlated in the regression analysis, they are equally important to measure the median housing prices in different urbanized areas, contributing approximately 0.18 R square changes to the models. They all have positive large prices effects on the median housing prices. Similar to Jun’s (2006) study, the housing density is highly related to the median housing prices. Moreover, consistent with Downs’ (2002) study, the best model consisted of average household income and job density, which contributed most to the median housing prices.

Only the median commute time had a negative medium price effect on the median housing prices, which measures the total commute time to and from work daily. In the classic urban economic theory, “prices adjust to ensure locational equilibrium”, which indicates the housing prices in the market is equilibrium between the housing cost and the transportation cost (O'Sullivan, 2009, p.28). Consistent with this economics theory, the finding in this analysis showed that longer median commute time spent the lower the housing price. However, this variable just contributes approximately 0.05 R square changes to regression model.

Limitations of the Regression Analysis

The existing regression model focused on the social and economic factors of the housing market; however, other factors regarding the physical characteristic of houses also contribute to the median housing prices. For example, as demonstrated in the previous literature, some independent variables should be included into the regression model, such as mean construction cost, construction index variable, land prices, or average house footage, etc.

The sample size of 35 urbanized areas is not large enough for multiple regression analysis which requires larger sample size to provide more accurate and reliable results. As a rule of thumb, the required sample size for a larger effect should be 40 for 3 predictors, and 80 for medium effect (Field, 2005). If more predictors are included in the regression model, the bigger sample size is required to achieve a better predictive regression model.

Since the data in this regression analysis are based on a single year, in this kind of cross-sectional study, certain independent variables had no correlation with the median housing prices; however, as shown in the literature review, these independent variables were correlated to the housing prices in the time series study. It is one of the main reasons the time period of the regression analysis should be expanded to multiple years. Moreover, if the time period of the model expanded to multiple years, the results the price effects of different independent variables on the median housing prices will be more comprehensive and accurate.

CHAPTER 6
CONCLUSIONS

This research is aimed to explore the relationship between the UGB in Portland and the local housing affordability. The first chapter introduced the research problems, concept of the UGB and housing affordability, and the second chapter reviewed all the previous studies related to this issue. Both qualitative and quantitative methods are adopted to describe and measure the price effect of the UGB on local housing prices. There were two hypotheses in this study:

Hypothesis 1. Due to the UGB constrain on the supply of land, the trends of land prices and land share in the Portland metropolitan area should be higher than other metropolitan areas without UGBs in United States. Since land prices have a significant impact on housing prices, the housing prices in Portland should be also higher. In addition, the Spearman Correlation Coefficient should supports the argument that the land and housing prices in Portland are highly correlated.

Hypothesis 2. Besides affecting the land prices, the UGBs also tend to change the urban development patterns, such as higher-density development, high redevelopment and infill development rate of the inner-city, etc. The regression model takes into account all of the factors that contribute to housing prices to measure the price effects of different predictors on the median housing prices among 35 urbanized areas. The result of the regression analysis should demonstrate the exact price effects of the UGB on the median housing prices.

For the first hypothesis, the results of prices trends and correlation coefficient demonstrated that the land prices, land shares and housing prices of Portland is higher than some of the metropolitan areas without UGBs, except for Phoenix and San Diego.

Moreover, San Diego and Portland have a very close correlation coefficient value. The above results did not indicate any evidence that the higher housing prices in Portland are resulted from the implementation of the UGB between 1984 and 2009.

As the second hypothesis, the best median housing regression model consisted of median household income, job density and median commute time. Furthermore, the vehicle density, housing density and population density had a similar price effect on the median housing prices as job density. However, the results of the regression model, and the correlation coefficients between the UGB and other independent variables indicated that UGB dummy variable had no direct or indirect price effects on Portland's median housing prices.

In conclusion, as shown in the literature review, UGB did increase the density of new development, and redevelopment and infill development rate within the Portland metropolitan area throughout the entire implementation period of the UGB. However, in 2000, the correlation coefficient between the UGB and other independent variables show that the UGB did not affect the urban development pattern, such as housing density, population density, job density, median commute time, etc. Though the housing prices in Portland did increase more than some of the other metropolitan areas, without further statistical analysis, it is still difficult to prove that the increase in housing prices are resulted from the implementation of the UGB. There is also no evidence in the analysis indicating that the UGB caused prices pressures on the housing affordability in the year 2000.

APPENDIX A
APPENDIX DATA USED IN THE REGRESSION MODEL

Table A-1. Data used in the median housing prices regression model

Urbanized Area	Median Housing Prices	Average Household Size	Housing Density (per square miles)	Mean Commute time (minutes)	Median Household Income	Job Density (per square miles)	Population Density (per square miles)	UGB	Unemployment Rate	Vehicle Density (per square miles)
Atlanta, GA	138700	2.7	692	31.1	52512	1360	1783	0	0.052	900
Baltimore, MD	138700	2.5	1279	29.1	46931	2369	3041	0	0.055	1439
Boston, MA	219900	2.5	924	28.3	53908	1842	2323	0	0.043	1158
Boulder, Colorado	302300	2.2	1467	19.2	48518	2931	3416	1	0.062	1931
Buffalo, NY	87900	2.4	1189	20.6	37060	2092	2664	0	0.075	1178
Charlotte, NC	141200	2.5	727	26.1	50731	1346	1745	0	0.051	909
Chicago, IL	161400	2.7	1490	31.2	50747	2975	3914	0	0.064	1789
Cincinnati, OH	116700	2.5	948	23.3	44485	1709	2238	0	0.043	1080
Cleveland, OH	121000	2.4	1195	24.4	41920	2143	2761	0	0.055	1276
Dallas, TX	97900	2.7	1144	26.8	46993	2206	2946	0	0.049	1427
Denver, Colorado	173800	2.5	1622	28.4	50372	3068	3979	1	0.040	2074
Detroit, MI	131500	2.6	1257	26.0	48541	2362	3094	0	0.061	1382
Houston, TX	89700	2.8	1113	28.4	44658	2181	2951	0	0.062	1324
Indianapolis, IN	113800	2.5	949	23.5	45503	1675	2205	0	0.046	1103
Lexington, Kentucky	110200	2.3	1617	19.4	39269	2915	3609	1	0.051	1899

Table A-1. Continued

Urbanized Area	Median Housing Prices	Average Household Size	Housing Density (per square miles)	Mean Commute time (minutes)	Median Household Income	Job Density (per square miles)	Population Density (per square miles)	UGB	Unemployment Rate	Vehicle Density (per square miles)
Los Angeles, CA	220500	3.0	2395	28.7	44735	5299	7068	0	0.077	2934
Memphis, Tennessee	90000	2.6	981	23.5	39309	1810	2431	1	0.067	1091
Miami, Florida	127900	2.6	1897	28.1	40214	3486	4407	1	0.066	1868
Milwaukee, WI	128300	2.5	1121	21.8	43727	2058	2688	0	0.057	1280
Twins Cities, Minnesota	140400	2.5	1071	22.6	53242	2047	2671	1	0.036	1439
New York, NY	209700	2.7	2042	35.1	49648	4143	5309	0	0.070	2301
Philadelphia, PA	120100	2.6	1157	28.2	47265	2218	2816	0	0.063	1300
Phoenix, AZ	126400	2.7	1498	26.0	44623	2760	3638	0	0.048	1669
Pittsburgh, PA	86400	2.3	925	24.9	38142	1654	2057	0	0.058	932
Portland, Oregon	167800	2.5	1396	23.6	46360	2591	3340	1	0.057	1676
Salt Lake city, UT	156200	3.0	1329	22.5	48130	2817	3847	0	0.045	1880
San Antonio, TX	73700	2.8	1221	23.6	38237	2432	3257	0	0.057	1426
San Diego, CA	224800	2.7	1265	25.0	46613	2630	3419	0	0.057	1586
San Jose, CA	443000	2.9	2039	25.9	74133	4603	5914	1	0.037	2920

Table A-1. Continued

Urbanized Area	Median Housing Prices	Average Household Size	Housing Density (per square miles)	Mean Commute time (minutes)	Median Household Income	Job Density (per square miles)	Population Density (per square miles)	UGB	Unemployment Rate	Vehicle Density (per square miles)
St.Louis, MO	101000	2.5	1064	24.7	44221	1924	2506	0	0.058	1191
Tampa, FL	93900	2.3	1228	25.0	37864	2064	2571	0	0.049	1176
Virginia Beach, Virginia	108900	2.6	1035	23.3	42176	2024	2647	1	0.051	1290
Washington, DC	189300	2.6	1351	32.2	63558	2643	3401	0	0.045	1770

Source: U.S. Bureau of Census, “2000 Census”, edit by author.

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BIOGRAPHICAL SKETCH

Xing Ma (Max) was born in 1986 in Xi'an, China. At three years old, his family moved to Guangzhou, where he was raised. He received his bachelor degree as Urban Planning at the South China University of Technology, which was five-year undergraduate program focusing on architecture and urban design.

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