URBAN CONTAINMENT IN THE AMERICAN WEST; AN EFFECTIVE OR MISGUIDED URBAN POLICY?

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A Thesis

By

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Abstract

of

URBAN CONTAINMENT IN THE AMERICAN WEST;
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This research attempts to answer the question of what effect do urban containment policies have on growth patterns in the urbanized areas of the western United States. I use multivariate regression analysis to answer this question. U.S. Census Bureau data from Urbanized Areas and Central Places comprises the part of my data set collected publicly. While the specific data used to construct the policy perspective for urban containment policies were identified, collected, and compiled from independent interviews and contacts with local city municipalities and county governments for each of the 113 Urbanized Areas in the West Region, as defined by the U.S. Census.

This analysis indicates that urban containment policies reduce or contain sprawl dependent upon location, construction, and enforcement. Moreover, variable geo-political and socio-economic conditions contribute to the ability of urban containment policies to reduce urban sprawl. While urban containment policies are likely policy options for land use authorities; the need to address urban sprawl requires a comprehensive strategic approach containing key elements such as the project scale (mixed-residential and commercial land use), community scale (jobs with housing), and regional scale (linking transportation funding with balanced growth options).

_____, Committee Chair
Robert W. Wassmer, Ph.D.

DEDICATIONS

To my wife Emily, who patiently offered guidance and support through her subtle and gentle nagging and by noting, more times than I can count, the further I delay producing this thesis equates to less time I am able to enjoy the delights of life, like completing a thesis.

To my Mother, Bonnie and Grandmother, Leah who raised the first generation Masters graduate of the family and who tirelessly kept interest and provided morale support in my undergraduate and graduate studies. I will forever be indebted to your sacrifices that now place me on the plane of success and good fortune.

To my friends and colleagues at the U.S. Geological Survey, County of Sacramento, Central Valley Regional Water Quality Control Board, and the Department of Food & Agriculture who provided the time, interest, and resources along the way to help create, develop, and finally close the chapters of this thesis. The combination of education and on the job training makes this thesis more valuable with the contribution of knowledge and support from such good people.

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I wish to express thanks to Master of Public Policy Administration graduate David Edwards, for collecting, compiling, and presenting the U.S. Census data in usable form to produce the regressions presented later in this thesis. Without David's hard work to combine all the information into one location, the effort to collect and display the data would have proven very arduous.

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Urban Containment and Urban Sprawl in the American West

I. Introduction

The late Hollywood actor Steve McQueen once said he would rather wake up in the middle of nowhere verses waking up in a city environment and this often typifies the American attitude towards cities. The aversion of city environs for many, with heavy crowds, tight and narrow spaces, pollution, and noise goes back to the days of Thomas Jefferson, America's second President. Jefferson's desire for a nation founded on yeoman farmers survives today with families wishing to own a single family detached home as a slice of the American Dream (Franciosi, 1998). The urbanized area is the fundamental experience setting the table for insight into the science of urbanism, zoning, and shaping the landscape by the art of civic design (Blumenfeld, 1967). Per the U.S. Census Bureau, an urbanized area (UA) consists of a densely settled core of census block groups and census blocks that meet minimum population density requirements, along with adjacent densely settled surrounding census blocks that together encompass a population of at least 50,000 people, at least 35,000 of whom live in an area that is not part of a military installation.

A proverbial tidal wave of urban expansion that has scoured the inner urban areas and deposited the population, jobs, transportation networks, utilities, etc., to the outer edges of the urban areas in the American West. Seemingly, organized chaos best describes the development pattern the American West continues to experience. The focus of my research reflects the challenges and responses to the historic process of urban

expansion or more representative of today's terminology urban sprawl. Urban policy mechanisms to reduce the effects of sprawl (i.e., increasing social and infrastructure costs and externalities in the form of increasing traffic and air pollution) include inclusionary zoning, redevelopment or infill in suburbs, smart growth practices striving to balance the jobs/housing imbalance created by sprawl, and urban containment polices. I will provide evidence of the need for such policies from peer-reviewed journal articles, academic working papers, books, public opinion polls, and magazine/newspaper articles. My research will address the effect of urban containment polices, specifically urban growth boundaries, in the American West on growth patterns in urbanized areas. Finally, through a regression analysis I will determine the effectiveness of urban growth boundaries in the American West.

II. Background

Historically, the development and growth of the United States is unprecedented. Urban expansion beyond the core areas, into the suburbs, and outlying urban fringe characterizes urban sprawl.

Urban growth boundaries (UGB's) are a land use-planning tool that are symbolic on maps, but cause much discussion on appropriate limits to a jurisdictions growth patterns. Their significance within the economic framework of a county rests in the ability of the jurisdiction and the cities that surround it to maintain a vital economic base. Several concerns over UGB's are that they limit balanced growth and cause unnecessary costs to society in the form of imbalance of payment for infrastructure costs and indirect costs associated with air pollution and quality of life. Evidence suggests UGB's devalue

the lands that lie just outside the boundary and for creating a higher value on the lands within, in turn giving landowners outside the UGB no incentive to freely develop their land.

I will address the economic, social, environmental, incentives to applying UGB's to expanding urbanized areas in the United States based upon the U.S. Census West Region and Mountain Division. My focus will include urbanized areas and divisions like Portland, Oregon, Sacramento, California, Flagstaff Arizona, and Greeley Colorado just to name a few. Furthermore, the premise of my thesis is the simple question, what is the effect of UGB's upon the growth patterns in urbanized areas? Have there been successes and failures as well as what are the recent trends of such urban containment policies? Are UGB's decreasing or are such policies increasing with the burgeoning populations for example in California, with 36 million plus people? Further I will address the nearly innate desire on behalf of Americans to escape the city combined with the desire to "burn the bridge behind them" to prevent others from following (Franciosi, 1998). Moreover, this desire conflicts with the deeply held value and constitutional right for private property rights setting the stage for the difficulties that growth has upon the desire for growth controls such as urban growth boundaries.

III. Examples of Sprawl

California's Great Central Valley -- encompassing cities like Bakersfield, Modesto, Sacramento, Marysville, and Red Bluff -- has changed tremendously over the last 150 years. Due in part to individual capitalism like the Gold Rush of the 1850's and federal

policies encouraging settlement such as the Homestead Act the Central Valley landscape is no longer void of development, but rather outpacing anticipated growth projections.

The Central Valley is the most productive agricultural region in the world. In 2005, farms grossed roughly $22.14 billion in agricultural production value in the Sacramento and San Joaquin valleys. This is nearly 70 percent of the state's total $31.71 billion in agricultural production value (CDFA, 2007). Agriculture is responsible for over a quarter of all valley jobs and income. Furthermore, the Central Valley provides the nation with nearly half of all the vegetables consumed (McClurg, 1998).

The Central Valley is one of the fastest growing regions of the United States, in addition to ranking as California's top producing agricultural region. In just the two years between 1994-1996, the California Department of Conservation reported that approximately 18,000 acres of irrigated farmlands statewide became urban uses and 13,000 of those acres were in the Sacramento-San Joaquin Valleys (Farmland Conversion Report, 1998). Los Angeles County was the nation's top agricultural producing county as recent as the administration of John F. Kennedy and now Fresno and Tulare Counties hold this honor with the same urban threats that removed agriculture from the County of Los Angeles. This increased urbanization has generated concern for the future quality and quantity of natural resources, rural and urban lifestyles, local and regional economies and the values associated with each.

Inexpensive agricultural land and a strong regional tradition of emphasizing property rights over government regulation have directed urban growth outward, leading to sprawling cities and far-flung suburban communities. These actions threaten to

undermine the long-term livability and viability of the cities themselves (Cooper, 1997). Declining air quality, water supplies, and in some cases, ecological habitat concerns are among the several obstacles to further urban growth in cities like Phoenix, Denver, and Sacramento. Open spaces for habitat and human enjoyment, community identity, private property rights, and overall quality of life are at stake when urban sprawl threatens to overtake important values that we hold close to our hearts.

Urban sprawl by its primal form is simply just the maturation process of an urbanized area to a point of reaching limits. Limits over time become clearer whether the resource base such as water or land decrease in supply or the physical constraints of the land act as a barrier. Sprawl is advantages in the sense of greater housing affordability, homes with bigger yards, and auto ownership. However, the societal costs to sprawl may just out way the benefits.

In order to ensure reduction of urban sprawl, public policies often encourage and direct intense use of existing land within cities and suburban areas. Policies include enforcing infill, allowing up zoning in existing urban areas as well as promoting revitalization of established communities before sprawling outward and creating greater burdens on infrastructure costs to the older mature communities.

In addition, the political will, forethought, and conscientious understanding by policy-makers to have reasonable growth patterns is less of a concern and chasing retail dollars is more promising to restore public coffers. Some argue to maintain existing sprawling growth patterns the creation of urban growth boundaries (UGB's) will go a long way towards curbing the sprawl. UGB's carry weight and force of the general plan

behind them if so chosen by local government to install and enforce. The UGB's aim are primarily to ensure that land within the boundaries is utilized for the maximum benefit of housing, open spaces, agriculture, commercial development etc., before going outside of the boundary. Locating outside the boundary has both positive and negative externalities often described as benefits and costs not entirely borne by the elected representatives (Wassmer, 2001). External costs are hard and fast such as loss of open space, farmland as highlighted earlier, traffic congestion, blight, and air pollution. I examine external costs in Chapter 2.

IV. Layout of Thesis

The Literature Review contained in Chapter 2 introduces the topic of urban sprawl and announces my research question: *What is the effect of urban containment policies in the American West on growth patterns in urbanized areas?* I further explain the expectations of the forthcoming chapter.

In the Urban Form and Sprawl Defined section, I address the process to understand the nature of the development pattern known as sprawl. First, I set the stage by giving a historic perspective of the urban form with the creation of the city and the desire to move beyond the city footprint to create an enhanced lifestyle. Secondly, I give a recent perspective of how urban development the elements involved in conducting a response to my question such as defining sprawl, the causes and consequences. Third, I discuss and present evidence of the dimensionality of urban sprawl and the empirical measures useful toward assessing the impact. This section reveals the multiple aspects, in fact, eight currently derived determinants of the land use pattern. Understanding the

inner workings of dimensionality and empirical measurement for sprawl are critical towards the function, definition, and overall strategy to address containment policies. Fourth, I recognize functionality and the intent of this aspect of understanding sprawl is by a given unit of analysis. For example, nuclearity one of eight dimensions of sprawl (defined in chapter 2) generally has a unit of analysis of square miles footprint of City A verses footprint of City B in square miles.

I continue further to present evidence of causes and consequences of urban sprawl. Causes of sprawl can vary greatly depending on whom you ask. However, at least nine causes of urban sprawl I evaluate range from tax polices and moderate demographic change to growing affluence and the increase in roadway networks. Consequences reveal with extensive literature review that both positive and negative outcomes are expected and observed. However, the literature suggests the negative consequences especially to society outweigh any individual benefits.

Additionally, I outline the theories on urban containment as the definitional framework of urban containment and the historic origins. Moreover, I address the rationale for such policies and the expected outcomes of installing such policies. Additionally, I describe Nelson & Dawkins work to date of developing taxonomy of urban growth boundaries by type across the United States. Finally, I describe the theories on urban growth boundaries, discuss the effects known and anticipated with containment policies, and theories on containment practices effects on reducing sprawl.

In my section on Empirical Research on Urban Containment, I thoroughly discuss current research on urban containment with the four types introduced by Nelson. Second,

I study the framework for the protocol of empirical measurement relative to urban growth boundaries.

In Chapter 3, Research Methodology, I lay the groundwork for how the analysis is to proceed when answering the question of: *What is the effect of urban containment policies in the American West on growth patterns in urbanized areas?* I begin with an introduction and explain what econometrics is and the uses for such analysis. I further let the reader understand the framework for which I chose regression analysis. Essentially, I discuss the approaches to quantitative analysis. I then lead into the linear model and the purposes for which are best suited for the analysis. Finally, I describe and discuss the advantages and disadvantages of the linear model.

In my data collection section, I reveal how data is collected and where my data for this thesis project will have its genesis as well as which statistical program being applied to this thesis. The sources will generate from the U.S. Census Bureau and pertain to the Western Region of the United States. The Western Region includes the states of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Washington, Wyoming, and Utah along with 70 urbanized areas with urban containment policies.

My regression model section explains my regression model and the variables I use to measure the effectiveness of the urban growth boundary polices in place across the 13 states above. The regression equation follows with subsequent explanation of the explanatory and state-specific, and urban containment variables.

Finally, I elaborate as to the rationale for choosing the explanatory variables I chose and why I may have left out certain variables. Moreover, I will explain the positive and negative effects of the variables chosen. Included are a series of tables: (1) list of variables and sources, (2) descriptive statistics, (3) correlation matrix, and (4) an expected relationship matrix for purposes of explanatory variables to the dependent variable (size of urbanized area).

In Chapter 4, the Findings, I lead the reader into the "nitty gritty" of the regression analysis to determine whether or not the four types of containment being measured are effective means of controlling or containing urban sprawl in the American West. I evaluate the regression results with the R^2 regression coefficients and T-Statistic. I will also address the uncorrected regression model results with a table containing the explanatory variables.

Section IV, contains a serious discussion on related problems with results. Some of the problems may reflect the following components: (1) functional form or linear regression, (2) collinearity correction with variable proximity and distinguishing variable differences, (3) heteroskedasticity correction-weighing by population, and (4) endogeneity correction with a dual causality among the dependent variable.

The last portion of the chapter will focus on the Correction regression model results and I will offer an interpretation of the regression results with a table of significant findings and elasticity's. I then follow up with a conclusion outlining the findings and their policy implications.

Chapter 5 concludes my research analysis on this topic by first giving the reader a bearing on where I have come and what I have found and secondly identifies the inferences made. Section III will further breakdown the results of the regression analysis which directly will tie into Section IV where I discuss implications of the results.

CHAPTER TWO: Literature Review

I. Introduction

From every corner of urban America, public consciousness, as well as academia, is asking whether sprawl is something to fear, embrace, or ignore. The latter is not a likely option based upon current research. The suspected causes and consequences of sprawl invite divisive policy debate more now than any time in American history. In the early 21st Century, the population of the United States is nearing some 302 million persons, all of which demand goods and services in the form of clean water, arable and buildable land for food & shelter, adequate air quality, housing, road and utility infrastructure, means of earning a living, and some semblance of a quality lifestyle. All of these characteristics of our daily lives are part of our reflective landscape within the cities and counties we live -- the ways in which we sustain ourselves as a society through land uses and the subsequent lifestyle choices are at the heart of the public and academic lens through which I explore urban sprawl in this chapter. Particularly, I attempt to answer the research question: *What is the effect of urban containment policies on growth patterns in urbanized areas in the American West?*

To address the consequences or effects of urban containment policies on urban sprawl, I first will begin with an approach to define the elements comprising what we know collectively as urban sprawl. Secondly, I will assess urban containment policies, specifically urban growth boundaries, from the perspective of their genesis and the effects or consequences such polices may have upon the societal and economic frameworks within communities of the American West. Urban containment is more

commonplace in the urban policy sphere today compared to 25 plus years ago. Literature describing empirical, theoretical, or applied analysis pertaining to urban containment is prevalent across the American West. Academic and professional literature will enable me to assess urban containment policies effect upon urban sprawl.

Expectations

A key determinant to the degree of impact urban containment policies have on urban sprawl is to evaluate previous arguments made in the literature. I design this chapter with sections to maintain a coherent voice throughout, thus providing guidance to the reader. I enable the reader to gain a holistic and analytical understanding on urban sprawl. Expressly, I describe definitional as well as analytical measurement tools often applied to determine the framework of urban sprawl. I also provide the reader a solid insight into the measures I will use for the remainder of the thesis.

Section III reveals how urban containment impacts urban sprawl. This section will further allow me to detail the advantages and disadvantages of urban containment policies as implemented in urbanized areas. Section IV describes specific studies found during my research that assess the influential nature urban containment has upon urban sprawl. I address the likelihood of urban containment actually reducing sprawl and the indirect effects of such reduction or inducement theretofore of urban sprawl. Furthermore, I provide empirical research by Nelson, (2001) discussing three typologies of urban containment and their effects upon holding capacity or housing supply and infill effectiveness.

Section V highlights the discussion thus far on what new information or lack thereof, trends, and lessons ascertained from the literature will help direct the course of my research. By design, Section V outlines the critical factors affecting urban containment as well as urban sprawl. The goal of this section is to provide a clear path towards successfully answering my research question and conducting original research using the 2000 Census data from the American West.

Expressly, I will gather data on urban containment in the Western Region (contains both Mountain and Pacific Division) of the U.S. Census Bureau. Thirteen states including: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Washington, Wyoming, and Utah along with 113 urbanized areas fall within the Western Region of U.S. Census Bureau. Finally, my expectation with this research is to assist the general populous to understand their current and future demands upon the urban landscape and how their choices may or may not effect positively or negatively their future quality of life. I specifically examine whether urban growth boundaries reduce the spatial size of those urbanized areas currently using urban containment policies.

II. Urban Form and Sprawl Defined

The current base of knowledge on urban sprawl does not reveal an agreement on what sprawl is by definition, nor is there consensus on means to accurately measure this land use phenomena. Furthermore, urban sprawl is a metaphor rich in ambiguity and represents many conditions, (Galster, 2000). Urban sprawl style of development is the

dominant conventional suburban pattern and continues with over a half century of experience changing the landscape.

Moreover, information gathered for this thesis indicates much of what the literature suggests about sprawl is in a cause and consequence framework to describe the process of urban sprawl. Furthermore, the literature presents evidence for sprawl providing benefits to urban populations while evidence also indicates disadvantages from urban sprawl to urban populations. Finally, I will expand upon the definitional elements, measures, causes and consequences of urban sprawl.

Historic Perspective of Urban Form

Gauging urban sprawl from one's doorstep, car, bus, train, or plane window, sidewalk, or bicycle is not difficult assuming one remains in the same home or general vicinity for at least two to three years. This can be a large assumption given the human desire to survive and be economically self-sufficient. However, most reading this thesis should acknowledge they are not removed from any effects of urban sprawl, but rather are key elements to help maintain the health of this biologically active urbanized area we all live in. To determine what sprawl is I must first remind the reader, urban sprawl deals with a very important, yet simple and unequivocal concept of land use. What happens on the land depends on what humans take from the land or what humans manage not to remove (Blumenfeld, 1967). Land use is key for description and analysis as well as prescription and planning. Specifically, the key distinctions are uses *of the land* for agriculture dealing with productive capacity and the other distinction being *uses on the land* for urban purposes dealing with physical site and situation rather than a factor of

production. The definitional distinction is key to understanding the phenomena of urban sprawl.

Through recorded history, the city has remained a static unit, confined and essentially defined by the enclosing boundary separating it from open country. The static gives way to the overflow of uses on the land outside the city for residential and commercial purposes. With the dilution of the static city pattern and the greater emergence of the fluctuating mass of development into the countryside since the 1950's predominantly, urban sprawl is neither city nor country (Blumenfeld, 1967). The genesis of the city has given way to a new dynamic pattern of growth transforming the landscape. The historical change in pattern provides a valuable opportunity to study this apparent evolutionary process of growth known as urban sprawl.

Recent Perspective of Urban Sprawl: Definitions

The forthcoming definitions of urban sprawl coalesce around the concept of growth. That is growth of a physical and economic nature with the outward physical and infrastructure related expansion from the central city.

Economic growth is the life force of employment, population, and income of a given urbanized or rural area (Peterson & Vroman, 1992). Each characteristic of economic growth possesses natural increase as well as migration into and out of respective urban areas. Ideal growth is an orderly process whereby public and private institutions facilitate growth. Moreover, installing infrastructure on a needs basis and by not overusing nor under maintaining facilities is the best preference (Burchell, 1998). Burchell, (1997) characterizes urban sprawl as traditional economic growth and suggests

it deviates from the ideal growth pattern due to market share competition and the public/private and contributes to a weak regulatory structure.

According to a study sanctioned by the Brookings Institution, metropolitan (metro) areas by large measure are adding land faster than metros are gaining population. The findings offer that the West has some of the densest metro areas at 48.9 percent urbanized compared to 39.1 percent for the Northeast. This same study suggests urban sprawl is the consumption of land for urbanization compared with population growth (Fulton, et al., 2001). The study used a backwards-stepwise regression analysis to measure the relationship of variables relative to the definition of sprawl. While Squires (2002) suggests sprawl is a series of patterns of Metro growth insofar as the growth reflects low-intensity, auto-dependency, and exclusive urban fringe (outer ring of urban sphere) developments outside of decentralized core communities.

Excessive spatial growth of cities defines urban sprawl according to Brueckner, 2000. Additionally, Galster et al., 2000 suggest via a conceptual definition that urban sprawl is a pattern of land use in an urban area possessing low levels of dimensionality. Exclusively, Burchell (1998) concludes the following twelve defining elements embody the concept of sprawl:

- Low residential density,
- Unlimited outward extension of new development,
- Spatial segregation of different types of lands uses through zoning regulations,
- Leapfrog development,
- No centralized ownership of land or planning of development,
- Transportation dominated by privately owned motor vehicles,
- Fragmentation of governance over land use between multiple jurisdictions,

- Vast variance in fiscal capacity of local governments within Metro areas (revenue capability tied to property values and economic activity within municipal borders),
- Widespread commercial strip development along major roadways,
- Aesthetic judgment,
- Externalities (i.e., traffic congestion and greater air pollution),
- Major reliance on the trickle-down or filtering process to provide housing for low-income households.

Conversely, Glaeser & Kahn, (2003) in their research entitled "Sprawl and Urban Growth" submit sprawl is ubiquitous, expanding, and is an outgrowth of the automobile. From the lens of interest group politics, the Sierra Club defines urban sprawl as irresponsible, poorly planned development that destroys green space, increases traffic, crowds schools, and drives up taxes (2000). Finally, in his classic article "Density and Urban Sprawl", Richard Peiser (1989) argues the urban land market with discontinuous patterns of development inherently promotes higher density development, suggesting as does Galster et al., 2000; Glaeser & Kahn, 2003 that sprawl is essentially the lack of continuity in expansion. Wasserman, (2000), submits that experts in the field of planning, economics, and academia have a consensus on a basic definition of sprawl-unconstrained, low-density development that jumps over undeveloped lands. Galster, 2000, offers a definition of urban sprawl for a metaphor lost in a "semantic wilderness": Sprawl is a pattern of land use in an urbanized area exhibiting low levels of some combination of the following eight dimensions I outline in the next section. The breadth of definitions yields common themes and structure as to how humans characterize sprawl into a collection of characteristics that typify this land use pattern.

Dimensionality of Sprawl and Empirical Measurement

Urban sprawl, with the numerous definitions in the literature endeavoring to describe the phenomena is suitable for measurement. Critics could argue, without a clearly defined topic one there is a challenge to engage in measuring the occurrence of sprawl. On the contrary, conducting a thorough analysis to measure various characteristics of sprawl i.e., density and concentration of development may lead to a clearer understanding of urban sprawl. Furthermore, the U.S. Census collects data on data relevant to density such as population as well as size of urban area relative to concentration.

The empirical measurements of sprawl should quantify the scale of sprawl and accordingly Ewing, (1997) argues in "Is Los Angeles-style Sprawl Desirable?" sprawl is a matter scale. Finally, the empirical measurement of sprawl involves the multi-dimensionality of sprawl. Dimensionality, essentially in this section represents development style. Galster et al., (2000) offer eight dimensions as determinants of the land use conditions in urbanized areas as follows:

- ***Density*** with average number of residential units per square mile,
- ***Continuity*** scale land is built at urban densities in contiguous patterns,
- ***Concentration*** scale at which development occupies less square miles of total area,
- ***Compactness*** scale of clustering development thus minimizing land consumption,
- ***Centrality*** residential and commercial development relative to Central Business District,
- ***Nuclearity*** one power center verses several power centers or core areas,
- ***Diversity*** two different land uses coexisting in small spatial area throughout urban area,
- ***Proximity*** scale of spatial mismatch of available jobs and housing.

These dimensions of land use condition help comprehend how sprawl functions as a means toward empirical measurement.

Functionality of Sprawl

Just as the pattern of land use helps to define urban sprawl and the condition of land use offers insight into the dimensionality of sprawl, the functionality of the dimensions allow a testing of the definition of sprawl. Functionality essentially represents a unit of analysis or given amount of observations. The definition of urbanized area is a threshold of 1,000 persons per square mile. Therefore, decentralization and density are two land use conditions where specific measures of residential or commercial units per square mile can be measures of urban sprawl. Wassmer, (2002) in "An Economic Perspective on Urban Sprawl" uses decentralization measures such as comparison of central place population and urban population over time. Similarly, comparisons of the percentage change in urban population to the percentage change in urban fringe lands towards developing a sprawl index. Finally, measures of farmland conversion to urban uses over time are useful determinants of sprawl (Wassmer, 2002). Kahn, (2001) utilizes a concept similar to Galster et al., (2000); Wassmer, (2002), yet the measure of sprawl is by percent of employment within ten miles of the urban core with six additional measures of housing consumption by number of rooms, unit size (ft^2), surrounding scale of suburbanization, ownership, suburban ownership, and year constructed. Brueckner & Fansler, (1983) use empirical measures of spatial size, per acre agriculture land value, average household income, percent commuters using transit and or autos to derive a causal definition of sprawl or semblance of the its presence.

Causes of Sprawl

With the thorough assessment of the patterns, dimensions, and functional elements comprising sprawl aforementioned I will take the next step to identify and delineate the causes as best understood of urban sprawl. The causes of sprawl are not as illusive as the semantics of scale and characteristics determining sprawl, yet challenging nonetheless. Causes of urban sprawl are numerous and relatively complex in nature. As mentioned earlier in Section II under "Urban Form and Sprawl Defined" this conventional suburban development form commonly referred to as sprawl continues to evolve with over 50 years of experience changing the landscape. The aggregate effect of population growth is a strong driver towards urban sprawl (Brueckner, 2000;Brueckner & Fansler, 1983;Fulton, 1999;Galster, 2000;Glaeser & Kahn, 2003;Gordon & Richardson, 2000;Green, 1997;Mieszkowski & Mills, 1993;Squires, 2002;Wasserman, 2000).

According to Green's, (1999) research "Nine Causes of Sprawl" rent gradient, demographic changes, growing affluence, transportation changes, government service differentials within metro area, racial discrimination and segregation, plattage and plottage, Federal tax policy, and land use regulation all contribute to the causal structure of urban sprawl. The implications of several of these suggested causes are significant given how commonplace in society transportation funding, federal tax policies, and peripheral development are within urban areas.

Squires, (1983) chapter in "Urban Sprawl and the Uneven Development of Metropolitan America" provides another cause of sprawl when businesses relocate to suburbs for less expensive land development costs to develop green fields verses brown

fields in turn receiving incentives for moving to a given suburb. The competition for sales tax in urbanized areas with several power centers or job hubs creates several opportunities for businesses, however the lure of incentives and tax abatements is a driver to create more sprawl according to Squires, (1993). Furthermore, businesses tend to move to non-blighted areas according to research conducted by Mieszkowski & Mills, (1993). "Flight from Blight" likely causes sprawl, as does natural evolution of wealth and income being very important drivers as well (Mieszkowski & Mills, 1993).

Ewing's, (1997) article " Is Los Angeles Style Sprawl Desirable?" blames market imperfections for inducing sprawl arguing the rate of land appreciation is uncertain thereby causing land speculation and urban sprawl. Brueckner, (2000) argues that in addition to the three forces of population expansion, rising incomes, and falling commuting costs there are three market failures that "distort" the factors leading to urban sprawl. Namely, Brueckner submits failure to account for the following (1) benefits of open space, (2) social costs of congestion, and (3) making development pay for the full cost associated with infrastructure costs associated with urban sprawl has a negative effect upon the urban form.

Fulton *et al*., (1997) take the view in "Beyond Sprawl: New Patterns of Growth to Fit the New California" [sponsored by Bank of America, CA Resources Agency among others] that the decentralization of urban core employment centers, green field development, auto dependency, and isolation of mature communities as well as the perception of newer is safer than old, suburbs are less expensive relative to core areas, and the perception suburban is more flexible to business growth. Furthermore, disparity

between jobs and housing, roadway funding via state and federal governments, low density housing units, and the competition for tax dollars better known as “Fiscalization of Land Use” are critical parts of the cause for urban sprawl according to Fulton et al., 1999;Brueckner, 2000;Glaeser & Kahn, 2003;Jargosky, 2002. Other factors contributing to the cause of sprawl is Tiebout’s theory of “voting with one’s feet” or in California’s case, ballot box zoning (Brueckner, 2000).

Consequences of Sprawl

The literature is overflowing with the consequences of urban sprawl and the impacts upon taxpayers, businesses, new suburbanites, central city and mature community residents, farmers, and the environment (Fulton, 1997). As the reader might suspect the consequences are not all positive, there are some not so bright moments afforded by sprawl. According to research provided from “Divided We Sprawl” Katz & Bradley submit poverty rates, crime rates increase, schools show signs of failing, policies relative to mortgage-interest, property tax deductions, and certain aspects of state spending incur a negative effect upon the societal framework (1999). Squires (2002), argues heavy costs are inevitable because of sprawl. As an example, negative externalities such as air pollution, impaired water quality, disparities of the quality of public services grow; leading to diminishing quality of life, reducing social capital in communities, increasing poverty, and housing prices increase faster than incomes, (Cieslewicz, 2002;Downs, 1999;Frey, 2003;Fulton et al., 1999;Glaeser & Kahn, 2003;Helling, 2002;Jargosky, 2002;Peiser, 1989;Powell, 2002;Squires, 2002).

Conversely, the benefits to sprawl in some areas include less expensive housing, lower-density communities, easier commuting and access to freeways, lower crime rates, better schools, greater recreational opportunities, (Glaeser & Kahn, 2003;Gordon & Richardson, 2000;Mills, 1999;Squires, 2002).

Advantages & Disadvantages of Sprawl

Based upon research to this point the disadvantages in the short and long term appear to outweigh the advantages of urban sprawl at least from the perspective of net benefits to society (Glaeser & Kahn, 2003; Peiser, 1989). The urban sprawl advantage at least in the short term is low home prices, ability to have freedom to use an automobile with greater flexibility, and access to a less dense community which is the overwhelming market choice for residential living with bigger homes on larger lots, (Gordon & Richardson, 1997;Mills, 1999;Squires, 2002;Wassmer 2002). Excessive commuting times are a cost of sprawl (Kain, 1998; Calthorpe, 1993; Crane, 1994); reduced commuting times to and from suburban jobs is a benefit (Gordon & Richardson, 1994). I am not certain whether urban sprawl is in the eye of the beholder, due to the abundance of literature revealing the severe externalities burdening society associated with the development pattern delineated by sprawl.

III. Theories on Containment

Urban containment is not smart growth or simply growth management, expressly urban containment is a direct attempt to thwart or prevent via government policy the outward expansion of urban sprawl across the landscape unchecked (Nelson & Dawkins, 2003). Nelson (2001), in a paper entitled “Urban Containment Policy” beckons urban

containment is “gaining momentum throughout the nation”. Nelson submits urban containment is building momentum that could rival that of the U.S. Supreme Courts ruling sanctioning zoning in *Ambler Reality Co, vs. Euclid, Ohio* on January 27, 1926. Subsequent to the 1926 ruling, primarily cities began using their new authority known as the police power to regulate land for the purposes of protecting the general welfare of the polis.

To lessen the negative externalities of sprawl (i.e., traffic congestion, air pollution, degraded quality of life, etc.,) mechanisms such as urban containment are useful (Gordon & Richardson, 2000;Nelson, 2001;Nelson, 2003;Pendall & Martin, 2000). Currently there are three generalized types of urban containment (1) urban growth boundaries, (2) urban services boundary, and (3) greenbelts (Pendall, Martin, & Fulton, 2002). In this section I will outline and describe urban containment types as well as focus primarily on urban growth boundaries in an attempt to answer my research question:

Urban Containment

Urban containment commenced in biblical times throughout Europe and was a political concern at the beginning of the 20th Century in the United States. England reigns supreme holding the title of using urban containment longer than any other western nation (Nelson, 2001). Just as urban containment has become a movement within the land use planning circles in recent years, urban containment also has become the least studied (Nelson & Dawkins, 2003).

Urban containment can be an urban growth management program constructed to address the reasonable development needs of a community, region, or state. Furthermore, a growth management program can address needs of a community so as to (1) protect public goods, (2) enhance quality of life, (3) minimize fiscal burdens, (4) reduces adverse interactions between land uses while maximizing positive ones, and (5) attempts to improve benefits of growth in an equitable manner (Nelson, 2001;Nelson & Dawkins, 2003). The strategic approach to urban containment policies differs from traditional forms of land use regulation insofar as the policies are developed and written to limit the land outside the urban area. The other intent of the policy approach is to encourage infill development and necessary redevelopment in the urban core area.

Classification of Containment

According to Nelson & Dawkins, there are four major types of urban containment with specific measures of scale and enforcement (1) “Strong Accommodating”, (2)“Strong Restrictive”, (3)“Weak Accommodating”, and (4)“Weak Restrictive” (Nelson & Dawkins, 2003). However, with the four major types of containment the elements of taxonomy could but not limited to including: (1) scale-whether single jurisdiction or multiple/regional, (2) exurban and rural land implications-involves the use of the land(s) outside a containment boundary, and (3) supply-side orientation-relates to the absorption of projected growth within boundaries of containment.

First, the *Strong Containment with Growth Accommodation* contains two basic features: 1) the preservation of rural and other open spaces beyond a boundary for non-urban uses, and 2) the containment of urban-scale development within the boundary.

Second, the *Strong Containment with Growth Restrictions* or weak growth accommodation has two essential features: 1) the preservation of rural and other open spaces beyond a boundary for non-urban uses, and 2) the containment of urban-scale development within the boundary. The strong containment w/growth restrictions differs from the strong containment with growth accommodation due to the lack of direct relationship in comprehensive plans between projected growth needs and land or other provisions made available to meet a given need (Nelson & Dawkins, 2003). Third, the *Weak Containment with Growth Accommodation* is comprised of growth boundaries or urban service limits, yet do little to manage development outside the boundary, thus resulting in lower urban densities extending outward. Curiously, this type is proactive by identifying development needs while accommodating development needs with land available through a fiscally solvent capital investment program. Fourth, the *Weak Containment with Growth Restriction* is a policy that does not adequately contain the outward spread of development beyond a set limit line. Moreover, this type of policy tends to impede development by lack of clarity on needs of development (Nelson & Dawkins, 2003).

The push and pull factors associated with open space and infrastructure placement are major factors as to how urban containment policies will or will not effect the market equilibrium (Pendall, Martin, & Fulton, 2002). Initial results of Nelson & Dawkins "Urban Containment- American Style" suggest state planning mandates tremendously effect the containment type a jurisdiction adopts thereby, aggressively promotes compact development goals (2003).

Theories on Urban Growth Boundaries

Urban growth boundaries are the most commonly used type of urban containment as opposed to urban services boundaries or greenbelts (Pendall, Martin, & Fulton, 2002). According to Pendall, Martin, & Fulton, (2002) California maintains nearly 1/3 of all urban growth boundaries, having risen sharply since 1994. In the most simplest terms for the reader, the urban growth boundary can be adopted as a policy by the local government with a subsequent ordinance put into place within the zoning code (enforcement tool for policies) thereby granting the urban growth boundary legal and enforceable legitimacy. Once an enforceable zoning ordinance the urban growth boundary is a tool to slow urban growth by banning development in delineated areas at the urban fringe and reducing the resource strains (Abbott, 2002;Brueckner, 2000;Downs, 1999).

Effects of Containment Policies

Locating outside the boundary has both positive and negative externalities often described as benefits and costs not entirely borne by the elected representatives (Wassmer, 2001). Many scholars conduct analyses suggesting housing prices have a direct relationship and connection to urban growth policies or boundaries and a subsequent increase in housing prices. Analyzing data on home price movements from 1980 to 2000 some have shown that home prices did not rise nearly as fast in Portland as in many other localities in the 1980s. Moreover, to counter the argument that the urban growth boundary automatically causes housing prices to inflate is incorrect because the rapid rise in home prices in Portland only during the period of 1990-1996 reveals that

indeed in the 1990s home prices rose sharply, yet it was a short lived increase combined with a strong demand. Furthermore, home prices in several other regions without urban growth boundaries were steadily rising (Downs, 2002). This suggests that the land market was a likely cause of rising costs not the urban growth boundaries. The work Anthony Downs conducted involved multiple regression analyses of 85 large metropolitan areas and showed dummy variables measuring the effect of the urban growth boundary in Portland had a statistically considerable effect upon home prices only in the first half of the decade in 1990's. This result confirms research conducted by Phillips et al., in 2000 by using econometric analyses to assess the contribution of the urban growth boundary and effect on housing prices. Subsequently, it would be wrong to conclude the experience from the city of Portland; urban growth boundaries inevitably cause homes prices to sore quicker (Downs, 2002). It is most likely in all cases that the effect in increased housing prices is simply due to Portland's bull real estate market and nothing more (Phillips and Goldstein, 2000). Furthermore, evidence suggests urban growth boundaries result in a decrease in retail sales outside the boundary and secondarily a decrease in the degree of racial segregation (Nelson & Dawkins, 2003; Wassmer, 2002).

Theories on Containment as an effect of Sprawl Reduction

The aim of urban containment policies is just that, to contain and stop the sporadic manner with which development occurs thereby creating a manageable scenario where land use control will reign and leapfrog style development is subservient. The aforementioned helps to reduce the sprawl like patterns. Implementation of strong urban

containment policies especially in the American West is relatively absent with the exception of Portland with a regionally system of enforcement as well as a state mandate for growth management. In order for effective implementation of urban growth boundaries, there must be recognition from the onset the iterative nature and careful need for assessment and flexibility of such a process. On average every five to ten years all stakeholders, some 24 municipalities comprising the Metro in the greater Portland Oregon area must reevaluate how much land supply is available for development (Pendall, Martin, & Fulton, 2002). According to the State of Oregon's Legislature, every city is required to establish an urban growth boundary (Oregon revised statutes 197.175). The region surrounding Portland contains some 24 municipalities and 3 counties partially within the urban growth boundaries, but primarily Multnomah County that surrounds Portland (Richmond, 1997). The *purpose* of the urban growth boundary in Portland is not to stop growth or slow it down, but to be prodevelopment. According to Richmond (1997), urban growth boundaries are actually promarket.

IV. Empirical Research on Urban Containment

As previously discussed in the "Urban Containment" section, urban containment has become a solid movement within the land use planning and policy circles in recent years yet urban containment also has become the least studied professionally and academically (Nelson & Dawkins, 2003). As the literature review suggests, there is much to read and analyze about the efficacy of the urban containment policy world. Unfortunately, there is a deficit of knowledge regarding empirical assessments as to the efficacy of urban containment. Therefore, my research project enlisting regression

analysis will help determine to what extent if any urban growth boundaries have help reduce urban sprawl on a regional basis. In this case the American West.

Four Types of Containment

The most recent empirical research produced to date on typologies of urban containment is that of Nelson & Dawkins, (2003) and Section III of this chapter discusses this research. Each region or area is unique with their own set of circumstances as they relate to urban sprawl and this recognition is important to evaluating the type of containment in place to determine effectiveness. Research to date produced by Nelson, (2001); Nelson & Dawkins;(2003) yields much information for the American West.

Empirical Measures

In order to obtain an accurate measure of sprawl reduction two things must occur: 1) ensure the type of urban containment responsible, and 2) conduct and evaluation of the market failures in the region (Brueckner, 2002). Each subset area within a region presents unique sociopolitical, environmental, and socioeconomic conditions that will dictate what sort of containment may be necessary. Staley et al. (1999), suggest a before and after analysis take place for a given urbanized area to establish a baseline condition and then after the growth boundary has been installed to determine reduced sprawl.

Urban Growth Boundaries as Measures

Urban growth boundaries could be useful to measure other significant variables such as demographic changes after enactment of the containment policy i.e., change in housing types, change in neighborhoods income to a more of a mix, or a decrease in poverty (Nelson & Dawkins, 2003). Depending on the severity of sprawl, if an ordinance

is put into place the urban growth boundary could and hopefully would reduce the impact of some negative externalities, such as air pollution, traffic congestion, and possibly increase the quality of life. These factors are relative depending on severity of sprawl.

V. Conclusion

This literature review provides a great spread of information from the elementary definition of urban sprawl to the essential characteristics that ultimately define the patterns, dimensions, and functionality of sprawl. Moreover, I present a solid understanding of the causes and consequences to the reader, thereby allowing the nexus of containment and the various elements comprising means to contain urban sprawl. Finally, the empirical measurement opportunities with urban sprawl and in particular urban containment effectiveness are a measure of reduced sprawl.

I provided a holistic perspective of what salient elements comprise the land use pattern notoriously known as urban sprawl. With a topic comprised of so many semantics, it is any wonder the end of this chapter came together with some semblance.

As for the subsequent section Chapter 3 Research Methodology, I will be using a definition adopted by Galster. Additionally, I will be using Nelson & Dawkins four types of urban containment policies as explanatory variables with urbanized area square miles as the dependent variable. Furthermore, I will use a linear model to perform a regression analysis on the effects of urban containment policies on growth patterns in urbanized areas of the American West.

CHAPTER THREE: Research Methodology

I. Introduction

The literature review in the previous chapter outlined the common elements used to describe the complex process of why and how urban sprawl likely occurs across the urban and rural landscapes. Essential components of urban sprawl include patterns of land use, dimensionality or condition of the land, and the functionality of sprawl.

In this chapter, I discuss my methodology for evaluating the effect of urban containment policies in the American West on growth patterns in urbanized areas. The layout of the chapter consists of four sections including the introduction. I discuss the econometrics, the uses and approaches to quantitative analysis, the purpose of the linear model, advantages, and disadvantages. I explain my process to gather data by type and the causal factors. I explain the regression model as to what is being estimated and then identify the parts i.e., variables of the model. This chapter consists of tables that list sources of data, descriptive statistics for each variable, correlation coefficients, and the expected relationships between each variable.

II. Econometrics

Uses

A widely accepted definition of econometrics is the "quantitative measurement and analysis of actual economic and business phenomena," (Studenmond, 2001). The aim of econometrics is to be a bridge and unite the abstract economic concepts with daily human environment interactions.

The three primary uses for econometrics are (1) describes economic reality, (2) utility for testing hypotheses about economic theory, and (3) to assist in forecasting economic activity into the future. A critical step in utilizing econometrics is to postulate some relationship between variables of interest. This relationship has its roots in economic theory or some specific economic model (Fisher, 1996). In this study I use the multivariate regression analysis to gain an understanding of the relationship between two dependant variables *Urbanized Area in square miles* along with the ratio of *Urban Fringe* land to *Urbanized Area* and several explanatory variables outlined later in the chapter. The two primary uses of multivariate regression analysis are for prediction and causal analysis (Allison, 1999). Therefore, for the purpose of this analysis is to identify causal influences for explanatory variables and determine the effect upon the dependant variable.

Approaches to Quantitative Analysis

Several approaches to quantitative analysis include but are not limited to probability analysis, analysis of variance, hypothesis testing, simple correlation, and frequency distribution. Some of these techniques are more appropriate for biological, psychological, or physics examinations. I choose the multivariate linear regression approach.

The Linear Model Purpose

Whether discussing natural or social sciences, a general principle used when uncertain about the form of a relationship is a simple linear equation. The linear regression is likely the simplest means to delineate a relationship among two or more

variables and produce a relatively accurate prediction about the causal influences between them. The relative ease of a linear equation enables efficient calculations to retrieve good estimates of the intercepts and slope coefficients (Allison, 1999). Regression analyses, no matter how statistically significant, cannot prove causality, but the statistics can suggest a significant quantitative relationship exists among dependent and explanatory variables. The regression can only test the strength direction of the relationships.

Significant Advantage/Disadvantage

The major premise of causal reason is the ruling out of alternative explanations and regression analysis is very useful in this process. Conversely, regression similar to all methods of statistical control is not capable of measuring all variables to determine causal influence.

III. Data Collection

Types of Data

This section of the paper discusses the data collection methods and related tasks useful for statistical analysis. For the purposes of my analysis, I used panel data (also known as longitudinal data) at the urbanized area (UA) to address the likely causal influences on the spatial size of urbanized areas. I use the census defined UA given it more accurately reflects the dimensionality and functionality of the urbanization as described in Chapter 2 and it serves as a better measure of sprawl compared to the metropolitan statistical area (MSA). The advantage of the UA is that unlike the MSA it does not rely on distinct boundaries, but rather includes the central place (CP) like city

downtowns and existing developed areas as well as the urban fringe (UF), which includes the new growth areas. In total, I have used 113 urbanized areas in the U.S. Census West Region that includes the Mountain and Pacific Divisions. These geographic divisions include the states of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, Washington, and Wyoming.

Specifically, panel data refers to data from *n different* entities observed at T different temporal scales. Data identification, collection, and compilation in the form of several electronic Excel spreadsheets comprising the 2000 U.S. Census data on urbanized area, central place, and urban fringe are essential to this research. Tabulated data in the spreadsheets consisted of population, labor, income, ethnic, and other socioeconomic statistics. The source of the 2000 U.S. Census data is from 2000 Census of Population and Housing Summary Population and Housing Characteristics, U.S. Department of Commerce, Economics and Statistics Administration, Summary Tape File Three. The data is online in the American Fact Finder section of the U.S. Census website: http://www.census.gov.

Additionally, data was gathered from each of the 113 urbanized area representative jurisdictions i.e., county or city via Internet queries and email inquiries as to whether urban containment policies were adopted in their respective jurisdiction. As a basis of classifying the urban containment policies adopted, I used Nelson and Dawkins, (2003) guidelines to determine upon inquiry what type of policy a respective jurisdiction uses.

Statistical Package

The statistical package most appropriate for a study such as my examination of the effectiveness of urban containment policies is a complex and powerful program known as Statistical Package for the Social Sciences, or SPSS. This software program is widely used by researchers and students in the social sciences and is user friendly with the graphic user interface.

IV. Regression Model

This section of the paper outlines the specification or functional form of the regression model. The model delineates between the dependent variable, the broad causal factors, and the proxy or dummy variables used to represent the assumed explanatory variables. Furthermore, the expected relationship either positive, negative, or both are distinguished between dependent, explanatory, and the dummy variables.

Estimation & Dependent Variables

The regression model below estimates the causal influences on the spatial size in square miles of urbanized areas as defined by the U.S. Census Bureau in the American West. The dependent variables in the model are (1) *urban fringe lands as a ratio to urbanized area* in square miles and the (2) *urbanized area* in square miles. Since fringe land use is more likely to match the characteristics described as sprawl, the first ratio identifies the percentage of land in the urban area more likely to exhibit urban sprawl. Additionally, the second dependent variable, urbanized area, measured in square miles, identifies the quantity of land use in an urbanized area for the population that resides there. Both variables function in close proximity with each other in that as one variable

increase so does the likelihood of urban sprawl. I consider these variables to be positive measures of urban sprawl and thus allow me an opportunity to evaluate through the regression model their possible independent effects. The regression models used to estimate the impact of urban sprawl on the urban spatial size of urbanized areas is as follows:

UF/UA square miles$_{i,t}$ UA square miles $_{i,t}$ = f (UA Natural Evolution$_{i,t}$, Flight from
Blight$_{i,t}$, State Specific Effects$_{i,t,}$ Urban Containment Policy$_{i,t}$)

$_i$ = 1, 2, 3,…113 (urbanized areas in American West),
$_t$ = 2000 (base year of census data set)

V. Explanatory or Causal Variables and Their Measures

This section of the paper supplies the reader with specific source information for the dependant, explanatory, and dichotomous dummy variables identified previously in section III of this chapter to describe the broad causal factors of urbanized areas. Additionally, several tables describe the source of the each variable, relevant descriptive statistics for each representative variable, and correlation coefficients or statistical relationship among the explanatory variables.

Natural Evolution

The variables for the broad causal factor, natural evolution, are proxies of measure in the following categories: Population, Agricultural Land Price, Socioeconomic characteristics, and Transportation. Specifically the variables include urbanized area (UA) population, the weighted average value per acre of agricultural land, median age, percent population under 18, percent population over 65, and percent of the population that drive 90 plus minutes to work. These variables, holding constant, serve

as the best available proxy for addressing urbanized area natural evolution when determining the effect upon the spatial size of the urbanized area. Finally, this collection of variables will serve to measure the reasons people are drawn to the urban fringe notwithstanding individual desires and economic standing. I have included these variables in my model.

> Natural Evolution$_{i,t}$ = f (UA Population$_{i,t}$, UA Agricultural Land Price$_{i,t,}$ Median Age$_{i,t,}$ Percent Population Under 18 Years$_{i,t,}$ Percent Population Over 65 Years$_{i,t,}$ Percent Population Supercommuters$_{i,t}$),

Flight from Blight

The variables for the broad causal factor, flight from blight, are proxies of measure in the following categories: Income and Socioeconomic characteristics. Specifically the variables include Central Place (CP) median household income, Percent Latino, Percent African American, Percent Asian, Percent White, and Percent Households with Public Assistance. These variables serve as the best available proxy for addressing CP Flight from Blight and maintain constant to determine the effect upon the spatial size of the urbanized area. Furthermore, this collection of variables will serve to measure the reasons people leave the central city whether the evolution of individual wealth and income or the housing characteristics. I have included these variables in my model.

> Flight from Blight$_{i,t,}$ = f (CP Median Household Income$_{i,t,}$ CP Percent Latino$_{i,t,}$ CP Percent African American$_{i,t,}$ CP Percent Asian$_{i,t,}$ CP Percent White$_{i,t,}$ CP Percent Households With Public Assistance Income$_{i,t,}$),

Urban Containment Policy Type

The variables for the broad causal factor urban containment includes urban growth boundaries by type and are currently classified by Strong Accommodating, Strong Restrictive, Weak Accommodating, and Weak Restrictive. These dummy variables coded 0 for no such containment type to a code of 1 showing the presence of a specific containment type. Furthermore, an additional variable includes the total years the containment policy has been in place from inception until 2007. These variables serve as the best available proxy for addressing Urban Containment and maintain constant when determining the effect upon the spatial size of the urbanized area.

$$\text{Urban Containment Policy Type}_{i,t,} = f\ (\text{Strong Accommodating}_{i,t,}\ \text{Strong Restrictive}_{i,t,}\ \text{Weak Accommodating}_{i,t,}\ \text{Weak Restrictive}_{i,e,}\ \text{Years Policy In Place}_{i,t,}),$$

The following tables provide statistical information as well as source information for the proxy variables chosen to explain the causal influences and effect upon urbanized spatial size in square miles. Table 3.1 consists of urbanized areas with urban containment policies. Table 3.1b identifies the classification of containment by percentage within the West and Mountain Regions. Table 3.2 consists of source variables and descriptions. Table 3.3 consists of descriptive statistics for each proxy variable. Table 3.4 consists of correlation coefficients among all the explanatory variables. Table 3.5 consists of the expected relationships with urbanized areas in square miles.

State Specific Effects

To account for regional or state variance in urban growth policies I have dummy variables for each state in the West Region. Because of using dummy variables, the

omitting condition rule applies, in that out of the 13 state variables, dropping one variable for the purposes of comparing the other states effects is necessary.

> State Specific Effects$_{i,t,}$ = f (dummy variables for each of the 13 states in the American West$_{i,t,}$), **ID (Idaho) excluded**

Urbanized Areas with Urban Containment Policies

Table 3.1 identifies a list of the 70 jurisdictions (out of a total of 113) with containment policies currently in use, by typology, and years since policy inception up until 2007. Stated another way, some 62 percent of the jurisdictions in the American West have some type of urban containment policy as opposed to 38 percent of the jurisdictions that have no policy. Table 3.1b illustrates the percentage of jurisdictions or urbanized areas that use urban containment policies. Data contained in this table was based upon Nelson and Dawkins urban containment typologies and cross-referenced where applicable, and via personal contact (telephone interviews and direct email) with local planning agencies in each respective jurisdiction for identification of containment type. I asked consistent questions of each respective jurisdiction and community representative, making certain to consult specific and general plans to verify information provided by local jurisdictions.

Table 3.1
Urbanized Areas with Containment Policies

SA = Strong Accommodating, SR = Strong Restrictive,
WA = Weak Accommodating, WR = Weak Restrictive

Urbanized Area	SA	SR	WA	WR	Years Since Inception
Albuquerque, NM	X				32
Anchorage, AK	X				7

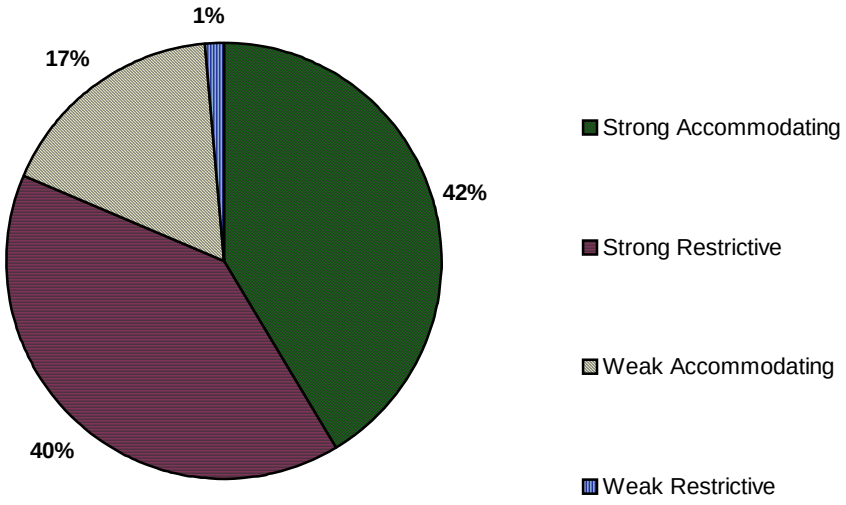
Table 3.1 Cont'd

Urbanized Area	SA	SR	WA	WR	Years Since Inception
Antioch, CA	X				17
Atascadero--Paso Robles, CA		X			27
Bellingham, WA	X				15
Bend, OR			X		26
Billings, MT			X		3
Boulder, CO		X			29
Cheyenne, WY			X		15
Chico-Paradise, CA		X			24
Corvallis, OR	X				25
Davis, CA	X				23
Denver-Aurora, CO		X			29
Eugene-Springfield, OR	X				25
Fairfield, CA		X			27
Flagstaff, AZ	X				7
Fort Collins-Loveland, CO		X			29
Fresno, CA		X			23
Gilroy-Morgan Hill, CA		X			27
Grand Junction, CO			X		11
Greeley, CO		X			29
Honolulu, HI	X				9
Kailua-Kaneohe, HI	X				9
Kennewick-Richland, WA	X				12
Lafayette-Louisville, CO		X			29
Lancaster-Palmdale, CA			X		10
Las Vegas, NV		X			7
Lewiston, ID			X		20
Livermore, CA	X				7
Lodi, CA		X			22
Lompoc, CA		X			18
Longmont, CO		X			29
Manteca, CA		X			17
Marysville, WA	X				15
Medford-Ashland, OR	X				25
Merced, CA		X			8
Missoula, MT	X				17
Mount Vernon, WA		X			10
Napa, CA		X			7

Table 3.1 Cont'd

Urbanized Area	SA	SR	WA	WR	Years Since Inception
Olympia-Lacey, WA	X				15
Oxnard, CA		X			7
Petaluma, CA	X				20
Phoenix--Mesa, AZ	X				8
Porterville, CA			X		7
Portland, OR	X				27
Redding, CA			X		7
Sacramento, CA	X				14
Salem, OR	X				15
San Diego, CA				X	28
San Jose, CA	X				35
San Luis Obispo, CA			X		26
San Rafael-Novato, CA	X				10
Santa Barbara, CA		X			18
Santa Cruz, CA			X		29
Santa Fe, NM			X		16
Santa Maria, CA	X				13
Santa Rosa, CA		X			11
Seaside-Monterey-Marina, CA	X				7
Seattle-Bellevue-Everett, WA	X				15
Simi Valley, CA		X			14
Spokane, WA	X				17
Thousand Oaks, CA		X			7
Vacaville, CA		X			27
Vallejo, CA		X			27
Visalia-Tulare, CA		X			33
Watsonville, CA			X		29
Wenatchee, WA	X				15
Yakima, WA	X				15
Yuba City-Marysville, CA		X			18
Yuma, AZ		X			11

Table 3.1b
Urban Containment Policies Used in Urbanized Areas
(Expressed as % of total in the West Region)



Variable Source Descriptions

Table 3.2 identifies a list of the dependant variables, explanatory variables, and dummy variables of the specified model in section IV of this chapter. I provide a brief description of each variable as well as the data source.

Table 3.2
Source Variables and Descriptions

Variable	Description	Source
Central Place (CP) Median Income	CP Median Household Income in 1999 dollars	U.S. Census Bureau, 2000 Data Tape File 3
CP % African American	CP Percent African American	U.S. Census Bureau, 2000 Data Tape File 3
CP % Asian	CP Percent Asian	U.S. Census Bureau, 2000 Data Tape File 3
CP % Latino	CP Percent Latino	U.S. Census Bureau, 2000 Data Tape File 3

Table 3.2 Cont'd

Variable	Description	Source
CP % White	CP Percent White	U.S. Census Bureau, 2000 Data Tape File 3
CP % w/Public Assistance	CP Percent Households with Public Assistance Income	U.S. Census Bureau, 2000 Data Tape File 3
Urbanized Area (UA) Population	Total number of persons in a defined urbanized area	U.S. Census Bureau, 2000 Data Tape File 3
UA in mi^2	Spatial Size of area measured in square miles and containing at least 50,000 persons.	U.S. Census Bureau, 2000 Data Tape File 3
Urban Fringe (UF)/UA Land in mi^2	Ratio of UF land to UA land	U.S. Census Bureau, 2000 Data Tape File 3
UA Agricultural Land Price	Urbanized are weighed average value per acre of farmland	U.S. Census Bureau, 2000 Data Tape File 3
UA Median Age	Age of sample that comprises the middle of the sample	U.S. Census Bureau, 2000 Data Tape File 3
UA % Population Under 18	UA Percent population in under the age of 18 years old	U.S. Census Bureau, 2000 Data Tape File 3
UA % Population Over 65	UA Percent population over the age of 65 years old	U.S. Census Bureau, 2000 Data Tape File 3
UA % Super Commuters	UA Percent Population Driving 90+ minutes to work daily one way	U.S. Census Bureau, 2000 Data Tape File 3
Urban Containment Policy -Strong Accommodating	Market accommodation with strong urban containment	Nelson. A. C., Dawkins, C.J., 2003. "Urban Containment-American Style(s)", Working Paper,
Urban Containment Policy -Strong Restrictive	Market restrictive with strong urban containment	Nelson. A. C., Dawkins, C.J., 2003. "Urban Containment
Urban Containment-Weak Accommodating	Market accommodation with weak urban containment	Nelson. A. C., Dawkins, C.J., 2003. "Urban Containment
Urban Containment Policy -Weak Restrictive	Market restrictive with weak urban containment	Nelson. A. C., Dawkins, C.J., 2003. "Urban Containment
Years Policy In Place	Inception date urban containment policy began until present	Independent Research Fall 2003-Spring 2007 for each 113 Urbanized Areas
Alaska (AK)	Dummy Variable for Alaska	Created
Arizona (AZ)	Dummy Variable for Arizona	Created
California (CA)	Dummy Variable for California	Created
Colorado (CO)	Dummy Variable for Colorado	Created
Idaho (ID)	Dummy Variable for Idaho	Created
Hawaii (HI)	Dummy Variable for Hawaii	Created
Montana (MT)	Dummy Variable for Montana	Created
New Mexico (NM)	Dummy Variable for New Mexico	Created
Nevada (NV)	Dummy Variable for Nevada	Created

Table 3.2 Cont'd

Variable	Description	Source
Oregon (OR)	Dummy Variable for Oregon	Created
Utah (UT)	Dummy Variable for Utah	Created
Washington (WA)	Dummy Variable for Washington	Created
Wyoming (WY)	Dummy Variable for Wyoming	Created

Descriptive Statistics

Table 3.3 identifies the summary of key characteristics of each variable within the regression model. The descriptive statistics are from the use of SPSS calculations from the U.S. Census dataset specific to the 113 urbanized areas. As measures of central tendency and variation, I have included both the mean and standard deviations with minimum and maximum values respectfully.

Table 3.3
Descriptive Statistics

Variable	Mean	Standard Deviation	Min	Max
Central Place (CP) Median Income	43243	11495	26817	76231
CP % African American	2.56	3.12	.10	17.38
CP % Asian	3.87	4.83	.28	28.60
CP % Latino	15.73	12.62	1.06	54.07
CP % White	52.32	16.98	10.10	83.20
CP % w/Public Assistance	1.08	0.59	0.12	2.87
Urbanized Area (UA) Population	4397424.3	1230023.1	50317	1178948
UA Land Area in mi^2	117.73	214.9	12.77	1667.93
Urban Fringe (UF)/UA Land Area	46.67	18.19	0.00	92.31
UA Agricultural Land Price	1032.48	1173.22	0.00	6390.05
UA Median Age	33.05	3.51	23	43
UA % Population Under 18	27.29	4.28	11.8	35.3
UA % Population Over 65	11.11	3.27	5.2	26.3
UA Super Commuters	1.27	0.924	0.36	5.18
Urban Containment-Strong Accommodating	0.26	0.44	0	1
Urban Containment-Strong Restrictive	0.25	0.43	0	1
Urban Containment-Weak Accommodating	0.11	0.31	0	1
Urban Containment-Weak Restrictive	0.01	0.094	0	1
Years Policy In Place	11.17	11.03	0	35
Alaska (AK)	0.02	0.13	0	1
Arizona (AZ)	0.05	0.23	0	1

Table 3.3 Cont'd

Variable	Mean	Standard Deviation	Min	Max
California (CA)	0.48	0.50	0	1
Colorado (CO)	0.08	0.27	0	1
Hawaii (HI)	0.02	0.13	0	1
Montana (MT)	0.03	0.16	0	1
New Mexico (NM)	0.04	0.19	0	1
Nevada (NV)	0.03	0.16	0	1
Oregon (OR)	0.05	0.23	0	1
Utah (UT)	0.04	0.21	0	1
Washington (WA)	0.10	0.30	0	1
Wyoming (WY)	0.02	0.13	0	1

Correlation Coefficients

Table 3.4 identifies the correlation coefficients by describing the relationship among the explanatory variables minus the dummy variables for each respective state. The primary reason for including these correlation coefficients is to gain overall insight into the possibility of multicollinearity occurring in my regression model.

Table 3.4
Correlation Coefficients

SA = Strong Accommodating, SR = Strong Restrictive,
WA = Weak Accommodating, WR = Weak Restrictive, UC = Urban Containment

Variable	CP Median HH Income	CP % Black	CP % Asian	CP % Latino	CP % White	CP % Pub Assist	UA Pop	UA Ag Land Price	UA Median Age
CP Median HH Income	1	0.067	0.312	-0.079	-0.049	-0.362	-0.022	0.191	0.276
CP % Black	0.067	1	0.413	0.247	-0.168	0.341	0.269	0.129	-0.101
CP % Asian	0.312	0.413	1	0.046	-0.307	0.099	0.272	0.232	-0.008
CP % Latino	-0.079	0.247	0.046	1	-0.114	0.382	0.145	0.126	-0.276
CP % White	-0.046	-0.168	- .307	-0.114	1	-0.052	-0.136	-0.423	0.009
CP % Pub Assist	-0.362	0.341	0.099	0.382	-0.052	1	0.043	-0.071	-0.237
UA Pop	-0.022	0.269	0.272	0.145	-0.136	0.043	1	0.235	0.006

Table 3.4 Cont'd

Variable	CP Median HH Income	CP % Black	CP % Asian	CP % Latino	CP % White	CP % Pub Assist	UA Pop	UA Ag Land Price	UA Median Age
UA Ag Land Price	0.191	0.129	0.232	0.126	-0.423	-0.071	0.235	1	0.060
UA Median Age	0.276	-0.101	- .008	-0.276	0.009	-0.237	0.006	0.060	1
UA % Pop Under 18 yrs	-0.039	0.227	- .119	0.436	-0.252	0.417	-0.040	0.060	-0.387
UA % Pop Over 65 yrs	-0.187	-0.26	- .143	-0.183	-0.061	-0.059	-0.061	-0.019	0.673
UA % Super Commuters	0.263	0.392	0.163	0.070	-0.139	-0.015	-0.030	0.299	0.074
UCSA	0.035	-0.076	0.227	-0.234	-0.055	-0.075	0.028	-0.103	0.104
UCSR	0.115	0.142	0.115	0.162	0.106	-0.047	-0.091	0.080	-0.054
UCWA	-0.099	-0.087	- .152	0.003	0.070	0.090	-0.097	-0.041	0.077
UCWR	0.019	0.075	0.091	0.06	0.003	0.007	0.172	0.024	-0.004
Yrs Urban Containment Policy	0.083	0.037	0.143	-0.113	0.129	-0.101	-0.050	-0.035	-0.004

Table 3.4
Correlation Coefficients Cont'd

Variable	CP Median HH Income	CP % Black	CP % Asian	CP % Latino	CP % White	CP % Pub Assist	UA Pop	UA Ag Land Price
CP Median HH Income	-0.039	- .187	0.263	0.035	0.115	-0.099	0.019	0.083
CP % Black	0.227	- .260	0.392	-0.076	0.142	-0.087	0.075	0.037
CP % Asian	-0.119	- .143	0.163	0.227	0.015	-0.152	0.091	0.143
CP % Latino	0.436	- .183	0.07	-0.234	0.162	0.003	0.060	- .013
CP % White	-0.252	- .061	- .139	-0.055	0.106	0.07	0.003	0.129
CP % Pub Assist	0.417	- .059	- .015	-0.075	-0.047	0.09	0.007	- .101
UA Pop	-0.040	- .061	-0.03	0.028	-0.091	-0.097	0.172	- .050
UA Ag Land Price	0.060	- .019	0.299	-0.103	0.080	-0.041	0.024	- .035
UA Median Age	-0.387	0.673	0.074	0.104	-0.054	0.077	-0.004	- .004

Table 3.4 Cont'd

Variable	CP Median HH Income	CP % Black	CP % Asian	CP % Latino	CP % White	CP % Pub Assist	UA Pop	UA Ag Land Price
UA % Pop Under 18 yrs	1	- .320	0.281	-0.274	0.059	-0.127	-0.035	- .302
UA % Pop Over 65 yrs	-0.32	1	- .162	-0.011	-0.156	0.099	0.000	- .149
UA % Super Commuters	0.281	- .162	1	-0.052	0.040	-0.073	-0.026	- .095
UCSA	-0.274	- .011	- .052	1	-0.337	-0.203	-0.056	0.272
UCSR	0.059	- .156	0.04	-0.337	1	-0.198	-0.054	0.469
UCWA	-0.127	0.099	- .073	-0.203	-0.198	1	-0.033	0.17
UCWR	-0.035	0.000	- .026	-0.056	-0.054	-0.033	1	0.145
Yrs UC Policy	-0.302	- .149	- .095	0.272	0.469	0.17	0.145	1

Expected Relationships

This section outlines expectations on the direction of effect each of the below explanatory variables may have on spatial size of overall urbanized areas, based upon logical deduction, existing base of knowledge from literature reviews and current theory (see Table 3.5).

I expect to find that that my dependent variables Urbanized Area in mi^2 and the ratio of Urban Fringe to Urban Area land positively correlate to the Urbanized Area Population. Given the nature of growth patterns, the extension of the urban footprint is determinant of the movement of population upward at an increasing rate. Agricultural Land Price appears to be both negatively and positively correlated depending upon whether it is the long or short run and proximity of agricultural land to the urbanized area. Median Age, Population under 18 Year Old, and Population Over 65 Years Old all are expected to have a positive relationship relative to Urbanized Area in mi^2. However,

the relationship may be negative if measured against public services needed for Population over 65 Years Old. The Percent Population Driving 90+ minutes to work daily one way is expects to have a negative effect relative to Urbanized Area in mi^2 due to likely externalities generated from long peak trips to and from work.

I expected to find the Central Place Median Household Income to have a positive effect upon Urbanized Area in mi^2 as an indicator of overall fiscal health of the urbanized area. Furthermore, the four variables representing ethnic makeup i.e., Central Place Percent Latino, African American, Asian, and White should have positive effects. Nevertheless, a likely negative effect is possible. The potential negative effect of Central Place Percent White that may surface is a correlation to majority population driving and commuting.

I further expect Percent Households w/ Public Assistance Income to both have a positive or negative effect upon Urbanized Area in mi^2. The proxy dichotomous dummy variables representing urban containment by type likely have a negative effect upon Urbanized Area in mi^2. Moreover, the remaining two dummy variables Base Year Policy and Y2K Difference may have a positive effect upon Urbanized Area in mi^2 depending upon length of time an urban containment policy is in place.

Table 3.5
Expected Relationships

Explanatory Variable	**Expected Relationship**
Central Place Median Income	+
Central Place % African American	+
Central Place % Asian	+
Central Place % Latino	+

Table 3.5 Cont'd

Explanatory Variable	Expected Relationship
Central Place % White	-
Central Place % w/Public Assistance	-
Urbanized Area Population	+
Urbanized Area Agricultural Land Price	-
Urbanized Area Median Age	+
Urbanized Area % Age Under 18	-
Urbanized Area % Age Over 65	+
Urbanized Area % Super Commuters	-
Urban Containment-Strong Accommodating	-
Urban Containment-Strong Restrictive	+
Urban Containment-Weak Accommodating	-
Years Policy In Place	-
Alaska (AK)	+/-
Arizona (AZ)	+/-
California (CA)	+/-
Colorado (CO)	+/-
Hawaii (HI)	+/-
Montana (MT)	+/-
New Mexico (NM)	+/-
Nevada (NV)	+/-
Oregon (OR)	+/-
Utah (UT)	+/-
Washington (WA)	+/-
Wyoming (WY)	+/-

VI. Conclusion

The current chapter has clearly delineated the method of analysis for this study, including the specified linear regression model, and appropriate proxy variables to address the broad causal factors. The following chapter will address the findings of the regression analysis and statistical disruptions experienced during the analysis. My results for expected relationships should be similar to what I predicted in Table 3.5.

Furthermore, the variables identified in Table 3.2 should be appropriate measures of urban sprawl in the West Region as defined by the U.S. Census and identify whether the urban containment policies have an effect on urban sprawl.

Lastly, I will address steps taken to test and remediate problems like multicollinearity or heteroskedasticity.

CHAPTER FOUR: Regression Findings

I. Introduction

The previous chapter outlined my linear regression model and the suggested causal influences serving as proxies to the broad causal factors to spatial size of urbanized areas. In Table 3.2, I discuss the variables one by one and their respective source descriptions. Moreover, I forecast the likely relationship, positive or negative, among all explanatory variables.

The forthcoming sections seek to present results produced by executing a multivariate regression analysis via the SPSS software for the specified model in Chapter 3. I will address regression analysis and describe the statistical significance of critical statistical measures key to determine the strength of the regression. I will include an overall description of reported regression statistics, such as R-squared or coefficient of determination, statistical significance, level of confidence, and regression coefficients.

I will present the first phase of my regression results outlining the Linear-Linear relationships effects amongst the explanatory variables. Tables 4.1 and 4.1b illustrate the first phase of uncorrected variables. I will discuss model problems such as under specification, omitted variable bias, variables running too close to each other, and how I corrected for these issues.

After reporting the uncorrected results in Tables 4.1 and 4.1b I will attempt to make corrections and will present the final results in Tables 4.2, 4.2b, 4.3, 4.3b, 4.4, and 4.4b. I will present an interpretation of the results along with statistically significant variables in Tables 4.5 and 4.6 to convey the significant variables. Finally, the last section will

conclude with a discussion about the relationship of my regression model and its ability to identify effect of urban containment policies towards curbing urban sprawl.

II. Regression Analysis

Statistical Measures

Described below are several tables that demonstrate my multiple regression models in various forms (Linear-Linear, Log-Linear, and Log-Log). These models use controlling measures i.e., dependent variables Urbanized Area Land and the ratio of Urban Fringe Land verses Urbanized Area Land to determine the causal effects of the explanatory variables. A key principle to remember is that regression analysis can test whether a significant quantitative relationship exists.

In each respective table, there are a series of six consistent statistical measures with each describing a particular condition of the regression based upon the relationship of the dependent variable(s) and the explanatory variables. These statistical measures identify the overall fitness or strength of the regression model. Therefore, the following tables, 4.1, 4.1b, 4.2, 4.2b, 4.3, 4.3b, 4.4, and 4.4b, include statistical measures for the regression coefficient, *standard error, t-statistic, level of significance, variance inflation factor or VIF, and R-squared/adjusted (R^2).*

The first measure is the regression coefficient, represented by the β coefficient that indicates the slope in the regression. The slope is the change in Y intercept over the change in X intercept or rise over run that describes the change in the dependent variable(s) with one unit increase in the explanatory variable, assuming other explanatory variables held constant.

The second measure is the standard error that that I use to indicate the probability of making the mistake of failing to reject my null hypothesis that there is no relationship between my dependent variable Urbanized Area Land and my explanatory variable Super Commuters. The third measure is the t-statistic, which I use to discover the probability that a specific explanatory variable exerts a statistically significant influence on the dependent variable.

The fourth measure is the level of significance that helps demonstrate whether the explanatory variable(s) are good explanatory indicators of the dependent variable(s). A variable is significant if it falls at .05 (95% degree of confidence that the influence is not zero) or .01 (90% degree of confidence that the influence is not zero).

The fifth measure is the variable inflation factor or VIF. The VIF is a statistic to indicate the severity of collinearity or multicollinearity [one or more explanatory variables have a relationship that effects the estimation of the coefficients of one of the other explanatory variable(s)] by evaluating to what extent one explanatory variable can influence or explain other explanatory variables in the regression. A VIF measure higher than five suggests a multicollinearity problem and is of concern only if the relevant regression coefficient exhibits a statistically insignificant influence.

The final measure is that of R^2, that is a measure of a "goodness of fit" by identifying the percent variation of the dependent variable(s) in relation to explanatory variable(s). R^2 is very useful at indicating how well the explanatory variable(s) explain the dependent variable(s). Adjusted R^2 is very applicable in my thesis given the use of

more than more explanatory variable. The adjusted R-value measures each explanatory variable R^2 value and evaluates the regression overall.

III. Regression Results

The following section discusses the numeric results from the regression model outlined in Chapter 3. Table 4.1 illustrates the 29 explanatory variables in relationship to the dependent variable UA or Urbanized Area in mi^2. Table 4.1b illustrates the 29 explanatory variables in relationship to the dependent variable UF/UA or ratio of Urban Fringe land to Urbanized Area land. Both Table 4.1 and 4.1b are in the Linear-Linear regression form.

In Table 4.1, generally there appears to be minimal problems with the variance inflation factors, with only two variables "Urbanized Area Median Age" and "California" exceeding the acceptable level of five. Again, variables with a VIF over five indicate a possible problem with collinearity and the solution is to consider dropping variables. In Table 4.1b, the same two variables appear to be causing high VIF scores. Although both tables' possess relatively low VIF scores, it is best if I attempt to bring the scores down before making any claims on the models' strength.

Table 4.1
Regression Results for UA in mi^2 (Uncorrected Linear-Linear)

SA = Strong Accommodating, SR = Strong Restrictive,
WA = Weak Accommodating, WR = Weak Restrictive, UC = Urban Containment

Variable	β	Std. Error	t	Sig.	VIF
(Constant)	3.342	130.795	.026	.980	-------
Central Place					
Median Household Income	.001	.001	.983	.328	2.771

Table 4.1 Cont'd

Variable	β	Std. Error	t	Sig.	VIF
Central Place % African-American	6.000	3.362	1.785	.078*	2.462
Central Place % Asian-American	-5.546	2.586	-2.144	.035**	3.493
Central Place % Latino	-1.118	.941	-1.189	.238	3.155
Central Place % White	-.828	.594	-1.395	.167	2.274
Central Place w/ Public Assistance	15.682	20.692	.758	.451	3.304
Urbanized Area Population	.000	.000	24.243	.000**	1.418
Urbanized Area Ag Land Price	.007	.008	.956	.342	1.778
Urbanized Area Median Age	1.964	4.274	.459	.647	5.047
Urbanized Area % Under 18 Yrs Age	-.076	2.778	-.027	.978	3.165
Urbanized Area % Over 65 Yrs of Age	-2.631	4.198	-.627	.533	4.207
Urbanized Area % Super Commuter	-8.630	11.274	-.765	.446	2.429
UCSR	-8.950	30.956	-.289	.773	4.035
UCSA	45.743	29.629	1.544	.126	3.784
UCWR	347.86	80.753	4.308	.000**	1.292
UCWR	-8.756	31.864	-.275	.784	2.177
Total Years Policy In-Place	.146	1.277	.114	.909	4.437
Alaska	-75.33	68.360	-1.102	.274	1.836
Arizona	72.279	47.730	1.514	.134	2.588
California	-.768	40.627	-.019	.985	9.304
Colorado	37.533	44.634	.841	.403	3.299
Hawaii	8.355	86.428	.097	.923	2.934
Montana	-1.218	54.063	-.023	.982	1.707
New Mexico	36.585	54.489	.671	.504	2.290
Nevada	44.967	59.388	.757	.451	2.059
Oregon	1.349	47.548	.028	.977	2.568
Utah	37.754	48.134	.784	.435	2.214
Washington	12.728	44.393	.287	.775	3.912
Wyoming	7.787	61.304	.127	.899	1.476

** 95% Confidence Interval *90% Confidence Interval

N=113 $R^2 = .920$ Adjusted $R^2 = .892$

Table 4.1b
Regression Results UF/UA (Uncorrected Linear-Linear)

SA = Strong Accommodating, SR = Strong Restrictive,
WA = Weak Accommodating, WR = Weak Restrictive, UC = Urban Containment

Variable	β	Std. Error	t	Significance	VIF
(Constant)	157.946	14.294	11.050	.000	-------
Central Place Median Household Income	1.974E-05	.000	.187	.852	2.771
Central Place % African-American	-1.167	.367	-3.176	.002**	2.462
Central Place % Asian-American	-1.107	.283	-3.918	.000**	3.493
Central Place % Latino	-.098	.103	-.958	.341	3.155
Central Place % White	-1.005	.065	-15.488	.000**	2.274
Central Place w/ Public Assistance	-2.188	2.261	-.968	.336	3.304
Urbanized Area Population	-1.515E-06	.000	-2.142	.035**	1.418
Urbanized Area Agricultural Land Price	-.001	.001	-.839	.404	1.778
Urbanized Area Median Age	-.633	.467	-1.356	.179	5.047
Urbanized Area % Under 18 Yrs of Age	-.640	.304	-2.107	.038**	3.165
Urbanized Area % Over 65 Yrs of Age	-.255	.459	-.556	.580	4.207
Urbanized Area % Super Commuter	-.872	1.232	-.708	.481	2.429
UCSR	-.230	3.383	-.068	.946	4.035
UCSA	-2.135	3.238	-.659	.511	3.784
UCWR	8.899	8.825	1.008	.316	1.292
UCWA	-3.484	3.482	-1.001	.320	2.177
Total Years Policy In-Place	.013	.140	.095	.925	4.437
Alaska	-14.390	7.471	-1.926	.058*	1.836
Arizona	-16.398	5.216	-3.144	.002**	2.588
California	-4.635	4.440	-1.044	.300	9.304
Colorado	-3.056	4.878	-.626	.533	3.299

Table 4.1b Cont'd

Variable	β	Std. Error	t	Significance	VIF
Hawaii	-11.199	9.445	-1.186	.239	2.934
Montana	8.197	5.908	1.387	.169	1.707
New Mexico	-6.490	5.955	-1.090	.279	2.290
Nevada	-9.721	6.490	-1.498	.138	2.059
Oregon	.179	5.196	.034	.973	2.568
Utah	-8.962	5.260	-1.704	.092*	2.214
Washington	3.698	4.851	.762	.448	3.912
Wyoming	10.191	6.699	1.521	.132	1.476

** 95% Confidence Interval *90% Confidence Interval

N=113 $R^2 = .866$ Adjusted $R^2 = .819$

IV. Potential Model Problems

Multicollinearity

Given the aforementioned high variance inflation factors or VIF problems with Tables 4.1 and 4.1b, it is best to drop variables one at a time to determine effect and evaluate whether the VIF scores can return to or below 5. The reason for dropping variables is likely due to the problem of collinearity, the problem surrounding the effect of one explanatory variable upon another. Since "Urbanized Area Median Age" and my dummy variable "California" were both registering high VIF scores I began dropping one at a time. With "California" removed, the remaining VIF values fell below five. Some variables once not as significant became more significant with the removal of the "California" dummy variable from both models. "Urbanized Area Median Age" variable remains in the model. However, given "California" is one of my state specific dummy variables and I already do not account for one state, Idaho as a measure against all the remaining state variables, removing the dummy variable "California" would go against

the statistical rules. The model will simply have higher multicollinearity than I initially predicted.

Heteroskedasticity

Another problem that tends to show up because of using multivariate regression analysis is the occurrence of heteroskedasticity. Heteroskedasticity results from the error variance of the regression model being changeable amongst the explanatory variables. Methods of testing for heteroskedasticity are not the same and can be highly variable (Studenmond, 2001). A common test often used to calculate the residuals of the explanatory variables is the Park Test. The Park Test calculation takes the residuals of the explanatory variables, then calculates weighted least squares, and then runs a test with the log against a measure of size.

Functional Form log-log

Heteroskedasticity elimination from the regression model occurs by changing the functional form of the regression model. The standard regression model as previously noted in Chapter 3 assumes a linear-linear relationship among the dependent and explanatory variables. However, using a log-linear relationship among the dependent and explanatory variables has the potential to strengthen the power of the explanatory variables. Moreover, taking the log-log of both the dependent and explanatory variables could approximate a non-linear relationship. Taking the log-linear and especially the log-log of variables frequently results in a regression model that is more robust in terms of R^2 and significant variables.

V. Corrected Regression Results

Upon testing for heteroskedasticity, variance inflation factor values (VIF), and experimenting with the functional forms of my regression model, I now have a model closely resembling my original. In the corrected model run for linear-linear, log-linear, and log-log I calculated four interaction variables as a means to test the independent effects between all four urban containment policy types (denoted as "SA2", "SR2", "WA2", and "WR2") and "YRSPOLICY". Tables 4.1b through 4.4b show results based on the interaction variables and the functional forms of the equation in Linear-Linear, Log-Linear, and Log-Log. I now use 33 explanatory variables total.

Linear-Linear

The uncorrected model run for linear-linear, Table 4.1 the R^2 and adjusted R^2 for UA in mi^2 is .920 and .892 respectively. For UF/UA uncorrected, R^2 and adjusted R^2 is .866 and .819 respectively (Table 4.1b). In the corrected model run for linear-linear (Table 4.2), R^2 and adjusted R^2 for UA in mi^2 is .92 and .890 respectively. For UF/UA corrected, R^2 and adjusted R^2 is .867 and .816. Variance in variable significance ranges from (.000- .10) in UA mi^2 to (.000- .05) in UF/UA. In the uncorrected model, there are 12 significant variables total. In the uncorrected model linear-linear, there are four variables of significance in UA mi^2 and eight of significance in UF/UA respectively (Tables 4.1 and 4.1b). The overall variance inflation factor or VIF values are at or below five in the corrected version. However, there are eight variables with VIF's over 5.1 up to a maximum of 9.5.

Table 4.2
Regression Results for UA in mi^2 (Corrected Linear- Linear)

SA = Strong Accommodating, SR = Strong Restrictive,
WA = Weak Accommodating, WR = Weak Restrictive, UC = Urban Containment

Variable	β	Std. Error	t	Significance	VIF
(Constant)	6.487	135.011	.048	.962	-------
Central Place Median Household Income	.001	.001	.855	.395	2.821
Central Place % African-American	6.719	3.488	1.926	.058*	2.614
Central Place % Asian-American	-6.455	2.784	-2.318	.023**	3.993
Central Place % Latino	-1.158	.973	-1.190	.238	3.332
Central Place % White	-.771	.603	-1.277	.205	2.317
Central Place w/ Public Assistance	15.591	21.147	.737	.463	3.403
Urbanized Area Population	.000	.000	24.018	.000**	1.421
Urbanized Area Agricultural Land Price	.008	.008	1.022	.310	1.804
Urbanized Area Median Age	2.445	4.348	.562	.575	5.150
Urbanized Area % Under 18 Yrs of Age	-.319	2.859	-.112	.911	3.306
Urbanized Area % Over 65 Yrs of Age	-3.374	4.303	-.784	.435	4.361
Urbanized Area % Super Commuter	-9.782	11.424	-.856	.394	2.460
UCSA	16.270	43.635	.373	.710	8.094
UCSA 2	2.029	2.411	.842	.402	8.358
UCSR	2.375	39.658	.060	.952	6.532
UCSR 2	-.534	1.854	-.288	.774	7.193
UCWA	1.789	51.399	.035	.972	5.587
UCWA 2	**Excluded**	-------	-------	-------	-------
UCWR	366.414	104.793	3.497	.001**	2.146
UCWR 2	**Excluded**	-------	-------	-------	-------
Total Years Policy In-Place	-.508	2.726	-.186	.853	19.948
Alaska	-71.498	69.206	-1.033	.305	1.855
Arizona	75.131	48.340	1.554	.124	2.618
California	2.622	41.254	.064	.949	9.462
Colorado	39.440	47.096	.837	.405	3.623

Table 4.2 Cont'd

Variable	β	Std. Error	t	Significance	VIF
Hawaii	42.628	94.632	.450	.654	3.469
Montana	-9.026	55.936	-.161	.872	1.802
New Mexico	27.683	56.038	.494	.623	2.389
Nevada	39.669	60.077	.660	.511	2.078
Oregon	-11.475	49.950	-.230	.819	2.795
Utah	39.653	48.635	.815	.417	2.229
Washington	12.871	44.721	.288	.774	3.916
Wyoming	3.649	61.989	.059	.953	1.489

** 95% Confidence Interval *90% Confidence Interval

N=113 R^2 = .921 Adjusted R^2 = .890

Table 4.2b
Regression Results UF/UA (Corrected Linear-Linear)

SA = Strong Accommodating, SR = Strong Restrictive,
WA = Weak Accommodating, WR = Weak Restrictive, UC = Urban Containment

Variable	β	Std. Error	t	Significance	VIF
(Constant)	158.336	14.793	10.703	.000	-------
Central Place Median Household Income	1.147E-05	.000	.106	.915	2.821
Central Place % African-American	-1.113	.382	-2.912	.005**	2.614
Central Place % Asian-American	-1.178	.305	-3.860	.000**	3.993
Central Place % Latino	-.100	.107	-.942	.349	3.332
Central Place % White	-1.001	.066	-15.136	.000**	2.317
Central Place w/ Public Assistance	-2.213	2.317	-.955	.342	3.403
Urbanized Area Population	-1.533E-06	.000	-2.146	.035**	1.421
Urbanized Area Agricultural Land Price	-.001	.001	-.765	.446	1.804
Urbanized Area Median Age	-.598	.476	-1.255	.213	5.150
Urbanized Area % Under 18 Yrs of Age	-.661	.313	-2.111	.038**	3.306
Urbanized Area % Over 65 Yrs of Age	-.312	.471	-.661	.510	4.361

Table 4.2b Cont'd

Variable	β	Std. Error	t	Significance	VIF
Urbanized Area % Super Commuter	-.960	1.252	-.767	.446	2.460
UCSA	-4.403	4.781	-.921	.360	8.094
UCSA 2	.158	.264	.596	.553	8.358
UCSR	.536	4.345	.123	.902	6.532
UCSR 2	-.033	.203	-.165	.870	7.193
UCWA	-2.479	5.632	-.440	.661	5.587
UCWA 2	-.049	.299	-.163	.871	5.703
UCWR	10.643	11.482	.927	.357	2.146
UCWR 2	.332	.292	1.135	.260	1.088
Total Years Policy In-Place	-.049	.299	-.163	.871	19.948
Alaska	-14.066	7.583	-1.855	.067*	1.855
Arizona	-16.199	5.297	-3.058	.003**	2.618
California	-4.393	4.520	-.972	.334	9.462
Colorado	-2.979	5.160	-.577	.565	3.623
Hawaii	-8.576	10.369	-.827	.411	3.469
Montana	7.547	6.129	1.231	.222	1.802
New Mexico	-7.206	6.140	-1.174	.244	2.389
Nevada	-10.126	6.583	-1.538	.128	2.078
Oregon	-.792	5.473	-.145	.885	2.795
Utah	-8.833	5.329	-1.657	.101*	2.229
Washington	3.702	4.900	.756	.452	3.916
Wyoming	9.855	6.792	1.451	.151	1.489

** 95% Confidence Interval *90% Confidence Interval

N=113 $R^2 = .867$ Adjusted $R^2 = .816$

Log-Linear

In Tables 4.3 and 4.3b, the corrected form of the original model run displays in log-linear form. I calculate the log of the dependent variables to explain the non-linear relationship. In the corrected model run for linear-linear, R^2 and adjusted R^2 for UA in mi^2 is .921 and .890 respectively (Table 4.2). For UF/UA corrected model run for linear-

linear, R^2 and adjusted R^2 is .867 and .816 respectively. The corrected log-linear run for R^2 and adjusted R^2 for UA in mi^2 is .691 and .572 respectively (Table 4.3).

Variance in variable significance ranges from (.000- .10) in UA mi^2 to (.000- .05) in UF/UA. In the uncorrected model, there were four variables of significance in UA mi^2 and eight of significance in UF/UA respectively (Tables 4.1 and 4.1b). The corrected model reveals no change in the four variables of significance in UA mi^2 and eight of significance in UF/UA respectively (Tables 4.2 and 4.2b). Eight variables gained significance in the corrected model when previously no significance existed. The variable inflation factor values or VIF's held steady with the same eight variables over the value of 5.1 as in the previous corrected model of linear-linear. The corrected log-linear model run for R^2 and adjusted R^2 for UF/UA is .771 and .683 respectively, (Table 4.3b).

Table 4.3
Regression Results for UA in mi^2 (Corrected Log- Linear)

SA = Strong Accommodating, SR = Strong Restrictive,
WA = Weak Accommodating, WR = Weak Restrictive, UC = Urban Containment

Variable	β	Std. Error	t	Significance	VIF
(Constant)	1.285	.535	2.403	.019**	-------
Central Place Median Household Income	3.866E-06	.000	.993	.324	2.821
Central Place % African-American	.037	.014	2.675	.009**	2.614
Central Place % Asian-American	-.021	.011	-1.881	.064*	3.993
Central Place % Latino	-.008	.004	-2.027	.046**	3.332
Central Place % White	-.007	.002	-2.973	.004**	2.317
Central Place w/ Public Assistance	.123	.084	1.470	.146	3.403

Table 4.3 Cont'd

Variable	β	Std. Error	t	Significance	VIF
Urbanized Area Population	1.805E-07	.000	6.990	.000*	1.421
Urbanized Area Agricultural Land Price	5.799E-05	.000	1.901	.061*	1.804
Urbanized Area Median Age	.029	.017	1.672	.098*	5.150
Urbanized Area % Under 18 Yrs of Age	-.003	.011	-.273	.786	3.306
Urbanized Area % Over 65 Yrs of Age	-.025	.017	-1.488	.141	4.361
Urbanized Area % Super Commuter	-.088	.045	-1.936	.056*	2.460
UCSA	-.071	.173	-.409	.683	8.094
UCSA 2	.024	.014	1.726	.088*	17.453
UCSR	.110	.157	.703	.484	6.532
UCSR 2	-.001	.014	-.061	.952	24.384
UCWA	.032	.204	.158	.875	5.587
UCWA 2	**Excluded**	-------	-------	-------	-------
UCWR	1.043	.415	2.513	.014**	2.146
UCWR 2	**Excluded**	-------	-------	-------	-------
Total Years Policy In-Place	-.010	.011	-.905	.368	19.948
Alaska	-.372	.274	-1.357	.178	1.855
Arizona	.254	.191	1.329	.187	2.618
California	.018	.163	.107	.915	9.462
Colorado	.279	.187	1.497	.138	3.623
Hawaii	.029	.375	.077	.939	3.469
Montana	-.050	.222	-.224	.824	1.802
New Mexico	.215	.222	.969	.336	2.389
Nevada	.290	.238	1.221	.226	2.078
Oregon	-.018	.198	-.091	.928	2.795
Utah	.369	.193	1.915	.059*	2.229
Washington	-.092	.177	-.519	.605	3.916
Wyoming	-.021	.245	-.086	.931	1.489

** 95% Confidence Interval *90% Confidence Interval

N=113 $R^2 = .691$ Adjusted $R^2 = .572$

Table 4.3b
Regression Results for UF/UA (Corrected Log- Linear)

SA = Strong Accommodating, SR = Strong Restrictive,
WA = Weak Accommodating, WR = Weak Restrictive, UC = Urban Containment

Variable	β	Std. Error	t	Significance	VIF
(Constant)	3.294	.268	12.273	.000	-------
Central Place Median Household Income	2.869E-07	.000	.147	.884	2.821
Central Place % African-American	-.008	.007	-1.141	.257	2.614
Central Place % Asian-American	-.016	.006	-2.943	.004**	3.993
Central Place % Latino	-.001	.002	-.453	.652	3.332
Central Place % White	-.012	.001	-10.012	.000**	2.317
Central Place w/ Public Assistance	-.046	.042	-1.105	.272	3.403
Urbanized Area Population	-1.734E-08	.000	-1.337	.185	1.421
Urbanized Area Agricultural Land Price	-2.215E-05	.000	-1.446	.152	1.804
Urbanized Area Median Age	-.013	.009	-1.556	.124	5.150
Urbanized Area % Under 18 Yrs of Age	-.012	.006	-2.123	.037**	3.306
Urbanized Area % Over 65 Yrs of Age	.000	.009	-.040	.968	4.361
Urbanized Area % Super Commuter	-.029	.023	-1.266	.209	2.460
UCSA	-.220	.087	-2.535	.013**	8.094
UCSA 2	.013	.007	1.839	.070*	17.453
UCSR	-.084	.079	-1.064	.290	6.532
UCSR 2	.007	.007	.997	.322	24.384
UCWA	.012	.102	.121	.904	5.587
UCWA 2	**Excluded**	-------	-------	--------	-------
UCWR	.229	.208	1.097	.276	2.146
UCWR 2	**Excluded**	-------	-------	--------	-------
Total Years Policy In-Place	-.005	.005	-.854	.396	19.948
Alaska	-.665	.138	-4.833	.000	1.855
Arizona	-.144	.096	-1.502	.137	2.618
California	-.012	.082	-.147	.883	9.462
Colorado	-.013	.094	-.136	.892	3.623

Table 4.3b Cont'd

Variable	β	Std. Error	t	Significance	VIF
Hawaii	.064	.188	.338	.736	3.469
Montana	.124	.111	1.115	.268	1.802
New Mexico	-.083	.111	-.749	.456	2.389
Nevada	-.144	.119	-1.208	.230	2.078
Oregon	.011	.099	.112	.911	2.795
Utah	-.164	.097	-1.694	.094*	2.229
Washington	.055	.089	.624	.534	3.916
Wyoming	.148	.123	1.204	.232	1.489

** 95% Confidence Interval *90% Confidence Interval

N=113 $R^2 = .771$ Adjusted $R^2 = .683$

Log-Log

In Tables 4.4 and 4.4b, the corrected form of the original model run display in log-log form. The logs of both dependent and explanatory variables explain the non-linear relationship of the model. The corrected model run for log-log, R^2 and adjusted R^2 for UA in mi^2 is .966 and .954 respectively (Table 4.4). For UF/UA the corrected model, R^2 and adjusted R^2 was .718 and .610 respectively (Table 4.4b). While the R^2 and adjusted R^2 for UA, mi^2 log-log shows an increase over the log-linear model; the R^2 and adjusted R^2 for UF/UA log-log indicates a decrease below the values reported for the log-linear model.

In the corrected model run for log-log, I calculate and include four interaction variables along with four original component variables representing the four types of urban containments policies. The four interaction variables serve as a means to test the independent effects between all four urban containment policy types (denoted as "Strong

Accommodating 2", "Strong Restrictive 2", "Weak Accommodating 2", and "Weak Restrictive 2") and "Years Policy in Place". The purpose of the test was to determine if a difference exists among the four above interaction variables and observe and independent effects of each variable upon the other. Variance in variable significance ranges from (.000- .10) in UA mi^2 to (.000- .05) in UF/UA. In the uncorrected model, there were 12 significant variables total. My component variable "Weak Restrictive" and interaction variable "Strong Restrictive 2" are excluded by the running of the log-log model run. Variance in variable significance ranges from (.000- .10) in UA mi^2 to (.000- .05) in UF/UA. In the uncorrected model, there were four variables of significance in UA mi^2 and eight of significance in UF/UA respectively. The corrected model reveals there are eight variables of significance in UA mi^2, down from 10 variables of significance in the log-linear model. In the log-log of UF/UA, there are four variables of significance respectively, an increase of one from the previous log-linear model. Eight variables gained significance in the log-log model over the previous log-linear model. The variable inflation factor values or VIF's held steady with exceptions of variables "Central Place Percent Asian," "Central Place Percent Latino," " Urbanized Area Median Age," "Urbanized Area Percent Over 65 Years of Age," "Strong Restrictive," "Strong Accommodating," "Weak Accommodating," "Strong Accommodating 2," "Weak Restrictive 2," "Total Years Policy in Place," and "California." No values report over 15.1 and 7 out of the 11 are either dummy or interaction variables.

Table 4.4
Regression Results for UA in mi^2 (Corrected Log- Log)

SA = Strong Accommodating, SR = Strong Restrictive,
WA = Weak Accommodating, WR = Weak Restrictive, UC = Urban Containment

Variable	β	Std. Error	t	Significance	VIF
(Constant)	-3.345	.591	-5.658	.000	-------
Central Place Median Household Income	.160	.141	1.130	.262	2.894
Central Place % African-American	.093	.038	2.460	.016**	4.419
Central Place % Asian-American	-.212	.051	-4.145	.000**	6.395
Central Place % Latino	-.157	.049	-3.187	.002**	5.304
Central Place % White	-.061	.089	-.689	.493	2.775
Central Place w/ Public Assistance	-.016	.066	-.240	.811	3.687
Urbanized Area Population	.876	.027	32.413	.000**	2.309
Urbanized Area Agricultural Land Price	-.035	.023	-1.506	.136	3.409
Urbanized Area Median Age	-.141	.426	-.331	.741	5.290
Urbanized Area % Under 18 Yrs of Age	.237	.210	1.125	.264	3.192
Urbanized Area % Over 65 Yrs of Age	.034	.161	.211	.833	5.164
Urbanized Area % Super Commuter	-.121	.059	-2.067	.042**	2.844
UCSA	.021	.054	.395	.694	7.387
UCSA 2	.003	.004	.572	.569	16.451
UCSR	.019	.053	.353	.725	6.798
UCSR 2	.004	.004	.976	.332	24.005
UCWA	.105	.066	1.597	.114	5.378
UCWA 2	**Excluded**	-------	-------	-------	-------
UCWR	.316	.140	2.259	.027**	2.242
UCWR 2	**Excluded**	-------	-------	-------	-------
Total Years Policy In-Place	-.005	.004	-1.429	.157	19.870
Alaska	.080	.094	.846	.400	2.017
Arizona	.107	.073	1.468	.146	3.524
California	.102	.068	1.495	.139	15.125
Colorado	.070	.069	1.021	.310	4.554

Table 4.4 Cont'd

Variable	β	Std. Error	t	Significance	VIF
Hawaii	.075	.126	.592	.555	3.627
Montana	-.059	.073	-.810	.420	1.791
New Mexico	.195	.085	2.287	.025**	3.265
Nevada	.073	.097	.751	.455	3.208
Oregon	.125	.066	1.905	.060*	2.847
Utah	-.013	.066	-.202	.841	2.419
Washington	.162	.060	2.681	.009**	4.187
Wyoming	-.056	.089	-.631	.530	1.808

** 95% Confidence Interval *90% Confidence Interval

N=113 R^2 = .966 Adjusted R^2 = .954

Table 4.4b
Regression Results for UF/UA (Corrected Log- Log)

SA = Strong Accommodating, SR = Strong Restrictive,
WA = Weak Accommodating, WR = Weak Restrictive, UC = Urban Containment

Variable	β	Std. Error	t	Significance	VIF
(Constant)	5.314	.999	5.317	.000	-------
Central Place Median Household Income	.250	.239	1.047	.298	2.894
Central Place % African-American	.012	.064	.185	.854	4.419
Central Place % Asian-American	-.134	.086	-1.553	.124	6.395
Central Place % Latino	-.049	.083	-.584	.561	5.304
Central Place % White	-1.176	.151	-7.817	.000**	2.775
Central Place w/ Public Assistance	-.093	.111	-.835	.406	3.687
Urbanized Area Population	-.080	.046	-1.747	.084*	2.309
Urbanized Area Agricultural Land Price	-.051	.039	-1.311	.193	3.409
Urbanized Area Median Age	-1.111	.720	-1.542	.127	5.290

Table 4.4b Cont'd

Variable	β	Std. Error	t	Significance	VIF
Urbanized Area % Under 18 Yrs of Age	-.416	.355	-1.169	.246	3.192
Urbanized Area % Over 65 Yrs of Age	.074	.273	.272	.787	5.164
Urbanized Area % Super Commuter	-.308	.099	-3.107	.003**	2.844
UCSA	-.150	.092	-1.626	.108	7.387
UCSA 2	.012	.007	1.650	.103	16.451
UCSR	-.024	.089	-.269	.789	6.798
UCSR 2	.006	.007	.835	.406	24.005
UCWA	.023	.111	.211	.833	5.378
UCWA 2	**Excluded**	--------	--------	--------	--------
UCWR	.357	.236	1.510	.135	2.242
UCWR 2	**Excluded**	--------	--------	---------	--------
Total Years Policy In-Place	-.007	.006	-1.198	.234	19.870
Alaska	-.755	.159	-4.745	.000**	2.017
Arizona	-.126	.124	-1.021	.310	3.524
California	.096	.115	.832	.408	15.125
Colorado	.068	.116	.585	.560	4.554
Hawaii	-.256	.213	-1.200	.234	3.627
Montana	.015	.123	.118	.906	1.791
New Mexico	-.054	.144	-.371	.711	3.265
Nevada	-.140	.165	-.850	.398	3.208
Oregon	.084	.111	.760	.450	2.847
Utah	-.143	.112	-1.282	.203	2.419
Washington	.125	.102	1.224	.224	4.187
Wyoming	.088	.151	.587	.559	1.808

** 95% Confidence Interval *90% Confidence Interval

N=113 $R^2 = .718$ Adjusted $R^2 = .610$

VI. Interpreting Results

Between the two dependent variables of measure UA mi^2 and UF/UA, I found that in both the log-linear and log-log model runs, 20 explanatory variables calculate significance at a 90 percent confidence level or higher. In Table 4.3, four of my five

variables representing the "Natural Evolution" causal factor show significance. This significance suggests these variables measured and likely; others not measured are potential predictors of the log of UA mi^2 and UF/UA and therefore a measure of urban sprawl. Four of six variables representing the broad causal factor of "Flight from Blight" show significance (Tables 4.3, 4.3b, 4.4, and 4.4b).

The dummy variables representing each state in the West Region represents a state-specific characteristic that have different relationships with the dependent variables UA mi^2 and UF/UA. The variables for Alaska and Utah, under log-linear UA mi^2 and UF/UA show a positive relationship at (.000), (.059) and (.094). These dummy variables are results based on the relation to the omitted state variable for Idaho. There could be wildly different reasons based on the results that account for the differences in the use of raw land. For example, how the land in a given area is being regulated either based on land use planning guiding document like a general plan or specific growth restricting policy. Additionally, built out lands could account for differences and even more important for states like Alaska, Hawaii, and to an extent Utah, New Mexico, and Wyoming given federal land ownership, natural barriers for growth like water and landforms.

Log- Log UA in mi^2

In Table 4.5, several variables show a tendency to be reasonably strong indicators of the log-linear of UA mi^2. The values representing "Impact on Sprawl" in Table 4.5, column 2 are β coefficients. The impact on sprawl by the dependent variable UA mi^2 represents a percent change in the dependent variable in the form of an elasticity or on-

unit change in an explanatory variable. Exceptions to these changes are the dummy variables that are not applicable to elasticities. I calculated the elasticity by dividing the mean of the applicable explanatory variable by the mean of the dependent variable UA mi^2 and multiplying the product by the explanatory variable's β, or beta coefficient. Again, the purpose of the elasticity is to describe the percent change in the dependent variable from a one percent increase in a given explanatory variable.

To demonstrate the elasticity, an example from Table 4.5 below is for the variable "Central Place % African-American"; with an increase in the percent of African-Americans, living in the Central Place comes an increase in UA mi^2 of .238 percent. Another example could include a one percent increase in "Urbanized Area Population" with a corresponding increase in sprawl by .039 percent. Moreover, for the variable "Central Place Percent Latino," a one percent increase in the percent of Latino's living in the Central Place correspondingly results in a decrease in sprawl by –2.470 percent. A one percent increase in the "Weak Restrictive" urban containment policy there is a .003 percent increase in land protection.

Table 4.5
Significant Variables for UA mi^2 Log-Log

UC = Urban Containment, WR = Weak Restrictive

Variable	UA mi^2 Impact on Sprawl	Elasticities	Significance
Central Place % African-American	.093	0.238%	.016**
Central Place % Asian-American	-.212	-0.820%	.000**
Central Place % Latino	-.157	-2.470%	.002**
Urbanized Area Population	.876	0.039%	.000**
Urbanized Area % Super Commuter	-.121	-0.154	.042**
UCWR	.316	0.003%	.027**
New Mexico	.195	NA	.025**
Oregon	.125	NA	.060*
Washington	.162	NA	.009**

Log-Linear UF/UA

In Table 4.6, several variables show a tendency to be a reasonably strong indicator of the log-linear of UF/UA. The impact on sprawl by the dependent variable UF/UA represents a percent change in the dependent variable in the form of an elasticity or on-unit change in an explanatory variable. Exceptions to these changes are the dummy variables that are not applicable to elasticities. I calculated the elasticity by dividing the mean of the applicable explanatory variable by the mean of the dependent variable UF/UA and multiplying the product by the explanatory variable's β, or beta coefficient. Again, the purpose of the elasticity is to describe the percent change in the dependent variable from a one percent increase in a given explanatory variable.

To demonstrate the elasticity, an example from Table 4.6 below is for the variable "Central Pace Percent White", with a decrease in the percent of White living in the

Central Place comes a decrease in UF/UA of -.013 percent. Another example could include a one percent decrease in "Urbanized Area Percent under 18 Years of Age" with a corresponding decrease in sprawl by -.010 percent. A one percent increase in "Strong Accommodating" urban containment policy there is a -.001 percent increase in land protection. This is a curious elasticity for Strong Accommodating 2 containment policy; given approximately 42 percent of the urbanized areas in the West Region reportedly use this type of policy.

Table 4.6
Significant Variables for UF/UA Land Log-Linear

UC = Urban Containment, SA = Strong Accommodating

Variable	UF/UA Land Impact on Sprawl	Elasticities	Significance
Central Place % Asian-American	-.016	-0.001%	.000**
Central Place % White	-.012	-0.013%	.054**
Urbanized Area % Under 18 Years of Age	-.012	-0.010%	.003**
UCSA	-.220	-0.001%	.013**
UCSA 2	.013	0.000%	.070*
Alaska	-.665	NA	.019**
Utah	-.164	NA	.093*

Expected verses Actual Relationships

Table 4.7 below illustrates my predicted relationship between the explanatory variables and their likely relationship to the dependent variables. While several variables under both dependent variables are not significant at all given the log-log functional form, there are some variables exhibited a positive relationship and others exhibited a negative relationship. Again, as mentioned earlier the variables under the broad causal

factors “Natural Evolution” and “Flight from Blight,” as well as “Urban Containment Policy Type” do exhibit strong results that reinforce the argument that come of the individual variables contain within each broad causal factor contribute to a measure of urban sprawl.

Table 4.7
Expected verses Actual Relationships

SA = Strong Accommodating, SR = Strong Restrictive,
WA = Weak Accommodating, WR = Weak Restrictive, UC = Urban Containment

Explanatory Variable	Expected Relationship	Actual Relationship UA mi^2 Log-Log	Actual Relationship UF/UA Log-Linear
Central Place Median Income	+	Not significant	Not significant
Central Place % African American	+	+	Not significant
Central Place % Asian	+	+	-
Central Place % Latino	+	-	Not significant
Central Place % White	-	Not significant	-
Central Place % w/Public Assistance	-	Not significant	Not significant
Urbanized Area Population	+	+	+
Urbanized Area Agricultural Land Price	-	Not significant	Not significant
Urbanized Area Median Age	+	Not significant	Not significant
Urbanized Area % Age Under 18	-	Not significant	-
Urbanized Area % Age Over 65	+	Not significant	Not significant
Urbanized Area % Super Commuters	-	-	Not significant
UCSA	-	Not significant	Not significant
UCSR	+	Excluded	+
UCWA	-	Not significant	Excluded
UCWR	+	Excluded	Not significant
Years Policy In Place	-	Not significant	Excluded
Alaska (AK)	+/-	Not significant	-
Arizona (AZ)	+/-	Not significant	Not significant
California (CA)	+/-	Not significant	Not significant

Table 4.7 Cont'd

Explanatory Variable	Expected Relationship	Actual Relationship UA mi^2 Log-Log	Actual Relationship UF/UA Log-Linear
Colorado (CO)	+/-	Not significant	Not significant
Hawaii (HI)	+/-	Not significant	Not significant
Montana (MT)	+/-	Not significant	Not significant
New Mexico (NM)	+/-	+	Not significant
Nevada (NV)	+/-	Not significant	Not significant
Oregon (OR)	+/-	+	Not significant
Utah (UT)	+/-	Not significant	-
Washington (WA)	+/-	+	Not significant
Wyoming (WY)	+/-	Not significant	Not significant

VII. Conclusion

The preceding examination of the various regression models in three different functional forms demonstrated the potential significance and affects the explanatory variables had upon my two dependent variables. A preliminary review reveals my statistical model is partially successful at demonstrating causal variables that are significant indicators of urban sprawl. By attempting to control for the explanatory variables as my indicators of sprawl, the results have identified the likely effects of urban containment policies on urban sprawl. The following chapter will conclude this thesis by evaluating the regression results and identifying and suggesting policy direction based upon the results.

CHAPTER FIVE:

CONCLUSIONS and IMPLICATIONS FOR POLICY OPTIONS

I. Introduction/Summary

In the 117 plus years since 1900, the population of the United States has nearly reversed the ratio of living in a rural setting as opposed to an urban setting. Some 60 percent of Americans lived in a rural setting at turn of the 20th Century. Today, in 2007 some 82+ percent of Americans are now living in an urbanized area (Nelson, 2004). Furthermore, trends at the turn of the 21st Century, across the United States as a whole, new home densities are on the decrease, and housing market trends indicate more compact home styles are in vogue. Given the U.S. Census data from 2000, the population statistics suggest people over 65 years of age will double between 2000 and 2030 which will likely impact the desires to continue to build more compact home styles, at least we hope.

As noted in Chapter 1, my research reflects the nature of the challenges and responses to the historic process of urban expansion and the likely causal factors driving or contributing to this expansion. The goal of this paper is to identify the likely causes and consequences of urban sprawl; coupled with identifying the functionality and dimensionality of sprawl and possible policy options to address its' inherent presence.

Instead of producing research that characterizes growth as an apocalypse with the four horseman of growth being house on agricultural land, air pollution, traffic, and increased costs to society I set out to identify the effects of urban containment policies on urban sprawl and identify key solutions that have a realistic effect.

II. Findings Discussion

In this section, I discuss the findings and address how the data I use can be enhanced by more research to fine-tune the causal factors I used to measure urban sprawl. Specifically, I will discuss what has been learned from the model I developed to answer the question: What is the effect of urban containment policies in the American west on growth patterns in urbanized areas? Depending on the urbanized area within the West Region, urban containment policies are effective dependent upon certain circumstances such as containment policy type and socioeconomic factors. I continue below by discussing the significant findings from the four major broad causal factors (Natural Evolution, Flight from Blight, State Specific Effects, and Urban Containment Policy) in my model and their effect or non-effect upon the two dependent variables of UA in mi^2 and UF/UA land.

Natural Evolution

The six variables I include as measures of natural evolution serve as proxies to identify urban sprawl in the urbanized area. Moreover, these variables serve as my initial expectations of how influential the variables will change by conducting several regression analyses. Four out of five of these variables show some level of significance 90 percent of higher in log-linear or log-log regression models. By no surprise, "Urbanized Area Population" shows a strong positive relationship among the log-linear of UA land and UF/UA as well as log-log of UA land and UF/UA. Curiously, the elasticity of this causal variable is of no significance in the log-log of UA land, but in UF/UA land, the elasticity is .039 percent. Again, the elasticity indicates the sensitivity

of the dependent variable(s) to changes in the explanatory variable(s). Furthermore, of greater significance is that elasticity greater than one signifies a potentially larger impact upon the dependent variable(s). The simple relationship with "UA Population" is that with a greater increase in the human population there is a direct response relationship to the overall size of the urbanized area.

The "Urbanized Area Percent Super Commuters" variable has an interesting relationship. This variable represents the urbanized area percent of population considered super commuters because they drive over 90 plus minutes in one direction to get to and from work. The relationship is not significant in log-log UF/UA, but a negative relationship in UA land. Based on the elasticity, the value is very small and translates into having a -.154 percent impact on the ratio of urban area land leading to increased sprawl ever so slightly.

The remaining four variables of Natural Evolution did not indicate any significance in the log-log regression model form, which was unexpected. I was anticipating that "UA Agricultural Land Price", "Median Age", "Percent Population under 18 years old", and "Percent Population over 65 years old" would have registered some significance in log-log for. However, in the log-linear functional form Agricultural Land Price, Median Age, and Percent Population under 18 years old all had significance at the 90 to 95 percent confidence level.

The variable Urbanized Area Percent Under 18 years of Age is significant at the 99 percent confidence level displaying an elasticity in Table 4.6 of -.010. The Agricultural Land Price variable had surprising results. I was surprised to that only the

log-linear model of UA land shows significance. I began the analysis by thinking the expected relationship to both dependent variables would be a limiting factor. I assumed the value of agricultural land increasing on the fringe would preclude sprawl and in turn reducing sprawl. The significance of Agricultural Land Price is 94 percent in the log-linear model. The log-log did not show any significance above 90 percent. Given the results I wished I had identified a causal variable that would have accounted for the regional effects for the loss of agricultural lands or some measure as to the housing market trends in suburban areas as an indicator of wealth on the margins where sprawl is most likely to occur. Furthermore, another variable if I could have developed it, would account for the other forms of lands not zoned for agriculture, but rather urban reserve, rangelands, etc, given agricultural lands are not necessarily the only type of lands sprawl is likely to occur on.

Flight from Blight

The six variables I included as measures of flight from blight serve as proxies to identify urban sprawl relative to Central Place. Four of the six variables demonstrated significance and were measures of racial/ethnic movements and or functions. The variables include "Central Place Percent African-American," "Central Place Percent Asian-American," "Central Place Percent Latino-American," and "Central Place Percent White" representing. The predicted relationship is that these ethnic groups would have a positive effect. However, under the log-log function only African-American and Asian-American had a positive effect upon the dependent variable urbanized area land and thus the flight from blight argument. Subsequently, Latino-American had a negative effect

and the Percent White did not have a positive elasticity despite holding 95 significance. Interestingly enough, given the positive relationships, this suggests that as Central Place minority populations increase, urban sprawl increases and inversely central place densities decrease. The elasticities of African American, Asian American, and Caucasian do not have a very strong effect on land given the low values calculated. However, Caucasian was not a positive relationship in urbanized area land, but rather the dependent variable ratio of UF/UA. Latino American elasticity does show a negative value of –2.470 and does suggest a relationship that for every 1 one-unit change in the Latino population comes a –0.157 change in the UA land area.

Two variables that had no significance were Central Place percent Households with Public Assistance Income and Central Place Median Household Income. I had predicted that CP Median Income would have had a positive relationship, but in neither model was this variable significant. Curiously enough even in other regression model forms such as linear-linear and log-linear, these variables showed no significance.

Urban Containment

Per previous discussion in Chapter 3, there are four interaction variables I have used to specify type of urban containment. These variables based on (Nelson's, 2001) definitions, include Strong Accommodating, Strong Restrictive, Weak Accommodating, and Weak Restrictive. Of all the four variables, only two, Strong Accommodating and Weak Restrictive showed significance leaving Strong Restrictive and Weak Accommodating out of the analysis. I calculate these interaction variables by multiplying "Years Policy in Place" by each of the four urban containment policy types. The variable

"Years Policy in Place" is not in log form. The purpose for doing this calculation is to determine any effects that years of policy have upon the urban containment type.

In the log-linear form for UF/UA land, the Strong Accommodating dummy variable and the Strong Accommodating 2 interaction variable exhibit confidence of nearly 99 percent with a significance of .013 and 93 percent confidence at .070 respectively. This result is not surprising given the data I collected throughout the west indicated this type of containment policy accounts for 42 percent of the total policies currently in place to control sprawl (see Table 3.1b). The significance at .013 percent suggests, based on the type of policy, there might be the preservation of rural or open space lands beyond the urban containment boundary for non-urban uses and that this policy type holds urban scale development within the line.

In addition, in the log-linear form for UA land, the interaction variable, Weak Restrictive policy type, shows significance at .014, nearly 99 percent confidence. The implication that Weak Restrictive policy type is significant reinforces the fact more data for the model in terms of increased urbanized areas with this type policy would add clarity to the significance. Secondly, this policy type only accounts for 1 percent of the total urban containment policies identified across the West Region which suggests some degree of specification error is likely, however more information is needed to confirm.

Furthermore, in both log-log functional forms (Tables 4.4 and 4.4b) the SPSS model run excluded the variable Weak Restrictive and interaction variable Strong Restrictive. Similarly, in log-linear functional form SPSS excluded the variables Weak Accommodating and Weak Restrictive.

My variable for Policy Years in Place was a disappointing no show in terms of overall impact to the significance of the containment policy types. The SPSS log-linear and log-log runs exclude the interaction variables Weak Accommodating 2 and Weak Restrictive 2 given I observe no significance. I was hoping to be able to draw a few inferences as to the impact the variables would have in terms of effecting urban densities and ability to contain growth.

The regression results for the urban containment policies were disappointing and I presume that my models have some specification error in terms of either not including causal variables that might have given greater significance to the urban containment policy types. Furthermore, refining the definitions of the policy types and more thoroughly investigating each jurisdictions plans and policies might offer insight and clarification that currently does not reflect the current specified models.

State Specific Effects

The process of collecting urban containment policies throughout the West Region indicated, some regions had been addressing urban sprawl for over 30 years while some have just started. It appears each regional area addresses sprawl differently. Whether each region uses a different operational definition or there is no need to address sprawl given environmental or federal policy factors such as mountain ranges or land use there is recognition on my behalf that overall this research might suggest current policies in place may be more reactive verses proactive.

Five specific state variables demonstrate significance throughout the model runs I conducted. Within the log-log UA land, New Mexico, Oregon, and Washington were

significant at .025, .060, and .009 respectively. Within the log-linear of UF/UA Alaska and Utah showed significance at both the 90 and 95 confidence levels with a .019 and .093 respectively. I am uncertain as to the impact of Alaska and Utah, given the urbanized areas are physically controlled by water and landforms.

The observed highly variable nature of urban containment policy types in the West Region does not present overwhelming evidence nor was there a direct relationship that a concerted effort to develop urban sprawl measures is occurring, with the exception of California possibly. Having said this, my individual research indicates that 62 percent or 70 of the jurisdictions in the West Region, out of 113 have some type of urban containment policy. As stated earlier however, my regression results do not necessarily confirm nor deny the effectiveness of these policies across the West Region.

Strength of Model(s)

Generally, the models lend some inferences into the likely causal variables that influence the occurrence of sprawl inducement and the effect on the dependent variables.

However, as with most experiments, data refinement and the ability to increase overall data points, more N that are affirmative towards the precise urban containment policies used or not used is highly desirable. From my own individual research by contacting the 113 jurisdictions I found there to be a high degree of variability in terms of the type of mechanisms used to address growth management. Of these mechanisms, containment policies specifically were only a fraction of the tools local jurisdictions use to address the phenomenon of sprawl. To increase the overall outcome and strength of models used I would aim to categorize the policy type variables by including a much

wider array of mechanisms such as general plan policy boundaries, infrastructure financing mechanisms [i.e., roads and highways (The model would likely have been more robust had I been able to identify a series of causal variables that addressed road and highway miles built with each respective jurisdiction)], and state growth policy measures as a more inclusive approach to determining the effect of containment policies on urban sprawl.

III. Policy Implications

The American people are facing a dilemma especially in the West Region. They want and desire badly, two things. First, they want to live in an efficient, convenient, healthy, and pleasant environment. Secondly, they want as individuals and collectively as municipalities, to be able to make an honest dollar out of every piece of property they happen to own or have jurisdiction over. Theses are two basic incompatible philosophies. There is no Pareto optimality. Eventually, equilibrium or the balance of wants will guide the actions of the polis and the reason of need will define a new lifestyle.

My thesis focuses on urban containment policies, as a mechanism to address the balance of wants verses the need to redefine the current lifestyle choice. Policies alone will not solve the imbalance, even by addressing the limited broad causal factors of Natural Evolution and Flight from Blight that I examined. Local policies in a wide variety of shapes and sizes are the first step towards addressing the issue. Political will to implement and measure affects of policies are a second step. Individual or personal choices that address preferences and lifestyle demands are a third critical action having

tremendous impact upon the total urbanized foot print as well as both the positive and negative externalities to society.

I submit that while urban containment policies are likely policy options for local and statewide land use authorities; the need to address urban sprawl requires a comprehensive strategic approach containing key elements such as the project scale (mixed-residential and commercial land use), community scale (jobs with housing), and regional scale (linking transportation funding with balanced growth options).

A growth strategy demands cooperation among all three levels of government to address the broad causal factors of Natural Evolution, Flight from Blight, Urban Containment, and State-Specific effects while identifying specific and targeted solutions. It is apparent in many areas across the West Region that the issues facing individual communities are a testament to the effectiveness of that cooperation (Goehring, 2004). The local governments control land use by in large and the Federal and state governments control funds for public infrastructure. General consensus supports the argument that growth issues begin and end with land use with the most visible symptoms being traffic congestion, jobs to housing imbalance, and an aggregate decrease in open space or agricultural lands, among many others.

An effective growth strategy recognizes the strengths and weaknesses, abilities and inabilities of the locality to which a solution can take hold. Understanding the past in terms of sprawl and locality divisiveness and wanting to change land use and infrastructure funding that favors peripheral growth to a process that is respective of balanced growth is the future. Allowing a strategy that ensures all jurisdictions in a given

region adhere to the same principles and making them fiscally, sound via equitable and efficient means is one path forward. One key element that ties all jurisdictions together is road and highway investment. Strategically addressing this element to ensure any regional urban containment policies are effective at balancing growth is a first step of many at the scales of the project, community, and regional level.

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