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Rail Rebound: The Impact of Freight Rails on Regional Development in the United States, 1970-2010

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RAIL REBOUND: THE IMPACT OF FREIGHT RAILS ON REGIONAL DEVELOPMENT IN THE UNITED STATES, 1970-2010

BY

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This dissertation is approved as a creditable and independent investigation by a candidate for the Doctor of Philosophy degree and is acceptable for meeting the dissertation requirements for this degree. Acceptance of this dissertation does not imply that the conclusions reached by the candidate necessarily the conclusions of the major department.

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ABSTRACT

RAIL REBOUND: THE IMPACT OF FREIGHT RAILS ON REGIONAL DEVELOPMENT IN THE UNITED STATES, 1970-2010

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Railroads have played a critical role in economic growth and development, and they exert a tremendous impact on the distribution and redistribution of the population. However, the impacts of railroads, especially freight rails, on population change and socioeconomic development are not well understood. This study fills the gap in the literature by examining the demographic and socioeconomic impacts of freight rails using county-level data in the continental United States from 1970 to 2010.

The demographic and socioeconomic changes are measured by eleven dependent variables. Of those eleven, six are demographic (population, young, old, White, Black, Hispanic) and five are socioeconomic (high school, bachelor’s degree, graduate degree, employment, and income). The railroad is the explanatory variable, and it is measured by freight rail terminal density. This study utilizes data from various sources including the National Transportation Atlas Database, the Bureau of Labor Statistics, the National Historical Geographic Information System (NHGIS), cartographic boundary shapefiles, the land developability index, and decennial censuses of 1970, 1980, 1990, 2000, and 2010.

This study utilizes exploratory spatial data analysis, standard regression, and spatial regression models. The application of spatial lag model, spatial error model, and

spatial error model with lag dependence systematically considers the spatial effects and produces more robust results.

There are four broad major findings of this research. First, freight rail is a distributive force. Second, freight rail contributes to the urbanization and suburbanization process. Third, freight rail facilitates demographic and socioeconomic change. Fourth, freight rail has differential demographic and socioeconomic impacts at the regional level.

The findings of this study are the outcomes of the multiple dependent and independent variables tested for many decades using robust statistical methods that measure direct and indirect impacts. Not only does this study apply the most advanced statistical methods in the railroad research, but it also addresses the social impact, which are less-researched topics in transportation literature. This study contributes uniquely to the transportation, demographic and social equity literature and extends the transportation discussion from the development perspective, and it could be useful helping shape a just society, which is the ultimate goal of transportation policy.

CHAPTER ONE

INTRODUCTION

Background of the Study

From the very beginning of the industrial revolution, several demographic and socioeconomic factors such as population growth, agricultural development, and greater use of natural resources demanded fast and efficient modes of transportation to move people and goods from one place to another (Nationalatlas.gov n.d.). In response to the demand, privately owned toll or turnpike roads were developed in the United States. After the development of the roads, steamships became popular. They were followed by steam-powered trains around the 1830s (Nationalatlas.gov *N.d.*). Later, railroads became principal transportation routes during European settlement in the United States (Voss and Chi 2006).

The railroad is considered one of the most important innovations of the nineteenth century in terms of American economic growth (Fogel 1962; White 2008). Railroads triggered construction of numerous bridges and terminal stations (Warnes 2014). Railroads influenced the rise of business corporations, the development of agricultural, and the growth of manufacturing and interregional trade. The rise of the railroad is influenced by economic growth as well. The railroad played a significant role in the early settlement, migration, population growth, and urbanization of the United States (Fogel 1962; Hedges 1926; Jenks 1944; Kirby 1983; White 2008) and resulted in extensive demographic and socioeconomic change (Warnes 2014).

In the United States, the railroad flourished during the 1840s and lasted throughout the nineteenth century. In 1869, the Central Pacific and Union Pacific Railroads linked the eastern and western coasts for the first time (Warnes 2014). By 1916, the country had an effective and smoothly operating railroad network of nearly 254,261 miles. The nineteenth century was a prime time for both freight and passenger rails. As the principal mode of long-distance transportation, railroads both goods and people.

The railroad dominated the locomotive world, but that glory has vanished. According to Itzkoff (1985), the reasons behind the failure of the railroad were the unequal distribution of public funds, competition with private vehicles, intercity passenger buses, aviation, failed marketing, uncomfortable infrastructures, and higher fares for rail transportation. Despite its demise, however, the railroad still contributes significantly in the United States economy.

Transportation is one of the determinant factors of population structure; it affects population size, composition, and distribution, which are the foundation of any community. Not every mode of transportation affects every group equally, however. The effect is disproportionally distributed across the groups. In such a context, the demographic and socioeconomic impact of transportation is worth exploring because socioeconomic inequality detrimentally affects the welfare of society. Demographic and socioeconomic impact studies identify and reveal the magnitude of current and potential impacts. Such studies also explore spatial and temporal distributional effects.

The information generated by such research provides the rationale for planning and can help maximize the beneficial impacts of transportation. Decisions and policies made on the basis of inadequate or broad general information cannot be effective. Therefore, the findings of such studies are useful; they can guide the decision-making process to promote the ability of citizens to participle in society by helping to provide better access to government and private-sector services. Hence, demographic and socioeconomic impact studies related to transportation can be used to promote positive impacts and avoid negative ones.

Statement of the Problem

The United States has a very reliable freight rail system in terms of service and infrastructure network. Along with other strong transportation foundations, the railroad exerts tremendous economic impact (AAR 2015). The rail system employs millions of people and supports billion-dollar industries carrying raw materials, final products, and workers. The rail system also helps those industries remain globally competitive. In addition, the rail system contributes to environmental sustainability by decreasing energy consumption and pollution, lowering the emission of harmful gases, and saving millions of dollars in highway construction and maintenance costs.

The U.S. government recognizes the economic vitality of rail system, and the system is a major theme in U.S. transportation policy (Grunwald 2010; Button 2012; Goetz 2012; Hurst 2014). Although the rail system is a priority, trains are not considered a primary mode of transportation. Likely because of this secondary status, there is increasing debate about whether the railroad infrastructure should be expanded. This debate is not limited to the political arena; it affects the intellectual and media sectors, too. Most studies of the rail system are motivated by vested interests, and very few are considered objective (Levinson 2012).

It is vital to understand the impact of rail system because it is a mode of transportation that affects demographic and socioeconomic change. Much literature can be found on the impact of transportation (Levinson 2008; Chi 2010). Despite the large volume of literature and the significant contributions of the rail system, its impacts on development and the economy are not adequately understood. One of the reasons is that the focus of research on transportation is uneven. Less priority is given to the rail system compared with other modes of transportation, and systematic studies are rare. Among the studies carried out on railroads, some are explicitly about passenger rail, and others do not distinguish between freight and passenger trains. Those studies focus on limited geographic areas, such as a city or region. In this context, therefore, a holistic understanding of the impact of the rail system is crucial.

Research Question and Hypothesis

The key research question in this study is how freight rail affects demographic and socioeconomic change in the United States. I hypothesize that the railroad has a positive association with population, employment, education, median household income, the young population, and non-Hispanic White, and a negative association with the populations of the old and minorities (non-Hispanic Black and Hispanic). The hypothesis is based on the assumption that the railroad has a positive impact on the economy that attracts jobs and workers and increases income. Because the opportunity is not equally distributed, the railroad may have a negative association with minorities. Similarly, the old population is either left behind or does not depend on economic growth; this group may have a negative association with the railroad. In brief, the foundation of my hypothesis is that the railroad acts as a growth factor.

Contributions

This dissertation research is designed to help fill the gap in transportation literature. This study is important because it examines the role of the railroad in the process of social, economic, and demographic change in the continental United States. The impact of the railroad is calculated at national and regional levels. The analytical models employed control for metro and nonmetropolitan regions of the United States. The research considers four decades, from the 1970s through the 2000s. It examines the impact at the decade level (for four separate decades), as well as at the aggregate level (for forty years). Considering the impact during different periods is essential in determining the consistency of the railroad's effect. This research is likely the first to offer a systematic exploration of the impact of the railroad at the national level. In its analytical models, this study controls for several demographic, socioeconomic, and natural factors. Thus, this research helps broaden the holistic, scholarly understanding of the impact of railroads on overall development.

Most of the research on the impact of transportation pertains to highways. This study complements the literature by looking at the demographic and socioeconomic impact of freight rail. Literature on highways is available regarding the impact of all phases of construction, such as pre-construction and post-construction, as well as the expansion of highways. The current study looks at the impact of railroad terminal density on many demographic and socioeconomic variables.

This dissertation research also makes a methodological contribution. Most of the transportation research has been done using the standard regression method, which does not take account for spatial effects. Not considering spatial effects in an analytical model violates the fundamental assumption of independence and produces unreliable results. This study not only explores the spatial effects but also addresses them systematically, incorporating spatial regression methods in the analysis. The integrated spatial regression model controls for spatial lag and spatial error effects simultaneously. In my knowledge, no railroad study has been done using this statistical method.

Moreover, most studies have a limited number of dependent variables, and their research focuses are on limited time periods. The current dissertation research uses eleven dependent variables and tests their impact over a forty-year period, as well as for each decade from 1970 to 2010. By looking at the impact of eleven dependent variables over four separate decades and for the overall period, this research tested the consistency of freight rail impact. Hence, this research helps determine the true nature of freight rail impact.

Transportation research commonly focuses on environmental consequences and economic contributions, such as the impact on residential and commercial property values. Social impacts and equity issues are important aspects of transportation policy, but these fields receive less priority and are researched less (Lucas and Jones 2012). This dissertation research explores the distributional effects of the transportation system on many demographic and socioeconomic variables. It explores the impact of freight rail on the overall population, employment, age (young and old), education (high school, bachelor’s degree, and graduate degree), race and ethnicity (non-Hispanic White, non-Hispanic Black, and Hispanic), and median household income. The impact is calculated at national, metro, and regional levels. Also, this study considers the spatial effects on different demographic and socioeconomic categories.

Structure of the Dissertation

This dissertation is organized into six chapters. Chapter Two presents an extensive review and analysis of previous and contemporary studies on topics such as the importance of transportation. The chapter also contains a discussion of literature on the impact of transportation. It describes direct and indirect impacts, as well as demographic, and economic impacts of transportation, especially the impacts of the railroad. The second chapter also incorporates common theories that explain the relationship between transportation and change (demographic and economic) and hypothesis. The theories covered in the chapter are accessibility theory, neoclassical growth theory, growth pole theory, and location theory. Researchers in many academic disciplines, including sociology, study the interaction of transportation with society. These theories are common in different disciplines and are useful in broadening our understanding of the relationship between transportation and change. The interdisciplinary nature of transportation encourages researchers to learn from each other. I have maintained that tradition, and this study is influenced by the theories commonly practiced in disciplines other than sociology.

Chapter Three presents the data and methods used in this study. This research is built from multiple databases; the chapter describes them and their sources. The chapter also presents the unit of analysis and the reasons for choosing it. Description of variables (dependent, independent, and control) is another important aspect of this chapter. The analytical approach provides an understanding not only about the research methods used but also how they are used systematically. For better understanding, the chapter presents mathematical equations of the standard and spatial analysis used.

Chapter Four focuses on the exploratory analysis. The chapter describes the basic nature of variables, such as mean, standard deviation, and minimum and maximum values. Moran’s I scatter plot is used to show global spatial autocorrelation, and a LISA cluster map provides visual presentation of the spatial autocorrelation of dependent variables. The chapter also contains tables of correlation coefficient values. These show the strength and direction of the relationship between the independent variable and all other dependent and control variables. The descriptive statistics are presented by period, overall and at decade level.

Chapter Five presents findings of the study. Four sections of this chapter present the results of the analysis. The first section is about the impact of freight rail on population and employment change. The second section describes the impact of freight rail on race and ethnicity (non-Hispanic White, non-Hispanic Black, and Hispanic). The third section presents the findings of the analysis on different age groups. The age groups included in this section are young and old. Young represents the population between 15 and 19 years old. Old represents the population 65 years and above. The fourth section is about the impact of freight rail on socioeconomic status (education and income). It present findings on the impact of freight rail by education level, such as completion of high school, bachelor’s degree and graduate degree, and by median household income.

Chapter Six presents a summary and the conclusions of the study. It summarizes research findings, as well as data and methods. This chapter also relates the findings of the analysis to the existing demographic, social, economic, and transportation literature. The chapter also contains a discussion of policy implications, limitations of the study, and possible directions for the future research.

CHAPTER TWO

LITERATURE REVIEW, THEORY, AND HYPOTHESIS

THEORY

The role of transportation in population and socioeconomic change has long been debated in the context of urban development, suburban sprawl, decline of central cities, and inter/intra-metropolitan accessibility (Boarnet and Haughwout 2000; Chi 2007 and 2012). Being interdisciplinary, transportation is studied in different academic fields, such as planning, economics, geography, and sociology. Even though there are many theories in these different academic fields, regional economic theories are best for explaining the relationship between transportation and growth, especially economic and demographic growth (Chi 2007). Some common theories are described below.

Accessibility Theory

Conceptually, accessibility refers to the ability to access. In terms of transportation, accessibility refers to having physical access to desired goods, services, opportunities, and destinations (Ratner and Goetz 2013). Accessibility can be increased by the development of new or the improvement of existing transportation technology (Chatman and Noland 2011). For example, accessibility has evolved from walking and horse-pulled carriages to automobiles and high-speed trains. The literature shows that increased accessibility results in increased land values and more intensive use of land (Chatman and Noland 2011). Also, a new development in transportation technology is associated with the high speed, time efficiency, comfort, and convenience that fosters urban outward expansion from the central city (Boarnet and Haughwout 2000; Ratner and Goetz 2013).

In practice, accessibility theory considers issues of distance decay and competition effects (Silva 2014; Rodrigue 2015). Distance decay refers to the diminishing effect of access to transportation by distance. For example, land value decreases as distance increases with rail terminals. Accessibility increases competition, and competition effects create an increase in the activities and size of business establishments. The literature shows that accessibility theory also encompasses access to different transportation modes and times of day, or days of the week, or months. Therefore, according to accessibility theory, demographic and socioeconomic changes are the result of the distance decay function, competition effect, and transportation modes and their frequencies.

Neoclassical Growth Theory

Neoclassical growth theory considers the transportation infrastructure, such as highways, railway lines and terminals, and airport terminals, as capital input for economic output (Eberts 1990; Chi 2007). Land and labor are other forms of economic inputs. The association of inputs with outputs can be compared with a production system. In general, this theory assumes that an increase in economic inputs results in an increase in economic outputs and productivity. It may not be always true because investment in highways may not only result economic growth, but it can also generate traffic congestion that can significantly increase commute time and reduce productivity.

Many studies investigate the production function of transportation infrastructures and how it can influence regional demographic and socioeconomic growth (Chi 2007). The transportation infrastructure is viewed as a “public” good, and investment in the transportation infrastructure results in economic growth. The economic growth of a location depends on how well local government brings in investments for the transportation infrastructure. An unequal capital accumulation brings uneven development, which is a result of neoliberal policy. According to neoliberal ideology, a local or state government adopts market principles to public services to alleviate financial constraints through privatization or private–public partnership (Farmer 2011). This ideology encourages the government to act against social welfare policies in favor of the business climate, which focuses more on profits than on service. Accordingly, the transportation modes that connect the central city with industrial areas and affluent neighborhoods are likely to be profitable, and such areas are therefore better served. Demographic as well as economic growth favors such localities.

Public infrastructure such as transportation facilities can be understood as an amenity factor at the household level (Chi 2007). Such amenities attract workers, residents, students, and entrepreneurs who change the demographic composition of a place.

Growth Pole Theory

Growth pole theory is about the geographic dependence of economy and population (Chi 2010). Economic and demographic changes in nearby areas affect each other. A growth pole is an (urban) area that is the hub of economic growth and always in interaction with the surrounding areas for distribution and/or redistribution of growth (Thiel 1962; Darwent 1969). In growth pole theory, transportation infrastructure is neither necessary nor sufficient to bring demographic and socioeconomic change in surrounding areas (Chi 2007). In the beginning, new transportation infrastructure helps to bring in population from outside, but later it can help to move population out. Transportation infrastructure plays a facilitative role only, as the economy is the main determinant factor. A good economy generates plenty of employment, attracting outside population; a bad economy causes employment loss that affects population move-out.

The theory has two main concepts: spread and backwash. Spread refers to the situation when the growth of one place causes growth in the surrounding areas, and backwash is when growth in a location occurs at the cost of the surrounding areas' development. The former relationship is considered positive, and the later situation can be described as a negative relationship. Spread and backwash effects clearly show the geographic relationship between the urban area and adjacent rural areas in terms of economic growth and development (Henry, Barkley, and Bao 1997). If the demographic and socioeconomic growth of an urban center and its rural surrounding areas depends on the available transportation, the effect of spread and backwash will be more pronounced (Chi 2010).

Location Theory

Location theory argues that business organizations consider expected revenue, required investment, and transportation cost for different locations before they make location decisions (Chi 2007). They choose locations with the highest potential to yield maximum profits on minimum investment (Haggett, Cliff and Frey 1977; Chi 2010). Transportation infrastructures such as highways and railroads facilitate the flow of consumers, raw materials, and final products (Thompson and Bawden 1992; Chi 2007). Passenger transportation facilities help in the flow of the public, customers, and clients, whereas freight services regulate the movement of raw materials, fuels, and final products.

Certain demographic and economic tendencies appear within this context (Chi 2007). In the beginning, the increased flow of people and products transformed many small business centers into fewer business hubs. Naturally, big business centers have more access and flow than small areas. Next, a gap is created because of differential access between places. Later, these areas develop specialized products to meet the need of the markets. In the long run, such phenomena help to create demographic and socioeconomic dependency among different places. Hence, transportation infrastructure is an important factor in determining the location of manufacturing units, retail services, and warehouses.

Location theory also focuses on other critical factors that affect productivity, such as quality of labor, traffic planning, and traffic congestion. Those factors can play a critical role in attracting industries and workers that potentially affect demographic and socioeconomic dynamics of a location.

Community Capital Framework

The relationship between transportation and regional development also can be studied by means of the community capital framework. According to Flora and Flora

(2008), the community capital framework is a holistic approach to community intervention. The approach is inherently founded on the assumption that each community, no matter how remote, rural, or deprived, has some assets that can be used to build a sustainable community with a sound ecology, vibrant economy, and inclusive society. Any geographic areas with such outcomes attract population. The framework encompasses seven categories of capital: built, financial, natural, political, cultural, human, and social.

In the community capital framework, at least three meanings are applied to the concept of community (Flora and Flora 2008). A community is a place where people interact, is a social system or organization through which people meet their needs, and/or provides a sense of identity that people share. Similarly, capital is any resource or resources that can be invested to generate additional resources (Flora and Flora 2008; Emery, Fey and Flora 2006).

The seven types of capital influence each other, and one type of capital can be used to create other types. For example, a railroad network is built capital, and built capital can be seen as a foundation that facilitates human interactions. Policies related to build capital assume that having better-built capital in a community will enable communication and enhance access to services and markets that ultimately improve people's lives. Trains use efficient engines: they consume less fuel and emit fewer poisonous gases than any other modes of transportation. Thus, the use of trains minimizes the harmful impact to the natural environment (natural capital) and contributes to public health.

Access to railroad infrastructure is also associated with economic development (financial capital). Trains save commute time for millions of people, thereby contributing to economic productivity (Givoni and Banister 2012). Rail services carry people and goods from one place to other, allowing interactions among them. Such interactions enhance social networks (social capital) among people with different interests. In addition, social interactions help solidify the voices of civic societies (political capital) that influence government policies. Similarly, investment in rail infrastructure affects the labor market (human capital). The railway industry creates jobs and supports other industries that employ millions of workers.

Also, railroad networks are a part of public transportation. In general, public transportation is popular among people who do not own private vehicles and who are dependent on others for transportation. Hence, access to railroads may support a culture of public transportation (cultural capital). Thus, the relationships of railroad networks with other types of community capital show that railroad investments or access to railroads would have a ripple effect on a community. First, such investment brings economic development, which influences the labor market. Second, it helps in distribution and redistribution of employment and population.

On the basis of the above-described theoretical background, the primary argument in this study is that the railroad network is one of the factors of regional development and influence on demographic and socioeconomic change. Another argument is related to spatial variation. Rural and urban counties vary in railroad infrastructure investment, as well as in the abandonment of railroad (Flora and Flora 2008). Railroad infrastructure investment in urban counties is greater than in rural counties, and the abandonment of railroads is greater in rural counties than in urban counties. Thus, the economic base varies between rural and urban counties. This variation can affect the development of rural and urban counties differently. The situation is further impacted by the temporal factor, resulting in variation in different periods. The analytical models used in this study address the spatial and temporal factors that influence the dependent variables.

LITERATURE REVIEW

Transportation has a dynamic relationship with economy and population. It links them by providing access to different geographic areas (Lichter and Fuguitt 1980; van den Heuvel et al. 2014). In both good and bad economic times, transportation plays a role in distribution and redistribution of population and employment. Many scholars think transportation is an essential factor in economic growth, as well as for the social well-being of a community (Lichter and Fuguitt 1980). Transportation helps to expand the availability of resources or industrial products on regional and global scales, contributing to the rise of trade flow and the industrial sector. Areas with access to transportation infrastructure (such as a railroad) have higher average economic growth rates (Briggs 1981; Ozbay, Ozmen, and Berechman 2006; van den Heuvel et al. 2014). Access to transportation has a positive association with employment growth, labor supply, and willingness of individuals to supply their labor. The economic impact goes beyond the immediate area—neighboring counties also benefit from the increased levels of transportation accessibility (Boarnet and Haughwout 2000).

Previous and Contemporary Works

Earlier works on the relationship between transportation and development were conducted from the perspective of human ecology (Schnore 1957; Mark and Schwirian 1967; Lichter and Fuguitt 1980; White 2008; Duration and Turner 2012). The human ecological perspective essentially argues that demographic change is a response to the changes in available technologies and the local environment. Even though there are several studies from the human ecological perspective, those works did not explore the relationship between transportation and population growth (or decline) in a systematic way. Some works focused on the impact of transportation (highways) on population growth during the 1970s (White 2008), but the results of those works were ambiguous (Voss and Chi 2006), partly because of their limited scope and failure to adopt a holistic approach (Voss and Chi 2006; White 2008; Chi 2010). For example, those studies were limited to interstate highways, to one stage of highway development, to rural areas, and in only one direction (i.e., the impact of transportation on population growth but not vice versa).

The study of the relationship between transportation and population growth is becoming more specific. Contemporary research explores the impact on population change from different perspectives: for example, the dual roles of transportation (as an agent to redistribute population across locations), the double causal relationship (the impact of transportation on population change and vice versa), various developmental stages (pre-construction, construction, and post-construction of the transportation infrastructure), and the expansion of the transportation infrastructure, with a focus on highways (Chi et al. 2006; Voss and Chi 2006; Chi 2010). Those studies incorporate formal spatial dimensions, a research method that has been neglected in the past.

Table 2.1 presents findings of many studies that show railroad has a negative relationship with population change (Levinson 2008a; Gregory and Henneberg 2010; Alvarez, Franch and Marti-Henneberg 2013). Some of the reasons for the negative relationship are competition with automobiles (Levinson 2008a; White 2008), reduced investment in railroad (Levinson 2008a), job search (Gregory and Hennebert 2010), suburbanization (Alvarez, Franch and Marti-Henneberg 2013; Israel and Cohen-Blankshtain 2010), overcrowding in urban areas (Alvarez, Franch and Marti-Henneberg 2013), poor agricultural production (White 2008), and an efficient commute system (Israel and Cohen-Blankshtain 2010).

The table also shows a positive relationship of railroad with population change. Some of the reasons for a positive relationship are economic growth (Gregory and Hennebert 2010), urbanization (Atack and Margo 2011), employment creation (Alvarez, Franch and Marti-Henneberg 2013), migration (White 2008), and better accessibility (Van den Heuvel et al. 2014).

Table 2.1: Prior Studies on Railroad and Population Change

Study	Study area	Unit of analysis	Data set/source	Time period	Train type	'+' or '–' impact	Explanation
Levinson (2008)	London/UK	Borough (City)	LUDH[1], CLR[2], and UK Census	1801-1965	Passenger train	'–' overtime	• Arrival of competing modes; automobiles (car, bus, tram) give more flexibility to move to farther areas with lower housing costs • Reduced investment
Gregory and Hennebert (2010)	London and Wales/UK	Parish	GIS databases	1825-1911	Passenger and freight train	'+' in small urban centers in early period No impact in large urban centers in later period '–'	• Growth because the area can export goods cheaper, faster; more reliable service • Competition with road transportation • Easy to leave an area in search of jobs
Atack and Margo (2011)	Midwest/US	County	GIS database and HDESD[3]	1850-1860	Passenger and freight train	'+'	• Urbanization
Alvarez, Franch and Marti-Henneberg (2013)	England and Wales/UK	Parish	GBHGIS[4], Census records	1871-1931	Passenger and freight train	'+' '–'	• Easy accessibility helps create more jobs and makes jobs easier to find • Overcrowding in urban areas • Administration priority for healthy and natural (green) homes in suburban areas • Free annual rail pass for residents of suburban areas

[1] London Underground Diagrammatic History
[2] Chronology of London Railways
[3] Historical, Demographic, Economic, and Social Data: The United States, 1790–1970
[4] The Great Britain Historical GIS

White (2008)	West/US	County	HDESD	1900-1930	Passenger and freight train	'+' '–'	• Westward migration • Economic growth • Outmoded by other forms of transportation, such as automobile • Outmigration due to poor crop yield
Bollinger and Ihlanfeldt (1997)	Atlanta/US	Census tract	Census and ARC[5]	1980-1990	Passenger train	No impact	• No effective increase in accessibility because the area is already more accessible by automobiles • Inability to attract ridership
Van den Heuvel et al (2014)	US	County	US Census Economic Survey	2007	Freight train	'+' in nonmetropolitan employment No impact in metropolitan employment	• In nonmetropolitan counties, better accessibility attracts population • No impact in metropolitan counties because those counties are already accessible
Israel and Cohen-Blankshtain (2010)	Tel Aviv/Israel	City	Survey	2008	Passenger train	'–'	• Reliable and easy commute system from suburban areas

[5] Atlanta Regional Commission

Direct and Indirect Impacts

The impact of transportation on population can be both direct and indirect (Voss and Chi 2006; Chi 2010). The direct impact includes imposition of rights-of-way on residential housing, agricultural lands, and natural wilderness (Moore et al. 1964; Coffin 2007). Transportation destroys the quality of the ecosystem by changing the hydrology and water quality, increasing soil erosion and sediments deposition rates in rivers and streams, introducing chemical pollutants, increasing noise level, creating barriers to wildlife movement, and destroying wildlife natural habitats. This impact is mostly negative, resulting in demolition of residential housing and perhaps affecting the population composition of an area.

The indirect impact comes through growth or decline in the economy, change in employment opportunities, and change in the physical environment. Access to the transportation infrastructure plays an important role in these economic changes, which are ultimately linked with population distribution and redistribution (Lichter and Fuguitt 1980; Boarnet and Haughwout 2000).

Demographic and Economic Impacts

Some studies have examined the impact of railroad on population and employment change (Bollinger and Ihlanfeldt 1997; Levinson 2008a, 2008b; White 2008; Atack and Margo 2011). Access to railway services has a positive relationship with population growth (Akgungor et al. 2011; Kotavaara, Antikainen and Rusanen 2011; Franch-Auladell, Morillas-Torne and Marti-Henneberg 2014). The construction of railroad helps to increase population, and both railroad and population go through parallel evolution. It also contributes to increasing population density and dispersing the increased population. Geographic areas with a poor railway network coverage lose population, while areas with better coverage gain population (Gregory and Martí Henneberg 2010; Alvarez, Franch and Marti-Henneberg 2013). The reason might be that people value housing quality, the surrounding environment, and proximity to public transportation and facilities, such as shopping centers, schools, and parks. Accessibility to railway transit alleviates travel issues (Olaru, Smith and Taplin 2011) and enhances the quality and attractiveness of public transportation (Douglas 2010; Pagliara and Papa 2011). Also, accessibility is one of the factors that increase economic competitiveness. Better transportation accessibility to a geographic location is associated with the concentration of economic activities and population (Kotavaara, Antikainen and Rusanen 2011).

Transportation accessibility can be broadly categorized into three levels: micro, meso, and strategic (Jones and Lucas 2012). Micro-level accessibility is associated with ensuring transportation facilities to people with a range of physical disabilities. In applied transportation literature, micro-level accessibility is related to vehicle designs and user-friendly facilities in parking areas, such as large parking spots for people with disabilities. The meso-level focuses on transportation accessibility at the neighborhood level, such as a local street network for different modes of transportation. In a well-connected neighborhood, people are able to travel freely because of minimum physical access restrictions. In low-income communities, the consequences of poor connectivity may have a negative health impact. Strategic accessibility is related to land use patterns and transportation networks at the town, city, and regional levels.

Accessibility to railway transit is associated with identity of the location, too (Douglas 2010; Pagliara and Papa 2011). The identity or characteristics of a location are important for individuals and organizations such as local governments, tourists, business owners, and residents. Local governments have concern about locational identity because it affects the attraction of businesses to the area, which influences the generation of revenue through local taxes. Tourists are concerned about timely and safe navigation; for local residents, locational characteristics affect their personal identity; for business organizations, the identity of a place affects their earnings and investments.

Accessibility to public transportation improves the image of a location and makes neighborhoods appear more dynamic and supportive of the community. Such factors improve the lives of residents and enhance pride in their community. Because of community pride community, people are attracted to those areas, which become hubs of power, entertainment, and lifestyle. At the same time, people leave areas that are isolated from the mainstream society. Place attachment declines for deteriorated areas (Brown et al. 2003). Accessibility to railway transit also helps improve the status of "disadvantaged" locations, which in turn attracts new residents and ultimately results in demographic change (Olaru, Smith and Taplin 2011; Pagliara and Papa 2011).

Studies show a great variation in the impact of railroad on local economic development. Railroad infrastructure has a positive impact on the establishment of manufacturing units (Atack, Haines and Margo 2008) and on economic growth (Del Bo and Florio 2012). It is also positively associated with redistribution of employment activities and gains in labor productivity (Hensher et al. 2012). Transportation infrastructure and economy affect each other mutually (Lean, Huang and Hong 2014). Transportation improvement contributes to the economy through savings in time and costs, while economic growth brings development of transportation infrastructure.

Other studies show different results. For example, Bollinger and Ihlanfeldt (1997) did not find any impact of a rail system on population and employment change in station areas; they found that a railroad most likely does not effectively increase accessibility if a well-established network of highways already serves the city. However, their study did find an alteration in the composition of public and private employment. Even though the total number employed did not change, public-sector employment increased near transit stations. The researchers concluded that to increase ridership, decision makers may want to locate government offices near transit stations (Bollinger and Ihlanfeldt 1997).

In contrast, some studies show that railroads can influence farm and land values (Decker and Flynn 2007; Atack and Margo 2011). In their county-level study, Atack and Margo (2011) showed that the value of farms and land was positively associated with access to the railroad from 1850 to 1860 in the Midwest. Their research shows that the coming of the railroad was the single most important factor that linked Midwestern farmers to the wider trade network that ultimately opened up opportunity for business and raised land values. Other studies also show the positive impact of railroads on residential properties, such as condominiums and single-family homes (Al-Mosaind, Dueker and Strathman 1993; Agostini and Palmucci 2008; Duncan 2008; Pagliara and Papa 2011).

Some studies focus on proximity and show that nearby properties attract development of capital-intensive land use (Pan and Zhang 2008). Proximity to rail transit has a positive association with home value only where land supply is scarce. It does not hold true where land supply is more elastic (Sun et al. 2015). The impact on home value depends on zoning regulations, too (Duncan 2011a). Home prices near rail stations depend on permissive zoning regulation. In general, permissive zoning has a harmful influence on home prices except in the immediate rail station areas. Having an open policy for housing construction is associated with lowering home prices, but the association of proximity could be neutral or positive in the immediate areas around rail stations because of a greater demand for housing.

Besides proximity to rail stations, land values are affected by the development of transit-oriented policy (Duncan 2011b). The price of houses within a walkable distance to nearby rail stations is higher than the price of houses in the similar environment but not near a station. Hence, both transit-oriented development and train stations have a positive impact on housing prices. Proximity to rail stations not only enhances property values, but at the same time, it also promotes criminal activities (Bowes and Ihlanfeldt 2001). Hence, the impact of railroads is not uniform. High-income neighborhoods receive more property value gain than low-income neighborhoods, where criminal activities are higher.

The effect of railroad on property values can differ with property types (Coffman and Gregson 1998; Debrezion, Pels and Rietveld 2007; Donaldson and Hornbeck 2013; Mohammad et al. 2013; Kay, Noland and DiPetrillo 2014). The value changes in commercial areas are higher than in residential zones. The effect on commercial property value remains influential only at short distances, but the effect on residential property values continues even at longer distances (Debrezion, Pels and Rietveld 2007). The effect of railroad depends also on the type of train (Debrezion, Pels and Rietveld 2007;

Mohammad et al. 2013). The impact of commuter rail on land/property value changes is higher than the impact of light rail. Higher service coverage of a commuter railway draws more people to the areas surrounding the stations (Debrezion, Pels and Rietveld 2007). Proximity to railroads is valuable because of decreased transportation cost and increased access to regional and national markets (Coffman and Gregson 1998). Access of a county to markets increases when it becomes less expensive to do business with another county (Donaldson and Hornbeck 2013). Interestingly, the impact of railroads on land/property values is higher in European and East Asian cities compared with cities in North America (Mohammad et al. 2013).

Railroads have a positive effect on employment growth and on office and housing construction, which eventually alters demographic composition (Levinson 2008a, 2008b; Casson 2013). Such impact varies with locations; for example, central cities observe a rise in business complexes that increases the concentration of jobs, while suburban areas experience an increase in housing complexes that helps raise the population (Levinson 2008a, 2008b; Israel and Cohen-Blankshtain 2010). Commercial development increases land value, making downtown a very expensive place to live; therefore, new residents inhabit the periphery or suburban areas. Under such conditions, rails offer fast, comfortable, dependable, and stress-free travel at peak office hours to the population in suburban areas—the commuters who work in metropolitan downtowns (Pucher and Renne 2003).

A vast amount of literature on railroad outside the United States shows the influence of railroads on local as well as regional growth (Kotavaara, Antikainen, and Rusanen 2011; Chen 2012; Knowles 2012; Mejia-Dorantes, Paez, and Vassallo 2012).

Knowles (2012) shows that the railway helped in Copenhagen's economic growth by attracting substantial investment in housing, retail, education, and leisure facilities, as well as creating thousands of new jobs. Similarly, the study by Mejia-Dorantes, Paez, and Vassallo (2012) shows the economic impact of the railroad in Spain. The railroad positively impacts economic activity and changes the mix of business establishments. The railroad is associated with an increase in retail activities over time, which displaced manufacturing firms in Spain. In Finland, accessibility to transportation infrastructure, including railroads, influenced the population change (Kotavaara, Antikainen, and Rusanen 2011). Their study found that at the regional level, accessibility increases the population, while it has the opposite effect at the urban level.

In China, railroads positively contribute to regional economic growth (Chen 2012); however, the benefits are not universal or equally distributed. Large, industrialized cities receive more benefits than small and intermediate-size cities. After reviewing predictive and observational studies, Loukaitou-Sideris et al. (2013) arrived at a similar conclusion: that big cities reap more benefits from trains than small urban areas do. Those cities observe growth in employment, the real estate market, and tourism (Topalovic et al. 2012). The economic impacts of rails eventually alter the composition of employment and population at the local as well as the regional level. Rails, assisted by revolutionary development in information technology (or digital network), connect businesses in multiple urban areas and contribute to polycentric urban growth, which differs and evolves from the earlier assumption of monocentric urban growth (Auimrac 2005; Mejia-Dorantes, Paez and Vassallo 2012).

Transportation Inequality

Transportation does have demographic and economic impacts, but it does not impact everyone equally. One of the responsible factors is transportation policy. Transportation policy in the United States discriminates against people, and it has a long history of doing so (Wellman 2014). The historical discriminatory role of public transportation that maintained segregation was seen in famous incidents such as what happened to Rosa Parks and Homer Plessy, as well as from the activities of the Freedom Rider activists. Rosa Parks refused to give up her seat to a White passenger, resisting the discriminatory transportation policy; Homer Plessy violated the transportation segregation laws; and Freedom Rider activists rode interstate public buses to challenge the government’s failure to implement Supreme Court decisions to end prejudice in transportation policy.

A discriminatory policy can have significant social impact, especially for those who are already vulnerable (Lucas and Jones 2012). Such policies help to distribute advantages and disadvantages of transportation disproportionately across the population. The discrimination can be very high between the richest and poorest in society. The adversity can be significant for children, young people, old people, disabled people, and ethnic minorities.

Discrimination based on transportation policy in public areas is obvious, but some policy changes can have subtle yet serious impacts. The policy shift from the public to private use of transportation is one such change, and it helped to perpetuate existing transportation inequality. The priority given to private use of automobiles results in unequal access to space and time to those who can afford personal automobiles (Bullard, Johnson, & Torres, 2000; Domosh & Seager, 2001; Sachs 1992; Wellman 2014). Because of the rise of personal automobiles, wealthy people can move in space quickly, and they have more options for different modes of transportation. Affluent people can have better access and advantages in public and private services, such as education, employment, and health care.

What are some influencing factors that affect transportation inequality? And how do they affect people? The literature shows that transportation accessibility, income, age, education, and race and ethnicity are some influencing factors, and they have an effect through shaping travel behaviors that ultimately produce differential consequences of transportation.

The access differential to transportation modes produces different economic outcomes (Valenzuela 2000). It can increase or decrease access to economic opportunities; and it affects (increase or decrease) the quality of life. Access to transportation infrastructure can vary by geographic location (urban or rural), race and ethnicity, education level, and income level. According to Valenzuela (2000), the use of public and private vehicles is primarily related to economic activities, such as going to work, shopping, entertainment, and recreation. Since the White populaton has more access to the different modes of transportation compared with ethnic minorities, minorities cannot take full advantages of opportunities offered by the private and public sectors.

Similarly, differential ownership of private vehicles also produces unequal economic outcomes. Bohon, Stamps and Atiles (2008) found that the combined effect of less car ownership and less access to alternative modes of transportation severely limits ethnic minorities and the working-class population in gaining work and taking advantage of opportunities for personal advancement. The strongest effects are for Blacks, followed by Latinos and then Whites (Raphael and Stoll 2001). This effect for Black is largest in metropolitan areas where the Black population is relatively more isolated from the employment opportunities. Similarly, Ong (2002) claims that access to a car is very important in terms of job search and employment stability. Greater access to private vehicles will enhance the job search process and improve the stability of current jobs.

The ownership of private vehicles affects travel time. Those who use private vehicles have shorter travel times than transit users (Krovi and Barnes 2000). Travel time varies with income and education level attained (Krovi and Barnes 2000). Higher-education groups travel more often to pursue high-income opportunities (Besser, Marcus and Frumkin 2008). People who have less education and who live in the highest population-density areas take longer commutes using public transportation (Krovi and Barnes 2000). On the other hand, the same group of people have shorter commutes using bicycles in lower population areas. Travel times are highest during early morning and mid-day hours, possibly because of the tendency to use transit and carpooling more often. Private cars are used most often in late evening hours, primarily because of limited services offered by transit systems.

Travel time varies by race and ethnicity, too. The White population has the lowest travel times, and ethnic minority groups have to travel longer to seek high-income—or even part-time, low-skilled employment opportunities (Krovi and Barnes 2000). Young African American and Asian workers have longer commute times. It may be because Whites live closer to well-developed areas that provide more and better employment opportunities. Moreover, transit systems are not well integrated in minority neighborhoods. The low-income and low-skill jobs has been increasing in suburban areas over the past several years. As a result, the commute time of ethnic minorities has increase because of longer distances to transit points.

Household income affects the use of transportation modes (McDonald 2008). The rate of physical mode of transportation (walking and biking) to go to school for ethnic minorities (especially Black and Hispanic) and low-income children is higher than for Whites and high-income children (McDonald 2008). Similarly, the research findings of Yang and Diez-Roux (2012) give insight regarding the relationship between income level, nonmotorized modes of transportation (walking), and different trip purposes such as work and recreation. Members of households with the highest income levels walk the longest distance, whereas members of households with the lowest income walk the longest duration. Moreover, members of households with the highest income walk longer distances for recreation, and members of households with the lowest income walk longer distances for work.

The relationship between income and travel behavior is indirect. Income influences the car ownership, and car ownership determines the use of number of transportation modes. Having a car reduces dependency on public and nonmotorized modes of transportation (walking and biking). According to Pucher and Renne (2003), the use of public transit in urban areas drops sharply when a household owns a car. Similarly, bike and taxi use also drops (Pucher and Renne 2003). In urban areas, poor people walk twice as much as nonpoor people; in rural areas, both the poor and nonpoor walk same distances (Besser and Dannenberg 2005; Pucher and Renne 2005). In urban areas, poor people live in central cities where trip distances are shorter and walkable. In addition, poor people walk to public transportation every day. In rural areas, because of the absence of public transportation, almost everyone depends on a car for travel, irrespective of income level.

Pucher and Renne (2003) also identified the association of income with the type of public transit use. Increased income is inversely associated with public bus use and positively associated with suburban rail use. The use of public buses by the poor is higher than their use by the affluent. On the other hand, the use of suburban rail by the affluent is higher than by the poor. One of the reasons behind the use of suburban rail by the affluent is its service from high-income suburban areas to metropolitan downtowns, where they work. In addition, suburban rail offers fast, comfortable, dependable, and stress-free travel at peak office hours. On the other hand, bus services are limited within central cities, and they are slow, less comfortable, less dependable, more stressful, and useful primarily for local trips. According to Pucher and Renne (2003), the association between income level and types of public transit can be found in all major metropolitan areas, including Boston, Chicago, New York City, and Washington, DC.

Education influences income potential, which in terms determines the ability to afford private vehicles (Krovi and Barnes 2000; Guequierre 2003). Education and income also have an impact on selection of neighborhood, which can affect access to transit. People with low education levels rely more on transit and carpooling. Among people with low education, women of color (especially Black) who live in the center city and who are in the low-income bracket have disproportionately longer commute times (Doyle and Taylor 2000). Urban single mothers have the longest commute time across any group.

The level of education has a strong relationship with walking trips (Weinstein and Schimek 2007). However, the reason for positive association of education attainment with recreational walking is not known. People with higher education levels may have a greater awareness of the health benefits of walking. Level of education has inverse relationship with work-related walking time (Besser and Dannenberg 2005). People with a graduate-level education walk less often to work than people with a high school diploma. A higher level of education among commuters is associated with decline in carpooling, too (Ferguson 1997; Guequierre 2003).

Race and ethnicity affect travel behaviors. Chu et al. (2000) argues that for non-work-related travel, the use of public transportation is several times higher among the poor and ethnic minorities than for the White population. The Black population is the most frequent user of public transportation. However, private vehicles are the dominant mode of transportation for all races and ethnic groups for non-work-related travel. Giuliano (2003) believes that our understanding of travel behavior is based on the behavior of the White population because that group comprises three-fourths of the United States population. If we do not take race and ethnicity clearly into account during the analysis, the behaviors of the White populatin conceals the behaviors of ethnic minorities. According to Yang and Diez-Roux (2012), walking behavior also differs by race and ethnicity and by gender. Blacks walk longer distances and for longer durations than do Whites and Asians, and the distance and duration are higher for men and boys than for women and girls.

Age has strong correlation with health and physical well-being among the elderly (Evans 1999). Definite mobility changes occur when older drivers reduce or cease driving (Kington et al. 1994; Burkhardt 1999; Georggi and Pendyala 1999; Giuliano, Hu, and Lee 2003; Newbold et al. 2005). In a majority of cases, mobility declines regardless of other factors (Chu 1994; Mercado and Páez 2009). The elderly avoid driving at night, during peak hours, and on limited-access highways; they drive at lower speeds, use larger automobiles, and carry fewer passengers (Chu 1994). The elderly show a higher risk of crash and injury (Chu 1994; Tay 2006; Tay 2008). They may often be traveling according to the schedules and convenience of others. As for nondriving older people, they prefer rides from friends and family members, but they dislike being dependent on them (Coughlin 2001; Newbold et al. 2005). They do not like the feeling of obligation created because of asking for a ride. Urban nondrivers older people are the most willing to use public transportation.

According to Bailey (2004), the mobility of people declines at old age because of declining health, eyesight problems, and weakening physical and mental abilities. They may also be concerned about safety. They may not have a private vehicle or any access to a car. They may choose not to drive. Household size has a negative relationship with decline in mobility (Evans 1999) because other adults are readily available to drive or because the elderly may make living arrangements that provide them with a larger pool of potential drivers upon whom they can rely (Kington et al. 1994). Moreover, retirement is the common factor for reduced driving in many countries (Raitanen et al. 2003).

Public transportation is one of the options to keep older people mobile. Research shows that in urban areas where public transportation is available, older people walk more often and use public transportation (Giuliano, Hu, and Lee 2003; Bailey 2004). For nondriving older people, public transportation seems to be an absolute need in households with no car. But in many places, particularly in rural and small towns, public transportation is not a practical choice (Bailey 2004) partially because of the need for additional funding from the federal, state, or local government. Minorities, such as older African Americans, Latinos, and Asian Americans, are the most affected by the lack of public transportation options (Bailey 2004).

Community structure also influences the travel behavior of everyone, including the aging population (Lynott, Mcauley and McCutcheon 2009; Mercado and Páez 2009). It affects the number of trips taken and transportation modes used by the elderly. Residents in neighborhoods with high commercial and residential mix are associated with less driving and shorter-distance travel (Mercado and Páez 2009). Mixed-use communities that are also characterized by walkable urban or town areas will be the best to address the mobility needs of the aging population.

The issue of mobility for everyone is critical because it is important for living an independent life, as well as for perceiving control of one’s life (Coughlin 2001). It is also a means of connection to society. It provides access to family members, friends, social and economic activities, medical centers, and public and private services that make one’s life enriched. Reduced driving or driving cessation is strongly associated with reduced activities outside of home (Marottoli et al. 2000). Outside home activities include social, economic, and religious activities, such as meeting friends, going shopping, and attending church. Limitation in mobility curtails participation in such activities, resulting in feelings of isolation. Mobility issue should not be perceived as a personal issue. Society suffers from reduced or lack of mobility because it results in the loss of people’s productivity as workers and volunteers (Burkhardt 1999). Thus, every effort should be made to reduce the loss of mobility.

The environmental justice and social inequality literature often addresses the negative consequences of transportation (Chi and Parisi 2011; Deka 2004; Grineski, Bolin, and Boone 2007; Mennis and Jordan 2005). The means of transportation, especially highways, bring environment-related negative consequences, such as pollution, noise, and fumes—all of which deteriorate the health the nearby residents (Chi and Parisi 2011). Research shows highways are associated with criminal activities (Deka 2004). Also, the presence of highways reduces nearby land values, which attracts minorities (Been and Gupta 1997; Chi and Parisi 2011). Lower property values lead to White flight (Chi and Parisi 2011; Pastor, Sadd, and Hipp 2001).

The disproportional presence of ethnic minorities is associated with inadequate infrastructure (Chi and Parisi 2011; Atlas 2002; Baden and Coursey 2002; Been 1995; Been and Gupta 1997; Bullard 1990). Studies in the 1970s indicate that air pollution has a positive correlation with the presence of minorities and low-income people (Asch and Seneca 1978; Berry 1977; Burch 1976; Freeman 1972; Kruvant 1975; Szasz and Meuser 1997; Zupan 1973). Hazardous waste facilities and dangerous chemicals discharged by factories influence low-income areas (Szasz and Meuser 1997). Three factors that contribute to negative consequences in the poor communities are lack of employment opportunities, insufficient political power to keep polluting companies away, and the need and desire of the community to increase tax revenue (Bullard 1990). Hence, poor communities become victims of the trade-off between the short-term benefits of employment and greater tax revenue and long-term environmental problems.

The United States has a transportation policy that favors automobile users and suburban commuters (Wellman 2014). It discriminates against poor and urban minority populations, most of whom depend primarily on public transportation. The benefits of transportation are unevenly distributed—affecting mostly poor, young, old, and minority residents (Chi and Parisi 2011; Lucas and Jones 2012). The social impact of transportation policy affects quality of life and social well-being (Jones and Lucas 2012). It may reduce the full participation of these groups in the development process (Lucas and Jones 2012) because access to a railroad raises people's participation in the service sector (Haines and Margo 2006).

Transportation inequality is an issue of civil and human rights, too. The United States government has policies to address issues faced by transportation-disadvantaged groups (Li and Loo 2015). For example, the Americans with Disabilities Act (ADA) of 1990 ensures equal transportation access to people with disabilities. The Transportation Equity Act for the 21st Century (TEA-21), which was enacted in 1998, promotes public participation of ethnic minorities and low-income populations in transportation planning.

This dissertation addresses social inequality issues by examining the impact of railroad on different socioeconomic groups. It analyzes the overall impact by population, employment, age group (young and old), education level (high school diploma, bachelor's degree, and graduate degree), median household income, and race and ethnicity.

HYPOTHESES

This dissertation research tests the following hypotheses. These hypotheses touch on demographic as well as socioeconomic factors, such as population and employment change, income, education level, age, and race and ethnicity.

1. **Railroads have a positive association with population and employment change.** Railroads are an additional mode of transportation for carrying people and goods, and railroads play important roles in supporting and maintaining the economy. A location with a healthy economy offers jobs and attracts workers. Over time, the population and the size of the economy (the gross domestic product) in the United States have increased (USCB 2011; Kushnirs.org N.d.). Therefore, I hypothesize that the net impact of railroads would be positive with population and employment change.
2. **Railroads have a positive association with education attainment.** The relationship between railroads and education attainment is indirect (Krovi and Barnes 2000; Guequierre 2003). They are connected through the economy. Accessibility to railroads helps with economic growth, which is closely related to the creation of jobs that attract economically productive people who are looking for those jobs (Levinson 2008a, 2008b; Casson 2013). Hence, I hypothesize that railroads have a positive association with educational attainment.
3. **Railroads have a positive association with median household income.** Since the railroads are one of the supporting modes of transportation for the local as well as regional economy (Lichter and Fuguitt 1980), they should have a positive

relationship with median household income. Median household income increases with growth in the regional economy, which may further attract new households of people who are in search of jobs.

4. **Railroads have a positive association with the young and a negative association with the old population.** Young people (15–19 years old) live with parents who are usually at their most economically productive ages (Seccombe 2012), and job availability determines residency. My hypothesis is that counties with access to railroads have a better economy and can offer more jobs for many households than counties that do not have access to railroads. Hence, railroads have a positive association with the young population.

   On the other hand, compared with the young population, people age 65 and above are independent and financially sound (Seccombe 2012). For that group, the economic situation of a county does not affect their residency. Older people are attracted to the more amenity-rich counties. Hence, I hypothesize the railroads have a negative association with the old population.

5. **Railroads have a positive association with the White population and negative associations with minorities (Black and Hispanic).** Employment opportunities are not equally distributed among different racial and ethnic groups, and Whites have more employment opportunities than minorities do (Bohon, Stamps and Atiles 2008). There is a high possibility that the availability of jobs in a county will attract more White people than they attract Black and Hispanic people. Hence, I hypothesize that railroads have a positive association with the White population and negative associations with Black and Hispanic populations.

CHAPTER THREE

DATA AND METHODS

This dissertation research focuses on the continental United States of America, and it examines the demographic and socioeconomic impacts of freight rail at the national level. The study covers demographic and socioeconomic change from 1970 to 2010 at the county level, utilizing data from various sources. This chapter describes the dependent variables, independent variable, control variables, unit of analysis, analytical approach, and data and data sources.

Dependent Variables

There are eleven dependent variables in this dissertation research. The digital data for dependent variables are obtained from different sources, such as the Bureau of Labor Statistics, National Historical Geographic Information System (NHGIS), and decennial censuses of 1970, 1980, 1990, 2000, and 2010. All data for dependent, independent, and control variables are publicly available, reliable, and widely used by researchers and research organizations.

Dependent variables can be grouped into demographic, social, and economic categories. Demographic dependent variables are population change and age (young and old). Education, along with and race and ethnicity, are the social dependent variables. Education is represented by high school diploma, bachelor’s degree, and graduate degree. The race and ethnicity social variables are Non-Hispanic White, non-Hispanic Black, and Hispanic. The economic dependent variables are employment and change in median household income. All dependent variables are expressed in the natural log of current over past value. For example, population change in the period of 1970 to 1980 is represented by the natural log of population in 1980 divided by population in 1970. The natural log helps to achieve a bell-shaped distribution and better linearity with the independent variables. Table 3.1 provides detailed information about measurement for all dependent, independent, and control variables.

Table 3.1: Variable Names, Descriptions, and Data Sources

Variable Names	Descriptions	Data Sources
Dependent variables		
Population	Log of recent population over previous population	U.S. Census Bureau, National Historical Geographic Information System
Employment	Log of recent employment over previous employment	U.S. Census Bureau, National Historical Geographic Information System
Young	Log of recent young population over previous young population	U.S. Census Bureau, National Historical Geographic Information System
Old	Log of recent old population over previous old population	U.S. Census Bureau, National Historical Geographic Information System
White	Log of recent White population over previous White population	U.S. Census Bureau, National Historical Geographic Information System
Black	Log of recent Black population over previous Black population	U.S. Census Bureau, National Historical Geographic Information System
Hispanic	Log of recent Hispanic population over previous Hispanic population	U.S. Census Bureau
High school diploma	Log of recent population with high school diploma over previous population with high school diploma	U.S. Census Bureau, National Historical Geographic Information System
Bachelor's degree	Log of recent population with bachelor's degree over previous population with bachelor's degree	U.S. Census Bureau, National Historical Geographic Information System
Graduate degree	Log of recent population with graduate degree over previous population with graduate degree	U.S. Census Bureau, National Historical Geographic Information System
Median household income	Log of recent median household income over previous median household income	U.S. Census Bureau
Independent variables		
Terminal density	Total number of freight rail terminals divided by square root of county area	National Transportation Atlas Database (Railway Network Database)
Control variables		
Highway	Total length of highway in miles divided by square root of county area	National Transportation Atlas Database (National Highway Planning Network Database)
Airport	Total number of public airport terminals within a county	National Transportation Atlas Database (Airports Database)

Population	Previous decade change rate of population	U.S. Census Bureau, National Historical Geographic Information System
Employment	Previous decade change rate of employment	U.S. Census Bureau, National Historical Geographic Information System
Young	Previous decade change rate of young population	U.S. Census Bureau, National Historical Geographic Information System
Old	Previous decade change rate of old population	U.S. Census Bureau, National Historical Geographic Information System
White	Previous decade change rate of White population	U.S. Census Bureau, National Historical Geographic Information System
Black	Previous decade change rate of Black population	U.S. Census Bureau, National Historical Geographic Information System
Hispanic	Previous decade change rate of Hispanic population	U.S. Census Bureau
High school	Previous decade change rate of population with high school diploma	U.S. Census Bureau, National Historical Geographic Information System
Bachelor's degree	Previous decade change rate of population with bachelor's degree	U.S. Census Bureau, National Historical Geographic Information System
Graduate degree	Previous decade change rate of population with graduate degree	U.S. Census Bureau, National Historical Geographic Information System
Median household income	Previous decade change rate of median household income	U.S. Census Bureau
Population	Population density	U.S. Census Bureau, National Historical Geographic Information System
Employment	Percent employed	U.S. Census Bureau, National Historical Geographic Information System
Young	Percent young (age 15 to 19)	U.S. Census Bureau, National Historical Geographic Information System
Old	Percent old (age ≥65)	U.S. Census Bureau, National Historical Geographic Information System
White	Percent White	U.S. Census Bureau, National Historical Geographic Information System
Black	Percent Black	U.S. Census Bureau, National Historical Geographic Information System
Hispanic	Percent Hispanic	U.S. Census Bureau

High school	Percent of population with high school diploma	U.S. Census Bureau, National Historical Geographic Information System
Bachelor's degree	Percent of population with bachelor's degree	U.S. Census Bureau, National Historical Geographic Information System
Graduate degree	Percent of population with graduate degree	U.S. Census Bureau, National Historical Geographic Information System
Median household income	Median household income	U.S. Census Bureau
Metro	Counties with at least one metropolitan area with population ≥50,000	U.S. Census Bureau
West	Counties in the West region	U.S. Census Bureau
Midwest	Counties in the Midwest region	U.S. Census Bureau
Northeast	Counties in the Northeast region	U.S. Census Bureau
South (reference)	Counties in the South region	U.S. Census Bureau
Land development index	Percent of land in a county that can be developed	Land developability http://www.landdevelopability.org/

Independent, or Explanatory, Variable

The railroad is the explanatory variable (Figure 3.1) and is represented by freight rail terminal density (Figure 3.2). The data used in this study for the independent variable were obtained from the National Transportation Atlas Database (NTAD), which is a vast geospatial database produced by the Bureau of Transportation Statistics (BTS) of the United States Department of Transportation (USDOT). For this study, the data for railway come from the Railway Network Database, which is a part of the NTAD. These data were prepared in ESRI shapefile format. The data can be found at http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_atlas_database/2011/index.html.

Freight rail terminal density is measured by dividing the number of freight rail terminals by the square root of the county's area. Even though I have presented the regression results of terminal density only, I ran regression analyses for four other railroad characteristics. They are the number of freight rail terminals, length of rail line, accessibility to rail terminal, and railway density. Railway density was measured by dividing the total length of rail line by the square root of the county's area.

Figure 3.1: Freight Rail Lines in the United States

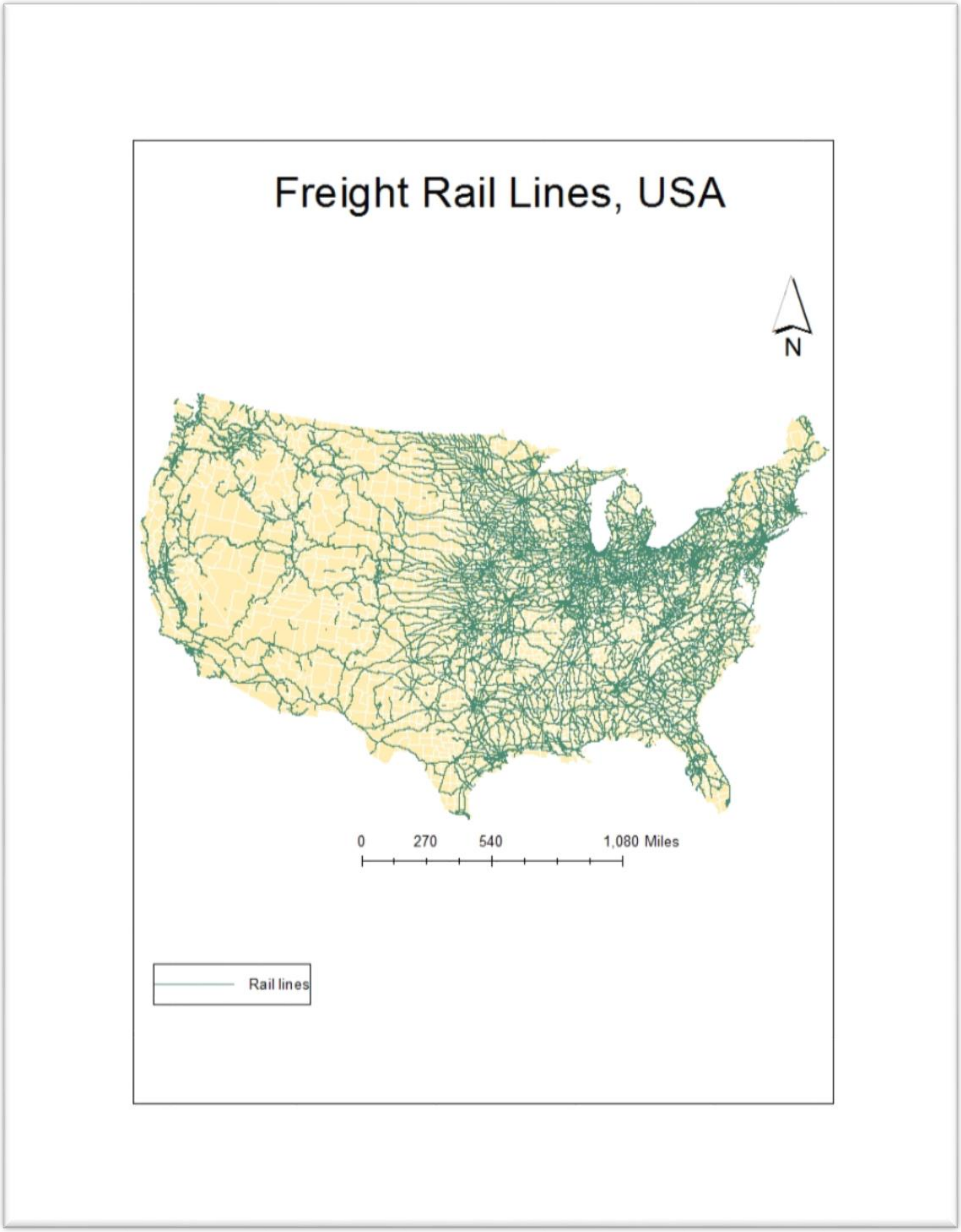
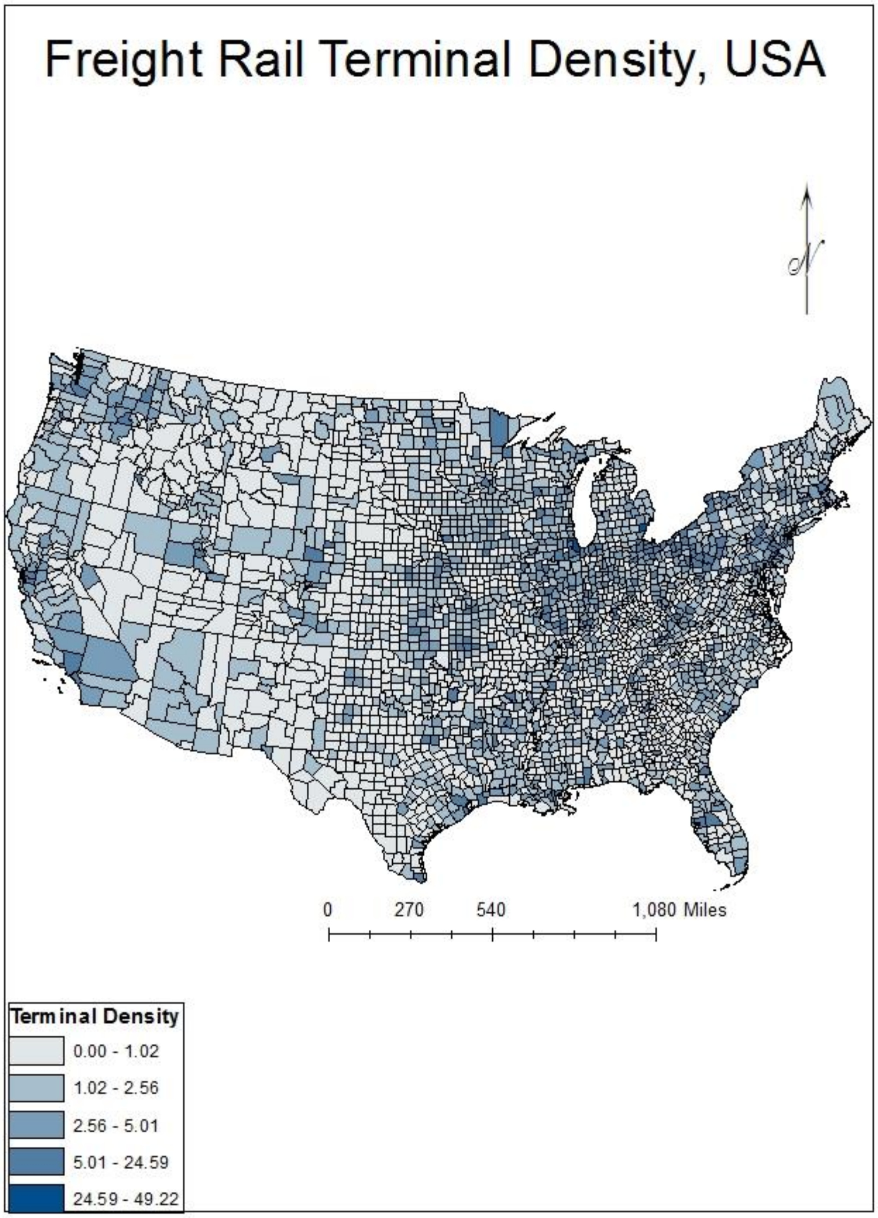


Figure 3.2: Freight Rail Terminal Density in the United States



Control Variables

Two additional modes of transportation and many demographic, socioeconomic, and geographic control variables were used in the analytical model. The data for control variables were acquired from many sources, such as decennial censuses, the NTAD, the National Historical Geographic Information System (NHGIS), cartographic boundary shapefiles, and the land developability index. For the identification of metro (and nonmetropolitan) and regions (West, Midwest, Northeast, and South), I used the U.S. Census Bureau's cartographic boundary files. Demographic and socioeconomic changes are influenced by land use and development (Chi 2010). In this study, the land developability index variable captures this concept, and the variable is controlled for, along with other socioeconomic variables in the model. The land developability index can be understood as the potential for land development and conversion in a geographic area. It is based on several factors, such as geophysical characteristics (slope, wetland), the amount of built-up lands (residential, commercial, and industrial areas; transportation infrastructure), culture, natural amenities (lakes, forests, good weather), and governmental policies. Data for the land developability index are available at http://www.landdevelopability.org/.

Highways and airports are other two modes of transportation used as control variables. Those data came from the National Highway Planning Network (NHPN) database and the airports database, respectively, from the NTAD. This study controls for highways and airports as a means to compare the impact of railroads with the impacts of highways and airports, which have been linked with population and employment change (Irwin and Kasarda 1991). The highway is represented by highway density, which is measured by dividing the total length of highway in miles divided by the square root of a county's area. Similarly, the total number of public airport terminals available within a county boundary represents the airports. Controlling for highways and airports helps to remove the effects of these variables on the association between freight rail and the dependent variables.

Demographic control variables are represented by the change rate of population in the previous decade; population density (number of people per square mile); percentage of the young (15 to 19 years of age) and the old (65 years of age and above) in the population. Socioeconomic control variables are represented by the race and ethnicity, education, employment and median household income. Race and ethnicity are measured in the percentage of non-Hispanic Whites, non-Hispanic Blacks, and Hispanics in the population; education is measured by the percentage of population with a high school diploma, bachelor's degree, and graduate degree; and employment is measured by the percentage of the population employed. The other control variables are the change rate of population, employment, young, old, non-Hispanic White, non-Hispanic Black, Hispanic, high school diploma, bachelor's degree, graduate degree, and median household income in the previous decade. This dissertation research also has a development control variable that is represented by the land developability index.

Two types of geographic control variables, metro and region, are used in this analysis. Metro represents counties that have at least one metropolitan area with a population of 50,000 or more. The West, Midwest, Northeast, and South represent region. The South is the reference variable. The regional variables represent the counties within those regions. The variables, such as freight rail terminal density, highways, airports, and land developability index are used in all of the study periods. The values of those variables and the four geographic variables are same in each period because of the unavailability of the data, as well as for consistency in the research analysis.

Unit of Analysis

The demographic and socioeconomic impacts of freight rail have been examined at the county level for the continental United States. Counties are considered in this research because they are important governmental units, they have rich social and economic data that are easily available, and their boundaries are relatively consistent over time (White 2008). Even though the county boundaries are stable, there were some changes in the geographic shape and size during over the forty years (1970 to 2010) of the study period. Some counties changed their shapes, some disappeared, and some new counties emerged. For this study, counties available in tye 2010 cartographic boundary shapefiles obtained from the United States Census Bureau are considered the standard, and applied to all periods. The necessary demographic changes were made in these counties based on the best available information. The other reason to consider counties in this study is several government programs related to agriculture, social welfare, education, taxes, and transportation construction and maintenance operate at the county level.

Analytical Approach

This dissertation research applies descriptive statistics, standard regression models, exploratory spatial data analysis (ESDA), and spatial regression models to examine the demographic and socioeconomic impacts of freight rail in the continental United States. The analysis begins with the descriptive statistics and standard regression method. A full ordinary least squares (OLS) regression model is used to examine general causality from the railroad to the dependent variables.

In the next step, the OLS regression is refined to address the issue of spatial autocorrelation, sometimes also known as spatial dependence (Chi and Zhu 2008; Chi and Ventura 2011). From the methodological perspective, the issue of spatial dependence must be addressed. Statistical inference without consideration of spatial dependence may lead to unreliable conclusions. In this study, that issue is addressed by application of spatial regression methods. The spatial regression method includes models such as spatial lag, spatial errors, and spatial error with lag dependence.

Spatial analysis, or the spatial regression model, is built upon the concept of spatial dependence, which is defined differently by many scholars. The concept of spatial dependence emerges from Tobler's First Law of Geography (1970), according to which, "Everything is related to everything else, but near things are more related than distant things." Anselin (1988) thinks of spatial dependence as a functional relationship if what happens in one area links with what happens elsewhere. For LeSage and Pace (2009) and Fotheringham, Brunsdon, and Charlton (2002), spatial dependence is a situation where the value of one variable at one location depends on the values of variables at nearby locations. According to Chang (2010), spatial dependence is simply a spatial association.

Opinions of scholars may vary, but one thing is clear: proximity does matter, and it influences the interaction of variables and their spatial spillover effects.

I measure spatial dependence for all dependent variables using Moran's I, which is the most common measures of spatial dependence (Loftin and Ward 1983; Baller et al. 2001; Chi and Zhu 2008). This study applies Moran's I statistics to identify spatial correlation. Moran's I statistic measures the linear association between a variable at a given location and the weighted average of the variable at its neighboring locations (Chi and Zhu 2008). The design and determination of the best-fit spatial weight matrix are important processes in research. The weight matrix, which has the highest level of spatial dependence followed by statistical significance, should be used in the analysis (Anselin 1988). However, there is no clear guidance regarding the selection of the spatial weight matrix (Anselin 2002; Chi and Zhu 2008).

The common spatial weight matrices in practice for polygon shapefiles are "rook" and "queen" contiguity weight matrices (Anselin 1992; GeoDa User's Guide), and they are used in my analysis. The rook contiguity weight matrix incorporates only common county boundaries to construct neighbors, while queen contiguity considers both common county boundaries and points in creation of neighborhood structures. Because of their nature, spatial weights matrices based on queen matrices have denser connectivity than rook contiguity matrices. I used first- and second-order rook and queen contiguity weight matrices. First-order queen and rook contiguity spatial weight matrices use immediate neighbors or counties, and the second-order ones use both the first-order neighbors and *their* neighbors in the calculation of weight matrices. I created several first- and second-order queen and rook weight matrices for each dependent variable, compared those weight matrices, and selected the one that has a high coefficient of spatial autocorrelation and a high level of statistical significance (Voss and Chi 2006).

After the spatial weight matrix is specified, an exploratory spatial data analysis is conducted to verify whether spatial clustering patterns exist in the data. ESDA helps in the visualization of spatial patterns and identification of spatial clusters. Two types of spatial clustering are possible. First, counties with high or low values can group together. Second, counties with high values can lump together with counties that have low values. The first case is an example of positive spatial autocorrelation, and the second case is an example of negative spatial autocorrelation. Using local Moran or local indicators of spatial autocorrelation (LISA) statistics, I identify visual spatial clusters in the data for each period.

In the next step of the analysis, the hidden spatial patterns need to be investigated, and the most suitable spatial regression model should be used. Lagrange multiplier test statistics can give some hints about spatial patterns. Diagnostic statistics in the first model of each table include the values for four Lagrange multiplier test statistics. Lagrange multiplier lag and robust Lagrange multiplier lag pertain to the spatial lag model, and the Lagrange multiplier error and robust Lagrange multiplier error refer to the spatial error model. The significant or higher value of the standard and robust Lagrange multiplier tests indicates the hidden patterns, as well as a suitable statistical regression model. For example, the significant or higher value of Lagrange multiplier lag indicates that spatial lag is the hidden spatial pattern and that the spatial lag regression model should be used for the analysis.

The use of Lagrange multiplier test statistics is the most common practice, but this dissertation research analysis goes beyond these two spatial models to include a third model, which is called the spatial error model with lag dependence. Hence, a suitable model is chosen based on the overall fitness including the log-likelihood, Akaike's information criterion (AIC), and Schwarz's Bayesian information criterion (BIC). The best-fit model has the highest value of the log-likelihood and the lowest values of AIC and BIC.

Based on the above-mentioned criteria, the spatial error model with lag dependence emerges as the best-fit model. I calculate and present the demographic and socioeconomic impact of freight rail by all four regression models (ordinary least squares, spatial lag, spatial error, and spatial error with lag dependence) using the spatial econometrics package or software named GeoDa.

Statistical equations for the models applied in this study can be shown as follows:

Ordinary least squares (OLS):

$$Ln(\frac{D_{t+10}}{Dt}) = \alpha + \beta X_t + \varepsilon \qquad \text{(Eq. 1)}$$

Spatial lag model (SLM):

$$Ln\left(\frac{D_{t+10}}{D_t}\right) = \alpha + \beta X_t + \rho w_1 Ln\left(\frac{D_{t+10}}{D_t}\right) + \varepsilon \qquad \text{(Eq. 2)}$$

Spatial error model (SEM):

$$Ln\left(\frac{D_{t+10}}{D_t}\right) = \alpha + \beta X_t + \varepsilon, \varepsilon = \lambda W_2 \varepsilon + \xi \quad \text{(Eq. 3)}$$

Spatial error model with lag dependence (SEMLD):

$$Ln\left(\frac{D_{t+10}}{D_t}\right) = \alpha + \beta X_t + \rho w_1 Ln\left(\frac{D_{t+10}}{D_t}\right) + \varepsilon, \varepsilon = \lambda W_2 \varepsilon + \xi \quad \text{(Eq. 4)}$$

where *Ln* represents the natural log, *Dt*+10 is a dependent variable in year *t*+10, *Dt* is the dependent variable in year *t*, α represents the intercept, *Xt* represents the matrix of independent and control variables in year *t*, *β* denotes a vector of coefficients of *Xt*, ρ is a spatial lag parameter, λ is a spatial error parameter, *W1* is a spatial weight matrix for the lag term, and *W*2 is a spatial weight matrix for the error term.

Equation 1 is the ordinary least squares model. An ordinary least squares or a standard linear regression model assumes that error terms are independent or randomly or normally distributed (Allison 1999; Agresti and Finlay 2009). This assumption ignores the spatial effects and often violates the assumption of independence due to spatial autocorrelation of residuals, which are the difference between observed and predicted values of dependent variables. The violation of assumption can produce severe bias in the estimation and produces unreliable results.

As shown in Equations 2, 3, and 4, this shortcoming of the standard regression can be overcome by application of the spatial regression model, which allows spatial autocorrelation in the model (Chi and Zhu 2008). The spatial regression model includes the usual regression coefficient of the explanatory variables (*β*), error term (ϵ), spatial autocorrelation coefficient (ρ), and spatial weight matrix (W). This study uses three spatial regression models: spatial lag model (Equation 2), spatial error model (Equation 3), and spatial error model with lag dependence (Equation 4).

In spatial lag models, spatial autocorrelation is determined by a linear relation between a dependent variable and the associated spatially lagged or weighted variable, but in spatial error models, spatial correlation is demonstrated by the linear relation between an error term and the associated spatially lagged or weighted error term (Anselin and Bera 1998; Chi and Zhu 2008). The interpretation of a significant spatial coefficient is complex and not always straightforward. Based on the literature, for this study, a significant spatial lag term or effect indicates strong spatial dependence, and a significant spatial error term or effect indicates lack of key explanatory variables in the model. In other words, there is ample opportunity to improve the model. Both spatial lag and spatial error models are better than the standard regression model because those models allow control for spatial lag and spatial error effects (Voss and Chi 2006; Chi and Zhu 2008). Furthermore, Chi (2010) argues for a spatial error model with lag dependence—a spatially integrated regression approach that considers spatial lag and spatial error effects simultaneously in a model. This is the most robust approach of all three spatial regression models, and this study includes this model along with the other two spatial regression models.

CHAPTER FOUR

EXPLORATORY ANALYSIS

Chapter Four addresses the exploratory analysis of the data used in this study. The analysis was carried out at the decade and aggregate levels. This chapter includes descriptive statistics tables, Moran's I scatter plots, LISA cluster maps, and correlation tables. The chapter has information on descriptive statistics for four decades (i.e., from 1970 to 1980, from 1980 to 1990, from 1990 to 2000, from 2000 to 2010, and for the entire study period, from 1970 to 2010). Each descriptive statistics table describes the dependent, independent, and control variables. Descriptive statistics tables show mean, standard deviation, minimum values, and maximum values. The chapter also includes Moran's I scatter plots to show the global spatial autocorrelation for the dependent variables. Local indicator for spatial autocorrelation (LISA) cluster maps display local-level spatial autocorrelation. At the end of the discussion of each study period, a correlation table shows the value for the correlation coefficient for each variable against the independent variable (freight rail terminal density).

For the Period of 1970 to 1980

Table 4.1 presents the descriptive statistics for the dependent, independent, and control variables used for the period of 1970 to 1980. The ten dependent variables for this period are measured in natural log. All minimum values except for median household income are negative. Freight rail terminal density is the independent, or explanatory, variable. For each county, the average value of terminal density is 1.71, and the value for this variable varies from 0 to 49.22. Two other modes of transportation, highways and airports, are used as control variables. The mean value for highway density is 6.42, and it varies from 0 to 46. Similarly, each county on average has 1.51 public airports. The number of public airports can vary from 0 (indicating that a county may not have any public airport) to as high as 17.

Table 4.1 also shows values for the previous decade's population change rate, as well as values for the previous decade's young, old, and White population change. The mean value for the previous decade's population change rate is 0.08, and the mean values for the young, old, and White population change rates are 0.30, 0.30, and 0.09, respectively. The negative minimum values indicate decline, and positive values show growth. The table shows that the old population declined the most and the growth of the young population was the highest in the previous decade.

The other control variables are population density, young, old, high school diploma, bachelor's degree, graduate degree, White, and employment percent in 1970. The mean value for population density is 213.13 per square mile. The values vary from 0.18 to 67,424.46 per square mile. The mean value for the population with a graduate degree is the lowest (2.71%), and the White population has the highest value (89.52%). Even though the average median household income in 1970 was $6,556.23, it varies from $2,211 to $14,984. Geographic variables are metro, West, Midwest, and Northeast. Most of the counties (1430) are in the South, while the Northeast has the least number of counties (218). The South is the reference group for the regional variables. The land developability index is used as a control variable. The mean value for the land developability index is 70.75 percent.

Figures 4.1 through 4.10 show the values for Moran’s I on the scatter plots. The Moran’s I scatter plots show that all dependent variables are spatially correlated. The Moran’s I values for population, employment, White, Black, young, old, high school diploma, bachelor’s degree, graduate degree, and median household income change are 0.49, 0.44, 0.47, 0.21, 0.42, 0.52, 0.66, 0.36, 0.19, and 0.44, respectively. They all are positive and fall in the high-high and low-low quadrants. The LISA cluster maps for the period of 1970 to 1980 are presented in Figures 4.11 through 4.20. They are a visual representation of the local spatial correlation. The color red indicates counties with high values, and blue indicates counties with low values; the cluster maps show that they are grouped together. Table 4.2 shows the correlation coefficient values between freight rail terminal density and all other dependent and control variables. Most of these values significant, they vary from weak to moderate, and the direction of the relationship is both positive and negative.

Table 4.1: 1970−1980 Descriptive Statistics of the Dependent and Independent Variables (N = 3109)

Variables	Mean	Stan Dev	Min	Max
Dependent variables				
Population change (ln)	0.14	0.17	−0.59	1.20
Employment change (ln)	0.34	0.20	−0.26	1.67
Young pop change (ln)	0.11	0.19	−0.64	1.10
Old pop change (ln)	0.17	0.15	−0.51	1.14
White pop change (ln)	0.12	0.19	−0.67	1.19
Black pop change (ln)	0.02	0.71	−5.54	3.53
High school diploma pop change (ln)	0.08	0.29	−1.13	1.32
Bachelor's degree pop change (ln)	0.28	0.30	−1.61	2.75
Graduate degree pop change (ln)	0.63	0.42	−2.30	3.82
Median household income (ln)	0.79	0.131	0.34	1.58
Independent variables				
Terminal Density	1.71	2.69	0.00	49.22
Control variables				
Highway density	6.42	3.64	0.00	46.00
Airport number	1.51	1.60	0.00	17.00
Prev. decade pop change rate (1960−1970)	0.08	1.34	−0.97	73.88
Prev. decade young pop change rate (1960−1970)	0.30	1.79	−0.96	98.37
Prev. decade old pop change rate (1960−1970)	0.30	1.23	−0.93	67.35
Prev. decade White pop change rate (1960−1970)	0.09	1.42	−1.00	78.30
Population density 1970	213.13	1720.82	0.18	67424.46
Young pop percent 1970	9.66	1.51	4.90	25.81
Old pop percent 1970	12.73	3.80	0.95	35.40
HS diploma pop percent 1970	45.18	8.13	7.41	71.64
BD pop percent 1970	12.65	4.99	0.00	44.06
GD pop percent 1970	2.71	2.02	0.00	20.45
White pop percent 1970	89.52	15.40	0.00	100.00
Black pop percent 1970	9.25	14.98	0.00	80.11
Median HH income 1970	6556.23	1796.89	2211.00	14984.00
Employed percent 1970	47.17	6.24	2.48	65.81
Metro	0.36	0.48	0.00	1.00
West	0.13	0.34	0.00	1.00
Midwest	0.34	0.47	0.00	1.00
Northeast	0.07	0.26	0.00	1.00
South (Reference)	0.46	0.50	0.00	1.00
Land development index	70.75	26.56	0.00	99.88

Figure 4.1: Moran's I for 1970−1980 Population Change

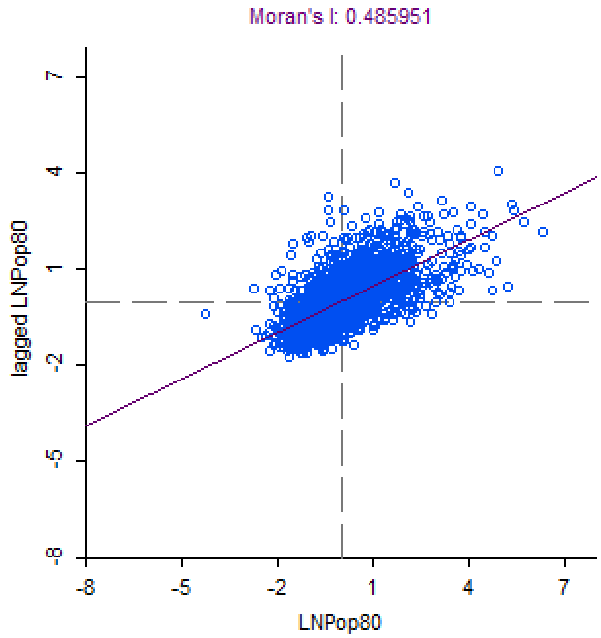


Figure 4.2: Moran's I for 1970−1980 Employment Change

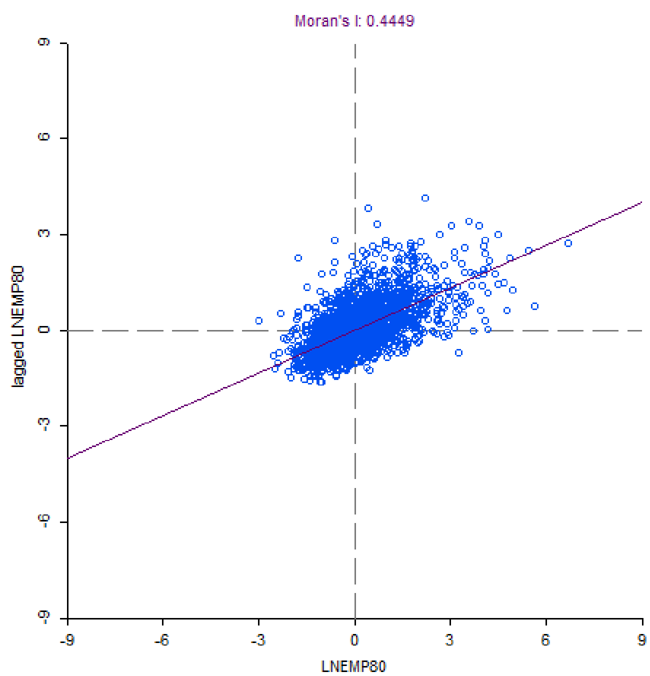


Figure 4.3: Moran's I for 1970−1980 White Population Change

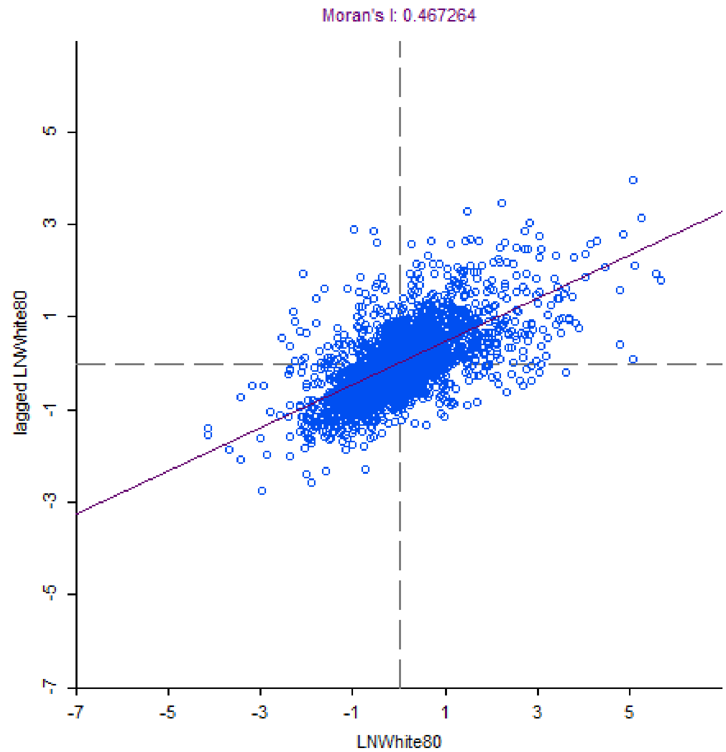


Figure 4.4: Moran's I for 1970−1980 Black Population Change

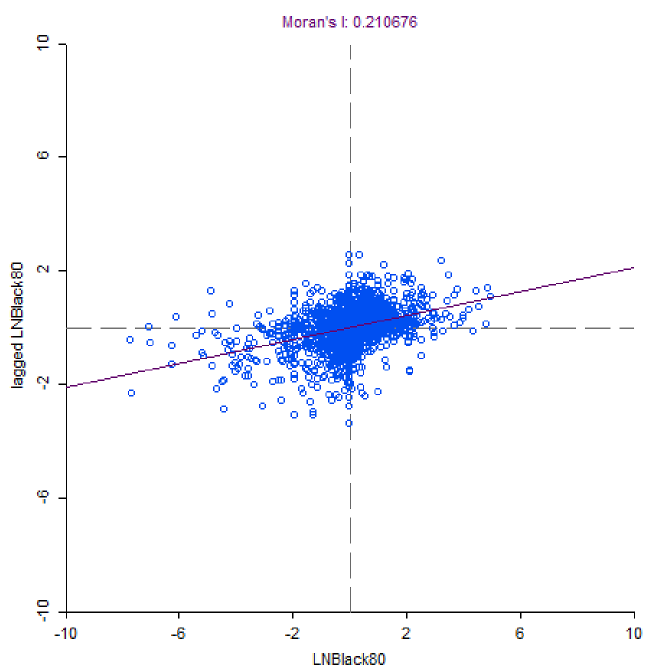


Figure 4.5: Moran's I for 1970–1980 Young Population Change

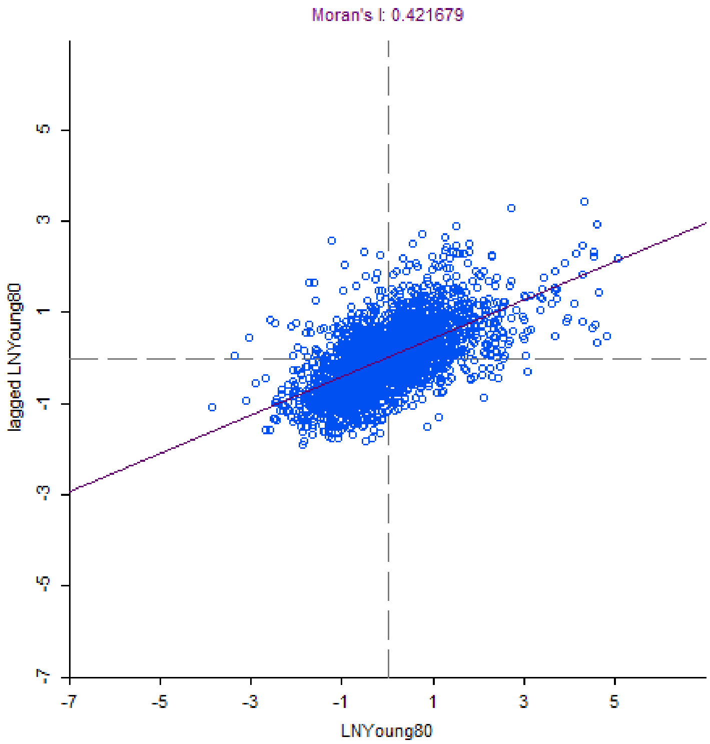


Figure 4.6: Moran's I for 1970–1980 Old Population Change

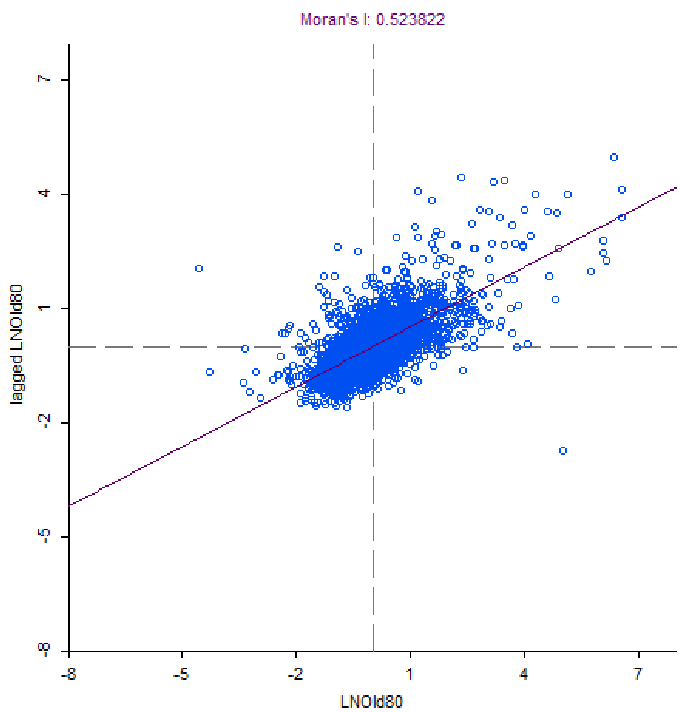


Figure 4.7: Moran's I for 1970–1980 High School Diploma Population Change

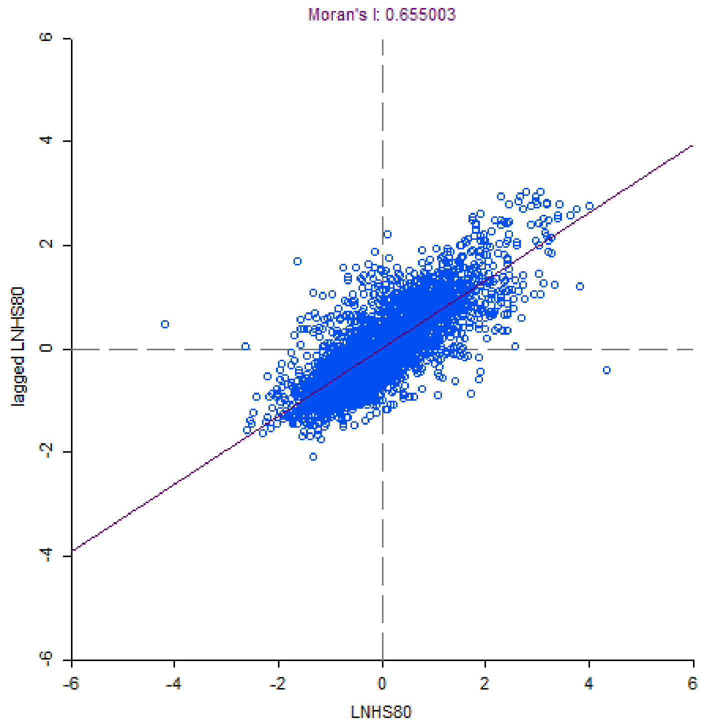


Figure 4.8: Moran's I for 1970–1980 Bachelor's Degree Population Change

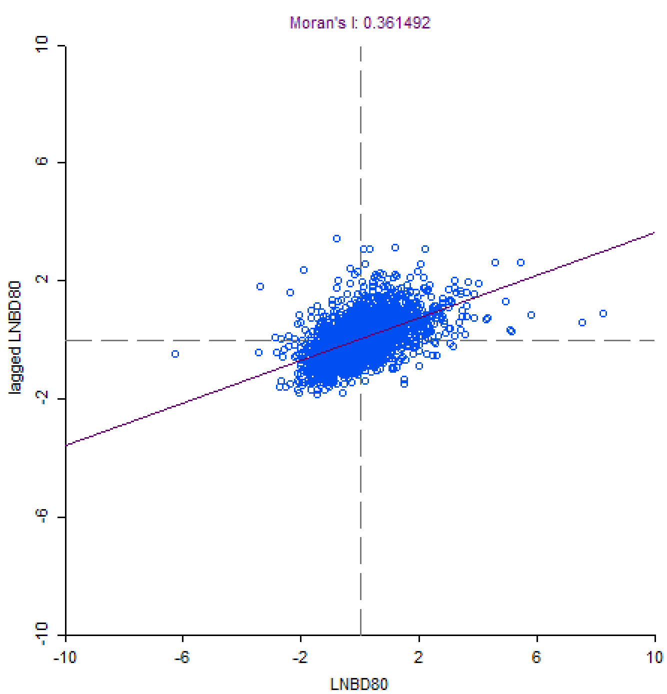


Figure 4.9: Moran's I for 1970–1980 Graduate Degree Population Change

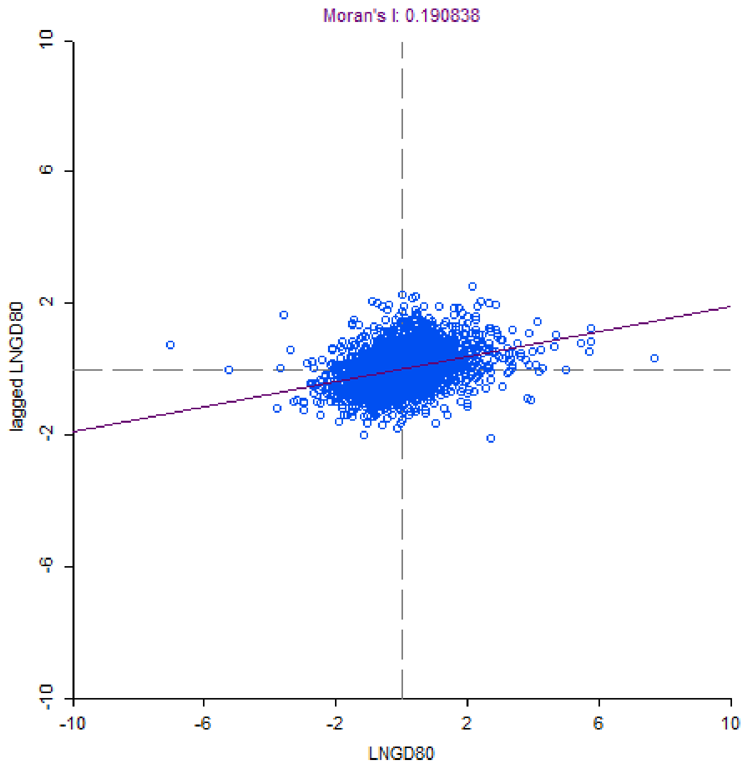


Figure 4.10: Moran's I for 1970–1980 Median Household Income Change

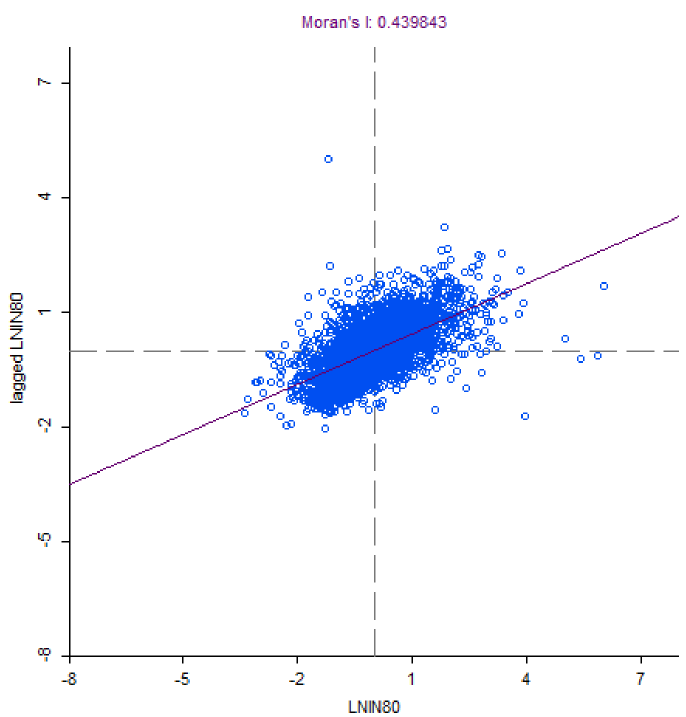


Figure 4.11: LISA Cluster Map of Population Change from 1970 to 1980 at the County Level in the Continental United States

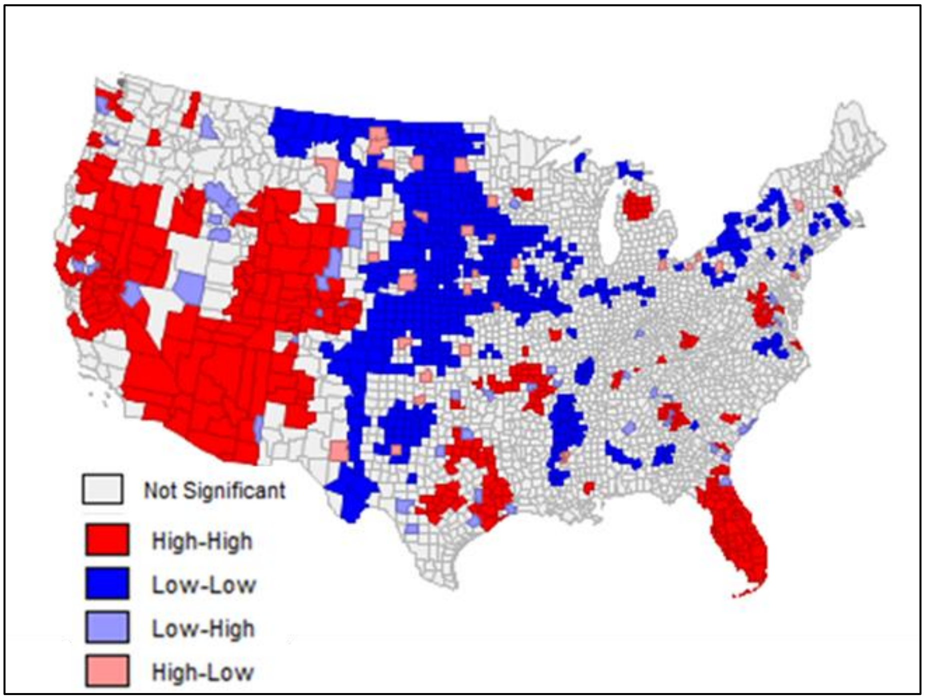


Figure 4.12: LISA Cluster Map of Employment Change from 1970 to 1980 at the County Level in the Continental United States

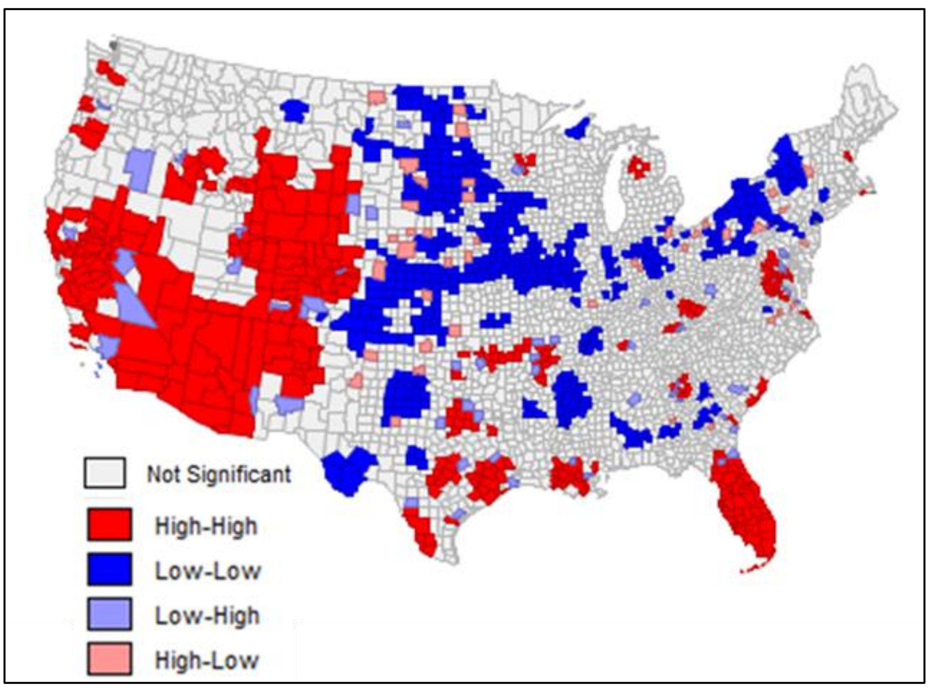


Figure 4.13: LISA Cluster Map of White Population Change from 1970 to 1980 at the County Level in the Continental United States

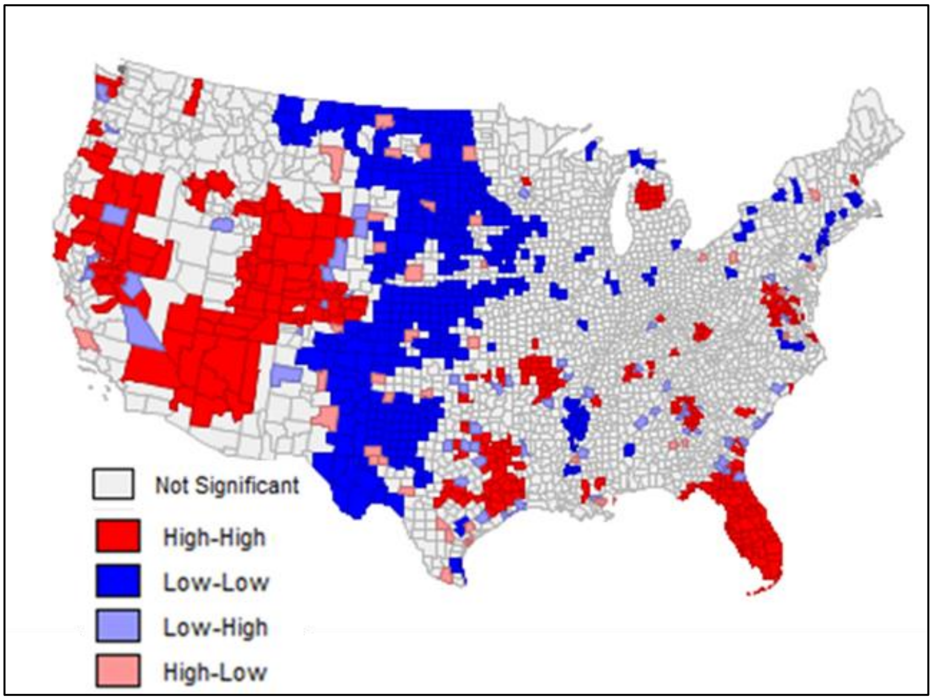


Figure 4.14: LISA Cluster Map of Black Population Change from 1970 to 1980 at the County Level in the Continental United States

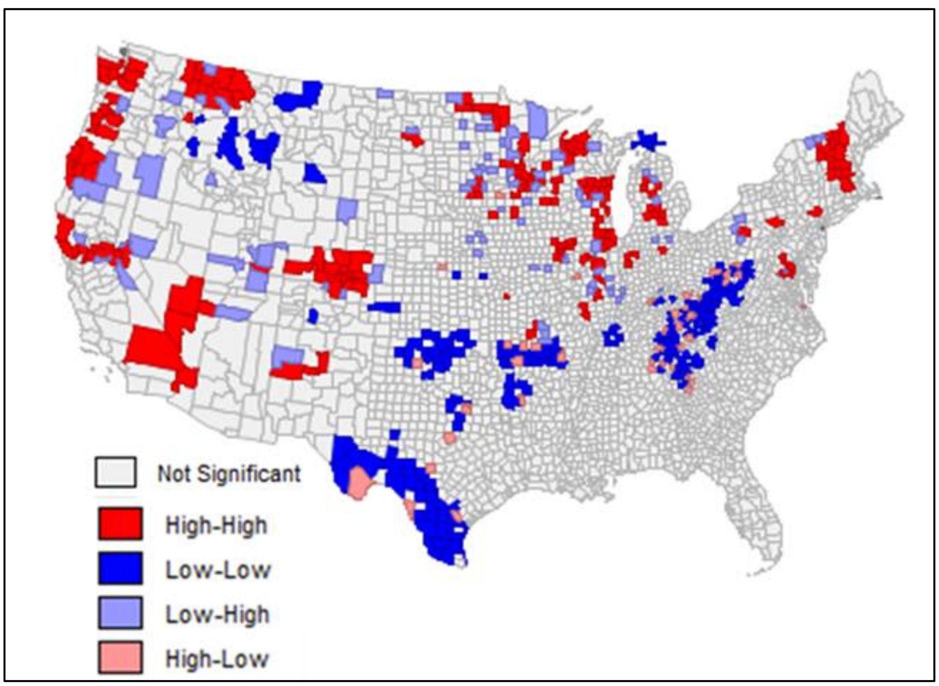


Figure 4.15: LISA Cluster Map of Young Population Change from 1970 to 1980 at the County Level in the Continental United States

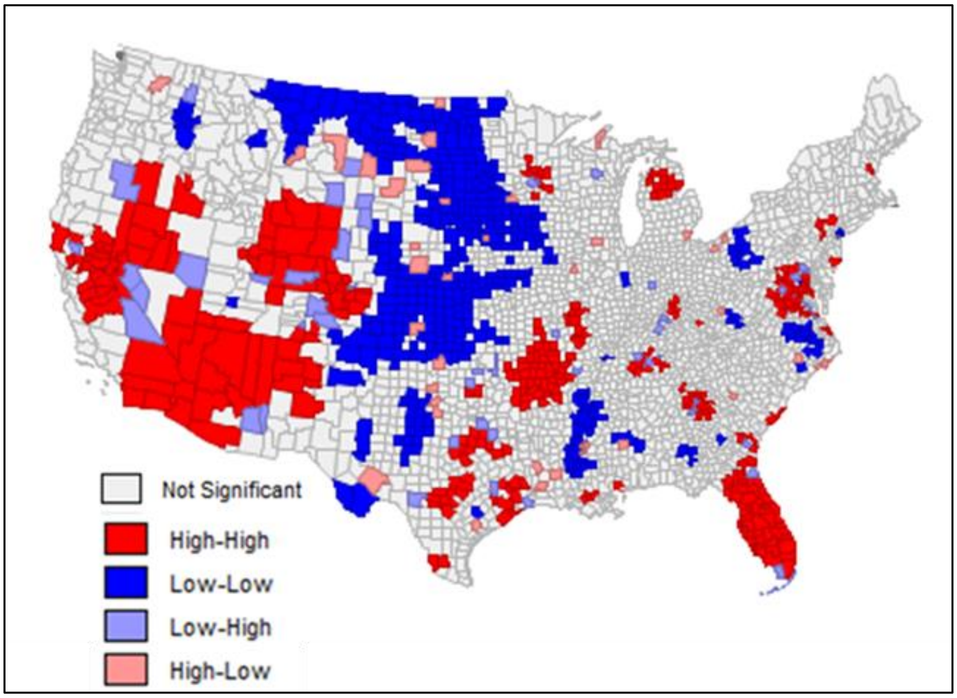


Figure 4.16: LISA Cluster Map of Old Population Change from 1970 to 1980 at the County Level in the Continental United States

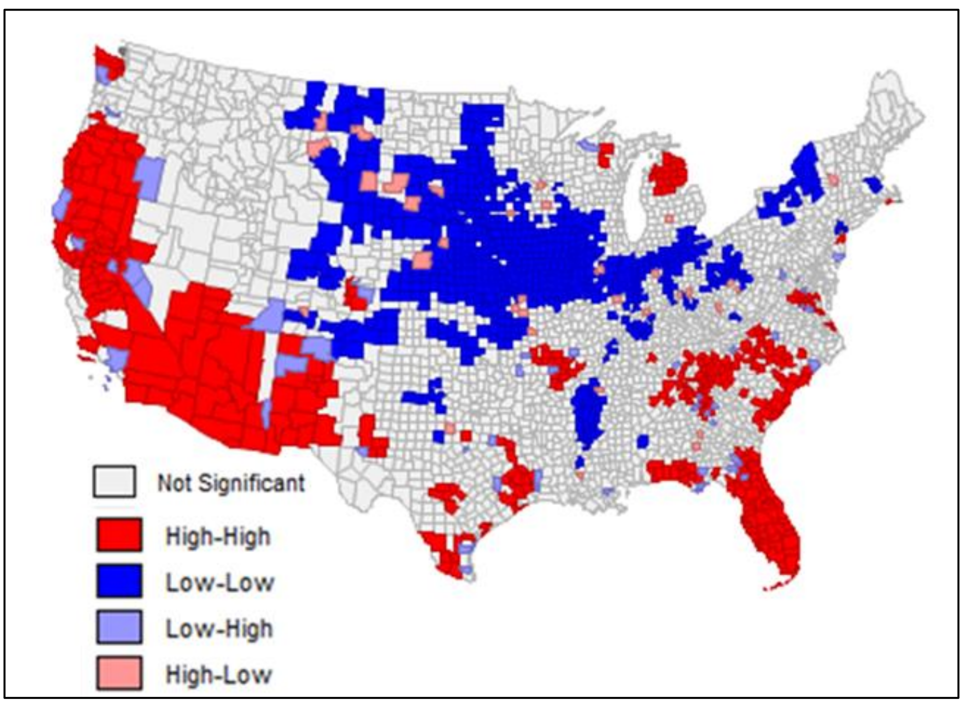


Figure 4.17: LISA Cluster Map of High School Diploma Population Change from 1970 to 1980 at the County Level in the Continental United States

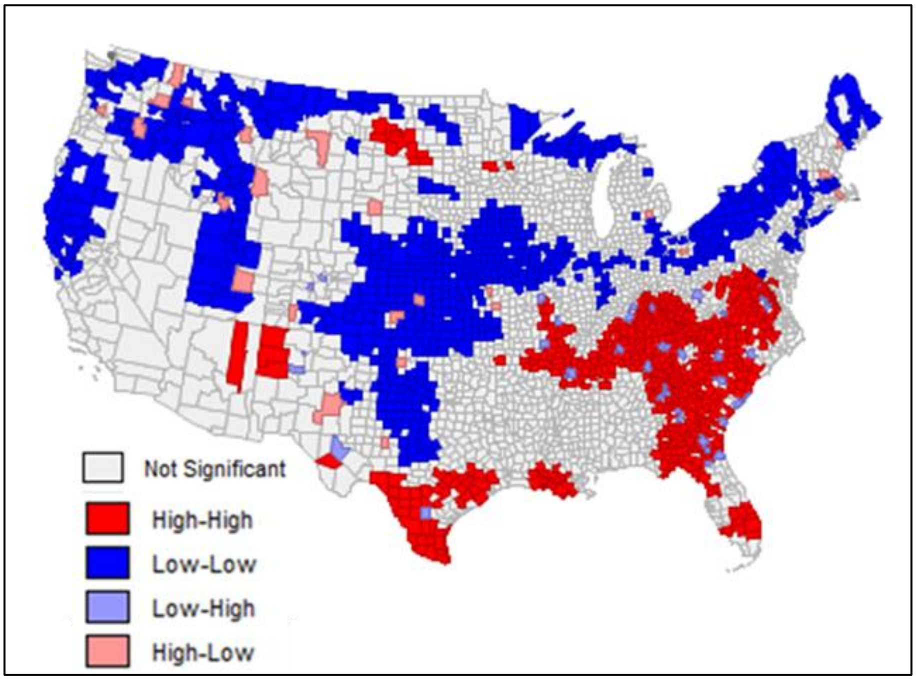


Figure 4.18: LISA Cluster Map of Bachelor's Degree Population Change from 1970 to 1980 at the County Level in the Continental United States

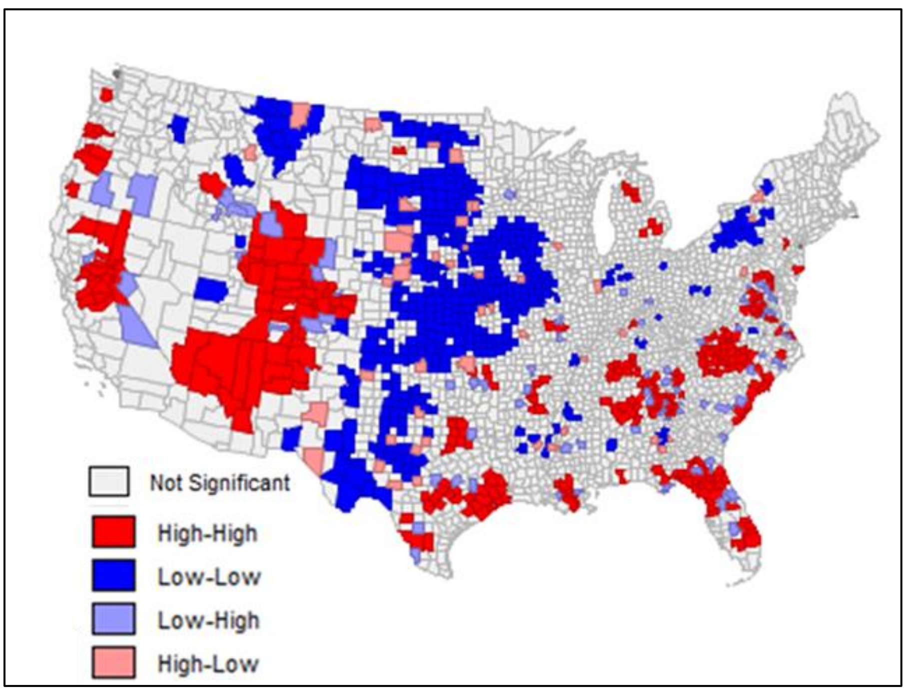


Figure 4.19: LISA Cluster Map of Graduate Degree Population Change from 1970 to 1980 at the County Level in the Continental United States

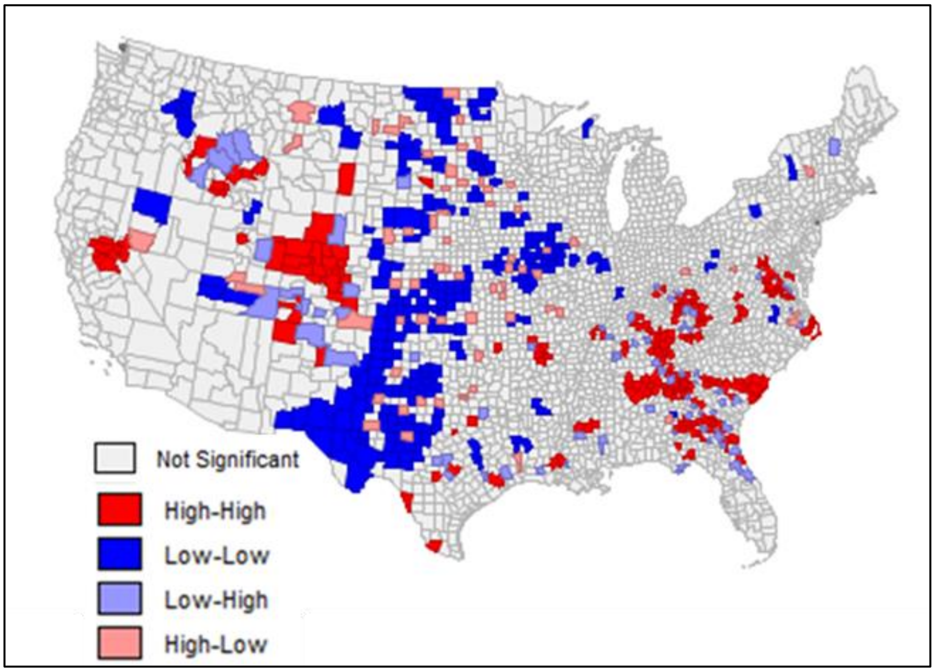


Figure 4.20: LISA Cluster Map of Median Household Income Change from 1970 to 1980 at the County Level in the Continental United States

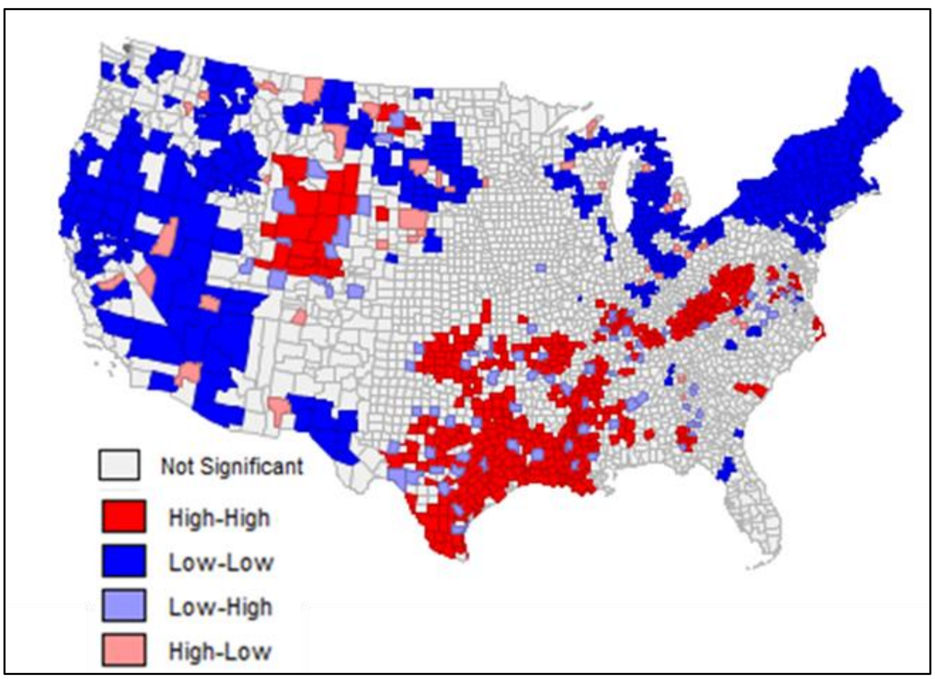


Table 4.2: Correlations between Terminal Density and Other Variables for the Period of 1970–1980

Variables	Cor. Coefficient
Independent variable	
Terminal density	1
Dependent variables	
Population change (ln)	−0.154***
Employment change (ln)	−0.144***
Young pop change (ln)	−0.121***
Old pop change (ln)	−0.132***
White pop change (ln)	−0.197***
Black pop change (ln)	0.087***
HS diploma pop change (ln)	−0.215***
BD pop change (ln)	−0.033
GD pop change (ln)	−0.076***
Income change (ln)	−0.219***
Control variables	
Highway density	0.579***
Airport number	0.194***
Prev. decade pop change rate	0.026
Population density 1970	0.353***
Prev. decade young pop change rate	0.045*
Prev. decade old pop change rate	0.02
Prev. decade White pop change rate	0.02
Young	−0.015
Old	−0.148***
High school diploma	0.152***
Bachelor’s degree	0.111***
Graduate degree	0.168***
White	−0.026
Black	0.044*
Income	0.335***
Employment	0.150***
Metro	0.284***
West	−0.092***
Midwest	0.147***
Northeast	0.175***
South (Reference)	−0.167***
Land developability index	−0.111***

* Significant at $p \leq 0.05$ for a two−tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

For the Period of 1980 to 1990

Table 4.3 presents descriptive statistics for all variables used for the period of 1980 to 1990. There are total ten dependent variables, and their values are in natural log. Each dependent variable observes both positive and negative change, except median household income. The median household income level of every county experienced some growth. The previous decade's demographic and socioeconomic change rates are used as control variables. The table shows both positive and negative values for the previous decade's rate of population change employment, young, old, White, Black, high school diplopma,bachelor's degree, and graduate degree. The mean value of the population with a high school diploma is the lowest (0.13), whereas the mean value for the population with a graduate degree is the highest (1.09). The minimum values for all previous decade's population change rates are negative, indicating that there was at least one county for each variable that faced decline in this ten-year period.

The average county-level population density in 1980 was 214.35, with a variation of 0.14 to 62,564.50 per square mile. Similarly, each county has an average young and old population of 9.42 and 13.25 percent, respectively. The average percentages for high school diploma, bachelor's degree, and graduate degree are 39.71, 13.53, and 3.96, respectively (highest to lowest). The average percent of White is 88.32, whereas the average percent of Black is 8.64. In 1980, the average median household value was $14,260.39. The minimum value for median household income is $1,884 and the maximum value is $30,011. The mean value for the employment is 53.62 percent, with variation from 8.43 to 84.28 percent. All of the values in these categories are positive.

Figures 4.21 through 4.30 show Moran's I values for the dependent variables for the period of 1980 to 1990. The Moran's I value for population, employment, White, Black, young, old, high school diploma, bachelor's degree, graduate degree, and median household income are 0.56, 0.52, 0.66, 0.17, 0.46, 0.55, 0.57, 0.37, 0.37, and 0.57, respectively. Moran's I values for all dependent variables are positive, showing that these variables have spatial autocorrelation. Figures 4.31 through 4.40 are visual representations of the spatial correlation; the color red indicates counties with higher values, and blue indicates counties in lower values. Red and blue counties are group together.

Table 4.4 presents correlation coefficient values between freight rail terminal density and other variables for the period of 1980 to 1990. The correlation coefficient values for dependent variables are mostly negative, except for old and bachelor's degree. These values are not significant for employment, old, Black, graduate degree, and income change. In this table, freight rail terminal density has the strongest (0.579) relationship with the highway density, and it has a positive relationship with both highways and airports. The relationship with freight rail terminal density is significant with all previous decade's population change rates except for the Black population, and all values are negative except for population density and Black population. The correlation coefficient values of freight rail with other demographic and socioeconomic control variables is mostly positive, except for old, high school diploma, and White. All variables in this category are significant except the variable young.

Table 4.3: 1980−1990 Descriptive Statistics of the Dependent and Independent Variables (N = 3109)

Variables	**Mean**	**Stan Dev**	**Min**	**Max**
Dependent variables				
Population change (ln)	0.03	0.14	−0.39	0.97
Employment change (ln)	0.18	0.18	−0.39	1.98
Young pop change (ln)	−0.22	0.18	−1.35	0.64
Old pop change (ln)	0.16	0.16	−0.54	1.30
White pop change (ln)	−0.02	0.23	−3.19	0.96
Black pop change (ln)	0.19	0.56	−3.00	6.29
High school diploma pop change (ln)	−0.03	0.21	−0.88	1.26
Bachelor’s degree pop change (ln)	−0.32	0.28	−1.41	1.37
Graduate degree pop change (ln)	0.25	0.33	−1.66	2.25
Median HH Income change (ln)	0.51	0.12	0.04	2.17
Independent variables				
Terminal density	1.71	2.69	0.00	49.22
Control variables				
Highway density	6.42	3.64	0.00	46.00
Airport number	1.51	1.60	0.00	17.00
Prev. decade pop change rate (1970−1980)	0.16	0.23	−0.45	2.32
Prev. decade emp. change rate (1970−1980)	0.43	0.34	−0.23	4.31
Prev. decade young pop change rate (1970−1980)	0.14	0.25	−0.47	2.00
Prev. decade old pop change rate (1970−1980)	0.20	0.20	−0.40	2.12
Prev. decade White pop change rate (1970−1980)	0.15	0.25	−0.49	2.29
Prev. decade Black pop change rate (1970−1980)	0.29	1.74	−1.00	33.00
Prev. decade HS diploma pop change rate (1970−1980)	0.13	0.36	−0.68	2.75
Prev. decade BD pop change rate (1970−1980)	0.39	0.59	−0.80	14.57
Prev. decade GD pop change rate (1970−1980)	1.09	1.47	−1.00	44.50
Population density 1980	214.35	1547.26	0.14	62564.50
Young pop percent 1980	9.42	1.33	5.51	22.51
Old pop percent 1980	13.25	4.10	0.81	33.96
HS diploma pop percent 1980	39.71	5.70	12.60	64.33
BD pop percent 1980	13.53	5.09	3.52	54.45
GD pop percent 1980	3.96	2.50	0.00	28.99
White pop percent 1980	88.32	15.09	6.33	100.00
Black pop percent 1980	8.64	14.44	0.00	84.16
Median HH income 1980	14260.39	3332.11	1884.00	30011.00
Employment percent 1980	53.62	6.79	8.43	84.28
Metro	0.36	0.48	0.00	1.00
West	0.13	0.34	0.00	1.00
Midwest	0.34	0.47	0.00	1.00
Northeast	0.07	0.26	0.00	1.00
South (Reference)	0.46	0.50	0.00	1.00
Land developability index	70.75	26.56	0.00	99.88

Figure 4.21: Moran's I for 1980−1990 Population Change

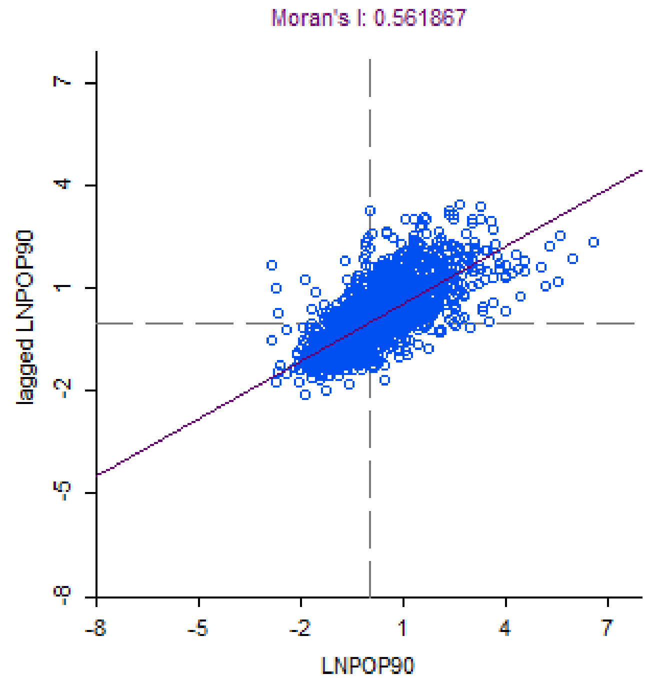


Figure 4.22: Moran's I for 1980−1990 Employment Change

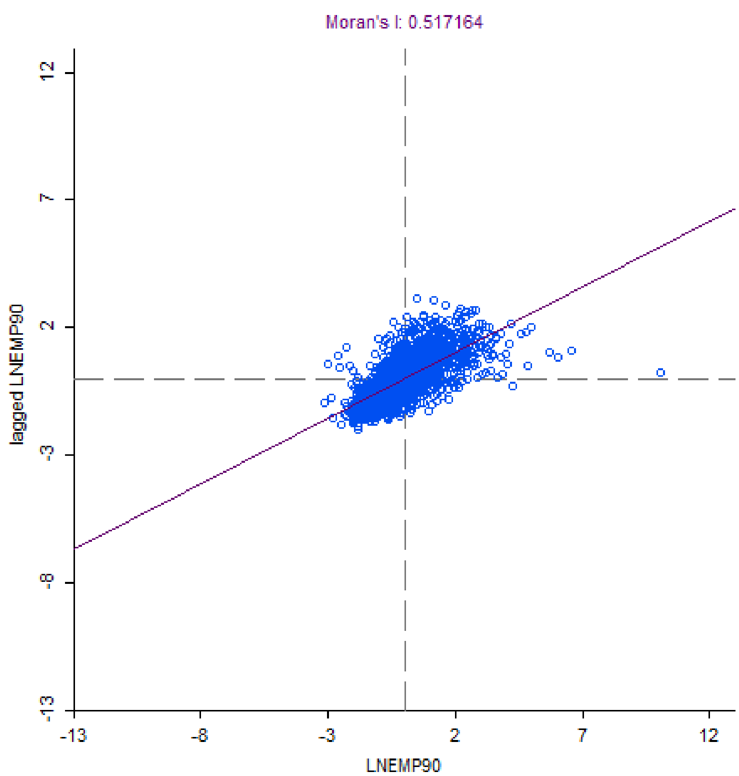


Figure 4.23: Moran’s I for 1980−1990 White Population Change

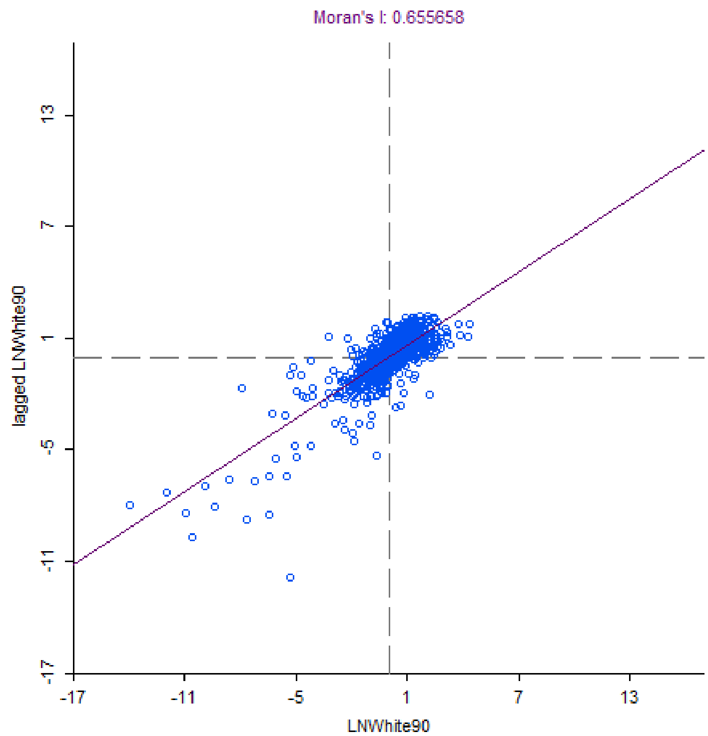


Figure 4.24: Moran’s I for 1980−1990 Black Population Change

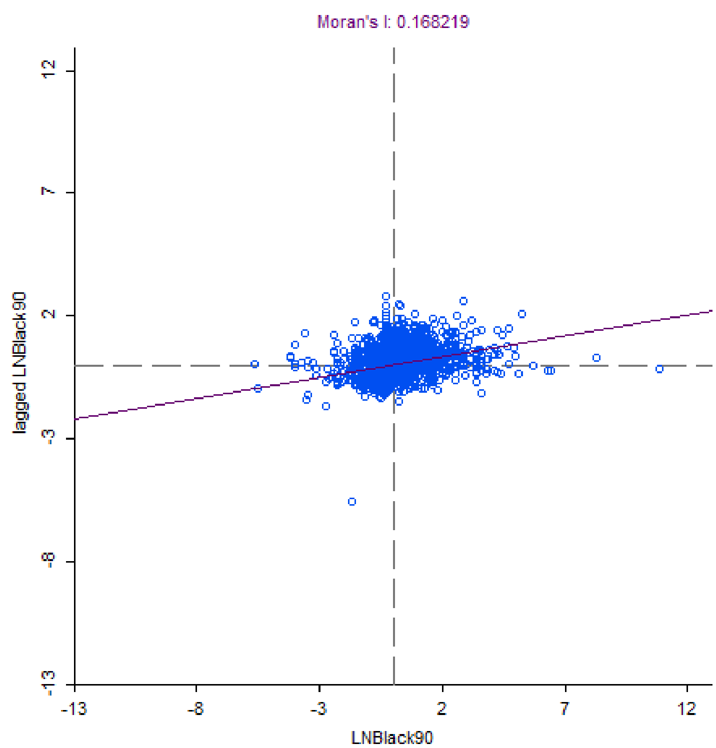


Figure 4.25: Moran's I for 1980−1990 Young Population Change

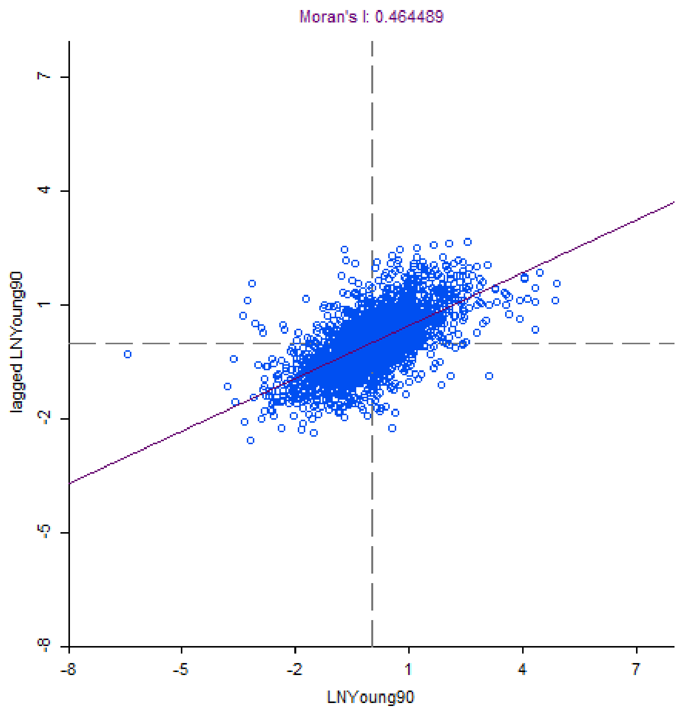


Figure 4.26: Moran's I for 1980−1990 Old Population Change

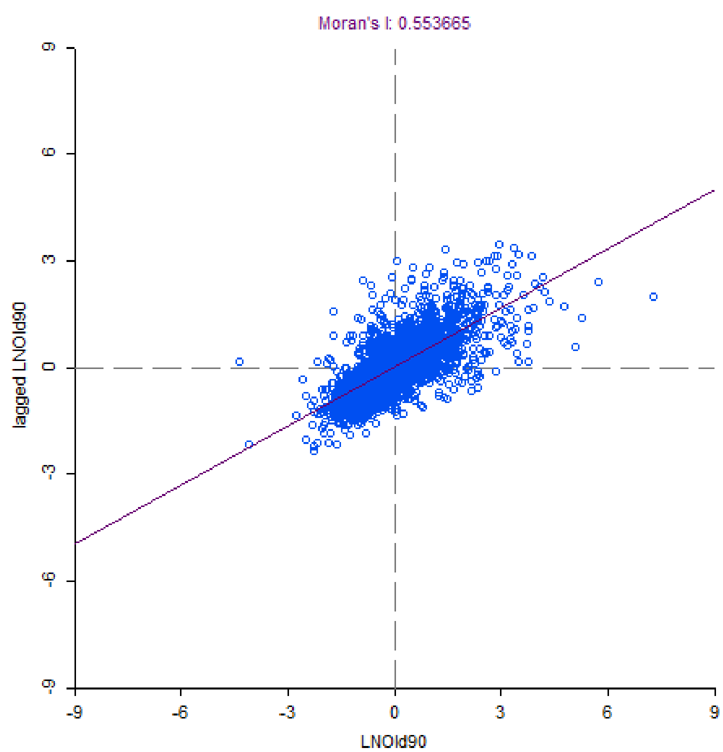


Figure 4.27: Moran's I for 1980−1990 High School Diploma Population Change

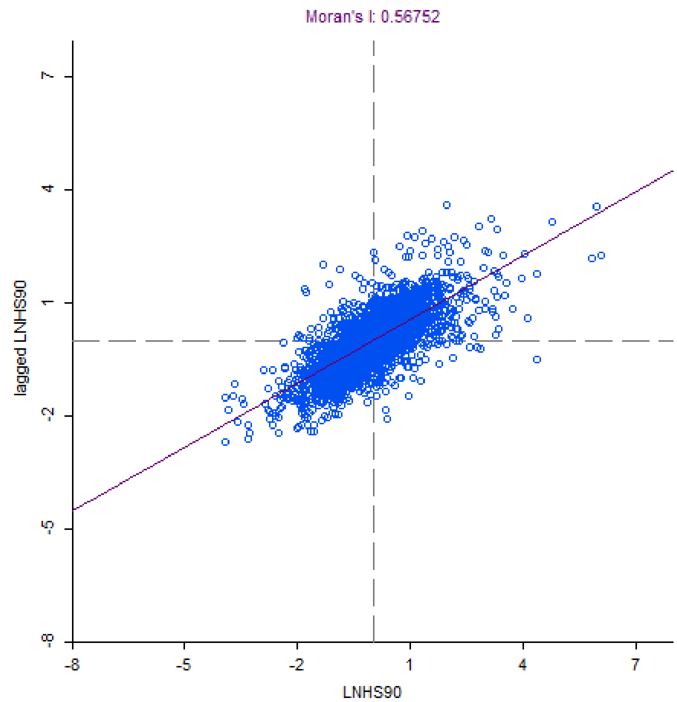


Figure 4.28: Moran's I for 1980−1990 Bachelor's Degree Population Change

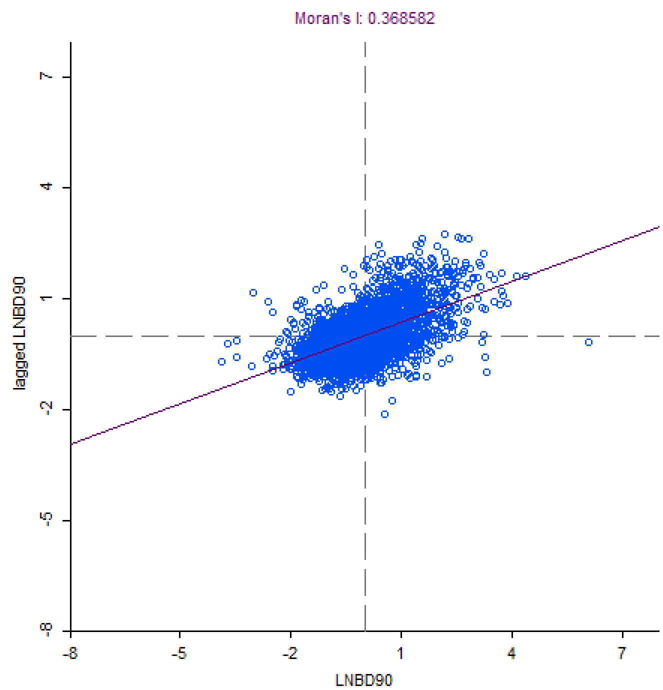


Figure 4.29: Moran's I for 17980−1990 Graduate Degree Population Change

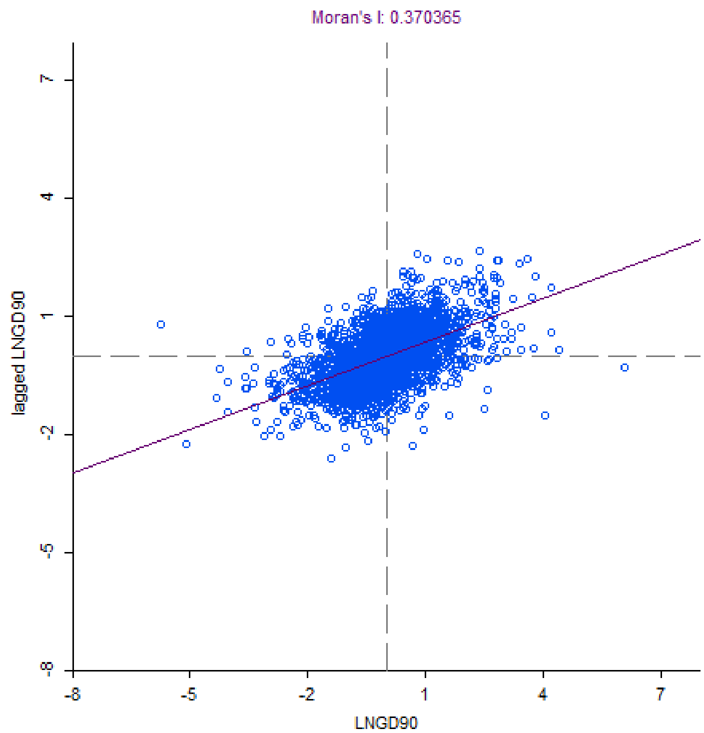


Figure 4.30: Moran's I for 1980−1990 Median Household Income Change

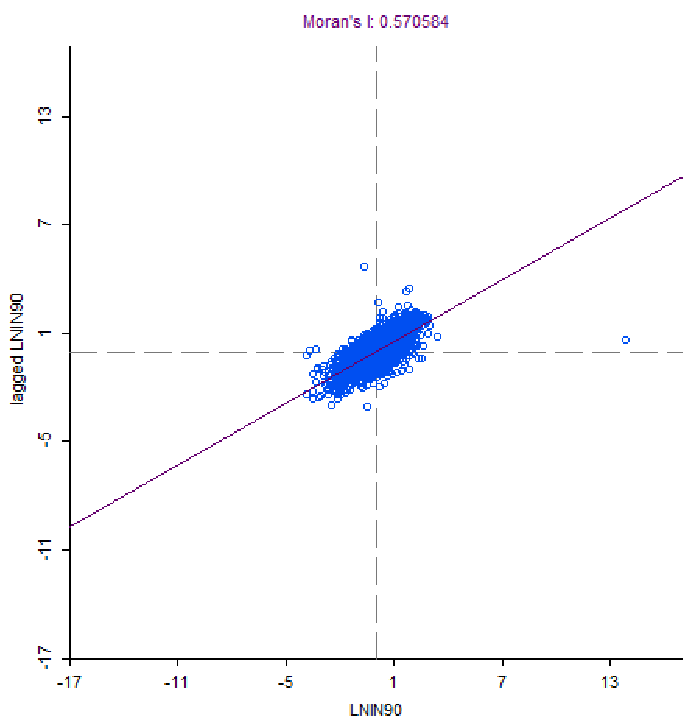


Figure 4.31: LISA Cluster Map of Population Change from 1980 to 1990 at the County Level in the Continental United States

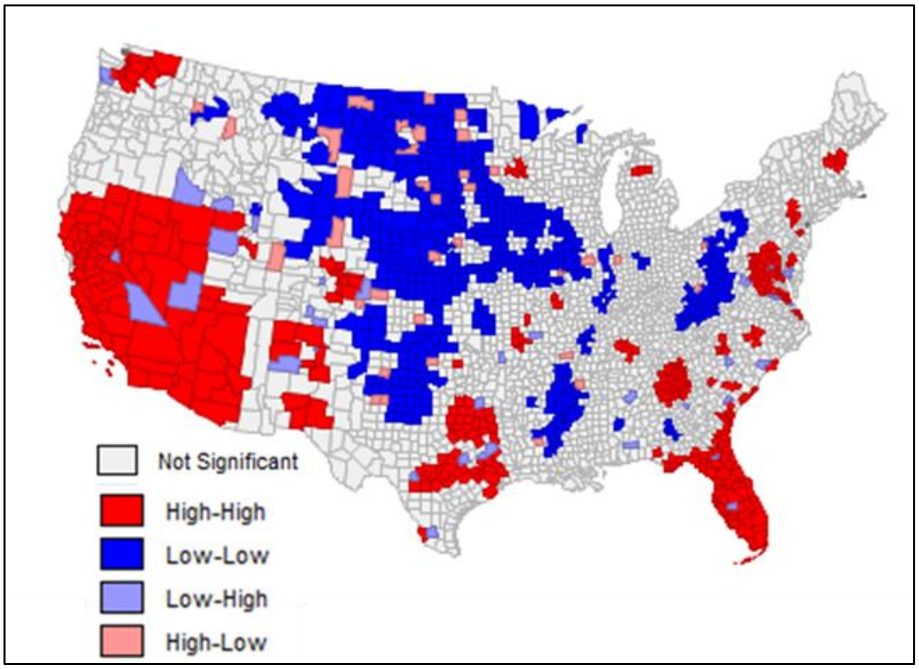


Figure 4.32: LISA Cluster Map of Employment Change from 1980 to 1990 at the County Level in the Continental United States

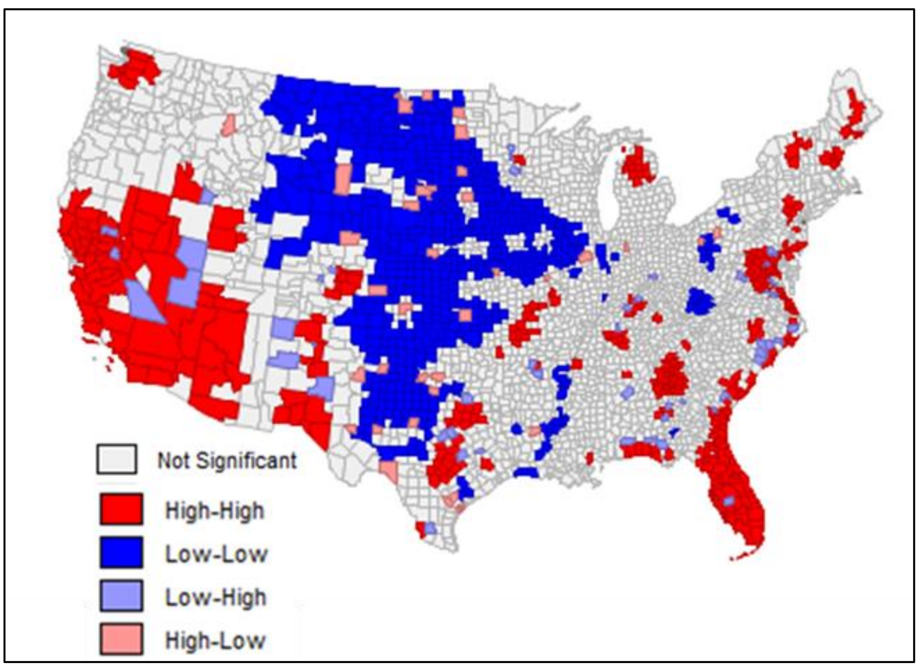


Figure 4.33: LISA Cluster Map of White Population Change from 1980 to 1990 at the County Level in the Continental United States

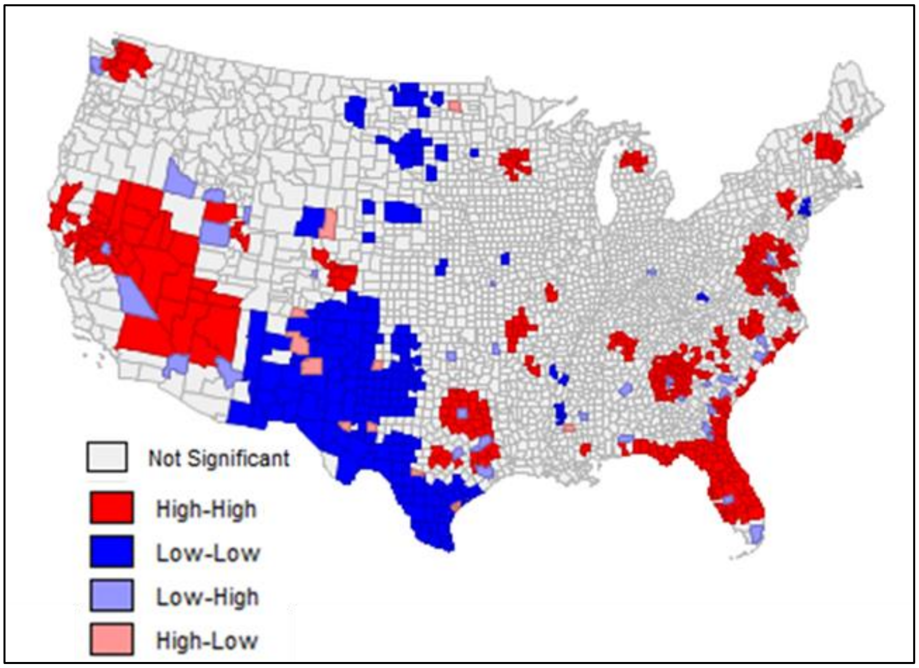


Figure 4.34: LISA Cluster Map of Black Population Change from 1980 to 1990 at the County Level in the Continental United States

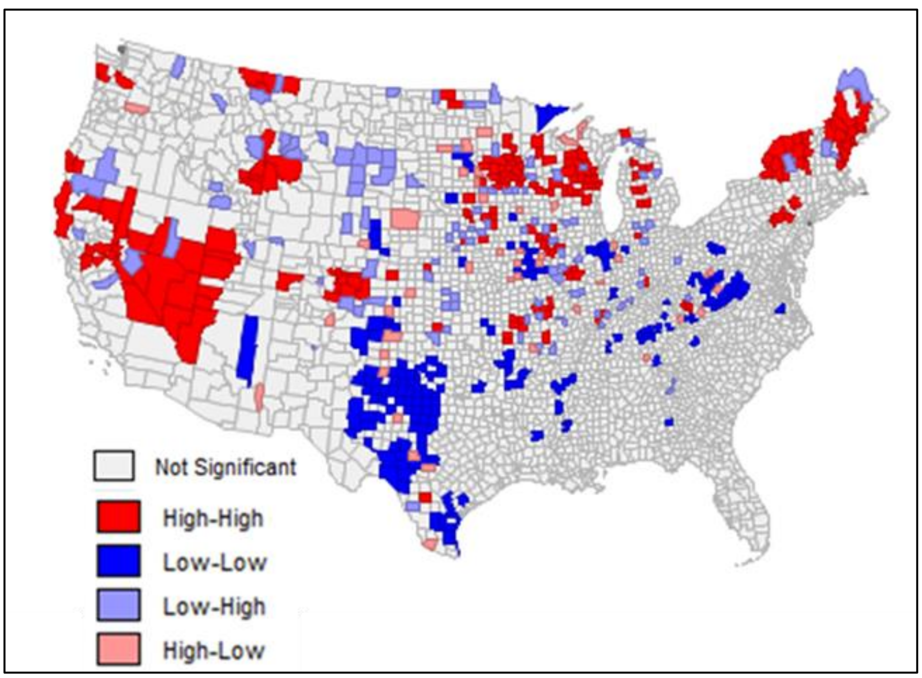


Figure 4.35: LISA Cluster Map of Young Population Change from 1980 to 1990 at the County Level in the Continental United States

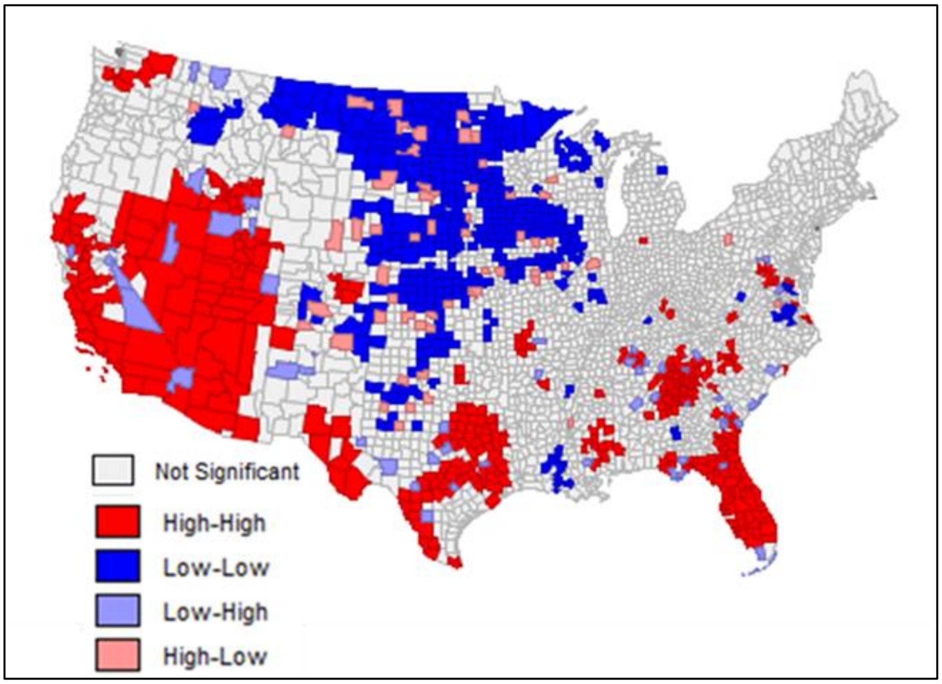


Figure 4.36: LISA Cluster Map of Old Population Change from 1980 to 1990 at the County Level in the Continental United States

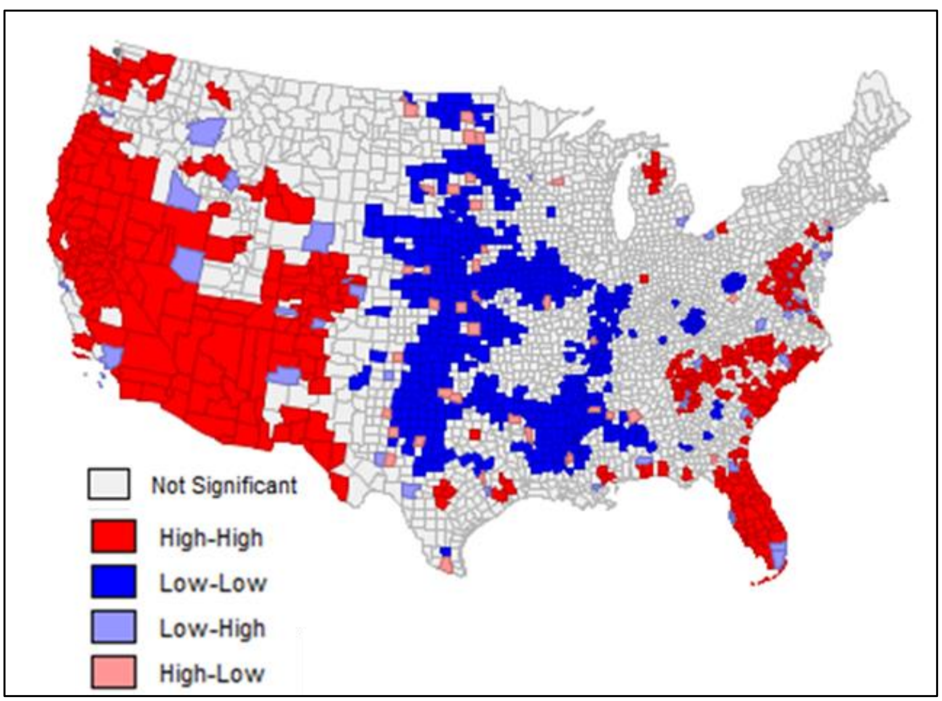


Figure 4.37: LISA Cluster Map of High School Diploma Population Change from 1980 to 1990 at the County Level in the Continental United States

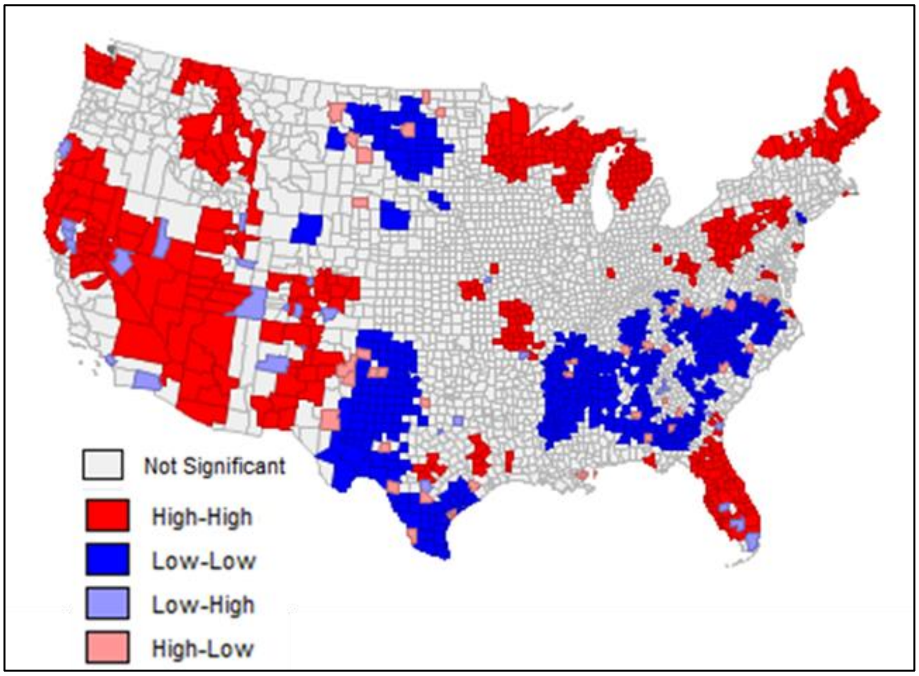


Figure 4.38: LISA Cluster Map of Bachelor's Degree Population Change from 1980 to 1990 at the County Level in the Continental United States

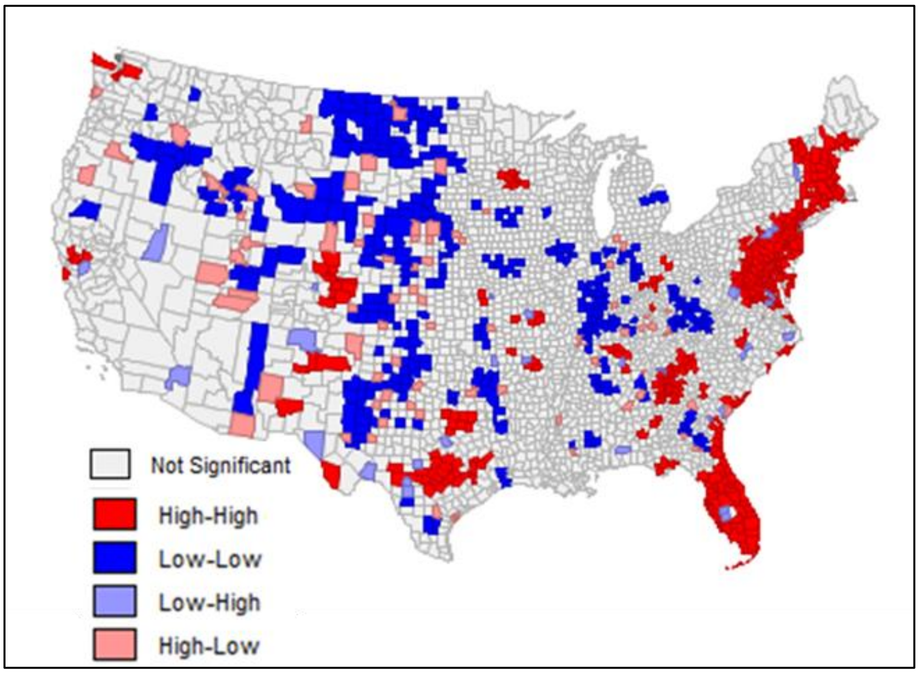


Figure 4.39: LISA Cluster Map of Graduate Degree Population Change from 1980 to 1990 at the County Level in the Continental United States

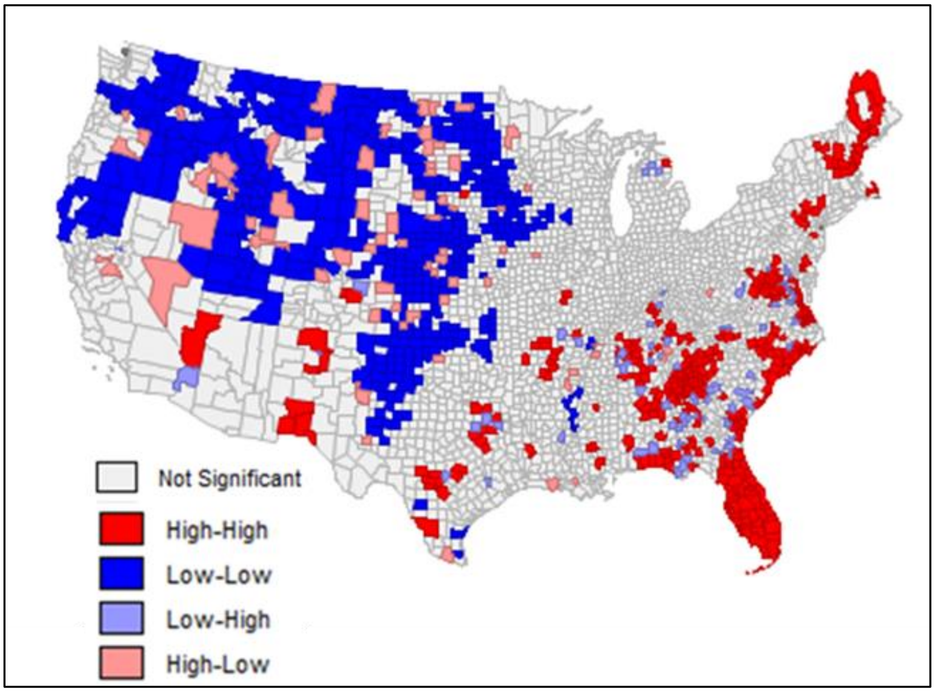


Figure 4.40: LISA Cluster Map of Median Household Income Change from 1980 to 1990 at the County Level in the Continental United States

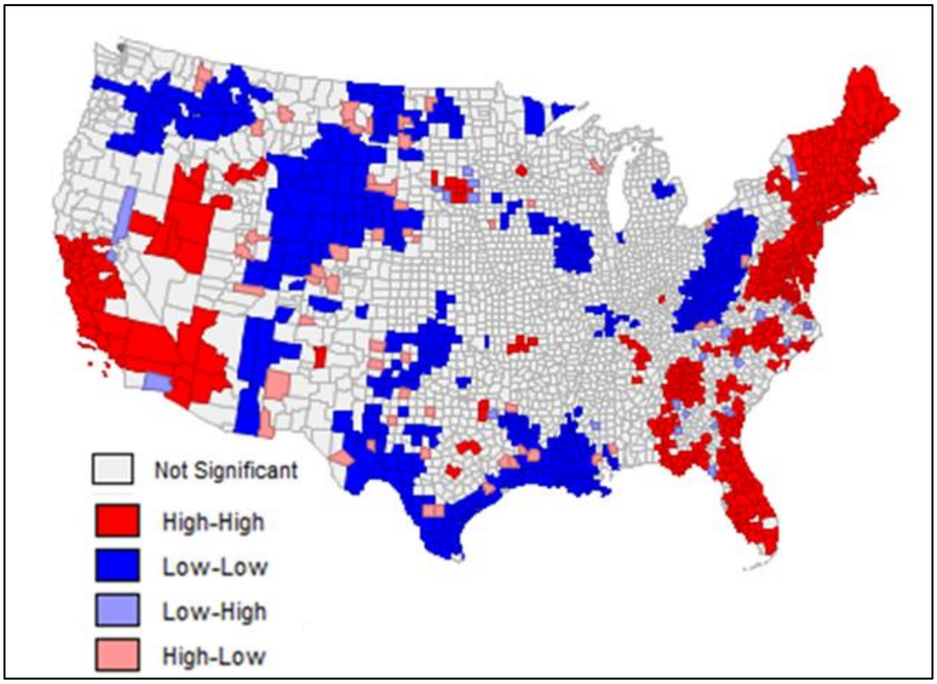


Table 4.4: Correlations Between Terminal Density and Other Variables for the Period of 1980-1990

Variables	Cor. Coefficient
Independent variable	
Terminal density	1
Dependent variables	
Population change (ln)	−0.039*
Employment change (ln)	−0.034
Young pop change (ln)	−0.048**
Old pop change (ln)	0.009
White pop change (ln)	−0.037*
Black pop change (ln)	−0.021
HS diploma pop change (ln)	−0.036*
BD pop change (ln)	0.064***
GD pop change (ln)	−0.005
Income change (ln)	−0.016
Control variables	
Highway density	0.579***
Airport number	0.194***
Prev. decade pop change rate	−0.141***
Population density 1980	0.358***
Prev. decade emp. change rate	−0.128***
Prev. decade young pop change rate	−0.122***
Prev. decade old pop change rate	−0.122***
Prev. decade White pop change rate	−0.174***
Prev. decade Black pop change rate	0.01
Prev. decade HS diploma pop change rate	−0.205***
Prev. decade BD pop change rate	−0.053**
Prev. decade GD pop change rate	−0.088***
Prev. decade income change rate	−0.206***
Young	0.001
Old	−0.130***
High school diploma	−0.067***
Bachelor’s degree	0.157***
Graduate degree	0.205***
White	−0.078***
Black	0.092***
Income	0.260***

Employment	0.114***
Metro	0.284***
West	−0.092***
Midwest	0.147***
Northeast	0.175***
South (reference)	−0.167***
Land developability index	−0.111***

* Significant at $p \leq 0.05$ for a two−tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

For the Period of 1990 to 2000

Table 4.5 presents mean, standard deviation, minimum values, and maximum values of all variables used in the analysis in the period 1990 to 2000. There are eleven dependent variables, and all of their minimum values are negative, except for employment. The maximum values for these variables are positive. The mean values for all dependent variables are positive, with employment being the highest (1.06) and White being the lowest (0.05). The table also contains one independent variable and twenty-eight control variables. Most of the average values for the previous decade’s change rates are positive, except for young, high school diploma, and bachelor’s degree. In this category, the average value of the population is lowest (0.04) and Black is highest (0.69). Moreover, all minimum values for the previous decade’s change rate are negative, and all maximum values are positive.

The average population density in 1990 is 225.39 per square mile, with a minimum of 0.16 and maximum pf 65,159.93. The composition of the old population in the population is higher (14.94%) than the young (7.40%). The population with a high school diploma is the highest (34.38%), followed by bachelor’s degree (9.03%) and graduate degree (4.49%). Among race and ethnicity, White is the largest group (84.90%), Black the second largest (8.57%), and Hispanic the smallest (4.49%). The average median household income in 1990 was $23,881.96. However, the value for median household income varies from $8,595 to $59,284. In 1990, the average value for the employment was 60.93 percent. In that year, the values for employment vary from 31.83 to 87.67 percent.

The values of Moran's I for dependent variables are shown in the scatter plots in Figures 4.41 through 4.51. The Moran's I values for population and employment change are 0.52 and 0.41, respectively. Similarly, the values for young and old population change are 0.47 and 0.49, respectively. Among race and ethnicity, the Moran's I values for White is the highest (0.46), followed by Black (0.23) and Hispanic (0.41). The Moran's I value for the population with a high school diploma is the highest (0.53), with bachelor's degree the second highest (0.26) and graduate degree the lowest (0.19). The Moran's I value for median household income change is 0.36. These figures show all dependent variables are positive and spatially correlated. The visual presentations of the spatial correlations are shown in LISA cluster maps in Figures 4.52 through 4.62. These figures present counties with high and low values grouped together.

Table 4.6 shows the correlations between freight rail terminal density and all other used variables in the analysis. The relationship of freight rail with all dependent variables is negative and significant. The relationship with population density is positive and significant (0.345). Among the previous decade's change rate, freight rail has a negative relationship with every variable except high school diploma. In addition, all correlation coefficient values are significant except for old, Black, and graduate degree. Similarly, freight rail has a significant relationship with all demographic and socioeconomic control variables except young and Hispanic. Interestingly, graduate degree has the strongest (0.227) relationship.

Table 4.5: 1990−2000 Descriptive Statistics of the Dependent and Independent Variables (N = 3109)

Variables	Mean	Stan Dev	Min	Max
Dependent variables				
Population change (ln)	0.10	0.13	−0.47	1.07
Employment change (ln)	1.06	0.16	0.22	2.84
Young pop change (ln)	0.12	0.17	−1.20	0.99
Old pop change (ln)	0.09	0.15	−0.32	1.07
White pop change (ln)	0.05	0.14	−0.49	1.01
Black pop change (ln)	0.39	0.67	−1.95	5.58
Hispanic pop change (ln)	0.79	0.59	−1.26	4.47
High school diploma pop change (ln)	0.13	0.15	−0.87	0.78
Bachelor’s degree pop change (ln)	0.32	0.21	−0.51	1.68
Graduate degree pop change (ln)	0.34	0.27	−1.23	2.08
Median HH Income change (ln)	0.40	0.09	−0.36	0.75
Independent variables				
Terminal density	1.71	2.69	0.00	49.22
Control variables				
Highway density	6.42	3.64	0.00	46.00
Airport number	1.51	1.60	0.00	17.00
Prev. decade pop change rate (1980−1990)	0.04	0.17	−0.32	1.63
Prev. decade emp. change rate (1980−1990)	0.22	0.27	−0.32	6.26
Prev. decade young pop change rate (1980−1990)	−0.18	0.15	−0.74	0.90
Prev. decade old pop change rate (1980−1990)	0.18	0.21	−0.41	2.67
Prev. decade White pop change rate (1980−1990)	0.00	0.19	−0.96	1.60
Prev. decade Black pop change rate (1980−1990)	0.69	10.10	−1.00	539.00
Prev. decade HS diploma pop change rate (1980−1990)	−0.01	0.23	−0.58	2.52
Prev. decade BD pop change rate (1980−1990)	−0.24	0.24	−1.00	2.92
Prev. decade GD pop change rate (1980−1990)	0.36	0.50	−0.81	8.48
Prev. decade income change rate (1980−1990)	0.68	0.23	0.04	7.79
Population density 1990	225.39	1596.32	0.16	65159.93
Young pop percent 1990	7.40	1.30	3.43	23.12
Old pop percent 1990	14.94	4.34	1.39	34.09
HS diploma pop percent 1990	34.38	6.14	13.67	53.25
BD pop percent 1990	9.03	4.23	0.00	40.68
GD pop percent 1990	4.49	2.75	0.35	29.80
White pop percent 1990	84.90	17.77	2.47	99.85
Black pop percent 1990	8.57	14.32	0.00	85.87
Hispanic pop percent 1990	4.49	11.10	0.00	97.22
Median HH income 1990	23881.96	6493.14	8595.00	59284.00
Employed percent 1990	60.93	6.80	31.83	87.67
Metro	0.36	0.48	0.00	1.00
West	0.13	0.34	0.00	1.00
Midwest	0.34	0.47	0.00	1.00
Northeast	0.07	0.26	0.00	1.00
South (reference)	0.46	0.50	0.00	1.00
Land developability index	70.75	26.56	0.00	99.88

Figure 4.41: Moran's I for 1990−2000 Population Change

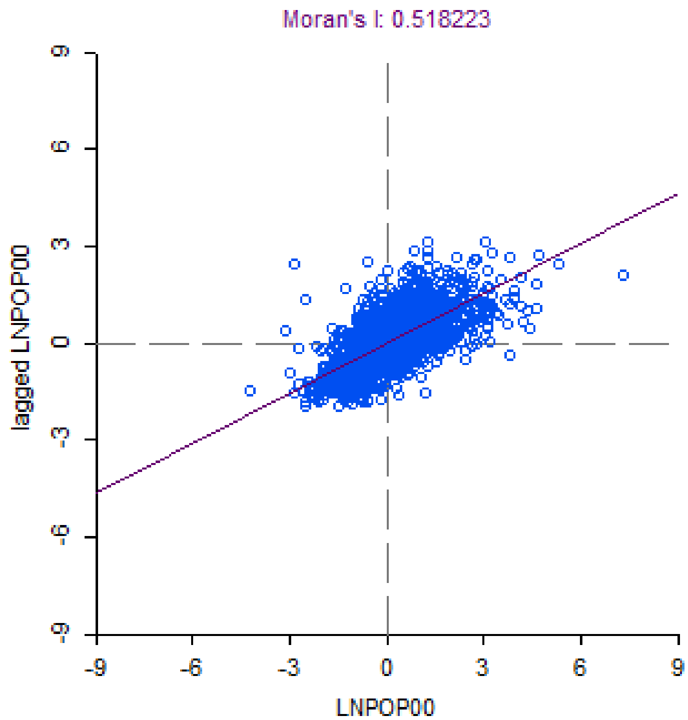


Figure 4.42: Moran's I for 1990−2000 Employment Change

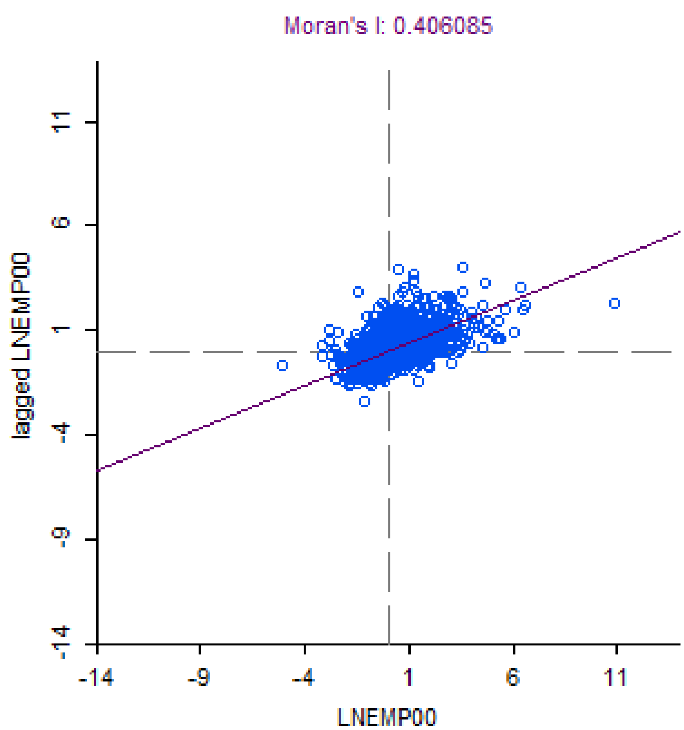


Figure 4.43: Moran's I for 1990−2000 Young Population Change

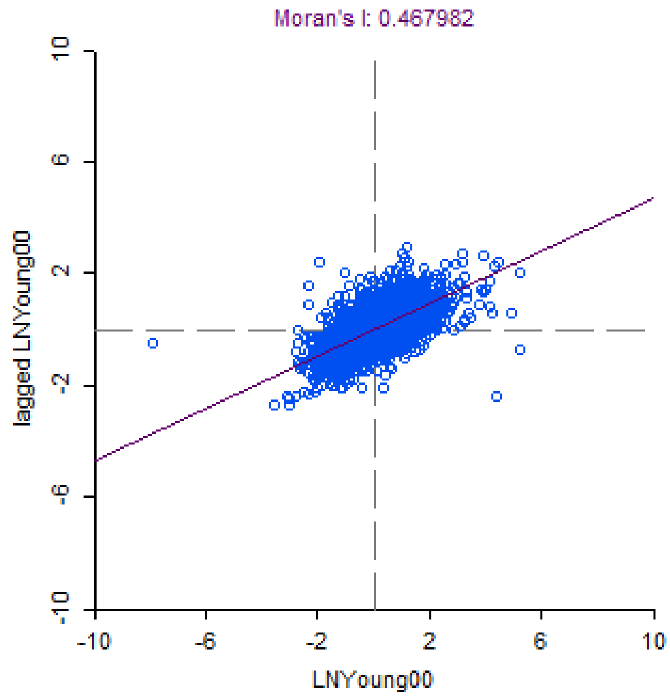


Figure 4.44: Moran's I for 1990−2000 Old Population Change

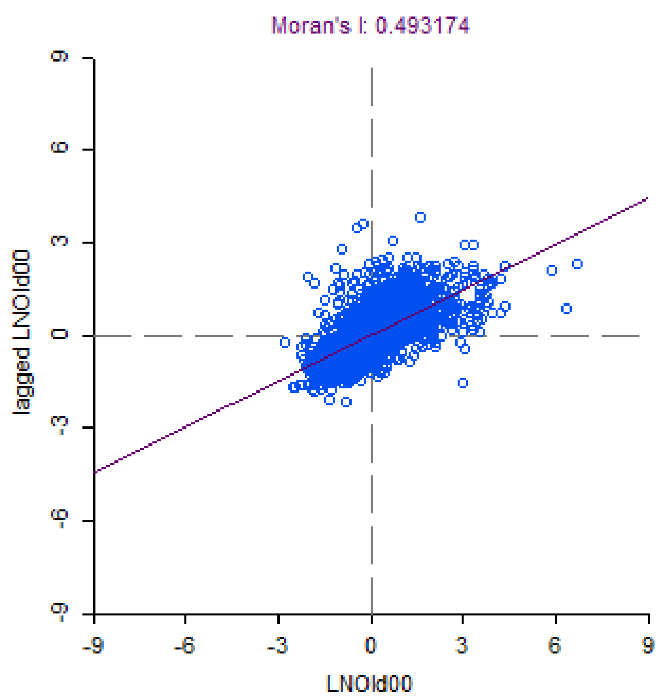


Figure 4.45: Moran's I for 1990−2000 White Population Change

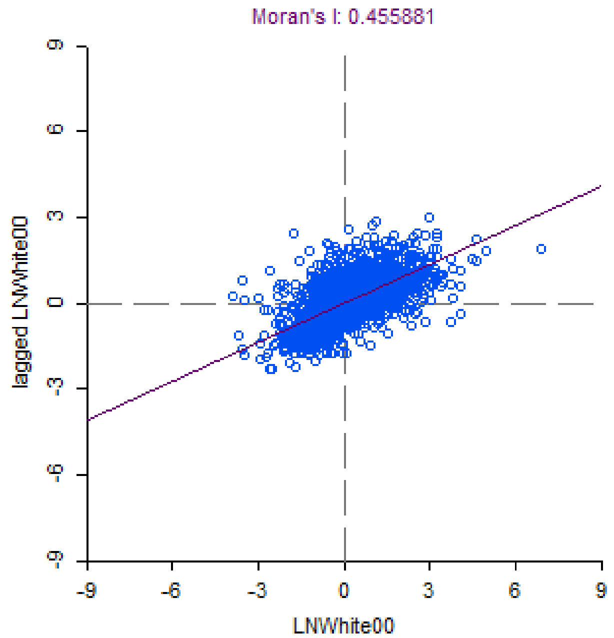


Figure 4.46: Moran's I for 1990−2000 Black Population Change

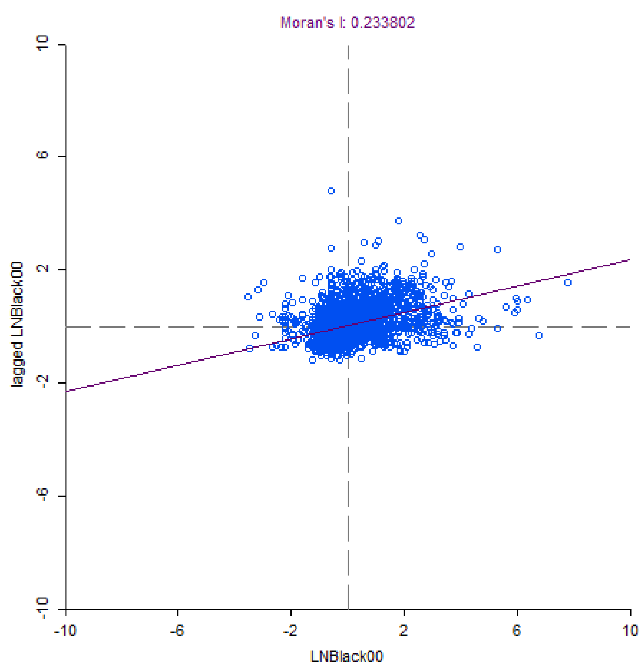


Figure 4.47: Moran's I for 1990−2000 Hispanic Population Change

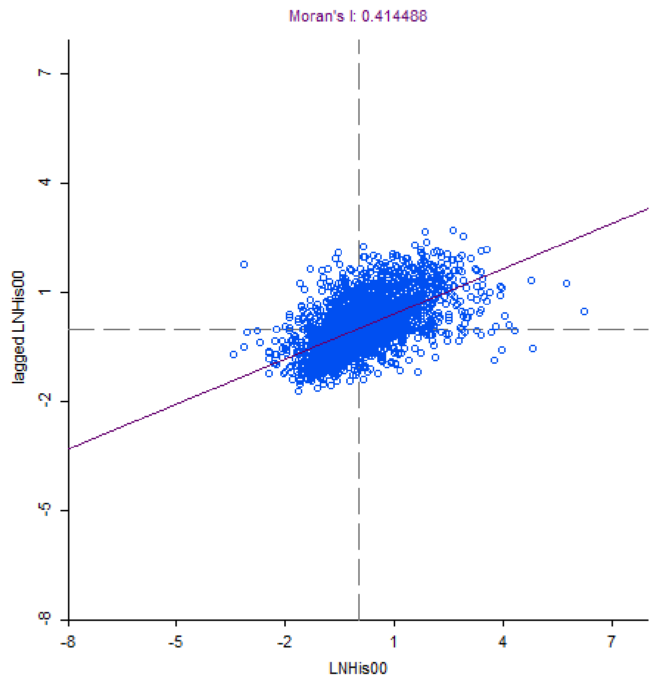


Figure 4.48: Moran's I for 1990−2000 High School Diploma Population Change

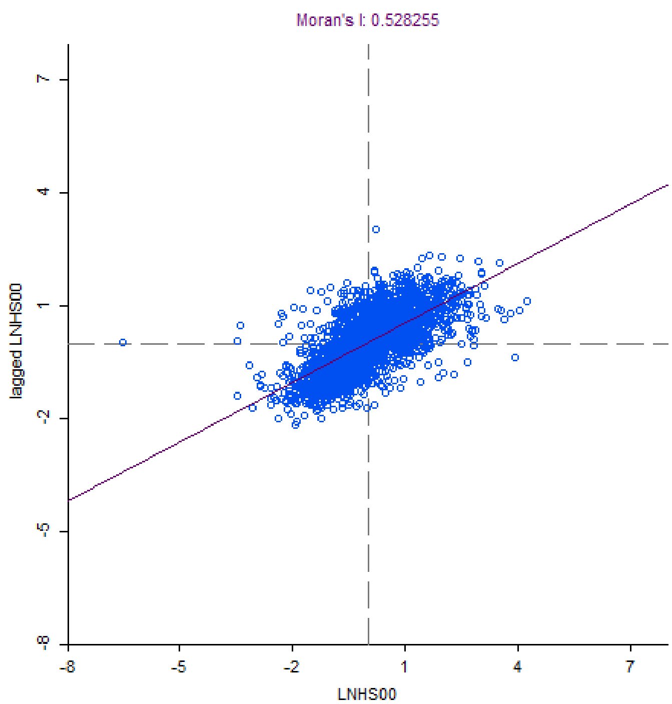


Figure 4.49: Moran's I for 1990−2000 Bachelor's Degree Population Change

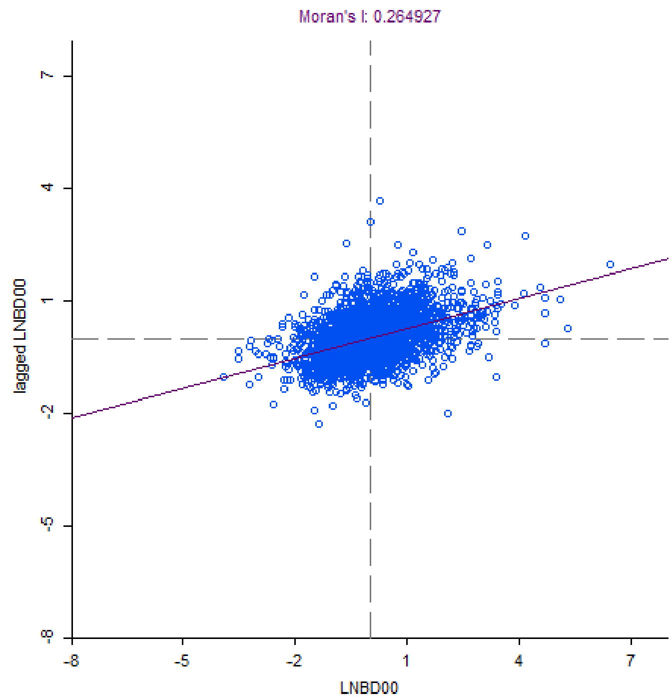


Figure 4.50: Moran's I for 1990−2000 Graduate Degree Population Change

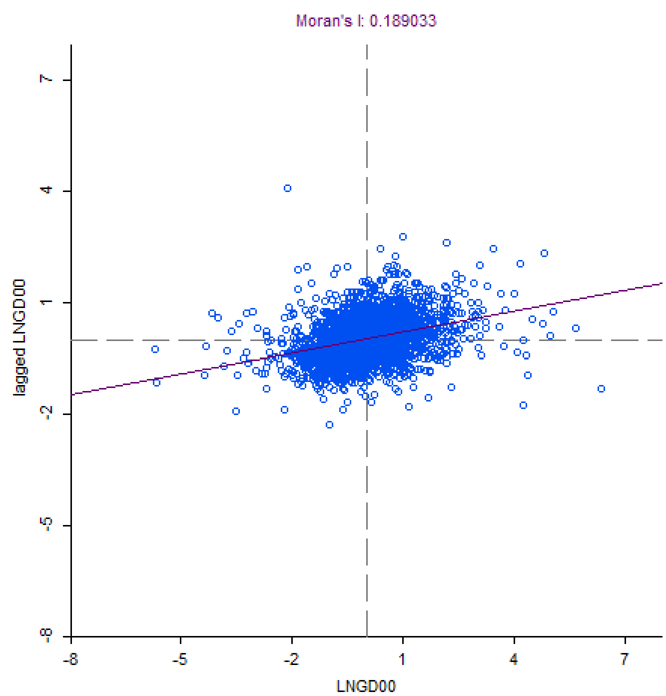


Figure 4.51: Moran's I for 1990−2000 Median Household Income Change

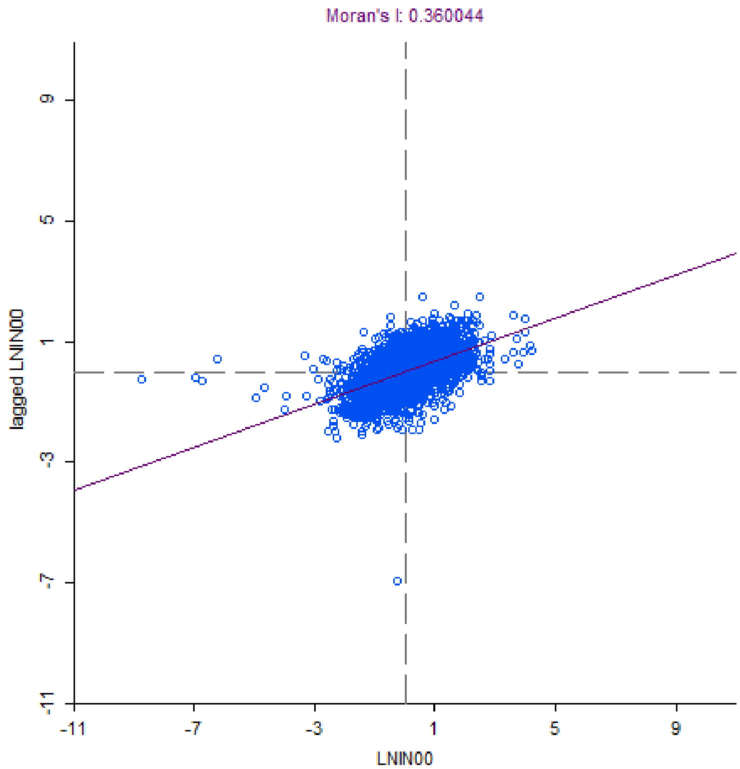


Figure 4.52: LISA Cluster Map of Population Change from 1990 to 2000 at the County Level in the Continental United States

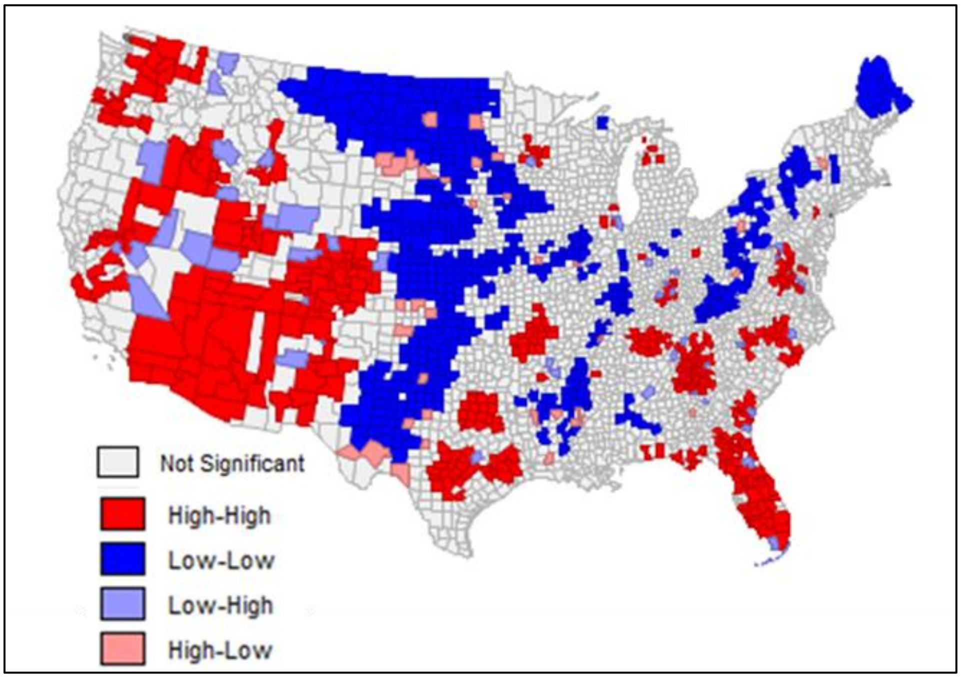


Figure 4.53: LISA Cluster Map of Employment Change from 1990 to 2000 at the County Level in the Continental United States

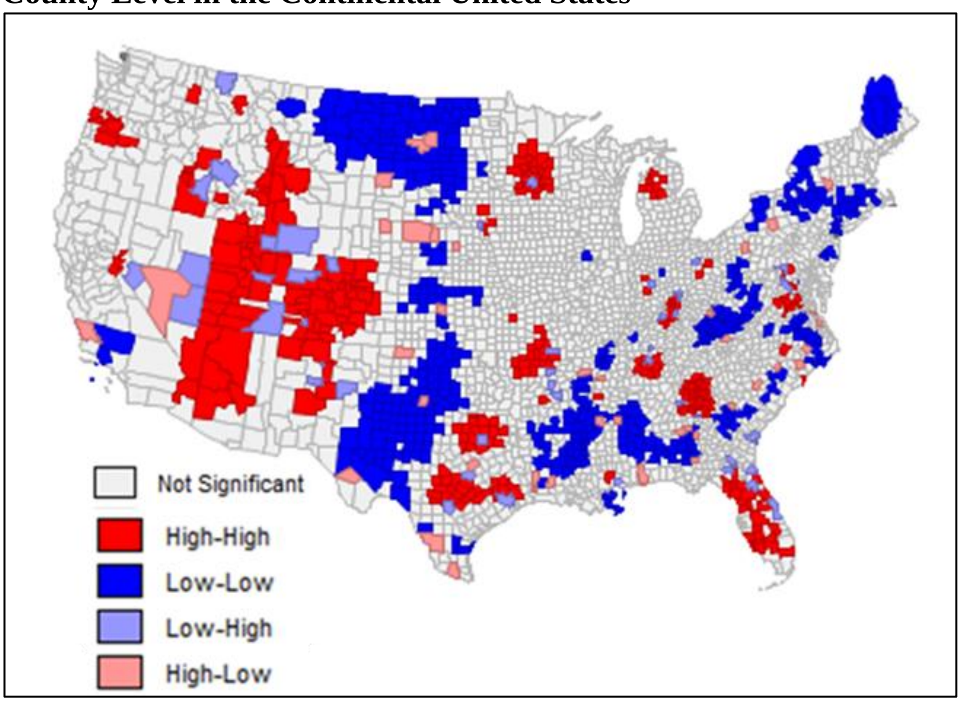


Figure 4.54: LISA Cluster Map of White Population Change from 1990 to 2000 at the County Level in the Continental United States

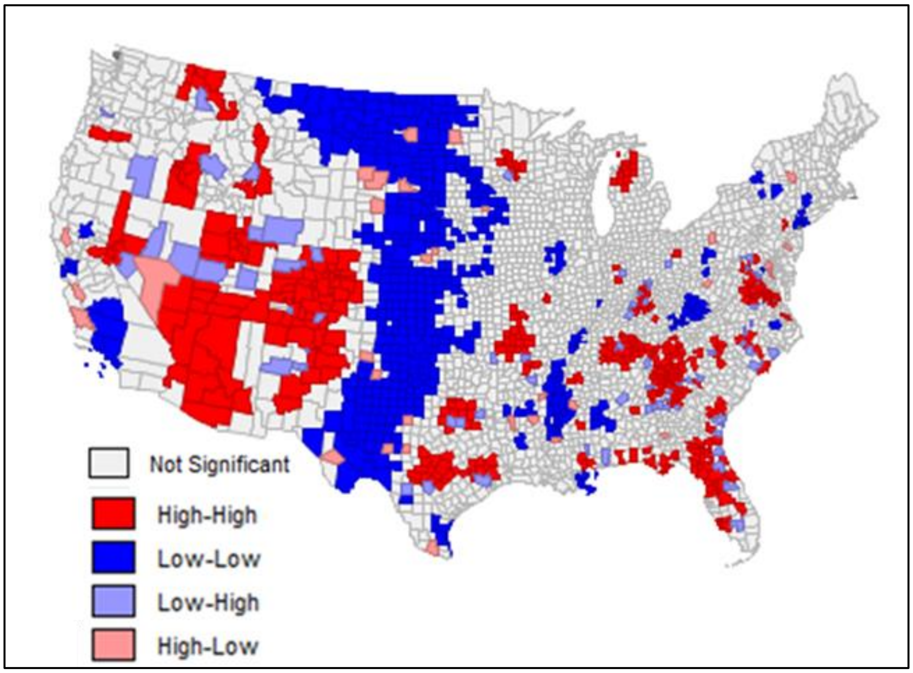


Figure 4.55: LISA Cluster Map of Black Population Change from 1990 to 2000 at the County Level in the Continental United States

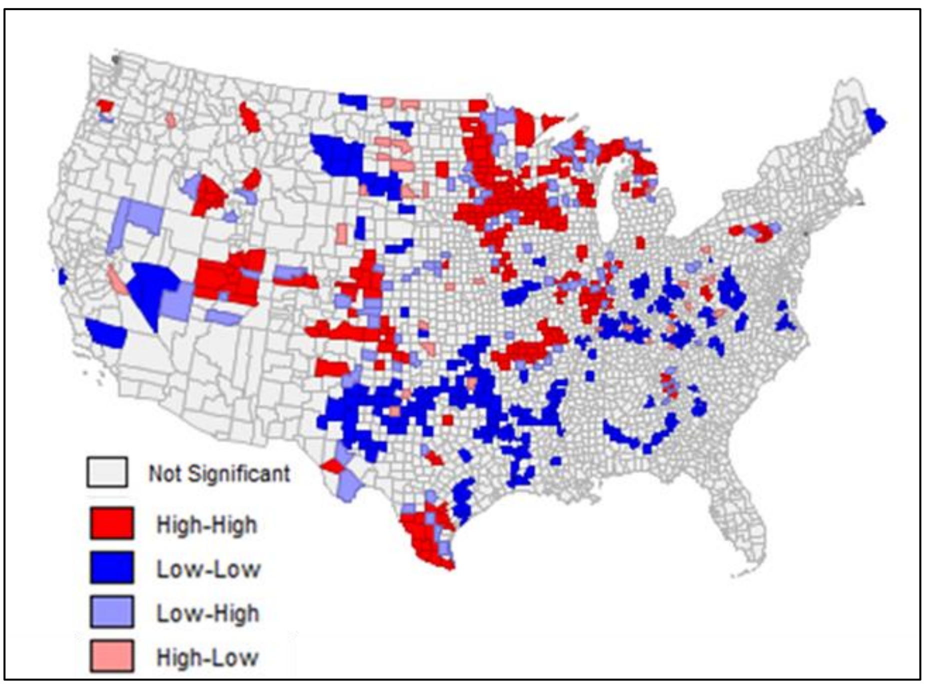


Figure 4.56: LISA Cluster Map of Hispanic Population Change from 1990 to 2000 at the County Level in the Continental United States

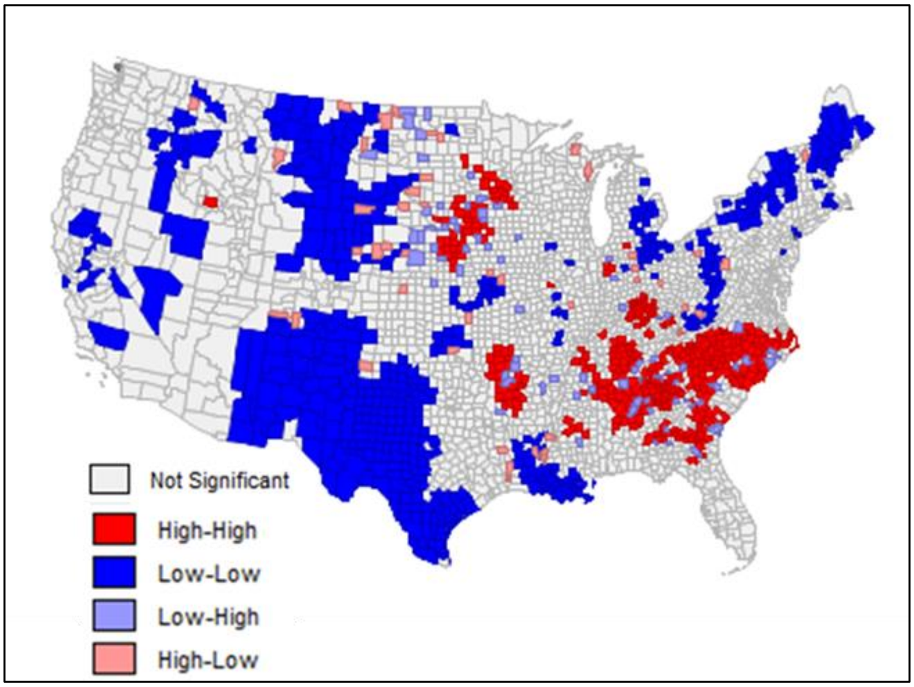


Figure 4.57: LISA Cluster Map of Young Population Change from 1990 to 2000 at the County Level in the Continental United States

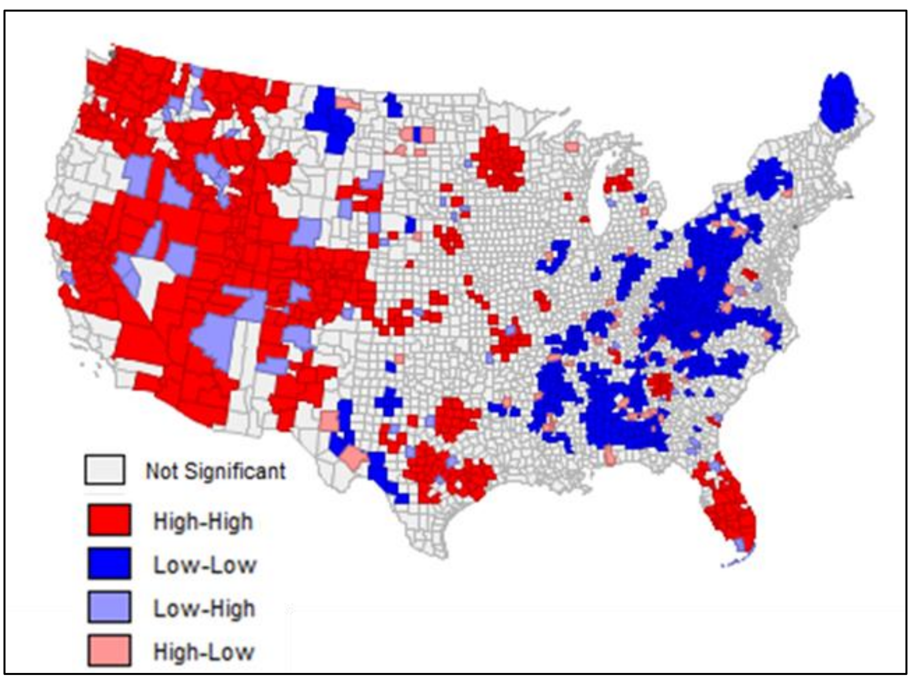


Figure 4.58: LISA Cluster Map of Old Population Change from 1990 to 2000 at the County Level in the Continental United States

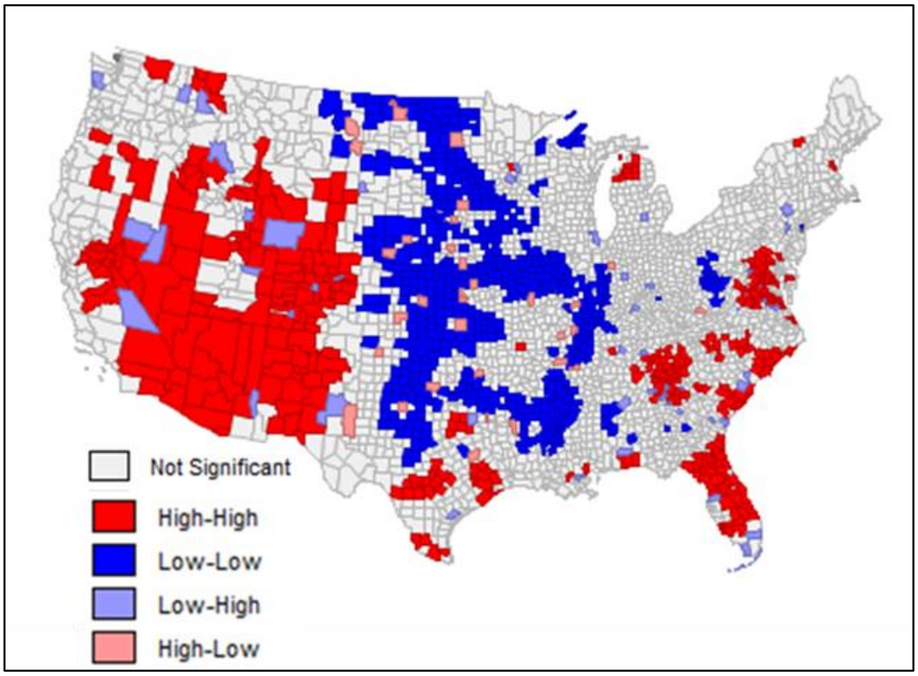


Figure 4.59: LISA Cluster Map of High School Diploma Population Change from 1990 to 2000 at the County Level in the Continental United States

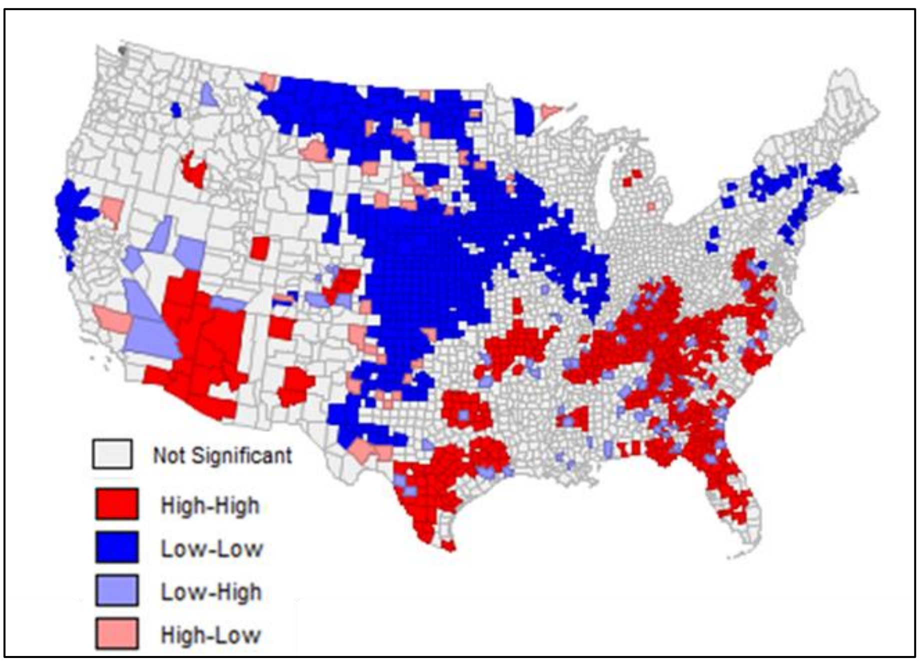


Figure 4.60: LISA Cluster Map of Bachelor's Degree Population Change from 1990 to 2000 at the County Level in the Continental United States

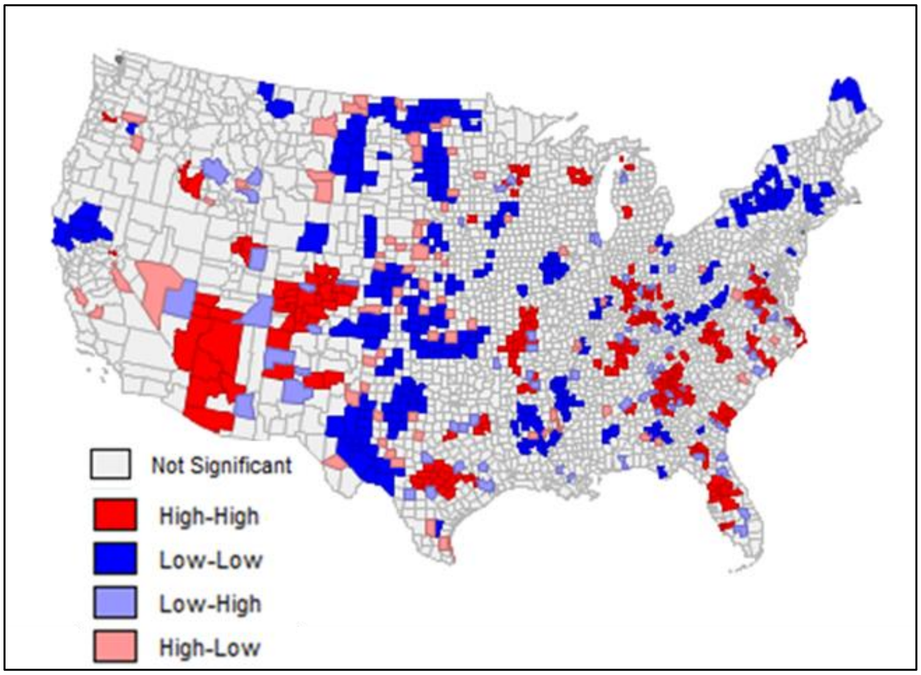


Figure 4.61: LISA Cluster Map of Graduate Degree Population Change from 1990 to 2000 at the County Level in the Continental United States

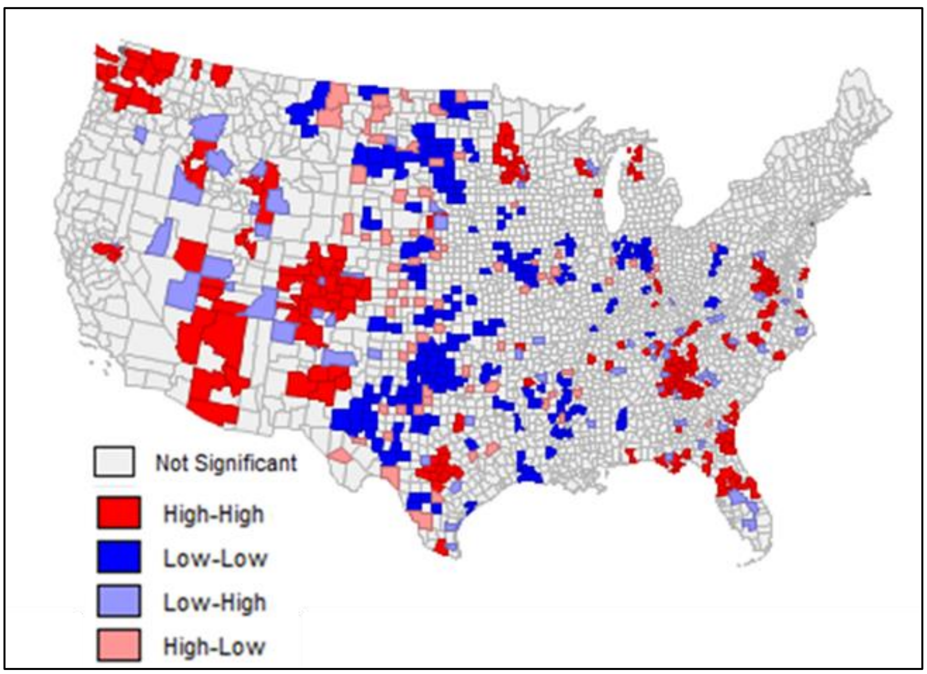


Figure 4.62: LISA Cluster Map of Median Household Income Change from 1990 to 2000 at the County Level in the Continental United States

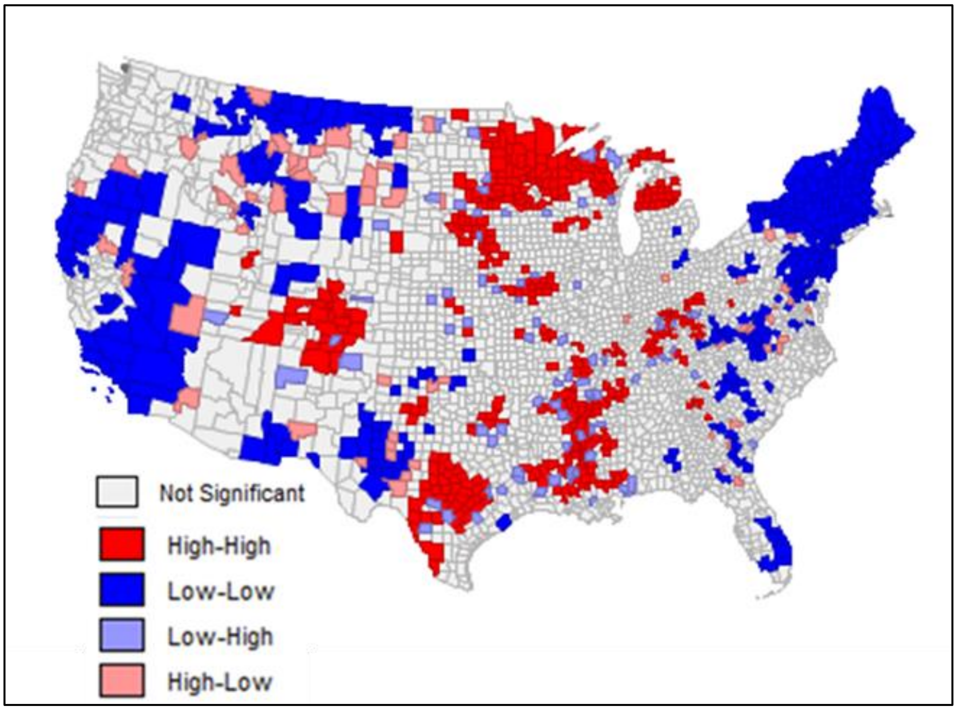


Table 4.6: Correlations Between Freight Rail Terminal Density and Other Variables for the Period of 1990–2000

Variables	Cor. Coefficient
Independent Variable	
Terminal density	1
Dependent Variables	
Population change (ln)	−0.114***
Employment change (ln)	−0.150***
Young pop change (ln)	−0.131***
Old pop change (ln)	−0.100***
White pop change (ln)	−0.200***
Black pop change (ln)	−0.065***
Hispanic pop change (ln)	−0.085***
HS diploma pop change (ln)	−0.208***
BD pop change (ln)	−0.128***
GD pop change (ln)	−0.104***
Income change (ln)	−0.196***
Control Variables	
Highway density	0.579***
Airport number	0.194***
Prev. decade pop change rate	−0.046*
Population density 1990	0.345***
Prev. decade emp. change rate	−0.041*
Prev. decade young pop change rate	−0.061***
Prev. decade old pop change rate	−0.004
Prev. decade White pop change rate	−0.069***
Prev. decade Black pop change rate	−0.017
Prev. decade Hispanic pop change rate	−0.051**
Prev. decade HS diploma pop change rate	0.043*
Prev. decade BD pop change rate	−0.049**
Prev. decade GD pop change rate	−0.015
Young	−0.018
Old	−0.114***
High school	−0.051**
Bachelor’s degree	0.192***
Graduate degree	0.227***
White	−0.082***

Black	0.113***
Hispanic	−0.008
Income	0.220***
Employed percent	0.129***
Metro	0.284***
West	−0.092***
Midwest	0.147***
Northeast	0.175***
South (reference)	−0.167***
Land developability index	−0.111***

* Significant at $p \leq 0.05$ for a two−tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

For the Period of 2000 to 2010

Table 4.7 presents the descriptive statistics for the dependent, independent, and control variables used in the analysis for the period of 2000 to 2010. The table shows mean, standard deviation, minimum values, and maximum values for all variables. In this period, there are eleven dependent variables, one independent variable, and thirty control variables. The mean values for all dependent variables are positive, except for young population. Similarly, the minimum values for all dependent variables are negative, and maximum values are positive. The mean and maximum values for the population change rate of the previous decade is positive. On the other hand, minimum values for the previous decade's change rate are negative.

In 2000, the population density was 245.75, with variation from 0.10 to 67,335.19 per square mile. The composition of the old (14.81%) in the population is higher than the young (7.58%). The average value for the population with a high school diploma is the highest (34.70%), followed by bachelor's degree (10.96%) and graduate degree (5.55%). Among race and ethnicity, the White population is largest (81.62%), and the Hispanic population is the smallest (6.21%), with the Black population in the middle (10.96%). The average median household income in 2000 was $35,270.40, and its values vary from $12,692 to $82,929. For that year, the average employment value is 57.19 percent, but the variation of employment ranges from 20.90 to 83.60 percent.

Moran's I is used to analyze global spatial correlation; its values for the dependent variables are shown in the Moran's I scatter plots in Figures 4.63 through 4.73. The Moran's I values for population, employment, young, old, White, Black, Hispanic, high school diploma, bachelor's degree, graduate degree, and median household income are 0.46, 0.41, 0.36, 0.46, 0.39, 0.06, 0.19, 0.32, 0.16, 0.12, and 0.37, respectively. All dependent variables used in this period are spatially correlated, and the direction is positive—indicating that counties with high and low values are grouped together. The visual presentations of the local-level spatial correlation are shown in the LISA cluster maps in Figures 4.74 through 4.84. The maps clearly show that counties with high values and low values are clustered together (shown in red and blue, respectively).

Table 4.8 presents the correlations between freight rail terminal density and the dependent and control variables. Freight rail terminal density has a mostly negative relationship with dependent variables, except for young and Hispanic. Most values are significant, except population, Black, and graduate degree. The correlation coefficient value with population density is 0.335. All correlation values for the previous decade's change rates are negative and significant. In the demographic and socioeconomic category, all values are significant, except for Hispanic (0.006).

Table 4.7: 2000−2010 Descriptive Statistics of the Dependent and Independent Variables (N = 3109)

Variables	Mean	Stan Dev	Min	Max
Dependent variables				
Population change (ln)	0.04	0.12	−0.63	0.74
Employment change (ln)	0.05	0.13	−0.65	0.84
Young pop change (ln)	−0.02	0.20	−2.32	0.79
Old pop change (ln)	0.09	0.14	−1.17	0.96
White pop change (ln)	0.00	0.11	−1.08	0.60
Black pop change (ln)	0.16	0.65	−4.88	5.03
Hispanic pop change (ln)	0.40	0.51	−3.68	3.60
High school diploma pop change (ln)	0.09	0.13	−1.34	0.74
Bachelor’s degree pop change (ln)	0.20	0.20	−0.90	1.07
Graduate degree pop change (ln)	0.20	0.27	−1.54	2.10
Median HH Income change (ln)	0.24	0.34	−0.86	1.49
Independent variables				
Terminal density	1.71	2.694	0.00	49.00
Control variables				
Highway density	6.42	3.64	0.00	46.00
Airport number	1.51	1.60	0.00	17.00
Prev. decade pop change rate (1990−2000)	0.11	0.16	−0.37	1.91
Prev. decade emp. change rate (1990−2000)	0.06	0.16	−0.78	1.84
Prev. decade young pop change rate (1990−2000)	0.15	0.20	−0.70	1.70
Prev. decade old pop change rate (1990−2000)	0.11	0.18	−0.28	1.90
Prev. decade White pop change rate (1990−2000)	0.06	0.16	−0.39	1.75
Prev. decade Black pop change rate (1990−2000)	1.23	6.83	−1.00	263.00
Prev. decade Hispanic pop change rate (1990−2000)	1.76	3.17	−0.72	86.00
Prev. decade HS diploma pop change rate (1990−2000)	0.15	0.18	−0.58	1.17
Prev. decade BD pop change rate (1990−2000)	0.42	0.34	−0.40	4.36
Prev. decade GD pop change rate (1990−2000)	0.47	0.47	−0.71	7.00
Prev. decade income change rate (1990−2000)	0.49	0.13	−0.30	1.12
Population density 2000	245.75	1681.36	0.10	67335.19
Young pop percent 2000	7.58	1.28	3.70	24.50
Old pop percent 2000	14.81	4.11	1.80	34.70
HS diploma pop percent 2000	34.70	6.58	10.90	53.20
BD pop percent 2000	10.96	4.92	0.00	40.00
GD pop percent 2000	5.55	3.31	0.90	36.00
White pop percent 2000	81.62	18.69	2.00	99.60

Black pop percent 2000	9.14	14.65	0.00	86.70
Hispanic pop percent 2000	6.21	12.05	0.10	97.50
Median HH income 2000	35270.40	8837.27	12692.00	82929.00
Employed percent 2000	57.19	7.54	20.90	83.60
Metro	0.36	0.48	0.00	1.00
West	0.13	0.34	0.00	1.00
Midwest	0.34	0.47	0.00	1.00
Northeast	0.07	0.26	0.00	1.00
South (reference)	0.46	0.50	0.00	1.00
Land developability index	70.75	26.56	0.00	99.88

Figure 4.63: Moran's I for 2000–2010 Population Change

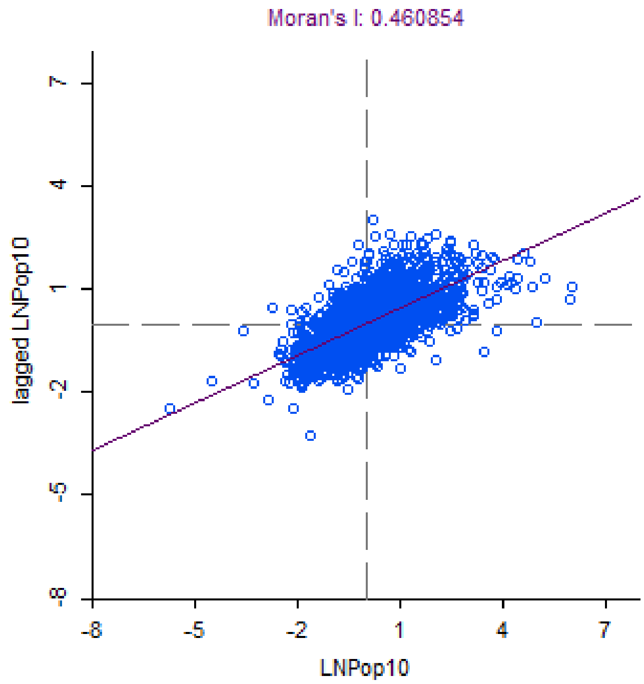


Figure 4.64: Moran's I for 2000–2010 Employment Change

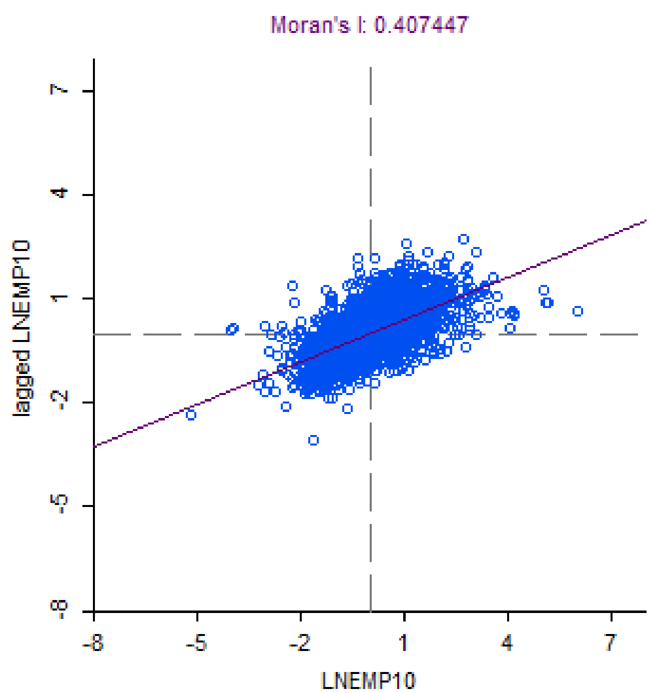


Figure 4.65: Moran's I for 2000−2010 Young Population Change (queen 1)

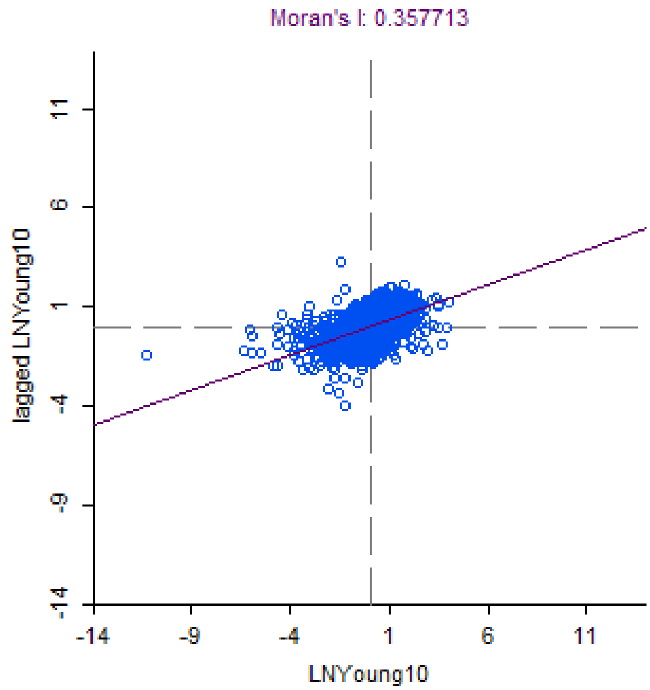


Figure 4.66: Moran's I for 2000−2010 Old Population Change

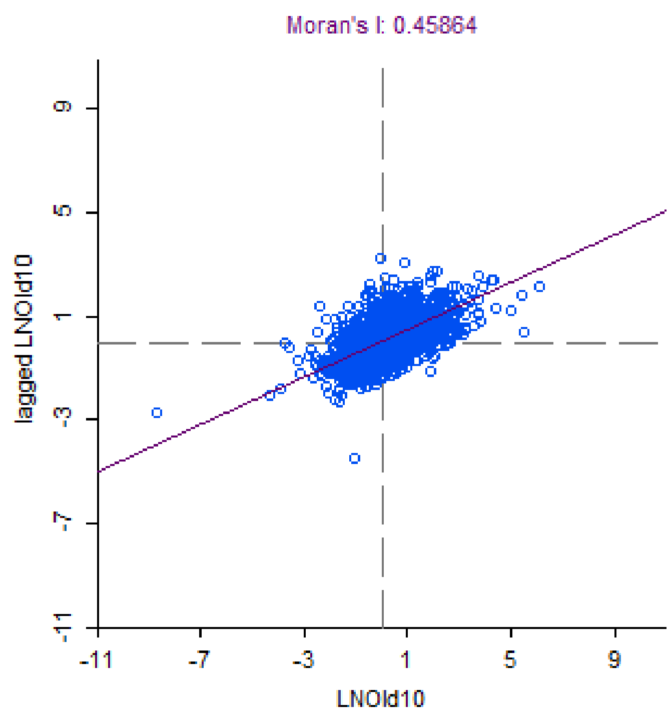


Figure 4.67: Moran's I for 2000−2010 White Population Change

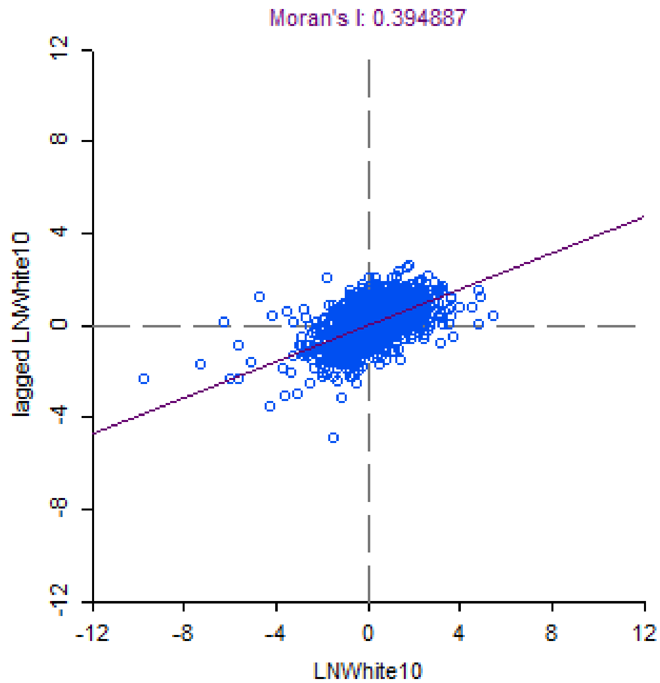


Figure 4.68: Moran's I for 2000−2010 Black Population Change

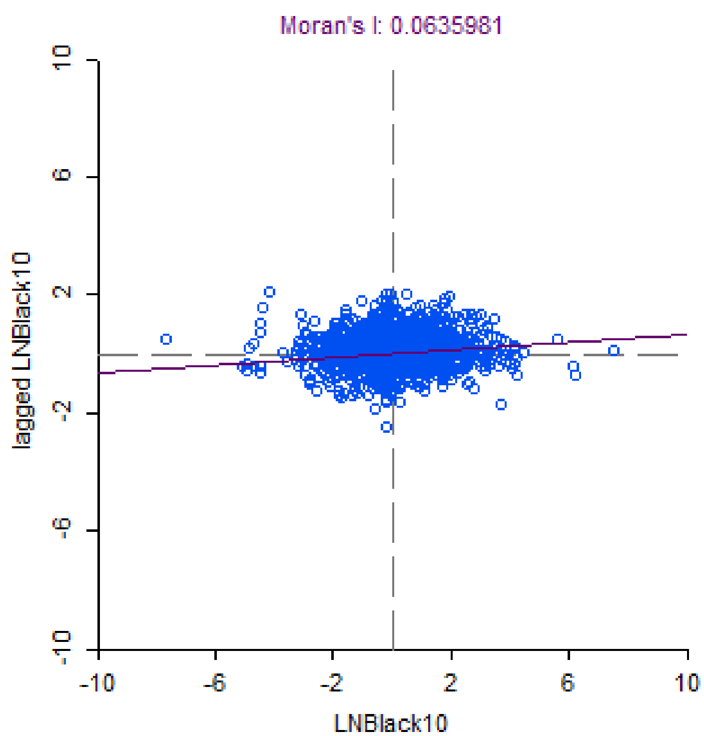


Figure 4.69: Moran's I for 2000−2010 Hispanic Population Change

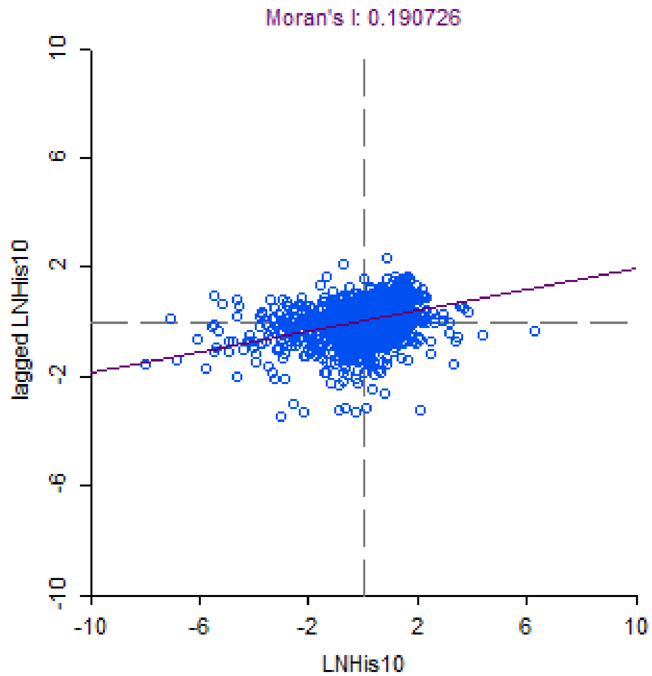


Figure 4.70: Moran's I for 2000−2010 High School Diploma Population Change

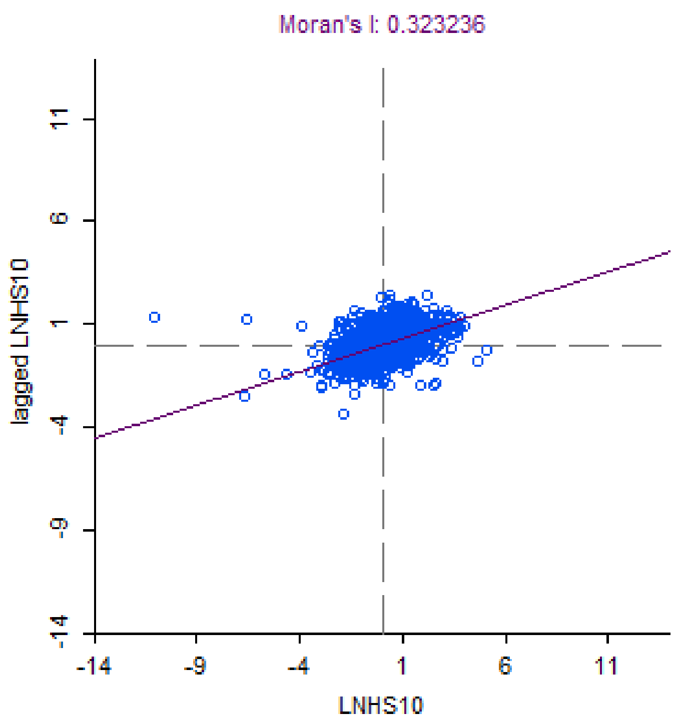


Figure 4.71: Moran's I for 2000–2010 Bachelor's Degree Population Change

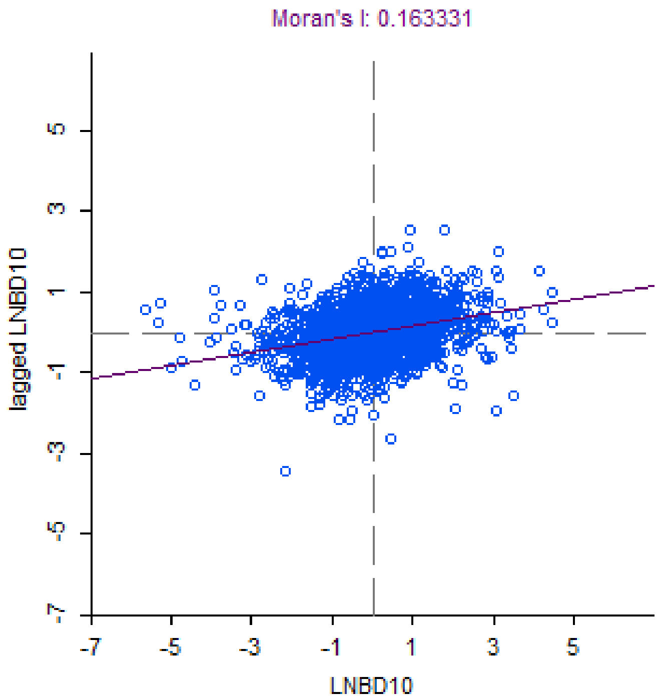


Figure 4.72: Moran's I for 2000–2010 Graduate Degree Population Change

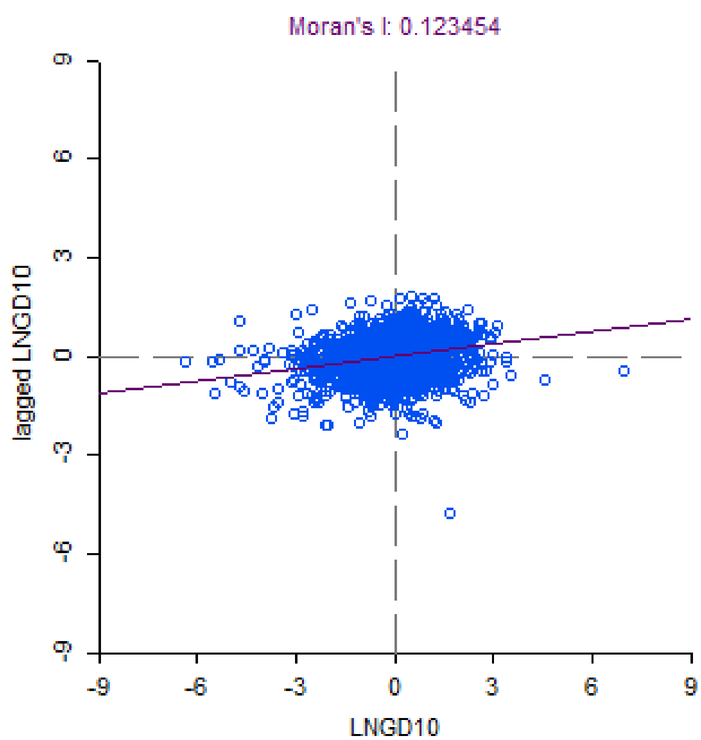


Figure 4.73: Moran's I for 2000−2010 Median Household Income Change

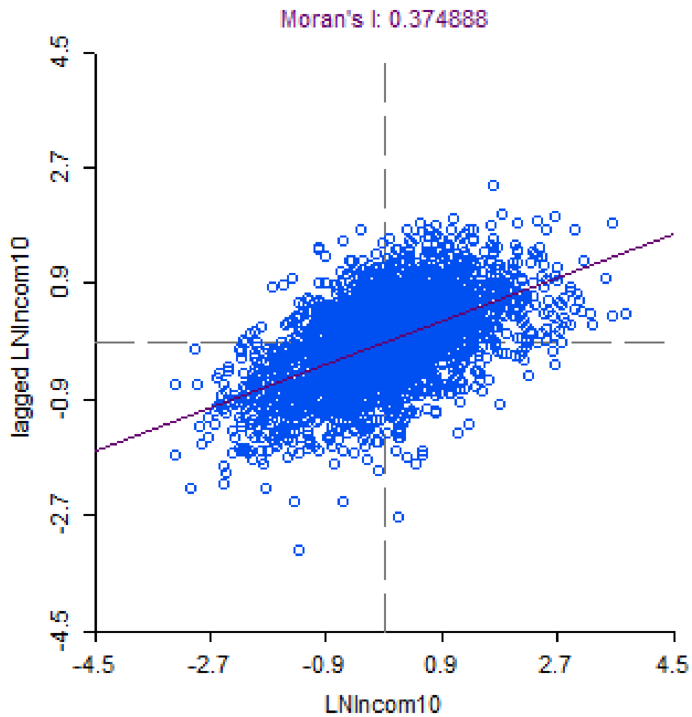


Figure 4.74: LISA Cluster Map of Population Change from 2000 to 2010 at the County Level in the Continental United States

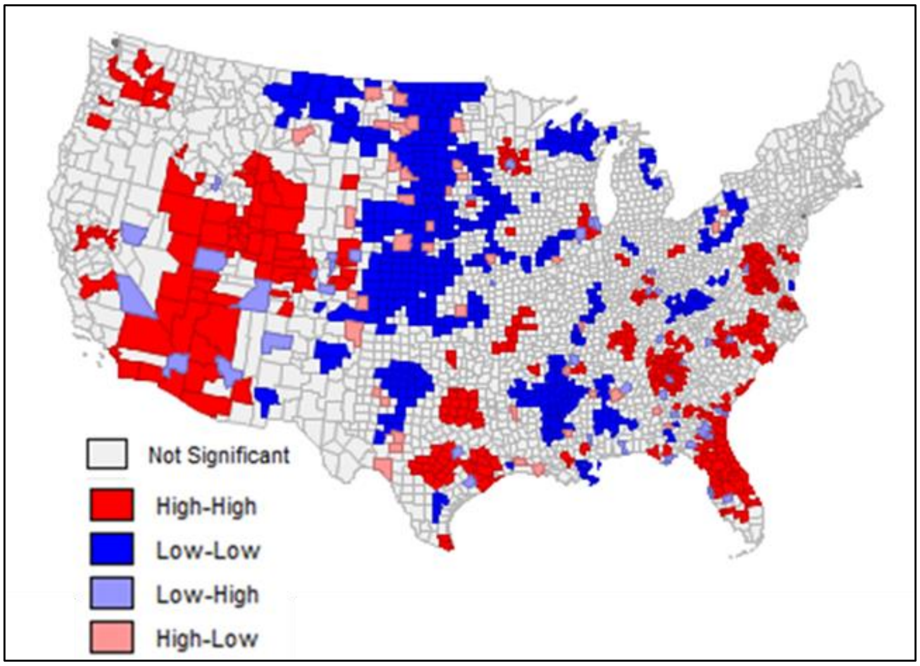


Figure 4.75: LISA Cluster Map of Employment Change from 2000 to 2010 at the County Level in the Continental United States

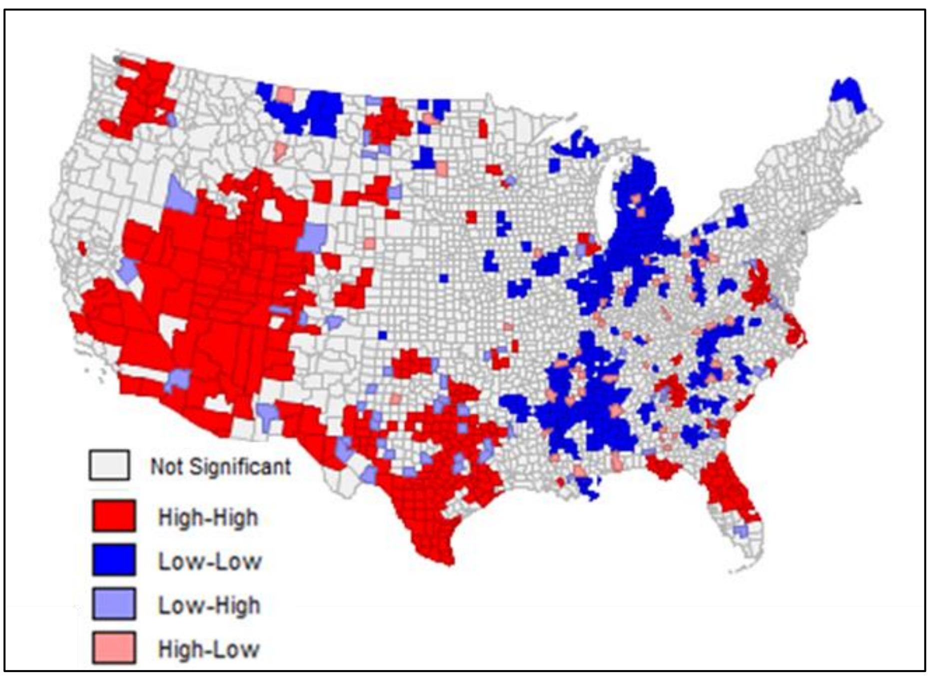


Figure 4.76: LISA Cluster Map of White Population Change from 2000 to 2010 at the County Level in the Continental United States

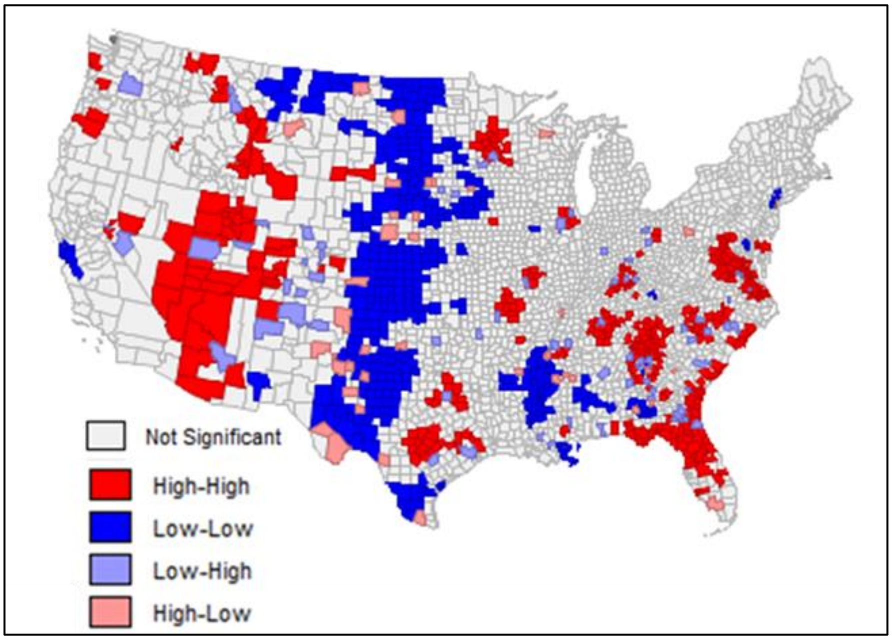


Figure 4.77: LISA Cluster Map of Black Population Change from 2000 to 2010 at the County Level in the Continental United States

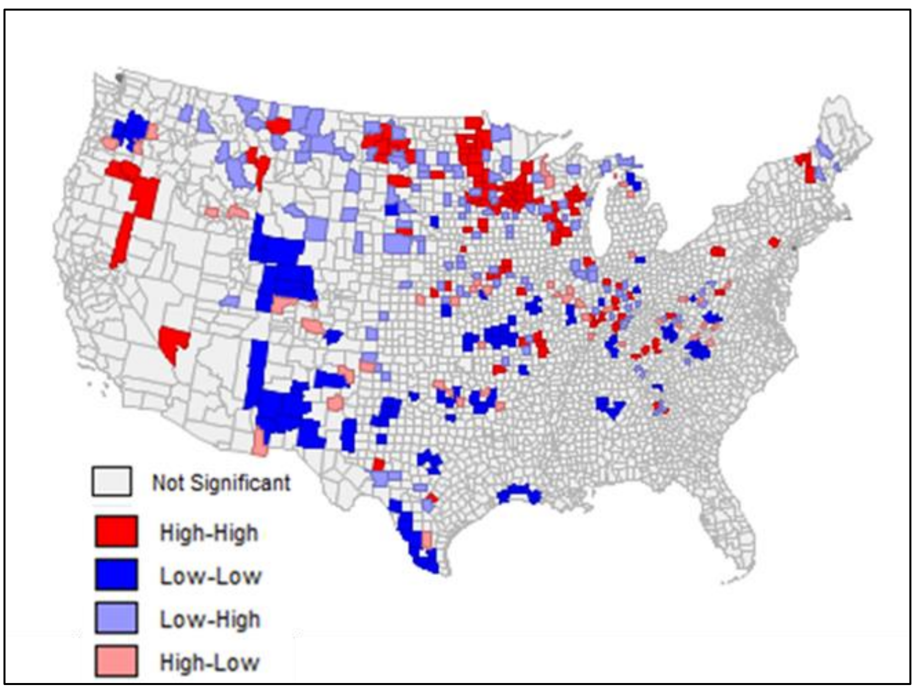


Figure 4.78: LISA Cluster Map of Hispanic Population Change from 2000 to 2010 at the County Level in the Continental United States

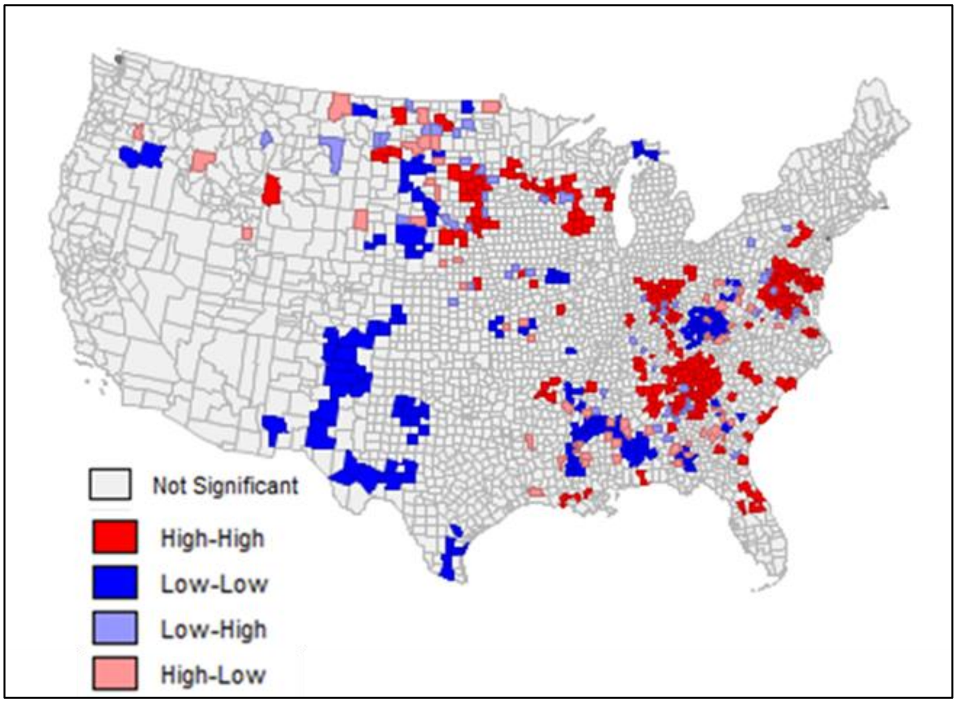


Figure 4.79: LISA Cluster Map of Young Population Change from 2000 to 2010 at the County Level in the Continental United States

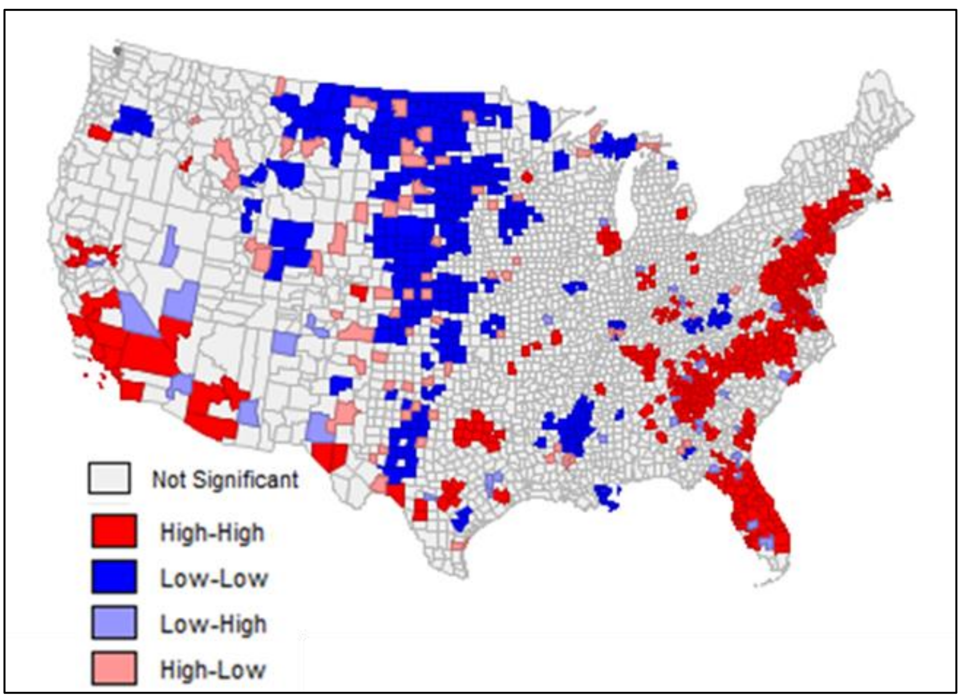


Figure 4.80: LISA Cluster Map of Old Population Change from 2000 to 2010 at the County Level in the Continental United States

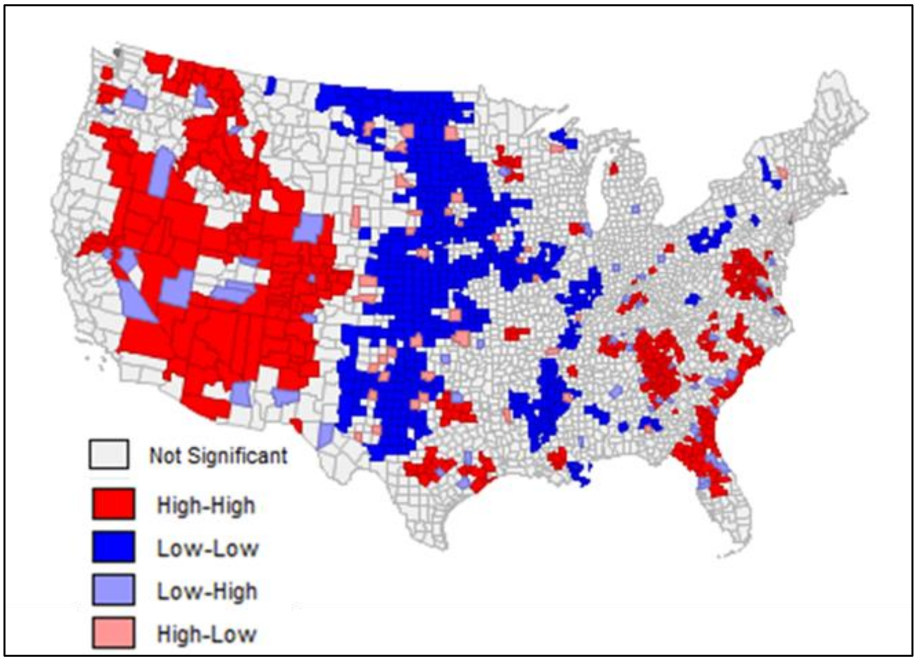


Figure 4.81: LISA Cluster Map of High School Diploma Population Change from 2000 to 2010 at the County Level in the Continental United States

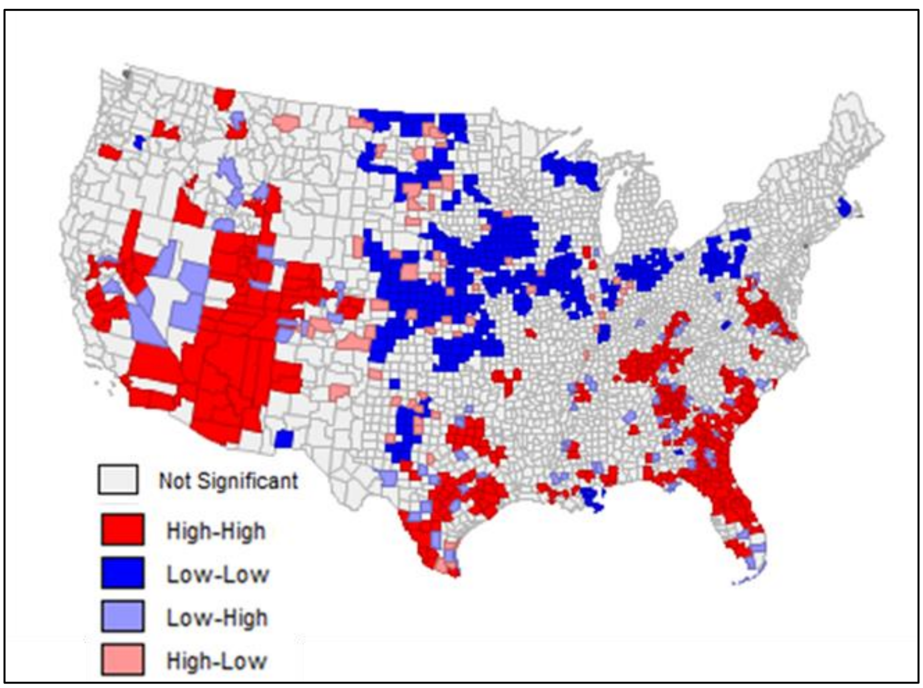


Figure 4.82: LISA Cluster Map of Bachelor's Degree Population Change from 2000 to 2010 at the County Level in the Continental United States

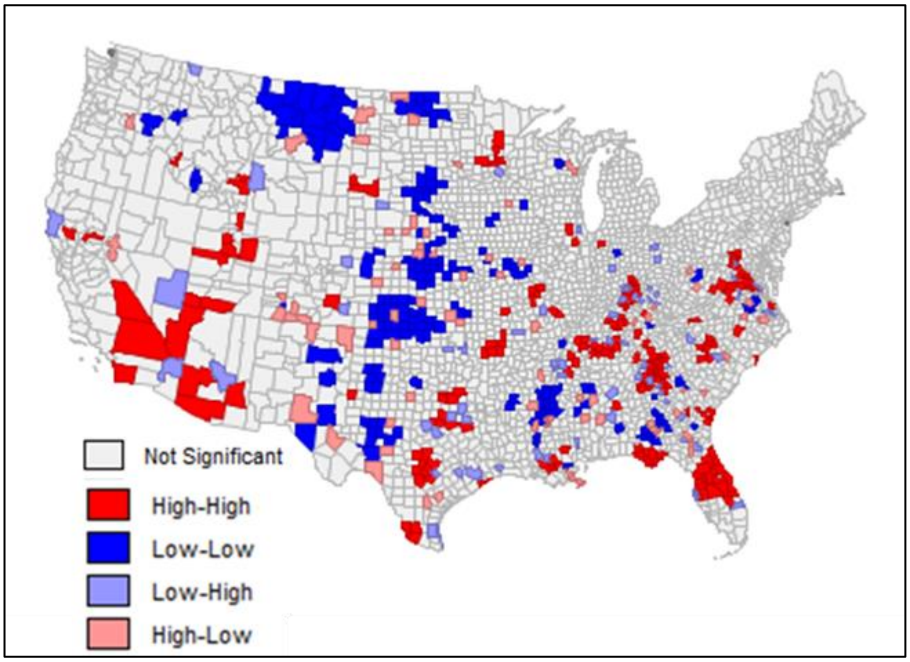


Figure 4.83: LISA Cluster Map of Graduate Degree Population Change from 2000 to 2010 at the County Level in the Continental United States

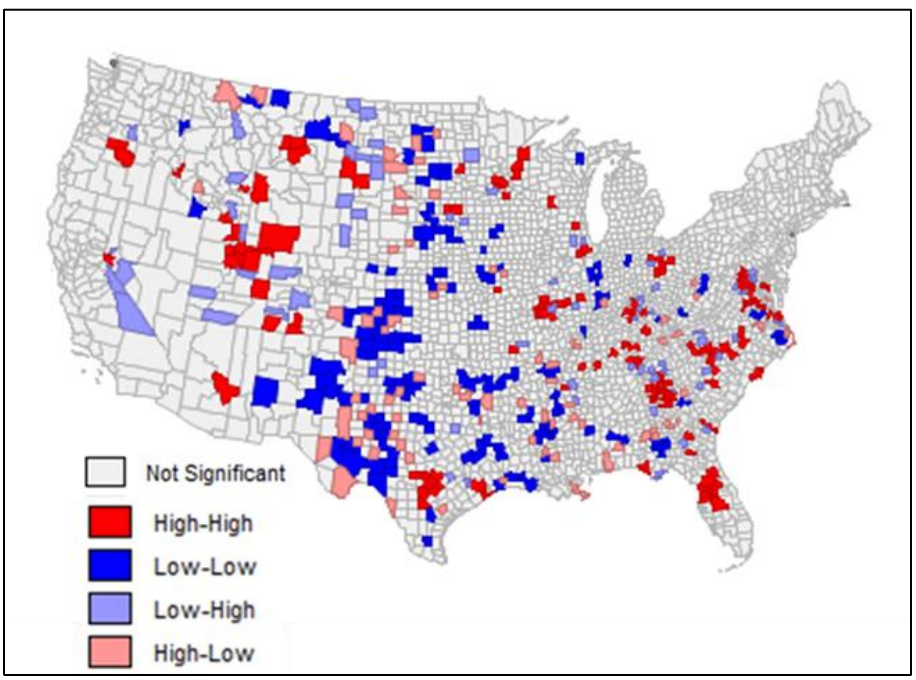


Figure 4.84: LISA Cluster Map of Median Household Income Change from 2000 to 2010 at the County Level in the continental US

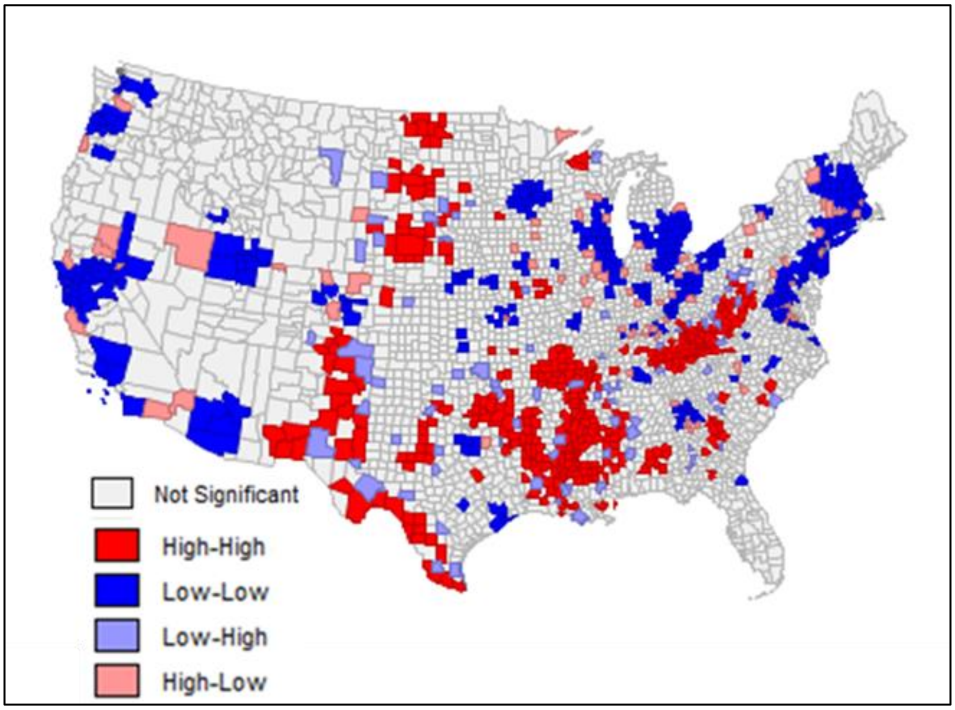


Table 4.8: Correlations Between Terminal Density and Other Variables for the Period of 2000–2010

Variables	Cor. Coefficient
Independent variable	
Terminal Density	1
Dependent Variables	
Population change (ln)	−0.025
Employment change (ln)	−0.081***
Young pop change (ln)	0.079***
Old pop change (ln)	−0.141***
White pop change (ln)	−0.092***
Black pop change (ln)	−0.028
Hispanic pop change (ln)	0.055**
HS diploma pop change (ln)	−0.103***
BD pop change (ln)	−0.037*
GD pop change (ln)	0.011
Income change (ln)	−0.123***
Control Variable	
Highway density	0.579***
Airport number	0.194***
Prev. decade pop change rate	−0.116***
Population density 2000	0.335***
Prev. decade emp. change rate	−0.150***
Prev. decade young pop change rate	−0.134***
Prev. decade old pop change rate	−0.100***
Prev. decade White pop change rate	−0.191***
Prev. decade Black pop change rate	−0.041*
Prev. decade Hispanic pop change rate	−0.074***
Prev. decade HS diploma pop change rate	−0.212***
Prev. decade BD pop change rate	−0.134***
Prev. decade GD pop change rate	−0.120***
Prev. decade income change rate	−0.200***
Young	−0.058***
Old	−0.116***
High school diploma	−0.109***
Bachelor’s degree	0.179***
Graduate degree	0.219***
White	−0.114***
Black	0.139***

Hispanic	0.006
Income	0.169***
Employment	0.084***
Metro	0.284***
West	−0.092***
Midwest	0.147***
Northeast	0.175***
South (reference)	−0.167***
Land developability index	−0.111***

* Significant at $p \leq 0.05$ for a two−tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

For the Period of 1970 to 2010

Table 4.9 presents descriptive statistics of the dependent, independent, and control variables for the entire period of 1970 to 2010. This table also contains mean, standard deviation, minimum values, and maximum values for the variables used in the analysis. The table has ten dependent, one independent, and eighteen control variables. The mean values of all dependent variables are positive, except for young. The minimum values are negative, except for median household income. All maximum values for the dependent variables are positive.

Figures 4.84 through 4.94 are the Moran’s I of dependent variables and show global spatial correlations. The Moran’s I values for population, employment, White, Black, young, old, high school diploma, bachelor’s degree, graduate degree, and median household income are 0.58, 0.53, 0.56, 0.34, 0.53, 0.60, 0.60, 0.49, 0.45, and 0.45, respectively. The visual presentations of local-level spatial correlations are presented in Figures 4.95 through 4.104. In the figures, the counties in red and blue are clustered together, showing high and low values, respectively.

Table 4.10 shows the correlations between the independent, or explanatory, variable (freight rail terminal density) and dependent and control variables. The correlation values for all dependent variables are negative and significant. The Black population change has a unique correlation with freight rail terminal density: it is neither negative nor significant.

Table 4.9: 1970−2010 Descriptive Statistics of the Dependent and Independent Variables (N = 3109)

Variables	Mean	Stan Dev	Min	Max
Dependent variables				
Population change (ln)	0.31	0.49	−0.90	3.53
Employment change (ln)	0.69	0.52	−0.63	4.00
Young pop change (ln)	−0.005	0.52	−2.60	3.02
Old pop change (ln)	0.51	0.50	−0.98	3.40
White pop change (ln)	0.15	0.54	−3.19	3.34
Black pop change (ln)	0.71	1.26	−4.22	7.07
High school diploma pop change (ln)	0.27	0.49	−1.53	2.94
Bachelor’s degree pop change (ln)	0.49	0.64	−1.22	4.04
Graduate degree pop change (ln)	1.42	0.75	−1.39	5.37
Median HH Income change (ln)	1.92	0.371	0.84	3.52
Independent variables				
Terminal Density	1.71	2.69	0.00	49.22
Control variables				
Highway density	6.42	3.64	0.00	46.00
Airport number	1.51	1.60	0.00	17.00
Population density 1970	213.13	1720.82	0.18	67424.46
Young pop percent 1970	9.6564	1.51	4.90	25.81
Old pop percent 1970	12.73	3.80	0.95	35.40
HS diploma pop percent 1970	45.18	8.13	7.41	71.64
BD pop percent 1970	12.65	4.99	0.00	44.06
GD pop percent 1970	2.71	2.02	0.00	20.45
White pop percent 1970	89.52	15.40	0.00	100.00
Black pop percent 1970	9.25	14.98	0.00	80.11
Median HH income 1970	6556.23	1796.89	2211.00	14984.00
Employed percent 1970	47.17	6.24	2.48	65.81
Metro	0.36	0.48	0.00	1.00
West	0.13	0.34	0.00	1.00
Midwest	0.07	0.26	0.00	1.00
Northeast	0.34	0.47	0.00	1.00
South (reference)	0.46	0.50	0.00	1.00
Land developability index	70.75	26.56	0.00	99.88

Figure 4.85: Moran's I for 1970−2010 Population Change

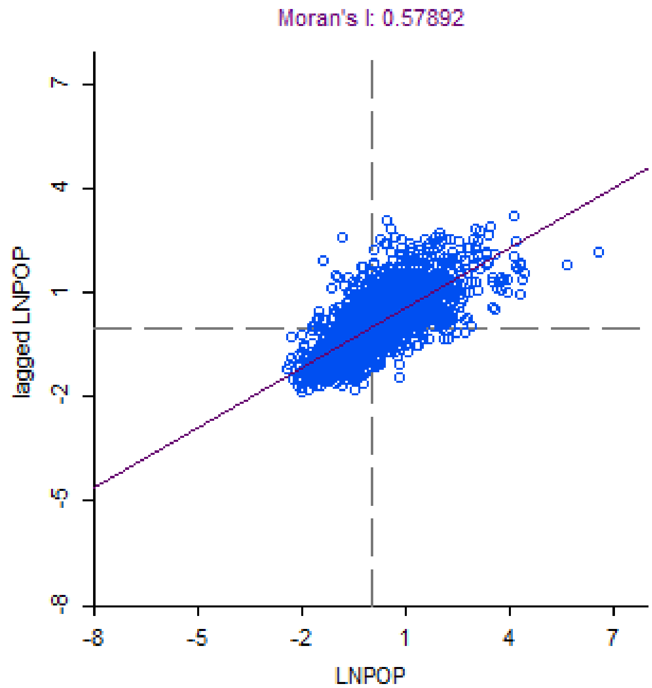


Figure 4.86: Moran's I for 1970−2010 Employment Change

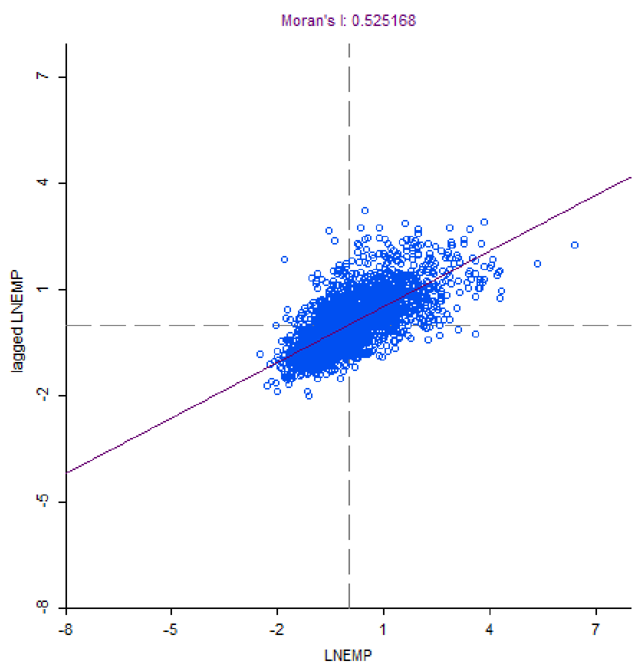


Figure 4.87: Moran's I for 1970−2010 White Population Change

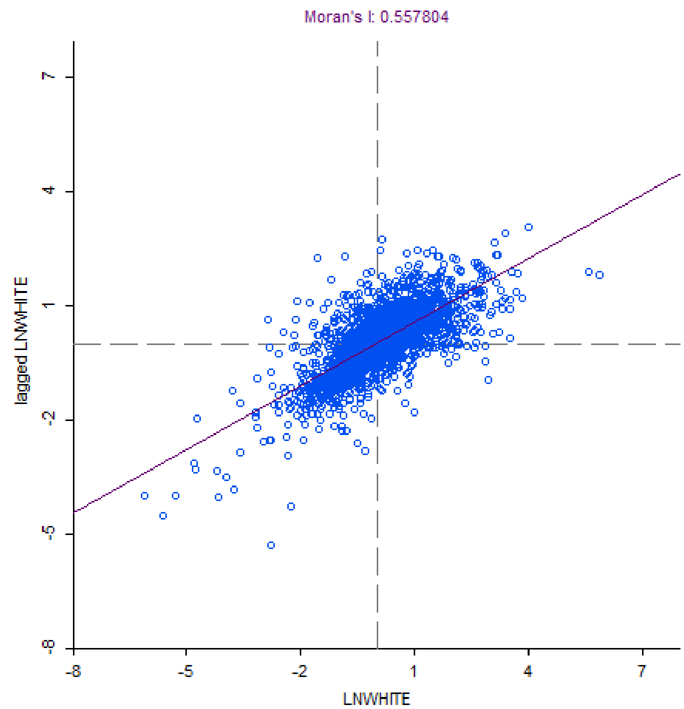


Figure 4.88: Moran's I for 1970−2010 Black Population Change

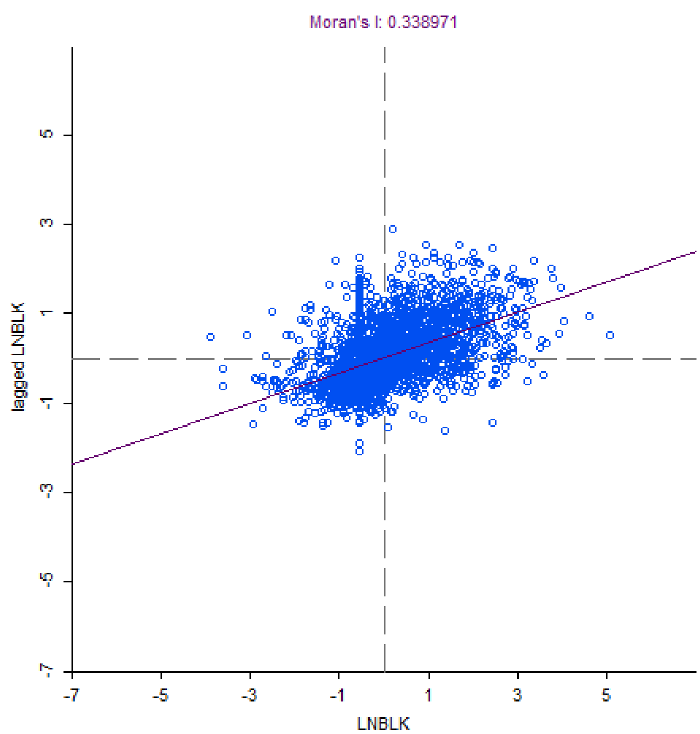


Figure 4.89: Moran's I for 1970−2010 Young Population Change

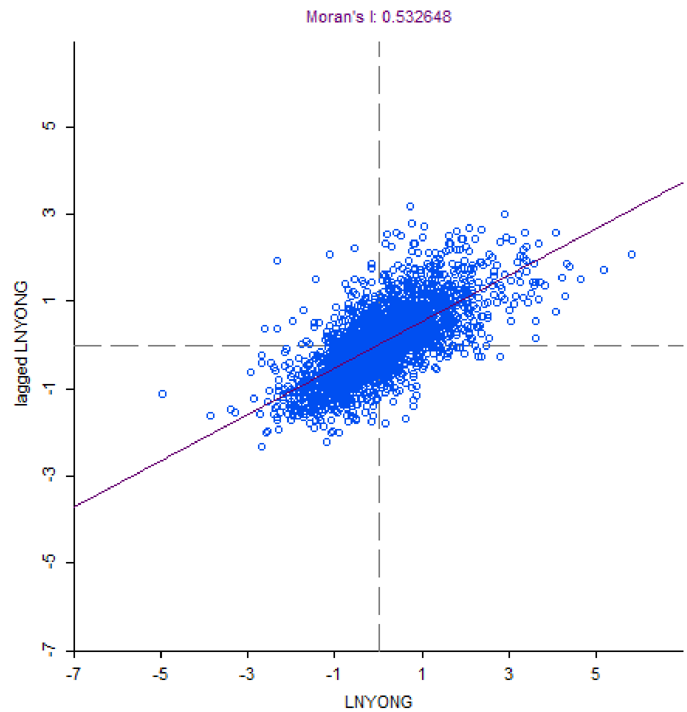


Figure 4.90: Moran's I for 1970−2010 Old Population Change

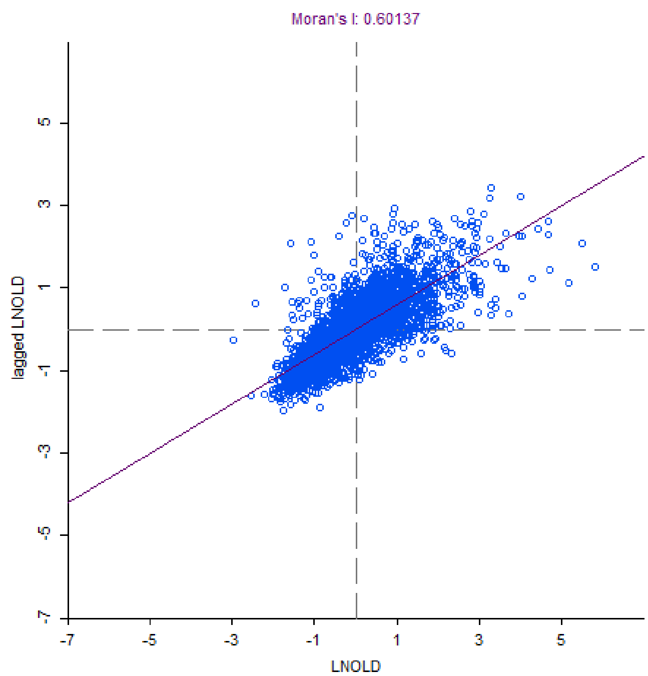


Figure 4.91: Moran's I for 1970–2010 High School Diploma Population Change

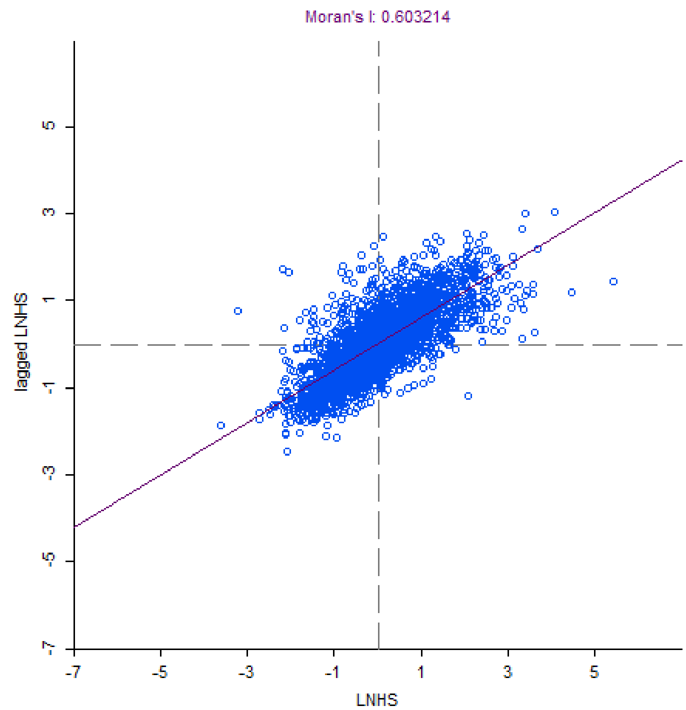


Figure 4.92: Moran's I for 1970–2010 Bachelor's Degree Population Change

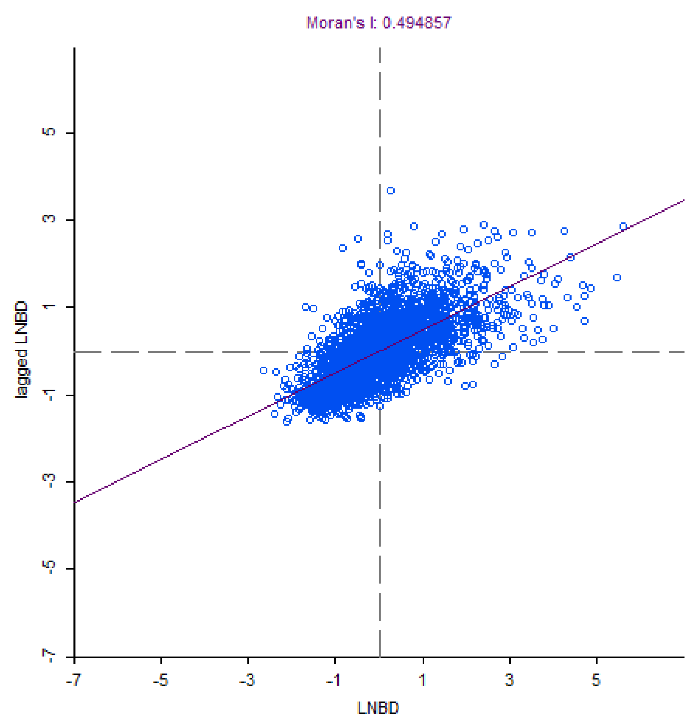


Figure 4.93: Moran's I for 1970–2010 Graduate Degree Population Change

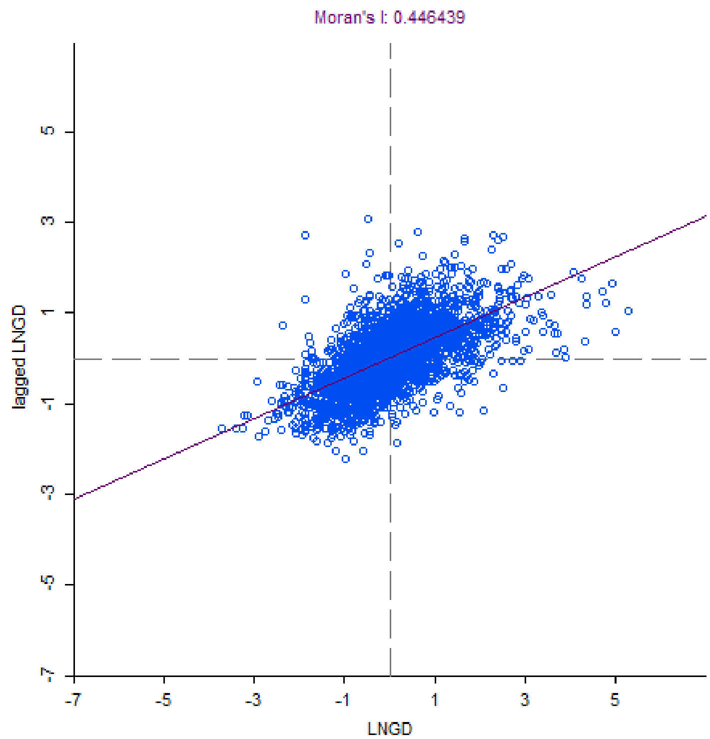


Figure 4.94: Moran's I for 1970–2010 Median Household Income Change

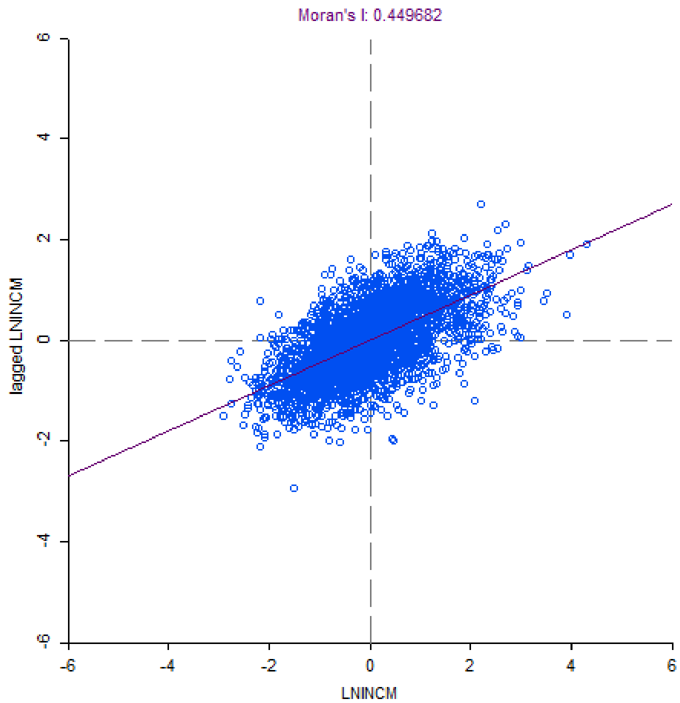


Figure 4.95: LISA Cluster Map of Population Change from 1970 to 2010 at the County Level in the Continental United States

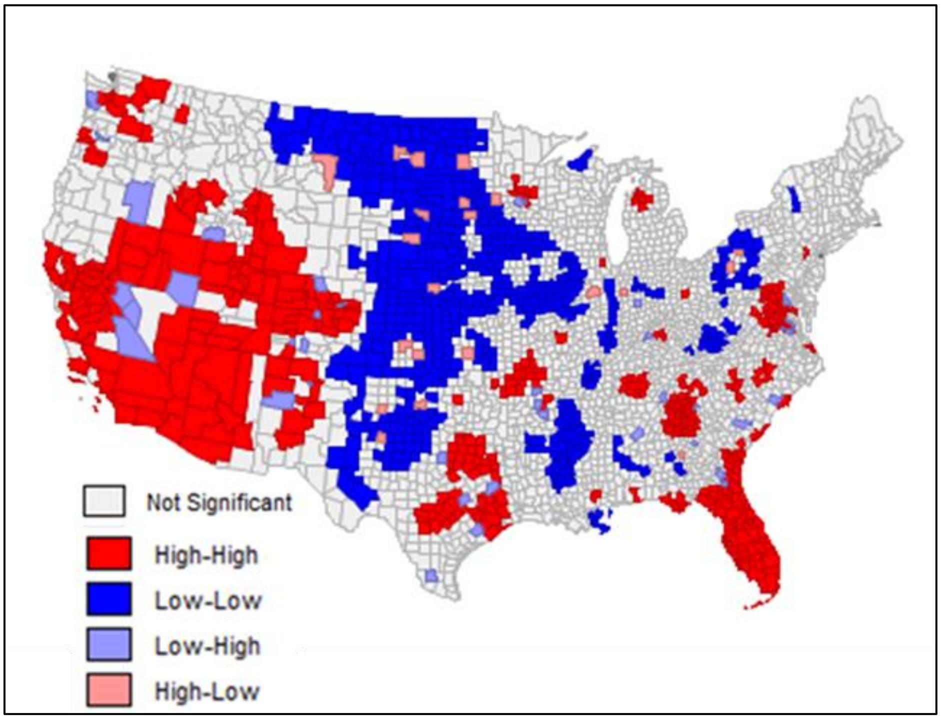


Figure 4.96: LISA Cluster Map of Employment Change from 1970 to 2010 at the County Level in the Continental United States

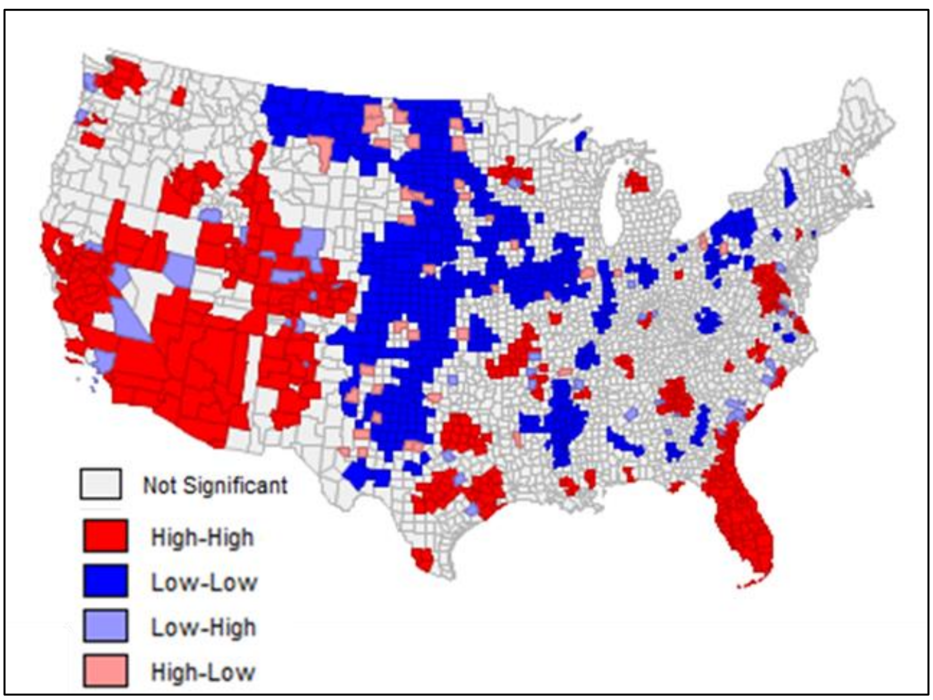


Figure 4.97: LISA Cluster Map of White Population Change from 1970 to 2010 at the County Level in the Continental United States

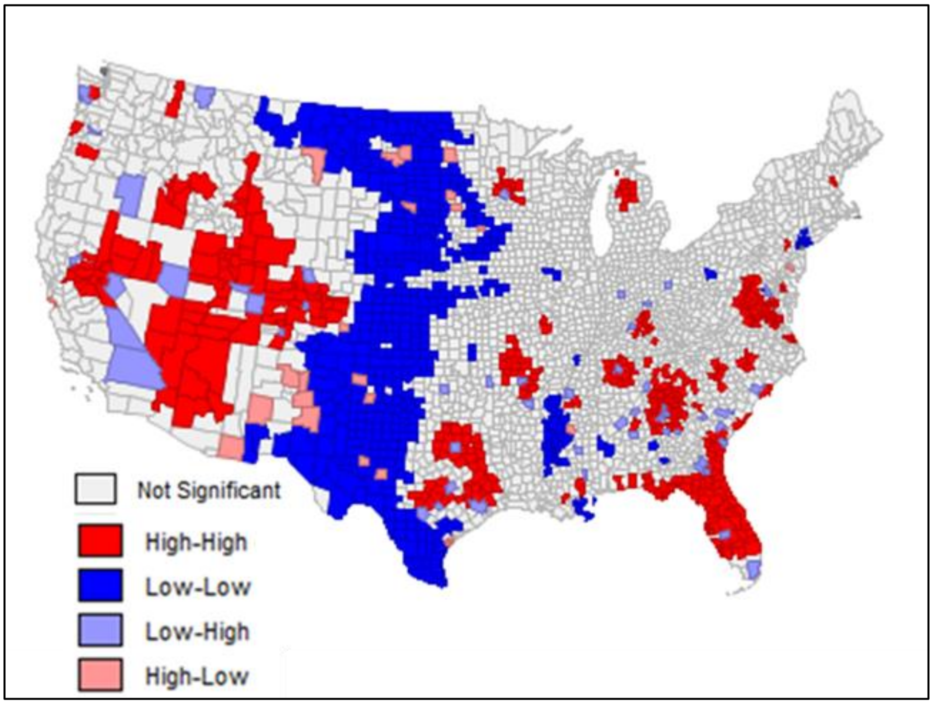


Figure 4.98: LISA Cluster Map of Black Population Change from 1970 to 2010 at the County Level in the Continental United States

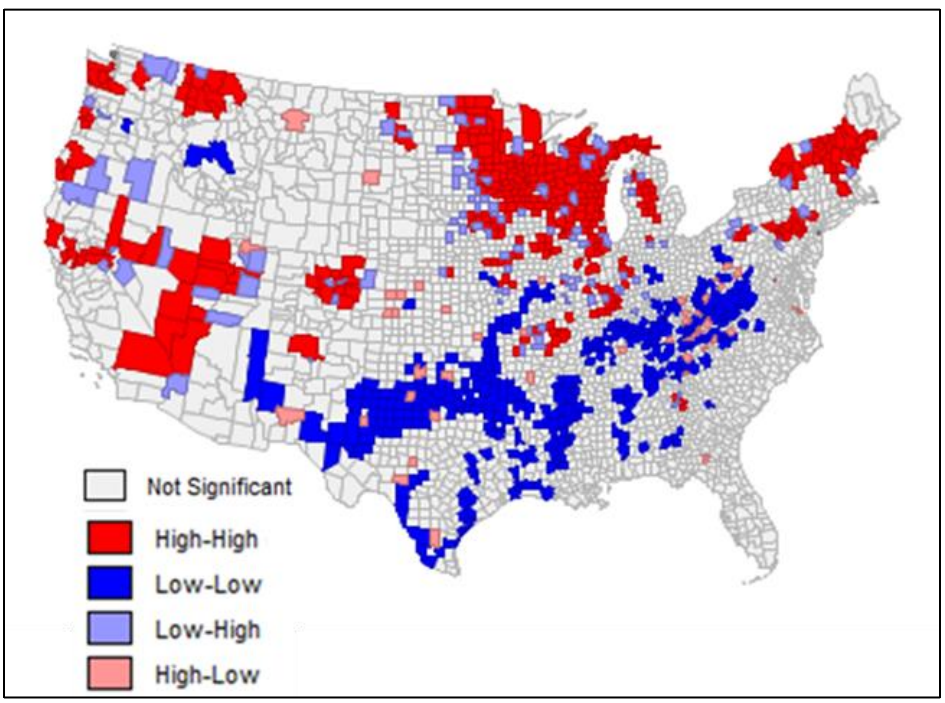


Figure 4.99: LISA Cluster Map of Young Population Change from 1970 to 2010 at the County Level in the Continental United States

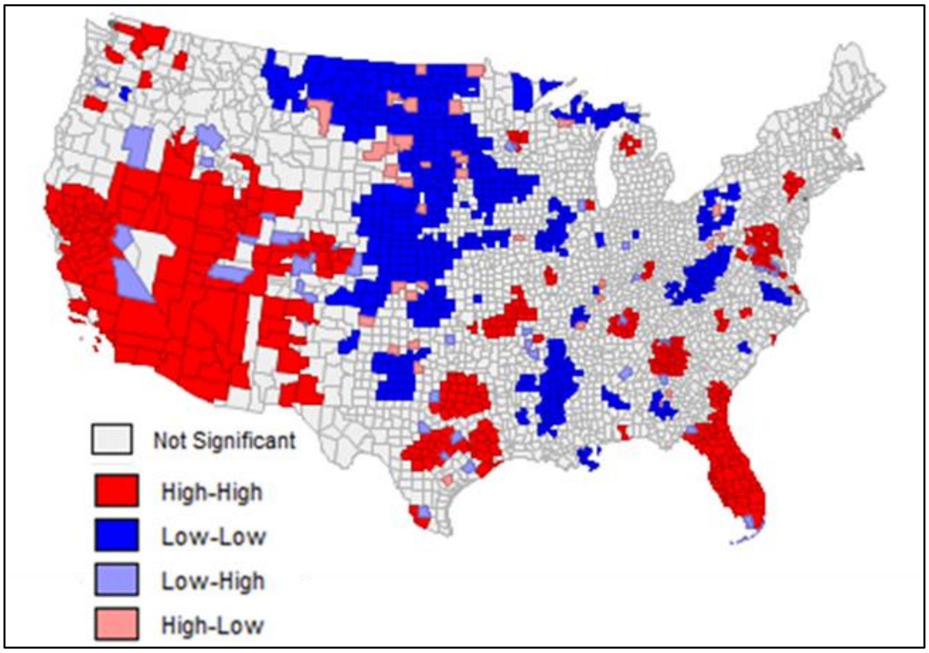


Figure 4.100: LISA Cluster Map of Old Population Change from 1970 to 2010 at the County Level in the Continental United States

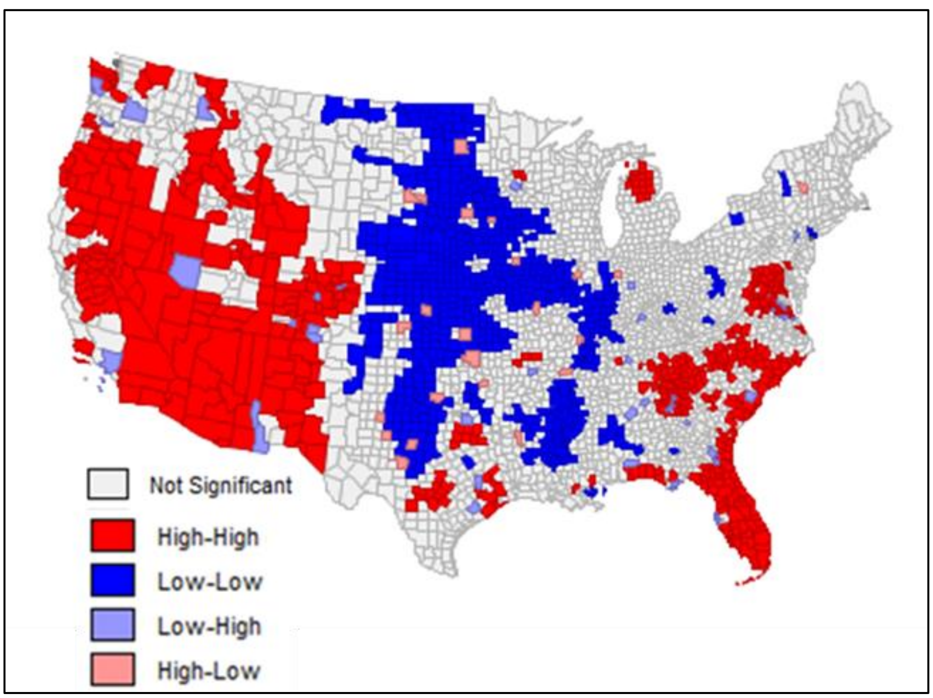


Figure 4.101: LISA Cluster Map of High School Diploma Population Change from 1970 to 2010 at the County Level in the Continental United States

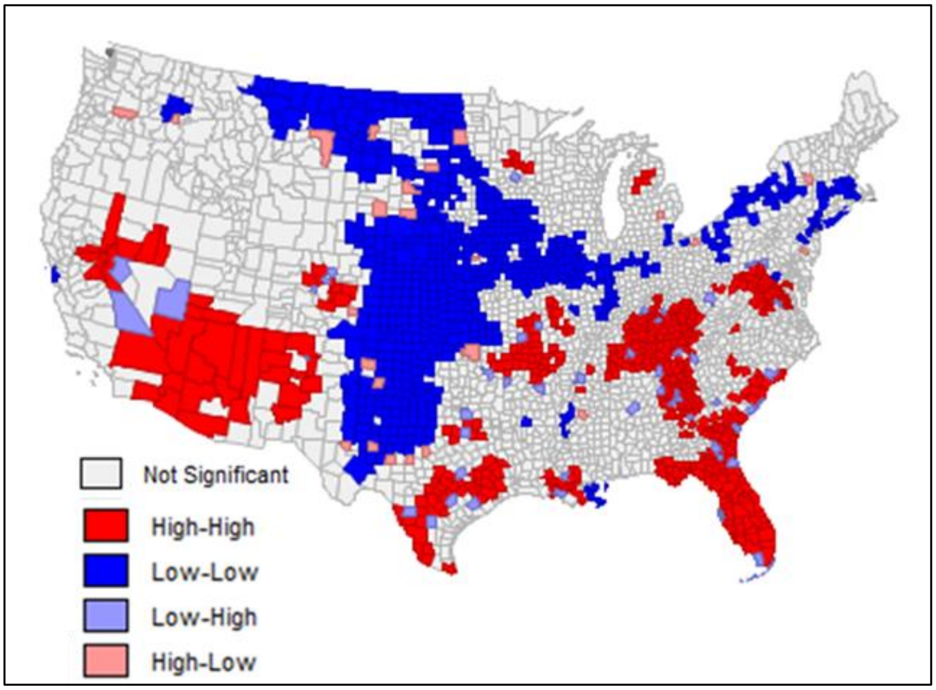


Figure 4.102: LISA Cluster Map of Bachelor's Degree Population Change from 1970 to 2010 at the County Level in the Continental United States

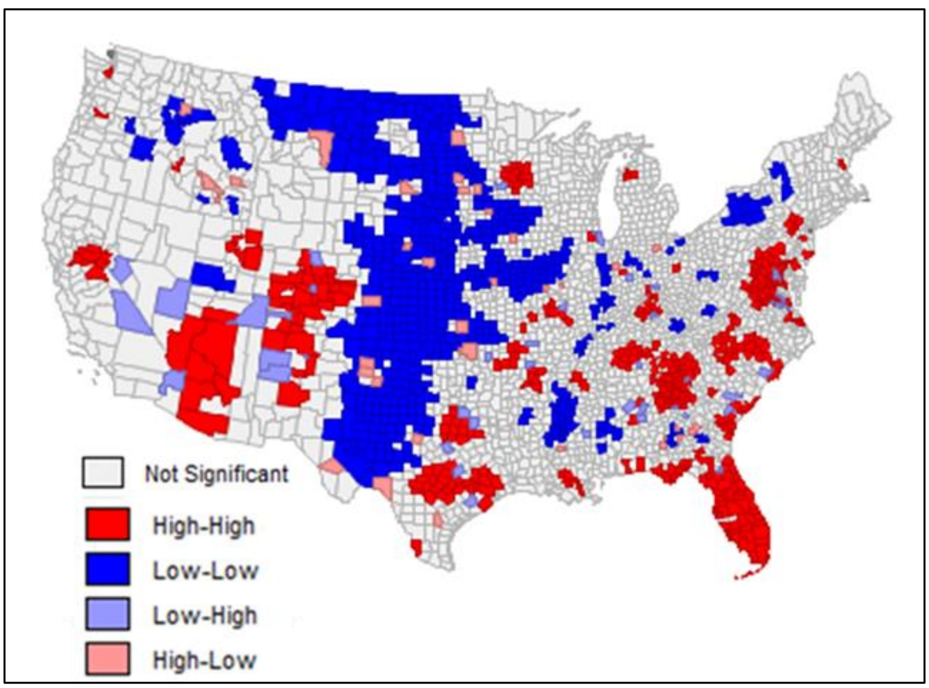


Figure 4.103: LISA Cluster Map of Graduate Degree Population Change from 1970 to 2010 at the County Level in the Continental United States

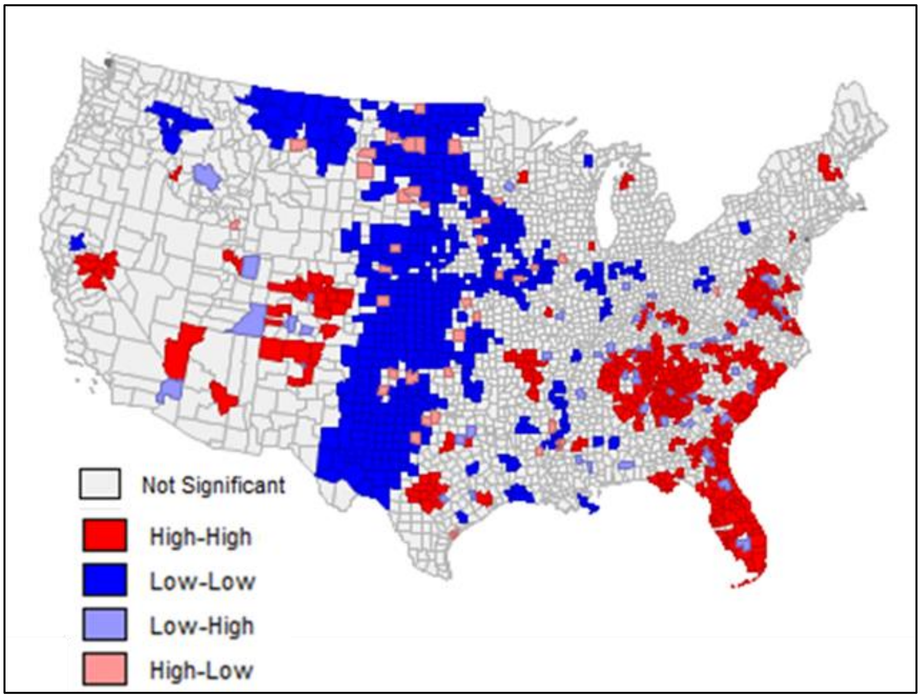


Figure 4.104: LISA Cluster Map of Median Household Income Change from 1970 to 2010 at the County Level in the Continental United States

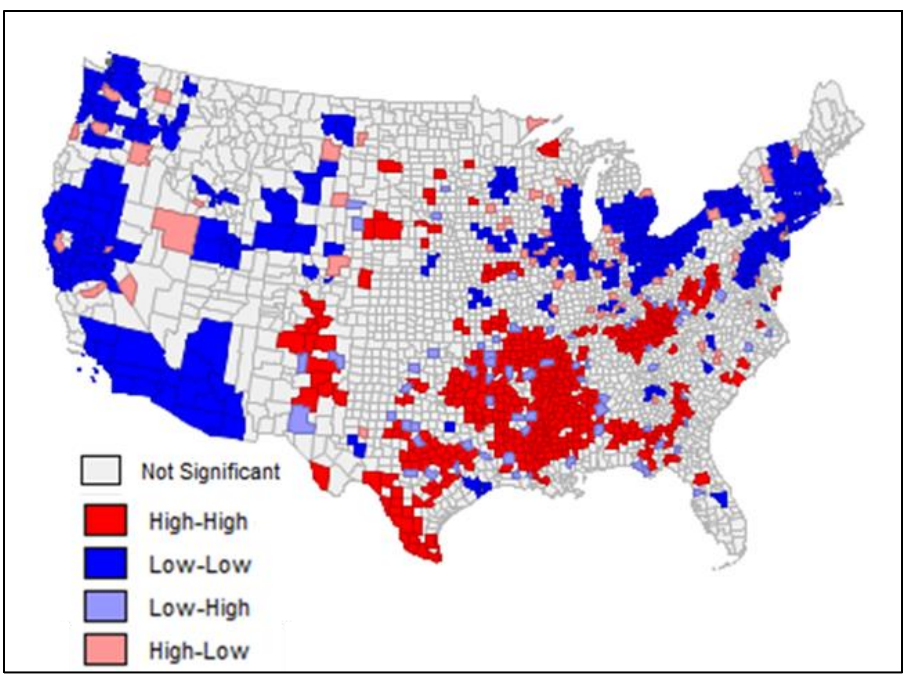


Table 4.10: Correlations Between Terminal Density and Other Variables for the Period of 1970–2010

Variables	**Cor. Coefficient**
Independent variable	
Terminal Density	1
Dependent variables	
Population change (ln)	−0.101***
Employment change (ln)	−0.096***
Young pop change (ln)	−0.073***
Old pop change (ln)	−0.106***
White pop change (ln)	−0.154***
Black pop change (ln)	0.008
HS diploma pop change (ln)	−0.231***
BD pop change (ln)	−0.041*
GD pop change (ln)	−0.076***
Income change (ln)	−0.238***
Control variables	
Highway density	0.579***
Airport number	0.194***
Population density 1970	0.353***
Young	−0.015
Old	−0.148***
High school diploma	0.152***
Bachelor’s degree	0.111***
Graduate degree	0.168***
White	−0.026
Black	0.044*
Income	0.335***
Employment	0.150***
Metro	0.284***
West	−0.092***
Midwest	0.147***
Northeast	0.175***
South	−0.167***
Land developability index	−0.111***

* Significant at $p \leq 0.05$ for a two−tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

CHAPTER FIVE

REGRESSION ANALYSIS

Chapter Five addresses the findings of the study resulting from the standard (or conventional) and spatial regression analyses. The findings of this study are categorized into four subsections: population and employment change, race and ethnicity, age, and socioeconomic status. The first section addresses the relationship of freight rail with population and employment change. The second section is about the relationship of freight rail with race and ethnicity. The results are shown for White, Black, and Hispanic. The third section presents the association of freight rail with age variables. Two age variables, young and old, are described. The fourth section is about the relationship of freight rail with socioeconomic variables that include education and income. There are three education variables: high school diploma, bachelor’s degree, and graduate degree. Income is represented by median household income.

The results of each analysis are presented in a table of five columns. The first column consists of variables names, such as the explanatory variables, control variables, diagnostic test, and measures of fit. The second column contains the results of the standard regression, or full ordinary least squares, model. The third column consists of the results of the spatial lag model. The fourth column is the spatial error model, and the last column is the spatial error model with lag dependence.

SECTION 1: POPULATION AND EMPLOYMENT CHANGE

Section 1 consists of twelve tables, the first six for population change and the last six for employment change.

Population Change

Tables 5.1 through 5.6 present the results pertaininfg to population change. Table 5.1 presents the relationship of freight rail terminal density with population change for the period of 1970 to 1980. The first model of the table shows the coefficient values for ordinary least squares, or standard regression. The regression in the first model was run using spatial weight.

The results show that freight rail has a negative relationship with population change. Each percentage point increase in freight rail terminal density contributes to a 0.013 percent decrease in the population. This study controls for other modes of transportation as well. Controlling for highways and airports refines the association of freight rail with population change. This study also shows the association of control variables with population change. The highway is not statistically significant to population change, but an airport does have a positive relationship. Each unit increase in public airport terminals contributes to a 0.006 percent growth in population.

The other control variables that have a positive relationship with population change are the previous decade’s population growth, high school diploma, and graduate-level education. Each percent increase in the previous decade’s population growth causes a 0.004 percent growth in population. Similarly, each percent growth in high school diploma and graduate-level education contributes, respectively, to a 0.002 and 0.007 percent population growth.

Population density in 1970, young, bachelor's degree, and Black have a negative relationship with population change in the 1970s. Even though population density is significant, its impact is small. Each unit increase in population density is associated with a 0.00001 percent decrease in population in that decade. Each one percent growth in the young and Black populations contributes to a 0.009 and 0.003 percent decline in overall population, respectively.

Among geographic control variables, metro has a positive relationship with population change. It indicates that metropolitan counties observe a 0.084 percent higher population growth than nonmetropolitan counties. The Midwest and Northeast are other significant variables. Counties in the Midwest and Northeast lost population by 0.121 and 0.146 percent, respectively, than the South. The land developability index has a negative relationship with population change, indicating that population decline is associated with an increase in the potentiality of land development. Each percent increase in land developability contributes to a 0.027 percent population decline.

All values in the diagnostic test are significant. Moran's statistics indicate the spatial autocorrelation, but they do not suggest a best-fit model for the analysis. The stronger values of the robust LM (lag) over robust LM (error) suggest that spatial lag is a better-fitting model, but in this analysis, spatial lag, spatial error, and spatial error with lag dependent models were run. The last model proved to be the best fit based on the measures-of-fit values. The best-fit model has the highest log-likelihood and lowest AIC and BIC values.

The second column in Table 5.1 contains the results for spatial lag analysis, and the third column contains the spatial error model results. Both spatial lag effects and spatial error effects are significant in these models. Controlling for spatial effects changes the values in the model, which is clearly seen in the table. The previous decade's population growth, which is significant in the full OLS model, is no longer significant, the strength of population density declines, West becomes significant in spatial lag model, and White becomes significant in both the spatial lag and spatial error models.

The fourth model (spatial error model with lag dependence) is the best-fit model according to the measures-of-fit values. This model is characterized by the inclusion of both spatial lag and spatial error effects. Comparison of the four models shows many changes. For example, some control variables, such as airport, population density, young, graduate degree, Midwest, and Northeast that are significant in other models are no longer significant. Freight rail is significant, and the relationship is negative—as in the other models. With each additional percentage point increase in freight rail terminal density, population declines by 0.006 percent on average. This value is less than the value in the full OLS model.

The changes in the demographic variable, previous decade's population growth, is interesting. This variable was positive in full OLS model. Now it becomes negative, indicating that one additional percent growth in the previous decade's population contributes to a 0.003 percent decline in the overall population, on average.

High school diploma is positive in all four models. Each percent growth in population with a high school–level education contributes to a 0.001 percent growth in the overall population. A bachelor's degree, which was negative in the first model, becomes positive, indicating that each additional percent growth in the population with a bachelor's degree contributes to a 0.001 percent overall growth in population. White, which was not a significant varabile in the first model, becomes significant and negative. Each percent increase in the White and Black population contributes to a 0.001 percent population decline.

Metro is consistently significant in all four models. Each metropolitan county gains 0.033 percent more population on average than the nonmetropolitan county. The West, which was not significant in the full OLS model, now establishes a negative relationship with population change. Each county in the West loses 0.020 percent more population than in the South.

The spatial lag effect is positive, indicating that each percentage point of weighted population growth in surrounding counties contributes to the growth of a county by 1.055 percent, on average. The significant spatial error effect indicates that there are additional variables that could be contributing in the model.

Table 5.1: Regressions of Terminal Density on Population Change from 1970 to 1980

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.013***	−0.011***	−0.010***	−0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	0.002	−1.44E−4	−0.002	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.006***	0.005**	0.005**	0.002
	(0.002)	(0.002)	(0.002)	(0.001)
Prev. decade pop.	0.004*	0.002	0.002	−0.003*
growth	(0.002)	(0.002)	(0.002)	(0.001)
Population density	−1.02E−5***	−5.06E−6***	−4.48E−6*	2.92E−7
	(1.70E−6)	(1.48E−6)	(1.92E−6)	(8.45E−7)
Young	−0.009***	−0.005*	−0.005*	−0.001
	(0.002)	(0.002)	(0.002)	(0.001)
Old	0.001	1.49E−4	3.92E−4	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
High school diploma	0.002***	0.001***	0.001*	0.001**
	(4.28E−4)	(3.73E−4)	(0.001)	(2.02E−4)
Bachelor's degree	−0.003***	−0.001	2.62E−4	0.001*
	(0.001)	(0.001)	(0.001)	(4.23E−4)
Graduate degree	0.007***	0.004*	0.003	−0.001
	(0.002)	(0.002)	(0.002)	(0.001)
White	−0.001	−0.001*	−0.002**	−0.001*
	(0.001)	(4.54E−4)	(0.001)	(2.89E−4)
Black	−0.002***	−0.002***	−0.004***	−0.001**
	(0.001)	(4.83E−4)	(0.001)	(2.98E−4)
Household income	4.79E−6	3.00E−6	5.06E−6	−9.13E−7
	(3.42E−6)	(2.98E−6)	(3.69E−6)	(1.81E−6)
Employment	−0.001	−0.001	−2.63E−4	−4.99E−4
	(0.001)	(4.81E−4)	(0.001)	(2.94E−4)
Metro	0.084***	0.064***	0.061***	0.033***
	(0.006)	(0.006)	(0.006)	(0.004)
West	−0.018	−0.029**	−0.010	−0.020***
	(0.011)	(0.009)	(0.017)	(0.005)
Midwest	−0.121***	−0.064***	−0.123***	0.004
	(0.008)	(0.007)	(0.013)	(0.004)
Northeast	−0.146***	−0.069***	−0.104***	0.009
	(0.012)	(0.011)	(0.021)	(0.006)
Land developability	−0.001***	−0.001***	−0.001***	8.60E−5
	(1.21E−4)	(1.07E−4)	(1.50E−4)	(6.02E−5)
Constant	0.365***	0.242***	0.365***	0.067
	(0.062)	(0.054)	(0.061)	(0.035)
Spatial lag effects	–	0.538***	–	1.055***
		(0.019)		(0.012)
Spatial error effects	–	–	0.598***	−0.929***
			(0.019)	(0.027)
Diagnostic Test				
Moran's I (error)	0.30***	–	–	–
Lagrange Mult (lag)	840.49***	–	–	–
Robust LM (lag)	90.94***	–	–	–
Lag Mult (error)	754.26***	–	–	–
Robust LM (error)	4.72*	–	–	–
Measures of Fit				
Log-likelihood	1699.37	2023.74	2017.64	2435.60
AIC	−3358.75	−4005.48	−3995.29	−4829.20
BIC	−3237.91	−3878.59	−3874.45	−4702.31

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.2 presents the results of the regression of freight rail terminal density on population change for the period of 1980 to 1990. The diagnostic test in the full OLS model shows that the dependent variable (population change) is spatially correlated. Spatial lag and spatial error effects are significant in all three models.

Based on the values of log-likelihood, AIC, and BIC, the fourth model—spatial error model with lag dependence (SEMLD)—is the best fit. The model shows that freight rail has a negative association with population change, which is consistently true with all four models. A one percentage point increase in freight rail terminal density results in a decline of 0.003 percent of the population.

Out of two transportation control variables, airport is positive and significant. With each addition of a public airport, population increases, on average, by 0.002 percent. Airport has a significant and positive relationship with population change in all four models. On the other hand, highway density is significant with the first three models, but not with the fourth, SEMLD. The previous decade's population growth—a demographic control variable—has a positive relationship with population change. A one percent increase in population in the previous decade contributes in a 0.173 percent growth of overall population. This variable is significant in all models.

Young and old are two age-related control variables, and of them, only young is significant. It suggests that with each one percent increase in the young population, overall population grows by 0.003 percent. It is interesting that none of the education variables are significant, but both of the race and ethnicity related variables have a negative relationship with population change, though the impact is very small. A one percent increase in the White and Black population contributes to the decline of 0.000361 and 0.000428 percent of the overall population, respectively. Similarly, the negative impact of median household income on population change is very small. Each unit increase in median household income contributes to the decline of population by 0.00000181 percent.

All four geographic control variables are significant. The population growth in the metropolitan area is 0.027 percent higher than the population growth in the nonmetropolitan area. The West has a decline in population of 0.021 percent more than the South. But the Midwest and the Northeast gained more population than the South did. The Midwest and the Northeast saw population growth of 0.011 and 0.015 percent higher, respectively, on average, compared the South.

Land developability has a positive relationship with population change. Each percent increase in the possibility of land development is associated with a 0.000238 percent population growth. Both spatial lag and spatial error effects are significant. The positive association of spatial lag shows that population growth in the decade of the 1980s is influenced by the population change in the surrounding counties. Each county gains 0.821 percent population with each percentage point increase in weighted population growth in the surrounding counties. The significant spatial error effect shows that there are other important variables not included in the model.

Table 5.2: Regressions of Terminal Density on Population Change from 1980 to 1990

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.005***	−0.004***	−0.003***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	0.005***	0.002***	0.002***	4.45E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.006***	0.004***	0.002*	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Prev. decade pop.	0.387***	0.291***	0.307***	0.173***
growth	(0.009)	(0.009)	(0.009)	(0.007)
Population density	−2.13E−6	−4.85E−7	−1.08E−6	7.23E−7
	(1.28E−6)	(1.09E−6)	(1.41E−6)	(7.75E−7)
Young	0.006**	0.004*	0.002	0.003*
	(0.002)	(0.002)	(0.002)	(0.001)
Old	0.001	−3.39E−4	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
High school diploma	−4.03E−4	−2.65E−4	−0.001	1.49E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Bachelor's degree	−0.002	4.63E−4	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	0.004***	0.002	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
White	−0.001***	−0.001***	−0.001***	−3.61E−4*
	(2.78E−4)	(2.37E−4)	(3.06E−4)	(1.73E−4)
Black	−0.001***	−0.001***	−0.002***	−4.28E−4*
	(2.89E−4)	(2.47E−4)	(3.51E−4)	(1.72E−4)
Household income	−1.22E−6	−1.63E−6*	−2.75E−7	−1.81E−6***
	(9.00E−7)	(7.68E−7)	(9.92E−7)	(5.57E−7)
Employment	0.003**	0.001	0.001	5.96E−5
	(0.001)	(0.001)	(0.001)	(0.001)
Metro	0.059***	0.038***	0.036***	0.027***
	(0.004)	(0.004)	(0.004)	(0.003)
West	−0.021**	−0.029***	−0.030*	−0.021***
	(0.007)	(0.006)	(0.012)	(0.004)
Midwest	−0.018***	0.001	−0.034***	0.011***
	(0.005)	(0.004)	(0.009)	(0.003)
Northeast	0.009	0.016*	0.011	0.015***
	(0.008)	(0.007)	(0.015)	(0.004)
Land developability	−2.72E−4***	1.28E−4	5.48E−5	2.38E−4***
	(8.24E−5)	(7.11E−5)	(1.01E−4)	(4.95E−5)
Constant	−0.103*	−0.046	0.059	−0.044
	(0.046)	(0.039)	(0.047)	(0.030)
Spatial lag effects	−	0.493***	−	0.821***
		(0.016)		(0.013)
Spatial error effects	−	−	0.636***	−0.638***
			(0.018)	(0.030)
Diagnostic Test				
Moran's I (error)	0.30***	−	−	−
Lagrange Mult (lag)	992.82***	−	−	−
Robust LM (lag)	251.63***	−	−	−
Lag Mult (error)	793.52***	−	−	−
Robust LM (error)	52.33***	−	−	−
Measures of Fit				
Log-likelihood	2973.19	3378.30	3337.58	3548.70
AIC	−5906.38	−6714.60	−6635.15	−7055.39
BIC	−5785.54	−6587.71	−6514.31	−6928.51

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.3 presents the values for the association of freight rail with population change for the period of 1990 to 2000. The diagnostic test in the full OLS model shows the spatial autocorrelation of population change for that decade. It is also clearly shows that spatial lag and spatial error effects are significant in the other three spatial regression models.

As shown in previous tables, the spatial error model with lag dependence is the best-fit model based on the measures-of-fit analysis. Freight rail has a negative relationship with population change, indicating that each unit percentage point increase in freight rail terminal density contributes to the decline of population by 0.003 percent, on average. The association of freight rail with population change is significant and negative in all four models. For the decade 1990 to 2000, in the spatial error model with lag dependence, neither of the transportation-related control variables (highway density and airport terminal) are significant nor are those variables significant in the other three models.

Demographic variables, such as previous decade’s population change and population density are significant. Each percent increase in the previous decade’s population growth contributes to a 0.203 percent population gain in the following decade. This variable is significant across all models. On the other hand, population density is significant in only in the spatial error model with lag dependence. Even though the relationship is significant, its value is very small.

Young, one of the age variables, is unique in the sense that it is not significant with spatial error with lag dependence, but it is significant with all other three models. This is the result of simultaneously controlling for both spatial lag and spatial error in the same model. The percentage of old population, another age-related control variable, has a negative association with population change. It shows that a one percent increase in the old population brings a 0.003 percent decline in population. This variable is significant across all models.

Each education variable has a different relationship with population change: high school diploma is not significant, bachelor's degree is positive, and graduate degree is negative. Each additional percent growth in bachelor's degrees contributes to a 0.002 percent population growth. On the other hand, an increase of one percent of graduate degrees contributes to a 0.002 percent decline in population growth.

Among race and ethnicity variables, only Hispanic has a significant relationship with population change. Each additional one percent growth of the Hispanic population contributes to a 0.000442 percent decline in population. White and Black are not significant in the 1990s.

The economic control variables, income and employment, have a negative relationship with population change. The association of median household income with population change is very small. Each unit increase in median household income is associated with a 0.00000151 percent decline in population. The relationship of employment with population change is slightly stronger than income. Each percent increase in employment causes a 0.001 percent decline in population, on average.

The association of freight rail with population change is positive in metropolitan counties. Each metropolitan county observes a 0.017 percent higher growth, on average, than the nonmetropolitan counties. Other geographic control variables are not significant, indicating that the association of freight rail with population change in the West, Midwest, and Northeast is not significantly different than in the South. Interestingly, these variables are significant in other models, but the effect has vanished after controlling for spatial lag and spatial error effects in the spatial error with lag dependent model. The Midwest and Northeast even change the direction of the impact.

The land developability index has a positive association with population change. Each percent increase in the land developability index contributes to a 0.000268 percent growth in population. This finding shows that the possibility of land development attracts population, even though the prediction is very small in this case. The association was a negative and small in the first column (the full OLS model).

Both spatial lag and spatial error effects are significant and strong. Each percentage point increase in weighted population growth in surrounding counties contributes to a 0.834 percent population growth in the surrounded county. The significant spatial error effects indicate that other important variables remain but are not included in the model; that may help to explain the impact of freight rail on population change.

Table 5.3: Regressions of Terminal Density on Population Change from 1990 to 2000

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.004***	−0.004***	−0.004***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	4.14E−4	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	−0.002	−0.001	6.60E−5	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Prev. decade pop.	0.487***	0.370***	0.409***	0.203***
growth	(0.013)	(0.012)	(0.013)	(0.011)
Population density	3.64E−7	1.16E−6	−2.73E−7	1.95E−6*
	(1.18E−6)	(1.07E−6)	(1.33E−6)	(7.76E−7)
Young	−0.006***	−0.005***	−0.007***	−0.002
	(0.002)	(0.002)	(0.002)	(0.001)
Old	−0.003***	−0.004***	−0.004***	−0.003***
	(0.001)	(0.001)	(0.001)	(4.56E−4)
High school diploma	0.001*	0.001	2.85E−4	3.54E−4
	(4.30E−4)	(3.88E−4)	(0.001)	(2.69E−4)
Bachelor's degree	−0.002**	4.01E−4	−3.81E−4	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	0.003*	−2.25E−4	−0.001	−0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
White	0.001	2.06E−4	−1.33E−5	1.22E−4
	(2.91E−4)	(2.63E−4)	(3.12E−4)	(2.00E−4)
Black	7.63E−5	−4.04E−4	−0.001**	−3.39E−4
	(3.09E−4)	(2.79E−4)	(3.48E−4)	(2.08E−4)
Hispanic	−1.05E−4	−0.001	−0.001*	−4.42E−4*
	(3.24E−4)	(2.93E−4)	(3.82E−4)	(2.15E−4)
Household income	−1.59E−6**	−1.51E−6***	−3.06E−7	−1.51E−6***
	(5.12E−7)	(4.63E−7)	(5.65E−7)	(3.55E−7)
Employment	0.001**	3.17E−5	−2.36E−4	−0.001*
	(4.38E−4)	(3.96E−4)	(4.75E−4)	(3.04E−4)
Metro	0.027***	0.022***	0.024***	0.017***
	(0.004)	(0.004)	(0.004)	(0.003)
West	0.033***	0.016**	0.032**	0.002
	(0.007)	(0.006)	(0.010)	(0.004)
Midwest	−0.031***	−0.012*	−0.038***	0.005
	(0.005)	(0.005)	(0.008)	(0.003)
Northeast	−0.069***	−0.028***	−0.052***	0.003
	(0.008)	(0.008)	(0.013)	(0.005)
Land developability	−1.71E−4*	1.38E−4	1.49E−5	2.68E−4***
	(7.87E−5)	(7.16E−5)	(9.69E−5)	(5.09E−5)
Constant	0.070	0.136***	0.243***	0.101***
	(0.043)	(0.039)	(0.046)	(0.030)
Spatial lag effects	−	0.431***	−	0.834***
		(0.018)		(0.016)
Spatial error effects	−	−	0.551***	−0.600***
			(0.021)	(0.030)
Diagnostic Test				
Moran's I (error)	0.26***	−	−	−
Lagrange Mult (lag)	568.93***	−	−	−
Robust LM (lag)	63.37***	−	−	−
Lag Mult (error)	592.93***	−	−	−
Robust LM (error)	87.36***	−	−	−
Measures of Fit				
Log-likelihood	3096.94	3343.81	3352.56	3471.11
AIC	−6151.88	−6643.62	−6663.12	−6898.22
BIC	−6025.00	−6510.69	−6536.24	−6765.29

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.4 shows the results for the association of freight rail with population change for the period between 2000 and 2010. The significant values in the diagnostic test of the full OLS model indicate the spatial dependency of population change. The measures-of-fit analysis confirm that the fourth model is the best fit, with the highest log-likelihood and the lowest AIC and BIC.

Freight rail does not have any significant association with population change for this period. The highway has a positive association, as shown in the first model, before controlling for the spatial effects. Its relationship vanishes after controlling for the spatial effects. Out of three modes of transportation, the association of airport is the strongest because the values are significant across all models. According to the fourth model, each unit increase in airport number contributes to a 0.004 percent population growth. The previous decade’s population growth rate is also positive.

The association of young and old with population change is opposite: young is a positive variable and old is a negative one. Each percent increase in the young population is associated with a 0.008 percent overall population growth, while each percent increase in the old population is associated with a 0.002 percent overall population decline. Education variables are not significant. Among race and ethnicity variables, Black and Hispanic are negative and significant. A one percent increase in the Black population is associated with a 0.001 percent population decline; but a one percent increase in the Hispanic population is associated with a 0.000398 percent population decline.

Among geographic variables, metro is positive and significant. The population growth in the metropolitan area is 0.02 percent higher than in the nonmetropolitan area.

All three regions—West, Midwest, and Northeast—experienced population declines, by 0.29, 0.022, and 0.013 percent, respectively. Land developability is positive. Each percent increase in the land developability index is associated with a 0.000259 percent growth in population.

The spatial lag effect is positive, indicating that each weighted percentage point increase in population in surrounding counties is associated with a 0.552 percent growth in population in the surrounded county. The spatial error effect is negative, which indicates that the model can be improved by adding important variables.

Table 5.4: Regressions of Terminal Density on Population Change from 2000 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−6.06E−5	−3.20E−4	3.86E−4	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	0.001*	4.61E−4	0.001	3.94E−5
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.005***	0.005***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
Prev. decade pop. growth	0.412***	0.351***	0.373***	0.298***
	(0.011)	(0.011)	(0.012)	(0.011)
Population density	−6.34E−7	−1.48E−7	−2.82E−7	1.82E−7
	(9.13E−7)	(8.59E−7)	(1.05E−6)	(7.65E−7)
Young	0.009***	0.008***	0.006***	0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
Old	−0.002***	−0.002***	−0.002***	−0.002***
	(4.97E−4)	(4.67E−4)	(0.001)	(4.23E−4)
High school diploma	5.38E−5	−2.50E−4	−4.36E−4	−2.66E−4
	(3.85E−4)	(3.62E−4)	(4.51E−4)	(3.20E−4)
Bachelor's degree	−0.002**	−4.95E−4	−0.002*	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	0.002*	0.001	0.002**	1.24E−4
	(0.001)	(0.001)	(0.001)	(0.001)
White	8.89E−5	9.95E−5	4.65E−5	1.28E−4
	(2.18E−4)	(2.05E−4)	(2.41E−4)	(1.86E−4)
Black	−0.001***	−0.001***	−0.001***	−0.001***
	(2.27E−4)	(2.14E−4)	(2.61E−4)	(1.92E−4)
Hispanic	−3.63E−4	−3.86E−4	−1.59E−4	−3.98E−4*
	(2.42E−4)	(2.28E−4)	(2.83E−4)	(2.03E−4)
Household income	1.66E−6***	8.99E−7**	1.61E−6***	4.21E−7
	(3.04E−7)	(2.89E−7)	(3.42E−7)	(2.64E−7)
Employment	0.001***	0.001*	0.001***	1.34E−4
	(3.24E−4)	(3.06E−4)	(3.39E−4)	(2.84E−4)
Metro	0.027***	0.022***	0.024***	0.020***
	(0.003)	(0.003)	(0.003)	(0.003)
West	−0.035***	−0.033***	−0.032***	−0.029***
	(0.005)	(0.005)	(0.008)	(0.004)
Midwest	−0.056***	−0.035***	−0.051***	−0.022***
	(0.004)	(0.004)	(0.006)	(0.004)
Northeast	−0.051***	−0.027***	−0.046***	−0.013*
	(0.007)	(0.006)	(0.010)	(0.005)
Land developability	6.73E−5	2.01E−4***	1.40E−4	2.59E−4***
	(6.51E−5)	(6.15E−5)	(7.91E−5)	(5.44E−5)
Constant	−0.162***	−0.112***	−0.111***	−0.085***
	(0.031)	(0.029)	(0.033)	(0.026)
Spatial lag effects	–	0.333***	–	0.552***
		(0.019)		(0.019)
Spatial error effects	–	–	0.451***	−0.224***
			(0.023)	(0.031)
Diagnostic Test				
Moran's I (error)	0.21***	–	–	–
Lagrange Mult (lag)	331.90***	–	–	–
Robust LM (lag)	40.69***	–	–	–
Lag Mult (error)	354.74***	–	–	–
Robust LM (error)	63.53***	–	–	–
Measures of Fit				
Log-likelihood	3711.30	3858.78	3867.50	3903.66
AIC	−7380.60	−7673.56	−7693.01	−7763.33
BIC	−7253.72	−7540.63	−7566.13	−7630.4

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.5 presents the values for the association of freight rail with population change, controlling for nineteen socioeconomic variables for the period of four decades, from 1970 to 2010. The second column contains the full OLS model. The significant value of Moran's I in the diagnostic statistics shows that population change in this period is spatially correlated. In addition, the significant values of the Lagrange multiplier test suggest running spatial analysis. This table has spatial lag and spatial error models, which include spatial lag and spatial error effects as control variables, respectively, in the models. The fourth model, spatial error model with lag dependence, incorporates both spatial lag and spatial error effects in the model simultaneously. The use of both spatial effects variables makes this model robust, and measures of fit prove that.

According to the measures-of-fit statistics, spatial error model for lag dependence is the best fit out of the four models. The value of log-likelihood is the highest, and the values of AIC and BIC are the smallest. The relationship between freight rail and population change will be interpreted based on this model, making frequent comparisons with other three.

Over the four decades (1970 to 2010) analyzed, freight rail contributes to population decline. Each percentage point increase in freight rail terminal density brings a 0.017 percent decline in population, on average. The relationship of freight rail in the other three models is also significant and negative.

Out of two transportation control variables, highway and airport, highway is not significant. The highway is significant in the full ordinary least squares model. After controlling for spatial effects, the association of highway with population change vanishes. Airport, the other transportation control variable, is positive across all models, even though the strength is reduced in the spatial error model with lag dependence. Each additional unit of airport terminal contributes to a 0.007 percent growth in population, on average, in each county.

Population density, a demographic control variable, is not significant. Similarly, of the two age control variables, young and old, only old is significant. Each additional percent growth in the old population contributes to a 0.006 percent population decline. Young is not significant across the models.

High school diploma and bachelor's degree are positive. Each one percent increase in high school diploma and bachelor's degree contributes to the growth of the population by 0.002 and 0.004 percent, respectively. The third education control variable, graduate degree, is not significant at all.

Among race and ethnicity variables, Black has a negative relationship with population change across the models, suggesting that an increase in the Black population results in population decline. Each one percent increase in the Black population contributes to a 0.003 percent decline in overall population. Household income, an economic control variable, is negative, and the strength of association is minor. A one-unit growth in median household income causes the population to decline by 0.0000172 percent.

Metro is a strong geographic control variable and positive across all models. The association of freight rail with population growth is 0.137 percent higher in metropolitan counties than in nonmetropolitan counties. The strength of association of freight rail at regional levels varies significantly. The West is a negative variable, indicating a population decline 0.051 percent higher than in the South. The Midwest and Northeast are not significant, which suggests that the strength of association of freight rail with these regions is not considerably different from that of the South. The association in the Northeast is interesting. Its values are negative in other models, but after controlling for spatial lag and spatial error effects simultaneously, the association of freight rail vanishes.

Land developability, a land development control variable, is positive, and its strength of association is minor. A one percent increase in the index contributes to a 0.00032 percent growth in population. This shows that the potentiality of land to use for development purposes contributes to population growth. Both spatial control variables—spatial lag and spatial error effects—are significant. The significant effect of spatial lag effects shows a spatial dependency of population change. A county observes a 1.029 percent positive population change for each additional percentage point increase in weighted population growth. For this analysis, the significant spatial error effects indicate that some important control variables are missing in the model, and the addition of such variables can improve the analysis.

Table 5.5: Regressions of Terminal Density on Population Change from 1970 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.041***	−0.031***	−0.027***	−0.017***
	(0.003)	(0.003)	(0.003)	(0.002)
Control Variables				
Highway density	0.013***	0.003	−0.003	−0.001
	(0.003)	(0.002)	(0.003)	(0.002)
Airport	0.023***	0.017***	0.016***	0.007*
	(0.005)	(0.004)	(0.004)	(0.003)
Population density	−2.04E−5***	−7.14E−6	−4.42E−6	7.89E−7
	(4.74E−6)	(3.77E−6)	(5.09E−6)	(2.27E−6)
Young	−0.010	−3.35E−4	0.001	0.005
	(0.006)	(0.005)	(0.005)	(0.004)
Old	0.001	−0.004	−0.007*	−0.006***
	(0.003)	(0.003)	(0.003)	(0.002)
High school diploma	0.003**	0.003**	0.001	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Bachelor’s degree	−0.010***	−0.001	0.004	0.004**
	(0.002)	(0.002)	(0.002)	(0.001)
Graduate degree	0.024***	0.007	−0.001	−0.001
	(0.006)	(0.005)	(0.005)	(0.003)
White	−0.002	−0.003*	−0.005***	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Black	−0.005***	−0.006***	−0.013***	−0.003***
	(0.002)	(0.001)	(0.002)	(0.001)
Household income	1.25E−5	−4.99E−6	−1.77E−6	−1.72E−5***
	(9.55E−6)	(7.59E−6)	(9.76E−6)	(4.88E−6)
Employment	0.005**	0.002	0.002	−0.001
	(0.002)	(0.001)	(0.001)	(0.001)
Metro	0.353***	0.242***	0.231***	0.137***
	(0.018)	(0.014)	(0.015)	(0.010)
West	−0.023	−0.061*	0.047	−0.051***
	(0.030)	(0.024)	(0.057)	(0.013)
Midwest	−0.396***	−0.136***	−0.141	0.018
	(0.035)	(0.028)	(0.070)	(0.015)
Northeast	−0.328***	−0.126***	−0.271***	0.016
	(0.022)	(0.018)	(0.040)	(0.010)
Land developability	−0.003***	−0.001***	−6.84E−5	3.20E−4*
	(3.37E−4)	(2.69E−4)	(4.10E−4)	(1.61E−4)
Constant	0.454**	0.349*	0.845***	0.117
	(0.172)	(0.137)	(0.159)	(0.093)
Spatial lag effects	–	0.644***	–	1.029***
		(0.016)		(0.011)
Spatial error effects	–	–	0.725***	−0.831***
			(0.016)	(0.028)
Diagnostic Test				
Moran’s I (error)	0.38***	–	–	–
Lagrange Mult (lag)	1462.25***	–	–	–
Robust LM (lag)	234.34***	–	–	–
Lag Mult (error)	1231.18***	–	–	–
Robust LM (error)	3.27	–	–	–
Measures of Fit				
Log-likelihood	−1499.80	−932.97	−953.68	−503.61
AIC	3037.61	1905.94	1945.37	1047.22
BIC	3152.41	2026.78	2060.17	1168.06

AIC = Akaike’s information criterion. BIC = Schwartz’s Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.6 shows the results of the spatial error model for lag dependence for different periods (the 1970s, 1980s, 1990s, 2000s, and 1970 to 2010). The association of freight rail with population change is negative across the models, except for the 2000s. For that decade, the association is not statistically significant.

This study controls for the association of highway and airport in the analysis. The airport exerts stronger effect than the highway. The association of highway is not significant across the models, but airport is significant in the 1980s, 2000s, and overall analysis period from 1970 to 2010. The association is positive, indicating that the number of public airport terminals contributes to population growth.

Among demographic variables, the strength of association of the the previous decade's population change rate is stronger than population density. The previous decade's population growth rate is significant for three periods (the 1970s, 1980s, 1990s, and 2000s), but the directions of the effect are opposite. The association is negative for the decade of the 1970s and positive for the decades of the 1980s, 1990s, and 2000s. The association between young and old with population change is the opposite: young is positive and old is negative. Young is positive for the 1980s, and 2000s, and old is negative for the 1990s, 2000s, and for the period between 1970 and 2010. The variable old is stronger than the variable young.

Among race and ethnicity, Black is a strong variable and has a negative relationship with population change in four periods: the 1970s, 1980s, and 2000s and from 1970 to 2010. Interestingly, White is negative for the 1970s and 1980s, and Hispanic is negative for the 1990s and 2000s. Similarly, among economic variables, income is stronger than employment. The coefficient values for median household income are negative for the 1980s, 1990s, and 1970 to 2010.

Metro is very strong variable and positive across all models, indicating that metropolitan counties in every period experience population growth. The West is the strongest regional variable and has a negative relationship with population change in the 1970s, 1980s, 2000s, and in 1970 to 2010. The population decline is higher in the West than the South. The Midwest and Northeast behave similarly. They gain population in the 1980s and lose population in 2000s. The land developability is another strong variable, and it is positive for the 1980s, 1990s, 2000s, and 1970 to 2010, which indicates that the possibility of land development contributes to population growth.

Spatial lag and spatial error effects are significant in all periods. Spatial lag effects show the geographic dependency of the dependent variable, population change. The positive value indicates that an increase or decrease of population in surrounding counties causes an increase or decrease, respectively, of population in the surrounded county. Spatial error effects indicate that the model is not perfect. It can be improved by the addition of other important variables.

Table 5.6: SEMLD Results for Population Change for All Periods

	SEMLD 1970-1980	SEMLD 1980-1990	SEMLD 1990-2000	SEMLD 2000-2010	SEMLD 1970-2010
Explanatory Variables					
Terminal density	−0.006***	−0.003***	−0.003***	−0.001	−0.017***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Control Variables					
Highway density	−0.001	4.45E−4	−0.001	3.94E−5	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Airport	0.002	0.002**	−0.001	0.004***	0.007*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Prev. decade pop. growth	−0.003*	0.173***	0.203***	0.298***	−
	(0.001)	(0.007)	(0.011)	(0.011)	
Population density	2.92E−7	7.23E−7	1.95E−6*	1.82E−7	7.89E−7
	(8.45E−7)	(7.75E−7)	(7.76E−7)	(7.65E−7)	(2.27E−6)
Young	−0.001	0.003*	−0.002	0.008***	0.005
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)
Old	−0.001	−0.001	−0.003***	−0.002***	−0.006***
	(0.001)	(0.001)	(4.56E−4)	(4.23E−4)	(0.002)
High school diploma	0.001**	1.49E−4	3.54E−4	−2.66E−4	0.002***
	(2.02E−4)	(0.001)	(2.69E−4)	(3.20E−4)	(0.001)
Bachelor's degree	0.001*	0.001	0.002***	0.001	0.004**
	(4.23E−4)	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	−0.001	0.001	−0.002*	1.24E−4	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
White	−0.001*	−3.61E−4*	1.22E−4	1.28E−4	−0.001
	(2.89E−4)	(1.73E−4)	(2.00E−4)	(1.86E−4)	(0.001)
Black	−0.001**	−4.28E−4*	−3.39E−4	−0.001***	−0.003***
	(2.98E−4)	(1.72E−4)	(2.08E−4)	(1.92E−4)	(0.001)
Hispanic	−	−	−4.42E−4*	−3.98E−4*	−
			(2.15E−4)	(2.03E−4)	
Household income	−9.13E−7	−1.81E−6***	−1.51E−6***	4.21E−7	−1.72E−5***
	(1.81E−6)	(5.57E−7)	(3.55E−7)	(2.64E−7)	(4.88E−6)
Employment	−4.99E−4	5.96E−5	−0.001*	1.34E−4	−0.001
	(2.94E−4)	(0.001)	(3.04E−4)	(2.84E−4)	(0.001)
Metro	0.033***	0.027***	0.017***	0.020***	0.137***
	(0.004)	(0.003)	(0.003)	(0.003)	(0.010)
West	−0.020***	−0.021***	0.002	−0.029***	−0.051***
	(0.005)	(0.004)	(0.004)	(0.004)	(0.013)
Midwest	0.004	0.011***	0.005	−0.022***	0.018
	(0.004)	(0.003)	(0.003)	(0.004)	(0.015)
Northeast	0.009	0.015***	0.003	−0.013*	0.016
	(0.006)	(0.004)	(0.005)	(0.005)	(0.010)
Land developability	8.60E−5	2.38E−4***	2.68E−4***	2.59E−4***	3.20E−4*
	(6.02E−5)	(4.95E−5)	(5.09E−5)	(5.44E−5)	(1.61E−4)
Constant	0.067	−0.044	0.101***	−0.085***	0.117
	(0.035)	(0.030)	(0.030)	(0.026)	(0.093)
Spatial lag effects	1.055***	0.821***	0.834***	0.552***	1.029***
	(0.012)	(0.013)	(0.016)	(0.019)	(0.011)
Spatial error effects	−0.929***	−0.638***	−0.600***	−0.224***	−0.831***
	(0.027)	(0.030)	(0.030)	(0.031)	(0.028)
Measures of Fit					
Log-likelihood	2435.60	3548.70	3471.11	3903.66	−503.61
AIC	−4829.20	−7055.39	−6898.22	−7763.33	1047.22
BIC	−4702.31	−6928.51	−6765.29	−7630.4	1168.06

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Employment Change

Tables 5.7 to 5.12 present the association of freight rail with employment change for different periods. Table 5.7 is for the period of 1970 to 1980. As shown in other tables, the spatial error model with lag dependence is the best-fit model based on the measures-of-fit statistics. Freight rail has a negative relationship with employment change. every percentage point increase in freight rail terminal density contributes to a 0.007 percent employment loss, on average. Freight rail is negative across all models. Among transportation variables, airport is stronger than highway. With each unit increase in a public airport terminal, employment grows by 0.004 percent. This variable is significant across all models. On the other hand, highway is not significant at all.

Age variables are interesting. Both young and old variables are negative across all models, except that young is not significant in the spatial error model with lag dependence. After controlling for spatial lag and spatial error effects, the association of young with employment change vanishes. On the other hand, each percent increase in the old population contributes to a 0.004 percent decline in the employed population. Among education variables, high school diploma and bachelor’s degree are positive. Each additional percent growth in high school diplomas and bachelor’s degrees contributes to a 0.001 percent growth in the employed population. The graduate degree variable is not significant.

Black is stronger than White in the race and ethnicity variables. Black is negative, which indicates that a one percent increase in the Black population causes a 0.001 percent employment decline. This variable is significant across all models. On the other hand, White is not significant. Income—an economic variable—is negative, and the strength of association is very small.

Metro is strong and positive, indicating that employment growth is higher in metropolitan counties. In comparison to a nonmetropolitan county, employment growth is 0.011 percent higher in a metropolitan county. Metro is significant across all models. Regional variables behave differently. The West is negative, the Midwest is positive, and the Northeast is not significant at all. The West experiences 0.027 percent greater decline in employment than the South. In the Midwest, employment growth is 0.010 percent higher than the South. The Midwest is significant across all models, but the association is negative in the other three models. The Northeast is not significant in the fourth model, even though values are significant and negative in the first three models.

Land developability is not significant in this period. But that variable is significant and negative in the first three models. The spatial lag effect is positive, which indicates that employment is spatially dependent. Each additional percentage point of weighted employment growth in surrounding counties contributes to 1.041 percent growth in employment in the surrounded county. The significant spatial error effects show the model is not perfect. Control variables can be added to improve the model.

Table 5.7: Regressions of Terminal Density on Employment Change from 1970 to 1980

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.016***	−0.014***	−0.013***	−0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	−2.98E−4	−0.001	−0.002	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.010***	0.008***	0.007***	0.004**
	(0.002)	(0.002)	(0.002)	(0.001)
Young	−0.012***	−0.008***	−0.007**	−0.002
	(0.003)	(0.002)	(0.002)	(0.002)
Old	−0.006***	−0.006***	−0.009***	−0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
High school diploma	−0.001	−5.19E−5	−0.001	0.001*
	(0.001)	(4.49E−4)	(0.001)	(2.43E−4)
Bachelor's degree	0.002	0.002*	0.003**	0.001*
	(0.001)	(0.001)	(0.001)	(4.95E−4)
Graduate degree	0.007**	0.004*	0.001	0.002
	(0.002)	(0.002)	(0.002)	(0.001)
White	−0.002	−0.002**	−0.002**	−0.001
	(0.001)	(0.001)	(0.001)	(3.50E−4)
Black	−0.004***	−0.003***	−0.005***	−0.001**
	(0.001)	(0.001)	(0.001)	(3.61E−4)
Household income	−2.17E−6	−4.89E−6	−2.97E−6	−6.85E−6***
	(3.77E−6)	(3.37E−6)	(4.11E−6)	(2.04E−6)
Metro	0.108***	0.086***	0.086***	0.044***
	(0.007)	(0.007)	(0.007)	(0.005)
West	−0.024	−0.037***	−0.006	−0.027***
	(0.013)	(0.011)	(0.020)	(0.006)
Midwest	−0.104***	−0.052***	−0.105***	0.010*
	(0.009)	(0.009)	(0.014)	(0.004)
Northeast	−0.153***	−0.073***	−0.109***	0.013
	(0.014)	(0.013)	(0.024)	(0.007)
Land developability	−0.002***	−0.001***	−0.001***	3.79E−5
	(1.34E−4)	(1.22E−4)	(1.71E−4)	(6.62E−5)
Constant	0.840***	0.565***	0.862***	0.110**
	(0.070)	(0.064)	(0.070)	(0.042)
Spatial lag effects	–	0.493***	–	1.041***
		(0.020)		(0.013)
Spatial error effects	–	–	0.556***	−0.935***
			(0.020)	(0.027)
Diagnostic Test				
Moran's I (error)	0.28***	–	–	–
Lagrange Mult (lag)	689.17***	–	–	–
Robust LM (lag)	27.78***	–	–	–
Lag Mult (error)	695.27***	–	–	–
Robust LM (error)	33.88***	–	–	–
Measures of Fit				
Log-likelihood	1194.32	1457.88	1472.39	1827.92
AIC	−2354.65	−2879.77	−2910.77	−3619.84
BIC	−2251.93	−2771.01	−2808.06	−3511.08

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.8 contains the regression results of freight rail on employment change for the period of 1980 to 1990. The diagnostic statistics in the first model indicate that the dependent variable has spatial autocorrelation, and it also suggests the use of spatial regression analysis. Based on the measures of fit, the fourth is the best-fit model. Freight rail has a negative relationship with employment change. Each percentage point increase in freight rail terminal density contributes to a 0.003 percent employment decline. The association is negative across all models.

During the 1980s, the highway emerges as a strong variable. The highway is a positive variable across all models. One additional unit increase in highway density contributes to a 0.002 percent growth in employment. Airport is a weak transportation control variable, and it is not significant in this decade. Both age variables—young and old—are strong and opposite. Young is positive, and old is negative across all the models. A one percent increase in the young population contributes to a 0.007 percent growth in employment. On the other hand, a one percent increase in the old population results in a 0.015 percent decline in employment.

All education variables—high school diploma, bachelor’s degree, and graduate degree—are negative. A one percent increase in high school diplomas contributes to a 0.012 percent decline in employment, a one percent increase in bachelor’s degrees causes a 0.008 percent decline in decline, and each percent increase in graduate degrees contributes to the reduction of employment by 0.013 percent. In addition, these three control variables are strong, being significant across all models.

White and Black, the two race and ethnicity variables, are opposite in their association with employment change. White is positive and Black is negative. Each percent increase in the White population contributes to a 0.001 percent growth in employment, whereas each one percent increase in the Black population is associated with a 0.001 percent decline in employment. Income, an economic variable, is associated with employment decline, though the association is weak. Each additional unit increase in median household income is associated with a 0.00000296 percent decline in employment.

Metro is positive, indicating that a metropolitan county experiences a 0.046 percent higher growth in employment than a nonmetropolitan county, on average. The variable metro is strong, too, because it is significant across all models. The regional variables shown in Table 5.8 are weak. Of three regional variables, only the Midwest is significant, and it has a positive association with employment change. It demonstrates that employment growth in the Midwest is 0.33 percent higher than in the South. The employment change in the West and Northeast is not significantly different than that of the South.

Spatial lag effects are negative, indicating that growth in one county causes a decline in the other. Each percentage point of weighted employment growth in surrounding counties contributes to a 0.867 percent employment decline in the surrounded county. The spatial error effects show that the model is not perfect. Relevant variables can be added to improve the model.

Table 5.8: Regressions of Terminal Density on Employment Change from 1980 to 1990

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.008***	−0.005***	−0.003***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	0.006***	0.003***	0.002**	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.008***	0.004**	0.002	0.002
	(0.002)	(0.001)	(0.001)	(0.001)
Prev. decade emp. change	0.257***	0.196***	0.210***	0.191***
	(0.009)	(0.008)	(0.008)	(0.008)
Young	0.009***	0.010***	0.007***	0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
Old	−0.010***	−0.010***	−0.017***	−0.015***
	(0.001)	(0.001)	(0.001)	(0.001)
High school diploma	−0.007***	−0.008***	−0.015***	−0.012***
	(0.001)	(0.001)	(0.001)	(0.001)
Bachelor’s degree	−0.011***	−0.007***	−0.010***	−0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	−0.004*	−0.008***	−0.016***	−0.013***
	(0.002)	(0.001)	(0.001)	(0.001)
White	0.001***	0.001*	0.001	0.001*
	(3.70E−4)	(3.13E−4)	(3.85E−4)	(3.40E−4)
Black	0.001***	4.51E−4	−0.001*	−0.001**
	(3.86E−4)	(3.27E−4)	(4.57E−4)	(4.28E−4)
Household income	−2.61E−6*	−1.73E−6	−1.29E−6	−2.96E−6*
	(1.19E−6)	(1.00E−6)	(1.23E−6)	(1.16E−6)
Metro	0.089***	0.059***	0.047***	0.046***
	(0.006)	(0.005)	(0.005)	(0.004)
West	−0.012	−0.016	−0.043*	−0.011
	(0.010)	(0.008)	(0.018)	(0.024)
Midwest	0.002	0.020***	−0.020	0.033*
	(0.007)	(0.006)	(0.012)	(0.016)
Northeast	0.047***	0.049***	0.050*	0.024
	(0.011)	(0.009)	(0.022)	(0.029)
Land developability	−3.99E−4***	2.63E−4**	6.49E−5	−1.19E−4
	(1.07E−4)	(9.20E−5)	(1.29E−4)	(1.10E−4)
Constant	0.427***	0.368***	0.991***	0.888***
	(0.061)	(0.052)	(0.058)	(0.074)
Spatial lag effects	−	0.527***	−	−0.867***
		(0.016)		(0.045)
Spatial error effects	−	−	0.724***	0.984***
			(0.016)	(0.005)
Diagnostic Test				
Moran’s I (error)	0.37***	−	−	−
Lagrange Mult (lag)	1042.97***	−	−	−
Robust LM (lag)	63.73***	−	−	−
Lag Mult (error)	1202.43***	−	−	−
Robust LM (error)	223.19***	−	−	−
Measures of Fit				
Log-likelihood	2056.90	2475.97	2619.64	2658.38
AIC	−4077.81	−4913.94	−5203.28	−5278.75
BIC	−3969.05	−4799.14	−5094.53	−5163.95

AIC = Akaike’s information criterion. BIC = Schwartz’s Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.9 pertains to the association of freight rail with employment change for the decade of the 1990s. As shown in previous tables, the diagnostic test in the full ordinary least squares model shows a spatial correlation of employment change. The diagnostic test also shows preferences in the spatial error model over the spatial lag model. But, based on the measures of fit, the spatial error model with lag dependence is the best-fit model, with the highest log-likelihood value (2188.09), and the lowest values for AIC (−4336.18) and BIC (−4215.33). Hence, all interpretation is based on the fourth model.

The fourth model shows freight rail has a negative relationship with employment change. Each additional unit increase in freight rail terminal density contributes to a 0.006 percent employment loss. The explanatory variable is very strong; it is significant across all models.

This analysis removes the influence of highway and airport by controlling for them in the model. The spatial error model with lag dependence, the fourth model, shows that highway exerts a stronger influence on employment change than airport, which is not significant. The highway is negative, indicating that each additional unit increase in highway density causes a 0.002 percent loss in employment. The impact of the previous decade’s employment growth rate is positive. Each percent increase in the previous decade’s employment growth rate contributes to a 0.054 percent growth in employment. This variable is strong: not only is it significant in the fourth model, it is also significant in the other three models.

The young and old variables are not strong enough to be significant in the fourth model. Similarly, high school diploma and graduate degree are weak in this decade. But bachelor’s degree is significant and positive. Each percent increase in bachelor’s degrees contributes in a 0.004 percent employment growth. Bachelor’s degree stands out as a strong variable and is significant in all models. Among race and ethnicity, White is the only variable that has a significant relationship with employment change. A one percent increase in White associates with a 0.001 percent employment growth. In addition, White is positive in all models. Black and Hispanic are not significant.

Metro is positive, indicating that a metropolitan county observes a 0.030 percent higher growth in employment, on average, than a nonmetropolitan county. None of the regional variables are significant in this decade for employment change. Land developability is positive and weak. A one percent increase in land developability index contributes to a 0.000185 percent growth in employment, which shows that land development could attract employment.

Spatial lag effects are positive, which indicates that the dependent variable is geographically interrelated. A growth in employment in one county influences the growth in a neighboring county. A county has a 0.92 percent growth in employment with each additional percentage point of weighted employment growth in surrounding counties. Spatial lag effects are significant, indicating the imperfection of the model. The model can be improved by adding relevant control variables.

Table 5.9: Regressions of Terminal Density on Employment Change from 1990 to 2000

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.008***	−0.007***	−0.006***	−0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	−2.06E−4	−0.002	−0.002*	−0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	−0.003	−0.001	1.69E−4	2.32E−4
	(0.002)	(0.002)	(0.002)	(0.001)
Prev. decade emp.	0.156***	0.107***	0.076***	0.054***
change	(0.011)	(0.010)	(0.011)	(0.008)
Young	−0.006*	−0.005*	−0.006**	−0.001
	(0.003)	(0.002)	(0.002)	(0.002)
Old	−0.002*	−0.001	−0.002	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
High school diploma	0.002***	0.001	−1.79E−4	1.17E−4
	(0.001)	(0.001)	(0.001)	(3.80E−4)
Bachelor's degree	0.005***	0.005***	0.003*	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	−0.001	−0.002	−0.003	−0.002
	(0.002)	(0.002)	(0.002)	(0.001)
White	0.002***	0.002***	0.002***	0.001***
	(4.45E−4)	(4.03E−4)	(4.72E−4)	(2.85E−4)
Black	−3.85E−4	−2.59E−4	−0.002**	2.91E−4
	(4.72E−4)	(4.29E−4)	(0.001)	(2.95E−4)
Hispanic	0.001	4.22E−4	−0.001	0.001
	(4.97E−4)	(4.51E−4)	(0.001)	(3.05E−4)
Household income	7.39E−7	8.94E−7	2.38E−6**	−2.82E−7
	(7.20E−7)	(6.53E−7)	(8.15E−7)	(4.55E−7)
Metro	0.055***	0.046***	0.050***	0.030***
	(0.006)	(0.006)	(0.006)	(0.005)
West	0.047***	0.021*	0.058***	−0.003
	(0.010)	(0.009)	(0.017)	(0.006)
Midwest	−0.036***	−0.026***	−0.040***	−0.005
	(0.008)	(0.007)	(0.012)	(0.004)
Northeast	−0.129***	−0.065***	−0.091***	−0.004
	(0.012)	(0.012)	(0.021)	(0.007)
Land developability	5.19E−5	1.84E−4	3.50E−4*	1.85E−4**
	(1.16E−4)	(1.05E−4)	(1.47E−4)	(6.66E−5)
Constant	0.764***	0.380***	0.910***	−0.038
	(0.056)	(0.054)	(0.059)	(0.039)
Spatial lag effects	−	0.447***	−	0.920***
		(0.020)		(0.015)
Spatial error effects	−	−	0.580***	−0.724***
			(0.020)	(0.029)
Diagnostic Test				
Moran's I (error)	0.27***	−	−	−
Lagrange Mult (lag)	578.23***	−	−	−
Robust LM (lag)	22.34***	−	−	−
Lag Mult (error)	649.64***	−	−	−
Robust LM (error)	93.75***	−	−	−
Measures of Fit				
Log-likelihood	1767.44	2001.37	2056.26	2188.09
AIC	−3496.88	−3962.74	−4074.52	−4336.18
BIC	−3382.09	−3841.90	−3959.73	−4215.33

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.10 addresses the relationship of freight rail with employment change from 2000 to 2010. Significant values in the diagnostic test in the full ordinary least squares model show the spatial autocorrelation of employment change. The measures-of-fit analysis show the fourth model, spatial error model with lag dependence, is the best fit because the log-likelihood is the highest (2956.40) and AIC (−5872.8) and BIC (−5751.96) are the lowest across all models.

In this period, both freight rail and highway are not significant. Airport is positive and significant only after controlling for spatial lag and spatial error effects simultaneously. Each unit increase in airport contributes in a 0.002 percent growth in employment, on average. The previous decade's employment growth is significant across all models. Each percent increase in employment contributes to a 0.079 percent employment growth, on average. The effect of the young population vanishes after simultaneous control for spatial lag and spatial error effects. On the other hand, each percent increase in the old population associates with a 0.002 percent decline in employment.

Education variables are not significant, and only Black is significant among race and ethnicity variables. Each percent increase in the Black population is associated with a 0.000416 percent employment decline. Similarly, median household income is also negative: each unit increase contributes to a 0.00000057 percent decline in employment.

Metro is very strong and significant across all models. Employment growth in a metropolitan county is 0.009 percent greater than in a nonmetropolitan county. Employment declines in the West by 0.015 percent, whereas the Northeast gains employment by 0.011 percent. The employment change in the Midwest is not significantly different than the South.

When we compare the first model with the fourth, the direction of the land developability index is opposite. After controlling for both spatial lag and spatial error effects simultaneously, each unit increase in the index is associated with a 0.000115 percent growth in employment. The spatial lag effect is positive, and the spatial error effect is negative. Each percentage point increase in weighted employment growth in surrounding counties contributes to a 1.026 percent growth in employment in the surrounded county. The negative value for the spatial error effect shows the possibility of model improvement.

Table 5.10: Regressions of Terminal Density on Employment Change from 2000 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.002	−0.002	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	−4.56E−4	−0.001	−3.72E−4	−4.83E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.002	0.002	0.003	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Prev. decade emp.	0.242***	0.200***	0.226***	0.079***
growth	(0.015)	(0.014)	(0.016)	(0.009)
Young	0.016***	0.009***	0.006**	0.002
	(0.002)	(0.002)	(0.002)	(0.001)
Old	0.002**	−1.67E−4	−0.001	−0.002***
	(0.001)	(0.001)	(0.001)	(4.09E−4)
High school diploma	−0.002**	−0.001**	−0.001*	−0.001
	(0.001)	(0.001)	(0.001)	(3.03E−4)
Bachelor's degree	0.005***	0.003***	0.002	4.67E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	−0.006***	−0.003**	−0.001	3.18E−4
	(0.001)	(0.001)	(0.001)	(0.001)
White	−0.002***	−0.001***	−0.001***	−1.88E−4
	(3.26E−4)	(2.94E−4)	(3.54E−4)	(1.88E−4)
Black	−0.003***	−0.002***	−0.002***	−4.16E−4*
	(3.42E−4)	(3.11E−4)	(3.94E−4)	(1.94E−4)
Hispanic	0.001*	1.58E−4	0.001*	−3.48E−4
	(3.64E−4)	(3.29E−4)	(4.27E−4)	(2.00E−4)
Household income	1.34E−6**	5.86E−7	1.36E−6**	−5.70E−7*
	(4.27E−7)	(3.86E−7)	(4.92E−7)	(2.44E−7)
Metro	0.017***	0.011*	0.011*	0.009*
	(0.005)	(0.005)	(0.005)	(0.003)
West	−0.052***	−0.039***	−0.022	−0.015***
	(0.008)	(0.007)	(0.013)	(0.004)
Midwest	−0.062***	−0.031***	−0.042***	0.003
	(0.006)	(0.006)	(0.009)	(0.003)
Northeast	−0.017	−4.35E−5	−0.012	0.011*
	(0.010)	(0.009)	(0.016)	(0.005)
Land developability	−1.83E−4*	1.86E−5	8.49E−5	1.15E−4*
	(9.27E−5)	(8.36E−5)	(1.18E−4)	(4.77E−5)
Constant	0.078	0.083*	0.125**	0.044
	(0.044)	(0.040)	(0.048)	(0.025)
Spatial lag effects	−	0.481***		1.026***
		(0.020)		(0.014)
Spatial error effects	−	−	0.551***	−0.848***
			(0.021)	(0.028)
Diagnostic Test				
Moran's I (error)	0.26***	−	−	−
Lagrange Mult (lag)	589.31***	−	−	−
Robust LM (lag)	25.59***	−	−	−
Lag Mult (error)	599.80***	−	−	−
Robust LM (error)	36.07***	−	−	−
Measures of Fit				
Log-likelihood	2435.69	2678.61	2694.68	2956.40
AIC	−4833.39	−5317.23	−5351.37	−5872.8
BIC	−4718.59	−5196.39	−5236.57	−5751.96

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.11 presents the association of freight rail with employment change from 1970 to 2010. It shows the impact for four decades. The measures of fit show the fourth model, thespatial error model for lag dependence, is the best fit because it has the highest value of log-likelihood (−836.36) and the lowest values of AIC (1708.71) and BIC (1817.47). Hence, the following interpretation is based on this model.

The value of freight rail is negative, indicating its influence on employment loss. Each percent increase in terminal density contributes to a 0.017 percent loss in employment. The explanatory variable is strong because it is significant across all models. Airport is a positive variable, indicating that each additional unit increase in airport terminals contributes to a 0.009 percent growth in employment. The airport is strong variable because it is significant in all models. The other transportation variable, highway, is weaker than airport and is not significant.

Young and old, the two age variables, behave differently. Young is not significant at all, whereas old is negative across all models. The coefficient value can be interpreted as each percent increase in the old population triggers a of 0.010 percent reduction in employment. High school dipoloma and bachelor’s degree are positive, which indicates that these two variables contribute to employment growth. Each percent increase in high school diplomas contributes a 0.003 percent growth in employment. Similarly, employment grows by 0.005 percent with each percent increase in bachelor’s degrees. The third education variable, graduate degree, is not significant.

Black, one of the two race and ethnicity variables, is negative. Each additional percent growth in the Black population is associated with a 0.003 percent loss in employment. This variable is strong because it is significant with all models. On the other hand, White is not significant. Income is negative, representing that each additional unit increase in median household income is associated with a 0.0000344 percent loss in employment.

Metro is positive and significant across all models. A metropolitan county observes a 0.176 percent higher growth in employment compared with a nonmetropolitan county. The West is negative, and the Northeast is positive. A county in the West experiences a 0.067 percent higher loss in employment than a county in the South. But in the Northeast, employment is 0.029 percent higher than the South. The Northeast is negative in the rest of the models. The Midwest is not significant.

The spatial log effect is positive, which shows a spatial correlation of employment change for this decade. Employment growth (decline) in one county is associated with employment growth (decline) in other counties. A county adds 1.022 percent employment with each additional percentage weighted employment growth in surrounding counties. The spatial lag effect is significant, demonstrating that the model is far from perfect. The addition of relevant variables can improve the model.

Table 5.11: Regressions of Terminal Density on Employment Change from 1970 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.044***	−0.034***	−0.030***	−0.017***
	(0.004)	(0.003)	(0.003)	(0.002)
Control Variables				
Highway density	0.008**	0.002	−0.003	−0.001
	(0.003)	(0.003)	(0.003)	(0.002)
Airport	0.028***	0.021***	0.019***	0.009**
	(0.005)	(0.005)	(0.005)	(0.003)
Young	−0.007	0.002	0.002	0.007
	(0.007)	(0.006)	(0.006)	(0.004)
Old	−0.013***	−0.015***	−0.024***	−0.010***
	(0.003)	(0.003)	(0.003)	(0.002)
High school diploma	0.002	0.003***	0.002	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Bachelor's degree	−0.002	0.003	0.009***	0.005***
	(0.002)	(0.002)	(0.003)	(0.001)
Graduate degree	0.017**	0.007	−0.005	0.002
	(0.006)	(0.005)	(0.005)	(0.003)
White	−0.002	−0.002	−0.004**	−0.001
	(0.002)	(0.001)	(0.001)	(0.001)
Black	−0.006***	−0.007***	−0.013***	−0.003***
	(0.002)	(0.001)	(0.002)	(0.001)
Household income	−1.22E−5	−3.10E−5***	−4.04E−5***	−3.44E−5***
	(9.54E−6)	(7.87E−6)	(1.00E−5)	(5.05E−6)
Metro	0.418***	0.306***	0.294***	0.176***
	(0.019)	(0.016)	(0.017)	(0.012)
West	−0.046	−0.083**	0.015	−0.067***
	(0.032)	(0.026)	(0.058)	(0.014)
Midwest	−0.327***	−0.107***	−0.112	0.028
	(0.037)	(0.031)	(0.071)	(0.016)
Northeast	−0.231***	−0.084***	−0.224***	0.029**
	(0.023)	(0.020)	(0.041)	(0.011)
Land developability	−0.004***	−0.001***	−0.001*	1.13E−4
	(3.38E−4)	(2.83E−4)	(4.35E−4)	(1.65E−4)
Constant	1.320***	0.781***	1.625***	0.141
	(0.177)	(0.148)	(0.169)	(0.101)
Spatial lag effects	–	0.604***	–	1.022***
		(0.017)		(0.011)
Spatial error effects	–	–	0.691***	−0.832***
			(0.017)	(0.028)
Diagnostic Test				
Moran's I (error)	0.35***	–	–	–
Lagrange Mult (lag)	1207.86***	–	–	–
Robust LM (lag)	160.51***	–	–	–
Lag Mult (error)	1057.52***	–	–	–
Robust LM (error)	10.18**	–	–	–
Measures of Fit				
Log-likelihood	−1695.24	−1226.80	−1232.36	−836.36
AIC	3424.48	2489.61	2498.72	1708.71
BIC	3527.19	2598.36	2601.43	1817.47

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.12 presents the results of the spatial error model with lag dependence for all periods. These are the best models in each period, and the data in this table help broaden our understanding of the association of freight rail with employment change.

Freight rail is negative across all periods except for the 2000s. Freight rail is associated with employment loss at the county level. Airport is significant in three periods and stronger than highway, which is significant in two periods only. The age variable, old, is stronger than young. The variable old is significant in four periods (the 1970s, 1980s, 2000s, and 1970 to 2010), whereas the variable young is significant only in one period (1980s). The negative value indicates that the variable old is associated with employment loss.

Among education variables, high school diploma and bachelor’s degree are stronger than the graduate degree. Both high school diploma and bachelor’s degree are associated with employment growth, except in the 1980s when the association for the both variables is negative. The graduate degree is also negative for this period.

Black is stronger than White and Hispanic, and it is associated with employment loss. Similarly, income is also associated with employment loss. Metro is strong and positive in all periods. Regional variables are weak, which indicates that the association of freight rail with employment change in the West, Midwest, and Northeast is not significantly different from the South.

Thespatial lag effect for employment change is positive, except in the 1980s when the effect is negative. The 1980s behave differently in terms of education, spatial lag, and spatial effects than the rest of the periods. Spatial error effect is significant in all periods.

Table 5.12: SEMLD Results for Employment Change for All Periods

	SEMLD 1970-1980	SEMLD 1980-1990	SEMLD 1990-2000	SEMLD 2000-2010	SEMLD 1970-2010
Explanatory Variables					
Terminal density	−0.007***	−0.003***	−0.006***	−0.001	−0.017***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Control Variables					
Highway density	−0.001	0.002***	−0.002*	−4.83E−4	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Airport	0.004**	0.002	2.32E−4	0.002*	0.009**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Prev. decade emp. change	−	0.191***	0.054***	0.079***	−
		(0.008)	(0.008)	(0.009)	
Young	−0.002	0.007***	−0.001	0.002	0.007
	(0.002)	(0.002)	(0.002)	(0.001)	(0.004)
Old	−0.004***	−0.015***	−0.001	−0.002***	−0.010***
	(0.001)	(0.001)	(0.001)	(4.09E−4)	(0.002)
High school diploma	0.001*	−0.012***	1.17E−4	−0.001	0.003***
	(2.43E−4)	(0.001)	(3.80E−4)	(3.03E−4)	(0.001)
Bachelor's degree	0.001*	−0.008***	0.004***	4.67E−4	0.005***
	(4.95E−4)	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	0.002	−0.013***	−0.002	3.18E−4	0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
White	−0.001	0.001*	0.001***	−1.88E−4	−0.001
	(3.50E−4)	(3.40E−4)	(2.85E−4)	(1.88E−4)	(0.001)
Black	−0.001**	−0.001**	2.91E−4	−4.16E−4*	−0.003***
	(3.61E−4)	(4.28E−4)	(2.95E−4)	(1.94E−4)	(0.001)
Hispanic	−	−	0.001	−3.48E−4	−
			(3.05E−4)	(2.00E−4)	
Household income	−6.85E−6***	−2.96E−6*	−2.82E−7	−5.70E−7*	−3.44E−5***
	(2.04E−6)	(1.16E−6)	(4.55E−7)	(2.44E−7)	(5.05E−6)
Metro	0.044***	0.046***	0.030***	0.009*	0.176***
	(0.005)	(0.004)	(0.005)	(0.003)	(0.012)
West	−0.027***	−0.011	−0.003	−0.015***	−0.067***
	(0.006)	(0.024)	(0.006)	(0.004)	(0.014)
Midwest	0.010*	0.033*	−0.005	0.003	0.028
	(0.004)	(0.016)	(0.004)	(0.003)	(0.016)
Northeast	0.013	0.024	−0.004	0.011*	0.029**
	(0.007)	(0.029)	(0.007)	(0.005)	(0.011)
Land developability	3.79E−5	−1.19E−4	1.85E−4**	1.15E−4*	1.13E−4
	(6.62E−5)	(1.10E−4)	(6.66E−5)	(4.77E−5)	(1.65E−4)
Constant	0.110**	0.888***	−0.038	0.044	0.141
	(0.042)	(0.074)	(0.039)	(0.025)	(0.101)
Spatial lag effects	1.041***	−0.867***	0.920***	1.026***	1.022***
	(0.013)	(0.045)	(0.015)	(0.014)	(0.011)
Spatial error effects	−0.935***	0.984***	−0.724***	−0.848***	−0.832***
	(0.027)	(0.005)	(0.029)	(0.028)	(0.028)
Diagnostic Test					
Moran's I (error)	−	−	−		−
Lagrange Mult (lag)	−	−	−		−
Robust LM (lag)	−	−	−		−
Lag Mult (error)	−	−	−		−
Robust LM (error)	−	−	−		−
Measures of Fit					
Log-likelihood	1827.92	2658.38	2188.09	2956.40	−836.36
AIC	−3619.84	−5278.75	−4336.18	−5872.8	1708.71
BIC	−3511.08	−5163.95	−4215.33	−5751.96	1817.47

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

SECTION 2: RACE AND ETHNICITY

Section 2 has fifteen tables that represent the association of freight rail with White, Black, and Hispanic population change. The White and Black variables have six tables each, and the Hispanic variable has three tables. Data for Hispanic population are not available for the 970s and 1980s.

White Population

Tables 5.13 to 5.18 represent results of the analysis carried out between freight rail terminal density and White population change in different periods. Table 5.13 is for the period of 1970 to 1980. In this table, the spatial error model with lag dependence is the best-fit model based on measures-of-fit statistics. Hence, the explanation of the results is based on this model.

Freight rail, the explanatory variable, is negative, showing that freight rail is associated with White population loss. Each percentage point increase in freight rail terminal density contributes to a 0.008 percent decline in the White population. This value is true after even after controlling for many socioeconomic and transportation variables. In this model, the impact of highway and airport is removed to reveal the association between freight rail and White population change. The highway is also negatively associated with White population change (i.e., every one-unit increase in highway density causes a 0.002 percent White population loss). Airport is not significant in the fourth model, but it is in the first three. Airport becomes statistically not significant because of controlling for the effects of spatial lag and spatial error effects simultaneously.

The metro variable is positive, showing that in a metropolitan county the White population growth is 0.034 percent higher than in a nonmetropolitan county. This variable is positive across all models. The direction of association of regional variables with White population change varies. The West is negative, which indicates a county in this region loses White population by 0.011 percent more than a county in the South. The Midwest is not significant, even though the impact is negative and significant in the first three models. On the other hand, the Northeast is positive, even though the values are negative in the first three models. A county in the Northeast gains 0.015 percent more White population than in a county in the South.

The spatial lag effect is positive , which shows the spatial correlation of the dependent variable, White population change. A county gains 1.062 percent in White population for each additional percentage point of weighted White population growth in surrounding counties. The significant spatial error effect shows the imperfect nature the fourth model. This model can be improved by adding relevant control variables.

Table 5.13: Regressions of Terminal Density on White Population Change from 1970 to 1980

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.017***	−0.015***	−0.014***	−0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	−0.003*	−0.003***	−0.005***	−0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.007***	0.005**	0.004*	0.002
	(0.002)	(0.002)	(0.002)	(0.001)
Prev. decade White change	0.004*	0.001	0.001	−0.002
	(0.002)	(0.002)	(0.002)	(0.001)
Young	−0.004	−0.003	−0.003	−0.001
	(0.003)	(0.002)	(0.002)	(0.002)
Old	0.006***	0.004***	0.005***	−3.32E−5
	(0.001)	(0.001)	(0.001)	(0.001)
High school diploma	0.002***	0.001**	0.001	4.06E−4
	(4.97E−4)	(4.22E−4)	(0.001)	(2.27E−4)
Bachelor's degree	−0.005***	−0.002*	−0.001	0.001
	(0.001)	(0.001)	(0.001)	(4.76E−4)
Graduate degree	0.004	0.001	0.002	−0.002
	(0.002)	(0.002)	(0.002)	(0.001)
Black	−4.46E−4	−0.001	−0.002***	−2.13E−4
	(2.60E−4)	(2.21E−4)	(3.72E−4)	(1.09E−4)
Household income	1.47E−5***	1.07E−5***	1.28E−5**	2.40E−6
	(3.93E−6)	(3.33E−6)	(4.16E−6)	(2.01E−6)
Employment	3.75E−4	3.56E−4	0.001	−3.85E−4
	(0.001)	(0.001)	(0.001)	(3.30E−4)
Metro	0.094***	0.070***	0.068***	0.034***
	(0.007)	(0.006)	(0.007)	(0.004)
West	−0.051***	−0.035***	−0.023	−0.011*
	(0.013)	(0.011)	(0.021)	(0.005)
Midwest	−0.126***	−0.061***	−0.123***	0.004
	(0.009)	(0.008)	(0.015)	(0.004)
Northeast	−0.147***	−0.058***	−0.098***	0.015*
	(0.014)	(0.012)	(0.026)	(0.006)
Land developability	−0.002***	−0.001***	−4.02E−4*	1.29E−4
	(1.38E−4)	(1.19E−4)	(1.69E−4)	(6.75E−5)
Constant	0.103*	0.005	0.035	−0.013
	(0.051)	(0.043)	(0.053)	(0.027)
Spatial lag effects	−	0.581***	−	1.062***
		(0.019)		(0.011)
Spatial error effects	−	−	0.637***	−0.930***
			(0.018)	(0.027)
Diagnostic Test				
Moran's I (error)	0.33***	−	−	−
Lagrange Mult (lag)	1056.12***	−	−	−
Robust LM (lag)	101.24***	−	−	−
Lag Mult (error)	957.78***	−	−	−
Robust LM (error)	2.90	−	−	−
Measures of Fit				
Log-likelihood	1225.12	1620.66	1617.81	2070.70
AIC	−2414.25	−3203.32	−3199.62	−4103.40
BIC	−2305.49	−3088.52	−3090.86	−3988.60

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.14 presents regression results between freight rail and White population for the period of 1980 to 1990. The diagnostic test shows the spatial autocorrelation of the dependent variable. The diagnostic test also suggests to run spatial analysis. The measures-of-fit statistics show the fourth model is the best-fit model because it has the highest value of log-likelihood (2362.11) and the lowest values of AIC (−4686.21) and BIC (−4571.41). Hence, the following description is based on the fourth model.

The negative value indicates that freight rail is associated with White population loss. Each additional percentage point increase in freight rail terminal density contributes to a 0.004 percent decline in the White population. The highway is also negative. Each unit increase in highway density causes a 0.001 percent decline in the White population. Airport, the other transportation variable, is not significant. The previous decade's White population change is positive. Each percent growth in White population in the previous decade contributes to 0.11 percent White population growth.

Metro is positive, suggesting that White population growth in a metropolitan county is 0.02 percent greater than in a nonmetropolitan county. This variable is significant across all models. The relationship of the West with White population is negative. A county in the West experiences a 0.015 percent greater decline in the White population than a county in the South. The Midwest and Northeast are positive. A county in the Midwest experiences a 0.014 percent greater White population growth than a county in the South. This value is 0.022 percent for the Northeast.

Land developability is positive, but the strength of the association is minor. A one percent increase in the land developbility index contributes to a 0.000263 percent growth in the White population. The spatial lag effect is positive. A county undergoes a 0.992

percent White population growth with each percentage point of weighed White population growth in surrounding counties. The significant spatial error effect suggests that the model can be improved by the addition of the relevant control variables.

Table 5.14: Regressions of Terminal Density on White Population Change from 1980 to 1990

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.006***	−0.005***	−0.004***	−0.004***
	(0.002)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	3.73E−4	−0.002	−0.001	−0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.004	0.002	0.003	0.001
	(0.002)	(0.002)	(0.002)	(0.001)
Prev. decade White	0.461***	0.276***	0.318***	0.110***
change	(0.016)	(0.011)	(0.012)	(0.007)
Young	−0.001	−0.001	−0.001	0.001
	(0.004)	(0.002)	(0.002)	(0.002)
Old	0.009***	0.003**	0.004***	−3.61E−4
	(0.002)	(0.001)	(0.001)	(0.001)
High school diploma	0.001	−0.001	−0.004*	−0.002
	(0.002)	(0.001)	(0.002)	(0.001)
Bachelor’s degree	−0.004	−6.24E−6	5.17E−5	0.001
	(0.003)	(0.002)	(0.002)	(0.001)
Graduate degree	0.007**	0.002	0.002	−0.001
	(0.003)	(0.002)	(0.002)	(0.001)
Black	0.003***	0.001***	2.80E−8	−4.88E−5
	(2.94E−4)	(1.99E−4)	(3.60E−4)	(1.11E−4)
Household income	7.39E−6***	3.42E−6**	6.16E−6***	8.78E−7
	(1.74E−6)	(1.17E−6)	(1.53E−6)	(7.29E−7)
Employment	0.003	0.001	0.002	0.001
	(0.002)	(0.001)	(0.001)	(0.001)
Metro	0.062***	0.033***	0.038***	0.020***
	(0.008)	(0.006)	(0.006)	(0.004)
West	−0.024	−0.026**	−0.010	−0.015**
	(0.014)	(0.009)	(0.026)	(0.005)
Midwest	0.070***	0.034***	0.019	0.014***
	(0.010)	(0.007)	(0.018)	(0.004)
Northeast	0.080***	0.046***	0.041	0.022***
	(0.016)	(0.011)	(0.032)	(0.006)
Land developability	−0.001***	3.51E−5	7.09E−5	2.63E−4***
	(1.61E−4)	(1.09E−4)	(1.58E−4)	(6.52E−5)
Constant	−0.510***	−0.176***	−0.180**	−0.030
	(0.074)	(0.050)	(0.061)	(0.033)
Spatial lag effects	–	0.716***	–	0.992***
		(0.013)		(0.007)
Spatial error effects	–	–	0.806***	−0.838***
			(0.012)	(0.028)
Diagnostic Test				
Moran’s I (error)	0.57***	–	–	–
Lagrange Mult (lag)	2709.55***	–	–	–
Robust LM (lag)	146.10***	–	–	–
Lag Mult (error)	2853.75***	–	–	–
Robust LM (error)	290.30***	–	–	–
Measures of Fit				
Log-likelihood	883.86	1924.60	1990.11	2362.11
AIC	−1731.72	−3811.19	−3944.22	−4686.21
BIC	−1622.96	−3696.39	−3835.46	−4571.41

AIC = Akaike’s information criterion. BIC = Schwartz’s Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.15 presents the direction and strength of the association of freight rail with White population change from 1990 to 2000. Full ordinary least squares, the first model, in its diagnostic test shows the spatial autocorrelation for the dependent variable. Also, it suggests to run spatial regression analysis. Out of four models, spatial error model with lag dependence, the fourth model, is the best-fit model based on the highest value of log-likelihood (3207.77) and the lowest values of AIC (−6375.53) and BIC (−6254.69). Hence, the results will be described based on the fourth model.

The association of freight rail with White population change is negative. Each percentage point increase in freight rail terminal density contributes to a 0.005 percent decline in the White population. This explanatory variable is significant and negative across all models. Highway density is negative: every additional unit increase in highway density causes a 0.001 percent White population loss. Highway is not significant for standard regression, but it is for all other three spatial analyses.

The previous decade's White population change is positive. Each percent increase in White population in the past decade causes a 0.411 percent growth in the White population. This variable is strong because it is significant across all models. Both age variables, young and old, are negative. Each additional percent growth in the young and old populations contribute to a 0.005 and 0.002 percent growth in the White population, respectively.

High school is not significant in the fourth model, but it is in the other three. This is the result of simultaneously controlling for spatial lag and spatial error effects. Bachelor's degree is positive. With each percent increase in bachelor's degrees, White population grows by 0.002 percent, on average.

The relationship of Black and Hispanic populations with White population is opposite. Black is negative and Hispanic is positive. Each additional percent growth in the Black population contributes to a 0.002 percent White population decline, but with the Hispanic population, a county observes the same amount of White population growth. Employment is negative. Each percent growth in employment is associated with a 0.001 percent decline in the White population.

Metro is positive, indicating that a metropolitan county sees a White population growth 0.026 percent greater than a nonmetropolitan county. This variable is significant across all models. The regional variable West is positive. The White population growth in a county in the West is 0.047 percent greater than in a county in the South. The West is a strong variable, and it is positive in all models. The association of land developability with White population is positive, though the strength of association is very small. Each percent increase in the land developability index contributes to a 0.000273 percent growth in the White population.

Spatial lag is negative, which shows spatial autocorrelation of the dependent variable. A county sees a 0.934 percent decline in the White population with each weighted percentage point increase in the White population in surrounding counties. The spatial error effect is significant, indicating that the model can be improved by adding some relevant control variables.

Table 5.15: Regressions of Terminal Density on White Population Change from 1990 to 2000

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.006***	−0.006***	−0.006***	−0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	−0.001	−0.002*	−0.002**	−0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	−0.005***	−0.004***	−0.002	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Prev. decade White	0.510***	0.394***	0.447***	0.411***
change	(0.014)	(0.013)	(0.014)	(0.014)
Young	−0.005*	−0.004*	−0.006***	−0.005***
	(0.002)	(0.002)	(0.002)	(0.002)
Old	−0.004***	−0.004***	−0.003***	−0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
High school diploma	0.003***	0.002***	0.002**	4.49E−4
	(4.69E−4)	(4.21E−4)	(0.001)	(0.001)
Bachelor's degree	−0.002*	0.001	0.001	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	0.004***	3.60E−4	−0.001	−0.002
	(0.001)	(0.001)	(0.001)	(0.001)
Black	−0.001***	−0.001***	−0.001***	−0.002***
	(1.59E−4)	(1.42E−4)	(2.23E−4)	(2.35E−4)
Hispanic	0.003***	0.002***	0.001***	0.002***
	(2.18E−4)	(1.96E−4)	(3.14E−4)	(3.50E−4)
Household income	−2.16E−6***	−1.17E−6*	−2.76E−7	−6.30E−7
	(5.61E−7)	(5.02E−7)	(6.05E−7)	(5.70E−7)
Employment	−2.58E−4	−0.001***	−0.002***	−0.001**
	(4.80E−4)	(4.29E−4)	(0.001)	(4.72E−4)
Metro	0.032***	0.027***	0.028***	0.026***
	(0.005)	(0.004)	(0.004)	(0.004)
West	0.037***	0.022***	0.040***	0.047*
	(0.007)	(0.007)	(0.012)	(0.021)
Midwest	−0.023***	−0.006	−0.033***	−0.014
	(0.006)	(0.005)	(0.009)	(0.013)
Northeast	−0.052***	−0.014	−0.037*	3.05E−4
	(0.009)	(0.008)	(0.015)	(0.024)
Land developability	−5.51E−5	2.54E−4***	2.88E−4**	2.73E−4**
	(8.49E−5)	(7.62E−5)	(1.03E−4)	(9.11E−5)
Constant	0.120**	0.158***	0.215***	0.259***
	(0.041)	(0.037)	(0.045)	(0.058)
Spatial lag effects	–	0.449***	–	−0.934***
		(0.018)		(0.046)
Spatial error effects	–	–	0.602***	0.975***
			(0.019)	(0.006)
Diagnostic Test				
Moran's I (error)	0.32***	–	–	–
Lagrange Mult (lag)	660.95***	–	–	–
Robust LM (lag)	19.18***	–	–	–
Lag Mult (error)	865.48***	–	–	–
Robust LM (error)	223.72***	–	–	–
Measures of Fit				
Log-likelihood	2797.73	3072.13	3148.91	3207.77
AIC	−5557.45	−6104.26	−6259.82	−6375.53
BIC	−5442.66	−5983.42	−6145.02	−6254.69

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.16 is on the association of freight rail with White population change for 2000 to 2010. The results of the diagnostic test in the first model suggest that the dependent variable, the change in White population, is spatially correlated because all values are significant. The measures-of-fit test show the fourth model is the best-fit model for this analysis because the log-likelihood is the highest (3832.31) and AIC (−7624.62) and BIC (−7503.78) are the lowest.

Freight rail has a negative association with White population change. Every unit increase in freight rail terminal density is associated with a 0.001 percent decline in the White population. This variable is significant even after simultaneously controlling for spatial lag and spatial error effect in the fourth model. Airport is a strong variable and positively significant across all models. Each unit increase in airport is associated with a 0.003 percent White population growth.

The previous decade's White population change and young are the other two strong variables. They are positively significant across the models. Each unit increase in the previous decade's White population contributes to a 0.25 percent increase in total White population growth. Similarly, each percent increase in young population is associated with a 0.006 percent White population growth.

The Black and Hispanic populations have a negative association with White population change. Both variables are strong and significant across all models. Each percent increase in Black and Hispanic populations is associated with a 0.001 percent White population decline. Similarly, employment is also negatively associated, and each percent increase in employment contributes to a 0.001 percent decline in White population.

Metro is positive across all models. A metropolitan county sees 0.015 percent more growth in its White population than a nonmetropolitan county. The West and Midwest are negative, indicating that these regions have a White population decline. White population loss in the West and Midwest counties is higher than the South by 0.012 and 0.006 percent, respectively.

Land developability is positively associated with White population change. Each percent increase in the land developability index is associated with a 0.000262 percent White population growth. The spatial lag effect is positive, which shows that White population change is influenced by the change in White population in surrounding counties. Each weighted percentage point increase in the White population in surrounding counties contributes to a 0.708 percent increase in the surrounded county. The spatial lag error is negative and shows the model can be improved by adding other important control variables.

Table 5.16: Regressions of Terminal Density on White Population Change from 2000 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−2.98E−4	−4.60E−4	1.47E−4	−0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	0.001**	0.001	0.001	2.50E−4
	(0.001)	(0.001)	(0.001)	(4.58E−4)
Airport	0.004***	0.004***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Prev. decade White change	0.428***	0.370***	0.397***	0.250***
	(0.011)	(0.011)	(0.012)	(0.010)
Young	0.006***	0.006***	0.005***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Old	−0.001**	−0.001*	−0.002**	−4.25E−4
	(4.86E−4)	(4.63E−4)	(0.001)	(3.63E−4)
High school diploma	0.001**	0.001	0.001*	1.48E−4
	(3.93E−4)	(3.75E−4)	(4.56E−4)	(2.75E−4)
Bachelor’s degree	−0.002**	−0.001	−0.001*	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	0.003***	0.002**	0.003***	5.10E−6
	(0.001)	(0.001)	(0.001)	(0.001)
Black	−0.001***	−0.001***	−0.001***	−0.001***
	(1.25E−4)	(1.19E−4)	(1.59E−4)	(8.28E−5)
Hispanic	−0.001***	−0.001***	−0.001***	−0.001***
	(1.43E−4)	(1.37E−4)	(1.86E−4)	(9.63E−5)
Household income	4.24E−7	3.72E−7	6.10E−7	1.76E−7
	(3.09E−7)	(2.93E−7)	(3.45E−7)	(2.29E−7)
Employment	−7.38E−7	−3.97E−4	−1.54E−4	−0.001***
	(3.26E−4)	(3.10E−4)	(3.42E−4)	(2.54E−4)
Metro	0.021***	0.018***	0.019***	0.015***
	(0.004)	(0.003)	(0.004)	(0.003)
West	−0.013*	−0.014**	−0.010	−0.012***
	(0.005)	(0.005)	(0.007)	(0.004)
Midwest	−0.029***	−0.018***	−0.028***	−0.006*
	(0.004)	(0.004)	(0.006)	(0.003)
Northeast	−0.028***	−0.013*	−0.025**	0.002
	(0.007)	(0.007)	(0.009)	(0.005)
Land developability	6.49E−5	1.89E−4**	1.24E−4	2.62E−4***
	(6.58E−5)	(6.27E−5)	(7.81E−5)	(4.62E−5)
Constant	−0.098***	−0.073**	−0.083**	−0.041*
	(0.027)	(0.026)	(0.030)	(0.020)
Spatial lag effects	–	0.313***	–	0.708***
		(0.020)		(0.018)
Spatial error effects	–	–	0.387***	−0.537***
			(0.024)	(0.031)
Diagnostic Test				
Moran’s I (error)	0.17***	–	–	–
Lagrange Mult (lag)	280.51***	–	–	–
Robust LM (lag)	59.59***	–	–	–
Lag Mult (error)	236.34***	–	–	–
Robust LM (error)	15.41***	–	–	–
Measures of Fit				
Log-likelihood	3636.23	3758.39	3743.06	3832.31
AIC	−7234.47	−7476.78	−7448.13	−7624.62
BIC	−7119.67	−7355.93	−7333.33	−7503.78

AIC = Akaike’s information criterion. BIC = Schwartz’s Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.17 presents the relationship of freight rail with White population change over four decades, 1970 to 2010. The first model, full ordinary least squares regression, has the diagnostic statistics. The value of Moran's I (0.42) indicates spatial autocorrelation of the dependent variable. The Lagrange multiplier (lag) and robust Lagrange multiplier (lag) are stronger than the Lagrange multiplier (error) and robust Lagrange multiplier (error), suggesting that the spatial lag model is a better fit for the analysis. On the other hand, based on the values of measures of fit, the spatial error model with lag dependence is the best fit because the log-likelihood is the highest (−871.43) and AIC (1778.85) and BIC are the lowest (1887.61). Hence, all explanations are based on the fourth model, spatial error with lag dependence.

The association of freight rail with White population change is negative. Each additional percentage point increase in freight rail terminal density contributes to a 0.023 percent White population decline. Freight rail is strong and significant across all models.

High school diploma is the strongest among the three education variables. The association of high school diplomas with the White population is positive. Each percent increase in high school diplomas brings a 0.002 percent White population growth. In addition, high school diploma is significant across all models. Another education variable, bachelor's degree, is positive, too. With each percent increase in bachelor's degrees, theWhite population grows by 0.003 percent, on average. The third education variable, graduate degree, is not significant at all. The association of the Black population with the White population is negative. A one percent growth in the Black population contributes to a 0.001 percent White population decline in a county.

The metro variable is positive, indicating that the growth of the White population in metropolitan counties is 0.139 percent higher than in nonmetropolitan counties. Metro is positive across all models. Only the Midwest has a positive relationship with White population. A county in the Midwest experience a 0.037 percent higher White population growth than a county in the South. The association of land developability with White population change is positive, but the strength of the association is negligible. Each percent increase in the land developability index contributes to a 0.000379 percent White population growth.

The spatial lag effect is positive. A county sees a 1.04 percent White population gain with each weighted percentage point growth of the White population in surrounding counties. The spatial error effect indicates that the fourth model, spatial error model with lag dependence can be improved by adding some relevant control variables.

Table 5.17: Regressions of Terminal Density on White Population Change from 1970 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.055***	−0.042***	−0.039***	−0.023***
	(0.004)	(0.003)	(0.003)	(0.002)
Control Variables				
Highway density	−0.003	−0.007*	−0.012***	−0.003
	(0.004)	(0.003)	(0.003)	(0.002)
Airport	0.013*	0.011*	0.012*	0.005
	(0.006)	(0.005)	(0.005)	(0.003)
Young	0.011	0.008	0.002	0.006
	(0.008)	(0.006)	(0.006)	(0.004)
Old	0.026***	0.012***	0.010**	0.000
	(0.004)	(0.003)	(0.003)	(0.002)
High school diploma	0.008***	0.004***	0.003*	0.002**
	(0.001)	(0.001)	(0.002)	(0.001)
Bachelor's degree	−0.020***	−0.005*	0.002	0.003*
	(0.003)	(0.002)	(0.003)	(0.001)
Graduate degree	0.017*	0.002	0.002	−0.005
	(0.007)	(0.005)	(0.006)	(0.004)
Black	0.002*	−0.001	−0.004***	−0.001***
	(0.001)	(0.001)	(0.001)	(2.93E−4)
Household income	4.57E−5***	1.80E−5*	1.12E−5	−4.31E−6
	(1.12E−5)	(8.57E−6)	(1.10E−5)	(5.32E−6)
Employment	0.008***	0.003	0.002	−0.001
	(0.002)	(0.001)	(0.002)	(0.001)
Metro	0.372***	0.258***	0.250***	0.139***
	(0.021)	(0.016)	(0.017)	(0.011)
West	−0.093**	−0.054*	0.073	−0.027
	(0.036)	(0.027)	(0.069)	(0.014)
Midwest	−0.301***	−0.064*	−0.043	0.037*
	(0.041)	(0.032)	(0.084)	(0.016)
Northeast	−0.227***	−0.082***	−0.178***	0.011
	(0.026)	(0.020)	(0.048)	(0.010)
Land developability	−0.005***	−0.001***	4.15E−4	3.79E−4*
	(3.95E−4)	(3.03E−4)	(4.59E−4)	(1.82E−4)
Constant	−0.732***	−0.391***	−0.286*	−0.103
	(0.146)	(0.111)	(0.142)	(0.073)
Spatial lag effects	–	0.682***	–	1.040***
		(0.016)		(0.009)
Spatial error effects	–	–	0.750***	−0.873***
			(0.015)	(0.028)
Diagnostic Test				
Moran's I (error)	0.42***	–	–	–
Lagrange Mult (lag)	1811.27***	–	–	–
Robust LM (lag)	256.06***	–	–	–
Lag Mult (error)	1555.96***	–	–	–
Robust LM (error)	0.76	–	–	–
Measures of Fit				
Log-likelihood	−2044.42	−1370.53	−1380.40	−871.43
AIC	4122.84	2777.05	2794.80	1778.85
BIC	4225.56	2885.81	2897.51	1887.61

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.18 presents the results from the spatial error model with lag dependence for all periods. The explanatory variable, freight rail terminal density, has a negative association with White population change. For all periods, freight rail is associated with a White population decline.

The transportation control variable, highway, is stronger than the airport variable. The highway is negative and contributes to White population decline in the 1970s, 1980s, and 1990s. The highway is not significant for the period of the 2000s, and 1970 to 2010. Airport is significant only for 2000 to 2010. The previous decade's White population change is significant only for the 1980s, 1990s, and 2000s. This variable is associated with White population growth. Both age variables, young and old, are significant and negative for the 1990s. Young is significant for the 2000s, too. Growth in both variables results in White population decline.

High school diploma is positive for the period of 1970 to 2010. Bachelor's degree is positive for the 1990s and 1970 to 2010. Growth in both education variables is associated with White population growth. Black is negative in the 1990s, 2000s, and 1970 to 2010. An increase in the Black population associates with a White population decline. Hispanic is positive in 1990s, indicating that the growth in the Hispanic population is associated with the growth in White population. In the 2000s, the association of employment with the White population is negative. The growth in employment contributes to White population decline.

Metro is strong and positive in all time periods. The growth of the White population in metropolitan counties is higher than in nonmetropolitan counties. The relationship of the West with the White population changes with time. The association is negative for the 1970s, 1980s, and 2000s, but the relationship is positive for the 1990s. The Midwest is positive for the 1980s and 1970 to 2010, and negative for the 2000s. On the other hand, the Northeast is positive for the 1970s and 1980s. The negative values show White population growth is less than the South, and positive values show White population growth is higher than the South. The land developability index is positive, though the value is small for the 1980s, 1990s, 2000s, and 1970 to 2010. The possibility of land development can attract a White population.

Spatial lag is positive for all periods, except for the 1990s. The statistical significance of the spatial lag effect shows the spatial correlation of the dependent variable. The positive value shows that growth of White population in a county contributes to White population growth in the neighboring counties, but the negative value indicates the opposite. The spatial error effect indicates that the model can be improved by adding some relevant control variables in all time periods.

Table 5.18: SEMLD Results for White Population Change for All Periods

	SEMLD 1970-1980	SEMLD 1980-1990	SEMLD 1990-2000	SEMLD 2000-2010	SEMLD 1970-2010
Explanatory Variables					
Terminal density	−0.008***	−0.004***	−0.005***	−0.001*	−0.023***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Control Variables					
Highway density	−0.002*	−0.001*	−0.001*	2.50E−4	−0.003
	(0.001)	(0.001)	(0.001)	(4.58E−4)	(0.002)
Airport	0.002	0.001	−0.001	0.003***	0.005
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Prev. decade White change	−0.002	0.110***	0.411***	0.250***	−
	(0.001)	(0.007)	(0.014)	(0.010)	
Young	−0.001	0.001	−0.005***	0.006***	0.006
	(0.002)	(0.002)	(0.002)	(0.001)	(0.004)
Old	−3.32E−5	−3.61E−4	−0.002*	−4.25E−4	0.000
	(0.001)	(0.001)	(0.001)	(3.63E−4)	(0.002)
High school diploma	4.06E−4	−0.002	4.49E−4	1.48E−4	0.002**
	(2.27E−4)	(0.001)	(0.001)	(2.75E−4)	(0.001)
Bachelor’s degree	0.001	0.001	0.002*	0.001	0.003*
	(4.76E−4)	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	−0.002	−0.001	−0.002	5.10E−6	−0.005
	(0.001)	(0.001)	(0.001)	(0.001)	(0.004)
Black	−2.13E−4	−4.88E−5	−0.002***	−0.001***	−0.001***
	(1.09E−4)	(1.11E−4)	(2.35E−4)	(8.28E−5)	(2.93E−4)
Hispanic	−	−	0.002***	−0.001***	−
			(3.50E−4)	(9.63E−5)	
Household income	2.40E−6	8.78E−7	−6.30E−7	1.76E−7	−4.31E−6
	(2.01E−6)	(7.29E−7)	(5.70E−7)	(2.29E−7)	(5.32E−6)
Employment	−3.85E−4	0.001	−0.001**	−0.001***	−0.001
	(3.30E−4)	(0.001)	(4.72E−4)	(2.54E−4)	(0.001)
Metro	0.034***	0.020***	0.026***	0.015***	0.139***
	(0.004)	(0.004)	(0.004)	(0.003)	(0.011)
West	−0.011*	−0.015**	0.047*	−0.012***	−0.027
	(0.005)	(0.005)	(0.021)	(0.004)	(0.014)
Midwest	0.004	0.014***	−0.014	−0.006*	0.037*
	(0.004)	(0.004)	(0.013)	(0.003)	(0.016)
Northeast	0.015*	0.022***	3.05E−4	0.002	0.011
	(0.006)	(0.006)	(0.024)	(0.005)	(0.010)
Land developability	1.29E−4	2.63E−4***	2.73E−4**	2.62E−4***	3.79E−4*
	(6.75E−5)	(6.52E−5)	(9.11E−5)	(4.62E−5)	(1.82E−4)
Constant	−0.013	−0.030	0.259***	−0.041*	−0.103
	(0.027)	(0.033)	(0.058)	(0.020)	(0.073)
Spatial lag effects	1.062***	0.992***	−0.934***	0.708***	1.040***
	(0.011)	(0.007)	(0.046)	(0.018)	(0.009)
Spatial error effects	−0.930***	−0.838***	0.975***	−0.537***	−0.873***
	(0.027)	(0.028)	(0.006)	(0.031)	(0.028)
Measures of Fit					
Log-likelihood	2070.70	2362.11	3207.77	3832.31	−871.43
AIC	−4103.40	−4686.21	−6375.53	−7624.62	1778.85
BIC	−3988.60	−4571.41	−6254.69	−7503.78	1887.61

AIC = Akaike’s information criterion. BIC = Schwartz’s Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Black Population

Table 5.19 shows the results for the association of freight rail with Black population change for the period of 1970 to 1980. The diagnostic test in the first model is significant, which indicates the spatial autocorrelation of Black population change. The measures of fit show the fourth model is the best fit because it has the highest value for the log-likelihood (−2758.53) and the lowest values for AIC (5553.05) and BIC (5661.81).

The association of freight rail with Black population change is significant in the first three models. In the fourth model, after simultaneous application of spatial lag and spatial error effects, the effect of freight rail vanishes. Young is a strong variable and is significant across all models. Each percent increase in the young population is associated with a0.015 percent Black population growth.

Three education variables behave differently. High school diploma is significant in the first three models, and bachelor's degree is significant for the last three models. Graduate degree is not significant in any model at all. Each percent growth in bachelor's degrees is associated with a 0.005 percent Black population growth.

The variable White is strong and significant across all models, but it changes its direction from negative to positive in the fourth model. Each percent growth of White population is associated with a 0.001 percent Black population growth. Median household income is a strong variable and significant across all models. This variable also changes direction from negative to positive in the fourth model. Each unit increase in median household income is associated with a 0.0000193 percent Black population decline.

Metro is strong, significant, and positive across all models, indicating that Black population growth is higher in metropolitan counties. Its growth rate is 0.04 percent higher than in a nonmetropolitan county. Both spatial effects, lag and error, are significant, with the first positive and the second negative. The spatial lag effects indicate that each weighted percentage point growth in Black population in adjacent counties contributes to a 1.066 percent Black population growth in the surrounded county. The spatial error effects suggest that there is a possibility to improve the model by controlling for more important and relevant variables.

Table 5.19: Regressions of Terminal Density on Black Population Change from 1970 to 1980

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.015**	−0.013*	−0.013*	−3.91E−4
	(0.005)	(0.005)	(0.006)	(0.004)
Control Variables				
Highway density	0.010*	0.009	0.009	0.002
	(0.005)	(0.005)	(0.005)	(0.003)
Airport	−0.003	−0.001	−0.001	−0.001
	(0.009)	(0.008)	(0.009)	(0.005)
Young	0.036***	0.034***	0.033**	0.015*
	(0.011)	(0.010)	(0.011)	(0.008)
Old	0.011*	0.008	0.008	−0.005
	(0.005)	(0.005)	(0.006)	(0.003)
High school	0.005**	0.005*	0.006*	0.001
diploma	(0.002)	(0.002)	(0.002)	(0.001)
Bachelor's degree	0.007	0.009*	0.011**	0.005*
	(0.004)	(0.004)	(0.004)	(0.002)
Graduate degree	0.015	0.014	0.013	0.012
	(0.009)	(0.009)	(0.010)	(0.006)
White	−0.009***	−0.007***	−0.008***	0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
Household income	5.93E−5***	4.27E−5**	5.43E−5***	−1.93E−5*
	(1.59E−5)	(1.57E−5)	(1.71E−5)	(9.72E−6)
Employment	0.007*	0.005*	0.005*	0.001
	(0.003)	(0.003)	(0.003)	(0.002)
Metro	0.106***	0.091**	0.095**	0.040*
	(0.029)	(0.029)	(0.030)	(0.020)
West	0.319***	0.215***	0.293***	−0.074**
	(0.049)	(0.050)	(0.059)	(0.026)
Midwest	0.340***	0.258***	0.320***	−0.017
	(0.035)	(0.036)	(0.042)	(0.019)
Northeast	0.262***	0.189***	0.255***	−0.041
	(0.057)	(0.057)	(0.070)	(0.028)
Land developability	−0.001	−4.16E−4	−1.43E−4	2.06E−4
	(0.001)	(0.001)	(0.001)	(2.96E−4)
Constant	−0.932***	−0.860***	−0.975***	−0.276*
	(0.216)	(0.212)	(0.227)	(0.139)
Spatial lag effects	–	0.235***	–	1.066***
		(0.026)		(0.019)
Spatial error effects	–	–	0.245***	−0.928***
			(0.027)	(0.027)
Diagnostic Test				
Moran's I (error)	0.10***	–	–	–
Lagrange Mult (lag)	85.27***	–	–	–
Robust LM (lag)	4.03*	–	–	–
Lag Mult (error)	81.32***	–	–	–
Robust LM (error)	0.07	–	–	–
Measures of Fit				
Log-likelihood	−3097.36	−3058.33	−3058.80	−2758.53
AIC	6228.72	6152.67	6151.60	5553.05
BIC	6331.44	6261.42	6254.31	5661.81

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.20 presents regression results between freight rail and Black population for the period of 1980 to 1990. The diagnostic test in the first model indicates that the Black population is spatially dependent. The highest value of the log-likelihood (−2104.33) and the lowest values of the AIC (4246.66) and BIC (4361.46) make the fourth model the best fit.

The fourth model indicates that the association of freight rail with Black population change is not significant. The relationship between these two variables is significant for the first three models. The simultaneous application of the spatial lag and spatial error effects in the fourth model makes the association between these two variables statistically insignificant. The previous decade's Black population change rate is significant. Each percent Black population growth in the previous decade is associated with a 0.009 percent Black population decline.

The West and Midwest are strong and significant across all models. The direction of the association changes from positive to negative in the fourth model, indicating that these regions see a decline in Black population in comparison to the South, by 0.047 and 0.038 percent, respectively. Spatial lag effect is positive, suggesting that Black population change is spatially dependent. When surrounding counties have a weighted one percentage point growth in Black population, the surrounded county has a 1.108 percent growth in Black population. The significant spatial error effect suggests that the model can be improved further by controlling for the more important variables.

Table 5.20: Regressions of Terminal Density on Black Population Change from 1980 to 1990

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.017***	−0.016***	−0.015***	−0.005
	(0.005)	(0.004)	(0.005)	(0.003)
Control Variables				
Highway density	0.004	0.005	0.004	0.001
	(0.004)	(0.004)	(0.004)	(0.003)
Airport	0.006	0.004	0.003	−0.002
	(0.007)	(0.007)	(0.007)	(0.005)
Prev. decade Black	−0.001	−0.002	−0.003	−0.009*
change	(0.006)	(0.006)	(0.006)	(0.004)
Young	0.011	0.007	0.006	−0.004
	(0.010)	(0.010)	(0.010)	(0.007)
Old	−0.006	−0.006	−0.007	−0.003
	(0.004)	(0.004)	(0.005)	(0.003)
High school diploma	−0.005	−0.005	−0.006	−0.001
	(0.006)	(0.006)	(0.007)	(0.004)
Bachelor's degree	0.004	0.004	0.003	0.001
	(0.007)	(0.007)	(0.008)	(0.005)
Graduate degree	−0.011	−0.011	−0.012	−0.002
	(0.008)	(0.008)	(0.008)	(0.005)
White	0.003***	0.003***	0.003***	4.45E−4
	(0.001)	(0.001)	(0.001)	(4.53E−4)
Household income	2.68E−6	2.66E−6	2.75E−6	2.27E−6
	(5.14E−6)	(5.06E−6)	(5.54E−6)	(3.08E−6)
Employment	0.003	0.002	0.003	−3.19E−4
	(0.006)	(0.006)	(0.006)	(0.003)
Metro	0.019	0.014	0.011	−0.006
	(0.024)	(0.024)	(0.025)	(0.017)
West	0.226***	0.168***	0.228***	−0.047*
	(0.040)	(0.040)	(0.046)	(0.022)
Midwest	0.240***	0.184***	0.228***	−0.038*
	(0.028)	(0.028)	(0.032)	(0.016)
Northeast	0.292***	0.227***	0.285***	−0.036
	(0.046)	(0.046)	(0.054)	(0.024)
Land developability	−0.001*	−0.001	−0.001	3.58E−4
	(4.68E−4)	(4.61E−4)	(0.001)	(2.64E−4)
Constant	−0.183	−0.127	−0.121	0.053
	(0.231)	(0.227)	(0.242)	(0.148)
Spatial lag effects	–	0.211***	–	1.108***
		(0.027)		(0.022)
Spatial error effects	–	–	0.209***	−0.853***
			(0.027)	(0.028)
Diagnostic Test				
Moran's I (error)	0.08***	–	–	–
Lagrange Mult (lag)	64.78***	–	–	–
Robust LM (lag)	8.05**	–	–	–
Lag Mult (error)	59.68***	–	–	–
Robust LM (error)	2.94	–	–	–
Measures of Fit				
Log-likelihood	−2478.42	−2448.64	−2450.25	−2104.33
AIC	4992.84	4935.28	4936.50	4246.66
BIC	5101.59	5050.07	5045.26	4361.46

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.21 contains regression results for the association between freight rail and Black population for 1990 to 2000. The significant values in the diagnostic test show that Black population is susceptible to the spatial autocorrelation. The fourth model is the best-fit model because the log-likelihood is the highest (−2502.12) and AIC (5044.24) and BIC (5165.08) are the lowest.

Freight rail is strong and significant across all models in this period. Every unit increase in freight rail terminal density is associated with a 0.008 percent decline in Black population. The Midwest is the next strong variable being significant across all models but it changes the direction of the association in the fourth model. After simultaneous control for the spatial lag and spatial error effects, the direction becomes negative. This region sees a decline in the Black population of 0.043 percent more than the South.

Spatial lag effect is significant and positive. Each weighted percentage point increase in Black population in surrounding counties contributes to a 1.064 percent Black population growth in the surrounded county. The significant spatial error effect indicates that the model lacks important control variables and can be improved by adding them.

Table 5.21: Regressions of Terminal Density on Black Population Change from 1990 to 2000

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.018***	−0.016***	−0.015**	−0.008*
	(0.005)	(0.005)	(0.005)	(0.003)
Control Variables				
Highway density	0.006	0.006	0.005	0.001
	(0.005)	(0.005)	(0.005)	(0.003)
Airport	−0.013	−0.010	−0.008	−0.001
	(0.008)	(0.008)	(0.008)	(0.005)
Prev. decade Black	0.001	2.22E−5	−2.88E−4	−3.05E−4
change	(0.001)	(0.001)	(0.001)	(0.001)
Young	0.018	0.009	0.001	−0.002
	(0.012)	(0.012)	(0.012)	(0.008)
Old	0.007	0.005	0.005	−0.001
	(0.005)	(0.004)	(0.005)	(0.003)
High school diploma	0.012***	0.010***	0.011***	0.002
	(0.003)	(0.003)	(0.003)	(0.002)
Bachelor’s degree	0.024***	0.019***	0.020***	0.003
	(0.006)	(0.006)	(0.006)	(0.003)
Graduate degree	−0.027***	−0.023**	−0.021**	−0.006
	(0.008)	(0.007)	(0.008)	(0.005)
White	0.007***	0.006***	0.008***	0.001
	(0.001)	(0.001)	(0.001)	(4.72E−4)
Hispanic	0.016***	0.012***	0.015***	2.85E−4
	(0.001)	(0.001)	(0.002)	(0.001)
Household income	−1.97E−6	−5.84E−7	−2.35E−6	1.13E−6
	(3.46E−6)	(3.34E−6)	(3.78E−6)	(2.02E−6)
Employment	0.003	0.002	0.002	−0.001
	(0.003)	(0.003)	(0.003)	(0.002)
Metro	0.001	0.004	0.002	0.017
	(0.029)	(0.028)	(0.030)	(0.019)
West	0.032	0.004	0.043	−0.025
	(0.045)	(0.044)	(0.058)	(0.022)
Midwest	0.192***	0.105**	0.157***	−0.043*
	(0.035)	(0.034)	(0.043)	(0.017)
Northeast	0.021	−0.002	0.013	−0.017
	(0.056)	(0.054)	(0.073)	(0.027)
Land developability	−0.002***	−0.002***	−0.002**	1.19E−4
	(0.001)	(0.001)	(0.001)	(2.83E−4)
Constant	−1.040***	−0.821***	−0.888**	−0.063
	(0.262)	(0.253)	(0.284)	(0.154)
Spatial lag effects	–	0.311***	–	1.064***
		(0.025)		(0.017)
Spatial error effects	–	–	0.321***	−0.924***
			(0.025)	(0.027)
Diagnostic Test				
Moran’s I (error)	0.14***	–	–	–
Lagrange Mult (lag)	183.65***	–	–	–
Robust LM (lag)	7.17**	–	–	–
Lag Mult (error)	176.49***	–	–	–
Robust LM (error)	0.01	–	–	–
Measures of Fit				
Log-likelihood	−2951.29	−2874.56	−2874.97	−2502.12
AIC	5940.59	5789.13	5787.94	5044.24
BIC	6055.39	5909.97	5902.74	5165.08

AIC = Akaike’s information criterion. BIC = Schwartz’s Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.22 adresses the relationship between freight rail and Black population change from 2000 to 2010. The significant values in the diagnostic test suggest that Black population is spatially dependent. The measures-of-fit analysis show that the fourth model is the best-fit model based on the highest value of the log-likelihood (−2755.54) and the lowest values of AIC (5551.07) and BIC (5671.91).

The association of freight rail with Black population is significant in the first three models. However, the relationship is not significant in the fourth model. None of the three transportation infrastructures has a statistically significant relationship with Black population. The previous decade's Black population change has a negative association with Black population change in the 2000s. Each percent increase in Black population in the previous decade is associated with a 0.003 percent Black population decline.

Spatial lag effect is positive. It suggests that every weighted percentage point increase in Black population in adjacent counties contributes to a 1.042 percent growth in Black population in the surrounded county. The spatial error effect is significant, suggesting that the model can be improved by adding more relevant control variables.

Table 5.22: Regressions of Terminal Density on Black Population Change from 2000 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.012*	−0.012*	−0.012*	−0.007
	(0.005)	(0.005)	(0.005)	(0.004)
Control Variables				
Highway density	−0.001	−0.001	−0.002	−0.001
	(0.005)	(0.005)	(0.005)	(0.003)
Airport	0.020*	0.019*	0.020*	0.007
	(0.008)	(0.008)	(0.009)	(0.006)
Prev. decade Black change	−0.003	−0.003	−0.003	−0.003*
	(0.002)	(0.002)	(0.002)	(0.001)
Young	0.018	0.017	0.017	−0.001
	(0.011)	(0.011)	(0.011)	(0.008)
Old	0.001	0.001	0.001	−0.003
	(0.004)	(0.004)	(0.004)	(0.003)
High school diploma	4.13E−4	0.001	0.001	0.001
	(0.003)	(0.003)	(0.003)	(0.002)
Bachelor’s degree	0.012	0.011*	0.011	0.003
	(0.006)	(0.006)	(0.006)	(0.004)
Graduate degree	−0.021***	−0.020**	−0.020**	−0.002
	(0.006)	(0.006)	(0.007)	(0.004)
White	0.002	0.002	0.002	2.95E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Hispanic	−0.002	−0.002	−0.002	4.46E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Household income	2.73E−6	2.68E−6	2.90E−6	3.83E−7
	(2.58E−6)	(2.57E−6)	(2.65E−6)	(1.63E−6)
Employment	0.006*	0.005	0.005	−1.03E−4
	(0.003)	(0.003)	(0.003)	(0.002)
Metro	0.046	0.044	0.045	0.022
	(0.030)	(0.030)	(0.030)	(0.021)
West	−0.017	−0.020	−0.014	−0.024
	(0.045)	(0.045)	(0.048)	(0.024)
Midwest	0.096**	0.084*	0.097**	−0.013
	(0.035)	(0.035)	(0.037)	(0.019)
Northeast	0.058	0.049	0.055	−0.015
	(0.056)	(0.056)	(0.060)	(0.030)
Land developability	−0.001	−0.001	−0.001	3.33E−5
	(0.001)	(0.001)	(0.001)	(3.16E−4)
Constant	−0.569**	−0.543*	−0.562*	−0.050
	(0.214)	(0.213)	(0.220)	(0.133)
Spatial lag effects	–	0.089**	–	1.042***
		(0.029)		(0.025)
Spatial error effects	–	–	0.082**	−0.872***
			(0.029)	(0.028)
Diagnostic Test				
Moran’s I (error)	0.03**	–	–	–
Lagrange Mult (lag)	7.50**	–	–	–
Robust LM (lag)	5.75*	–	–	–
Lag Mult (error)	5.87*	–	–	–
Robust LM (error)	4.11*	–	–	–
Measures of Fit				
Log-likelihood	−3008.95	−3004.43	−3005.26	−2755.54
AIC	6055.89	6048.85	6048.51	5551.07
BIC	6170.69	6169.69	6163.31	5671.91

AIC = Akaike’s information criterion. BIC = Schwartz’s Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.23 pertains to the relationship of freight rail with Black population from 1970 to 2010. The significant values in the diagnostic test show the spatial autocorrelation nature of the Black population. A change in Black population in one county affects the growth or decline of this population in neighboring counties. The measures-of-fit analysis indicate that the fourth model is the best-fit model because the log-likelihood value is the highest (−4244.86) and AIC (8525.72) and BIC (8634.48) are the lowest.

Freight rail in this period is statistically significant across all models. Every unit increase in freight rail terminal density is associated with a 0.021 percent Black population decline. The variable White is strong and significant across all models. Each percent of White population growth is associated with a 0.003 percent growth in Black population.

Metro is strong and significant across all models. Metro areas gain Black population by 0.121 percent more than nonmetropolitan areas. The West and Northeast are negative, which suggests these regions see a Black population decline by 0.128 and 0.064 percent, respectively. The South is the reference variable.

Spatial lag effect is positive (i.e., a county gains 1.032 percent Black population with each weighted percentage point increase in this population in the surrounding counties). The significant spatial error effect shows that the important variables are missing in the model.

Table 5.23: Regressions of Terminal Density on Black Population Change from 1970 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.063***	−0.051***	−0.045***	−0.021***
	(0.009)	(0.009)	(0.009)	(0.006)
Control Variables				
Highway density	0.016	0.012	0.008	0.004
	(0.008)	(0.008)	(0.008)	(0.005)
Airport	0.028	0.022	0.027	0.006
	(0.015)	(0.014)	(0.015)	(0.009)
Young	0.074***	0.055***	0.048**	0.022
	(0.018)	(0.017)	(0.017)	(0.012)
Old	0.023*	0.008	0.009	−0.004
	(0.009)	(0.009)	(0.010)	(0.005)
High school diploma	−0.002	0.001	0.004	0.003
	(0.003)	(0.003)	(0.004)	(0.002)
Bachelor's degree	0.019**	0.018**	0.018*	0.005
	(0.007)	(0.006)	(0.007)	(0.004)
Graduate degree	−0.047**	−0.028	−0.020	0.002
	(0.016)	(0.015)	(0.016)	(0.010)
White	0.005**	0.006***	0.010***	0.003***
	(0.002)	(0.002)	(0.002)	(0.001)
Household income	1.04E−4***	4.60E−5	5.78E−5*	−1.93E−5
	(2.71E−5)	(2.59E−5)	(2.95E−5)	(1.56E−5)
Employment	0.013**	0.012**	0.015***	0.003
	(0.004)	(0.004)	(0.005)	(0.003)
Metro	0.267***	0.255***	0.245***	0.121***
	(0.050)	(0.048)	(0.048)	(0.032)
West	0.485***	0.140	0.506***	−0.128**
	(0.084)	(0.083)	(0.128)	(0.041)
Midwest	0.649***	0.245*	0.512***	−0.078
	(0.097)	(0.095)	(0.157)	(0.046)
Northeast	0.849***	0.392***	0.667***	−0.064*
	(0.060)	(0.062)	(0.091)	(0.032)
Land developability	−0.005***	−0.003**	−0.002*	8.13E−5
	(0.001)	(0.001)	(0.001)	(4.84E−4)
Constant	−2.236***	−1.908***	−2.414***	−0.670**
	(0.367)	(0.351)	(0.390)	(0.225)
Spatial lag effects	−	0.486***	−	1.032***
		(0.033)		(0.015)
Spatial error effects	−	−	0.537***	−0.931***
			(0.033)	(0.027)
Diagnostic Test				
Moran's I (error)	0.18***	−	−	−
Lagrange Mult (lag)	293.97***	−	−	−
Robust LM (lag)	13.28***	−	−	−
Lag Mult (error)	281.20***	−	−	−
Robust LM (error)	0.52	−	−	−
Measures of Fit				
Log-likelihood	−4747.66	−4625.41	−4618.37	−4244.86
AIC	9529.32	9286.81	9270.75	8525.72
BIC	9632.03	9395.57	9373.46	8634.48

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.24 presents results for the spatial error model with lag dependence for all periods. Freight rail is significant for the 1990s and for 1970 to 2010. The relationship negatively contributes to Black population decline. The West is strong and significant for the 1970s and 1980s, and for 1970 to 2010. The West experiences a Black population decline during these periods. None of the other variables are consistently strong in these periods.

Spatial lag and spatial error effects are significant, with spatial lag effect positive and spatial error effect negative. The statistical significance of the spatial lag effect suggests that Black population change is spatially dependent, and growth and decline in this population in nearby counties affect a county's Black population size. The significant spatial error effects indicate that these models can be improved by adding important variables.

Table 5.24: SEMLD Results for Black Population Change for All Periods

	SEMLD 1970-1980	SEMLD 1980-1990	SEMLD 1990-2000	SEMLD 2000-2010	SEMLD 1970-2010
Explanatory Variables					
Terminal density	−3.91E−4	−0.005	−0.008*	−0.007	−0.021***
	(0.004)	(0.003)	(0.003)	(0.004)	(0.006)
Control Variables					
Highway density	0.002	0.001	0.001	−0.001	0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)
Airport	−0.001	−0.002	−0.001	0.007	0.006
	(0.005)	(0.005)	(0.005)	(0.006)	(0.009)
Prev. decade Black change	–	−0.009*	−3.05E−4	−0.003*	–
		(0.004)	(0.001)	(0.001)	
Young	0.015*	−0.004	−0.002	−0.001	0.022
	(0.008)	(0.007)	(0.008)	(0.008)	(0.012)
Old	−0.005	−0.003	−0.001	−0.003	−0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)
High school diploma	0.001	−0.001	0.002	0.001	0.003
	(0.001)	(0.004)	(0.002)	(0.002)	(0.002)
Bachelor's degree	0.005*	0.001	0.003	0.003	0.005
	(0.002)	(0.005)	(0.003)	(0.004)	(0.004)
Graduate degree	0.012	−0.002	−0.006	−0.002	0.002
	(0.006)	(0.005)	(0.005)	(0.004)	(0.010)
White	0.001*	4.45E−4	0.001	2.95E−4	0.003***
	(0.001)	(4.53E−4)	(4.72E−4)	(0.001)	(0.001)
Hispanic	–	–	2.85E−4	4.46E−4	–
			(0.001)	(0.001)	
Household income	−1.93E−5*	2.27E−6	1.13E−6	3.83E−7	−1.93E−5
	(9.72E−6)	(3.08E−6)	(2.02E−6)	(1.63E−6)	(1.56E−5)
Employment	0.001	−3.19E−4	−0.001	−1.03E−4	0.003
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)
Metro	0.040*	−0.006	0.017	0.022	0.121***
	(0.020)	(0.017)	(0.019)	(0.021)	(0.032)
West	−0.074**	−0.047*	−0.025	−0.024	−0.128**
	(0.026)	(0.022)	(0.022)	(0.024)	(0.041)
Midwest	−0.017	−0.038*	−0.043*	−0.013	−0.078
	(0.019)	(0.016)	(0.017)	(0.019)	(0.046)
Northeast	−0.041	−0.036	−0.017	−0.015	−0.064*
	(0.028)	(0.024)	(0.027)	(0.030)	(0.032)
Land developability	2.06E−4	3.58E−4	1.19E−4	3.33E−5	8.13E−5
	(2.96E−4)	(2.64E−4)	(2.83E−4)	(3.16E−4)	(4.84E−4)
Constant	−0.276*	0.053	−0.063	−0.050	−0.670**
	(0.139)	(0.148)	(0.154)	(0.133)	(0.225)
Spatial lag effects	1.066***	1.108***	1.064***	1.042***	1.032***
	(0.019)	(0.022)	(0.017)	(0.025)	(0.015)
Spatial error effects	−0.928***	−0.853***	−0.924***	−0.872***	−0.931***
	(0.027)	(0.028)	(0.027)	(0.028)	(0.027)
Diagnostic Test					
Moran's I (error)	–	–	–	–	–
Lagrange Mult (lag)	–	–	–	–	–
Robust LM (lag)	–	–	–	–	–
Lag Mult (error)	–	–	–	–	–
Robust LM (error)	–	–	–	–	–
Measures of Fit					
Log-likelihood	−2758.53	−2104.33	−2502.12	−2755.54	−4244.86
AIC	5553.05	4246.66	5044.24	5551.07	8525.72
BIC	5661.81	4361.46	5165.08	5671.91	8634.48

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Hispanic Population

Table 5.25 presents regression results for the association of freight rail with the Hispanic population for the period from 1990 to 2000. The significant values in the diagnostic test show the spatial autocorrelation of Hispanic population. The measures-of-fit analysis show the fourth model is the best fit based on the highest value of the log-likelihood (−1729.62) and the lowest values of AIC (3497.23) and BIC (3612.03).

Freight rail is not significant in the fourth model even though it is significant in the first three models. After simultaneously controlling for spatial lag and spatial error effects, the association of freight rail with Hispanic population becomes statistically not significant.

The only significant variables in the fourth model are spatial lag and spatial error effects. The spatial lag effect suggests that a county gains a 1.057 percent Hispanic population for each weighted percentage point increase in Hispanic population in surrounding counties. The significant value of the spatial error effect suggests that the model lacks important variables and can be improved by adding them.

Table 5.25: Regressions of Terminal Density on Hispanic Population Change from 1990 to 2000

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.022***	−0.014***	−0.013***	−0.005
	(0.004)	(0.004)	(0.004)	(0.003)
Control Variables				
Highway density	0.018***	0.011**	0.007	0.001
	(0.004)	(0.004)	(0.004)	(0.002)
Airport	−0.012	−0.005	0.001	0.003
	(0.007)	(0.006)	(0.007)	(0.004)
Young	0.005	−0.007	−0.015	−0.013
	(0.010)	(0.009)	(0.010)	(0.006)
Old	0.014***	0.008*	0.008	−0.001
	(0.004)	(0.004)	(0.004)	(0.002)
High school diploma	−0.015***	−0.009***	−0.009**	4.73E−4
	(0.003)	(0.002)	(0.003)	(0.001)
Bachelor's degree	−0.030***	−0.015***	−0.006	0.002
	(0.005)	(0.004)	(0.005)	(0.003)
Graduate degree	−0.009	−0.010	−0.014*	−0.003
	(0.007)	(0.006)	(0.007)	(0.003)
White	0.014***	0.008***	0.008***	3.47E−5
	(0.001)	(0.001)	(0.001)	(4.25E−4)
Black	0.013***	0.007***	0.005***	−0.001
	(0.001)	(0.001)	(0.002)	(4.69E−4)
Household income	−7.91E−6**	−5.16E−6**	−6.75E−6*	−1.82E−7
	(2.93E−6)	(2.63E−6)	(3.22E−6)	(1.54E−6)
Employment	0.032***	0.019***	0.015***	−9.94E−5
	(0.003)	(0.002)	(0.003)	(0.001)
Metro	0.020	0.011	−0.006	−0.008
	(0.025)	(0.022)	(0.022)	(0.014)
West	−0.202***	−0.098**	−0.230**	0.004
	(0.039)	(0.035)	(0.073)	(0.017)
Midwest	−0.143***	−0.090***	−0.141**	−0.015
	(0.030)	(0.027)	(0.051)	(0.013)
Northeast	−0.363***	−0.174***	−0.198*	0.017
	(0.048)	(0.044)	(0.091)	(0.021)
Land developability	−0.001	−8.59E−5	0.001	3.43E−4
	(4.48E−4)	(4.02E−4)	(0.001)	(2.08E−4)
Constant	−1.584***	−0.912***	−0.243	0.032
	(0.217)	(0.196)	(0.242)	(0.115)
Spatial lag effects	−	0.494***	−	1.057***
		(0.021)		(0.012)
Spatial error effects	−	−	0.685***	−0.973***
			(0.028)	(0.026)
Diagnostic Test				
Moran's I (error)	0.25***	−	−	−
Lagrange Mult (lag)	643.01***	−	−	−
Robust LM (lag)	121.29***	−	−	−
Lag Mult (error)	531.61***	−	−	−
Robust LM (error)	9.90**	−	−	−
Measures of Fit				
Log-likelihood	−2441.95	−2193.22	−2211.22	−1729.62
AIC	4919.91	4424.43	4458.43	3497.23
BIC	5028.66	4539.23	4567.19	3612.03

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-=tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.26 presents data on the relationship of freight rail with Hispanic population from 2000 to 2010. The significant values in the diagnostic test analysis show that the Hispanic population variable is are spatially dependent. The fourth model is the best fit because it has the highest value of the log-likelihood (−1734.12) and the lowest values of AIC (3508.24) and BIC (3629.08).

fFreight rail is not significant, but White is strong and significant across all models. Each percent growth in White population is associated with a 0.001 percent growth in Hispanic population. The land developability index is significant, suggesting that each percent increase in the index is associated with a 0.000499 percent Hispanic population growth.

Spatial lag and spatial error effects are the other two significant variables. Spatial lag shows that a county’s Hispanic population grows by 1.079 percent with each weighted percentage point growth in Hispanic population in surrounding counties. The significant value of the spatial error effect indicates that there are still other important variables can be controlled for to improve the model.

Table 5.26: Regressions of Terminal Density on Hispanic Population Change from 2000 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	0.004	0.003	0.006	4.35E−4
	(0.004)	(0.004)	(0.004)	(0.003)
Control Variables				
Highway density	0.003	0.002	0.003	−2.64E−4
	(0.004)	(0.004)	(0.004)	(0.002)
Airport	0.014*	0.014*	0.013*	0.007
	(0.006)	(0.006)	(0.006)	(0.004)
Prev. decade Hispanic change	0.003	0.002	0.001	−0.002
	(0.003)	(0.003)	(0.003)	(0.002)
Young	0.006	0.007	0.008	0.003
	(0.008)	(0.008)	(0.009)	(0.005)
Old	0.002	0.001	2.76E−4	−0.003
	(0.003)	(0.003)	(0.003)	(0.002)
High school diploma	0.003	0.002	0.002	−0.001
	(0.002)	(0.002)	(0.003)	(0.001)
Bachelor's degree	−1.85E−4	0.000	1.70E−4	0.004
	(0.004)	(0.004)	(0.004)	(0.002)
Graduate degree	0.004	0.004	0.005	4.33E−4
	(0.005)	(0.005)	(0.005)	(0.003)
White	0.004***	0.003***	0.004***	0.001*
	(0.001)	(0.001)	(0.001)	(4.17E−4)
Black	3.22E−5	−1.70E−4	−3.50E−4	−4.79E−4
	(0.001)	(0.001)	(0.001)	(4.35E−4)
Household income	5.60E−6**	4.32E−6*	5.88E−6**	−1.55E−6
	(1.91E−6)	(1.87E−6)	(2.07E−6)	(1.13E−6)
Employment	0.014***	0.012***	0.012***	4.20E−4
	(0.002)	(0.002)	(0.002)	(0.001)
Metro	0.081***	0.066**	0.063**	0.027
	(0.022)	(0.022)	(0.023)	(0.015)
West	−0.194***	−0.162***	−0.190***	−0.023
	(0.034)	(0.034)	(0.042)	(0.017)
Midwest	−0.173***	−0.150***	−0.159***	−0.025
	(0.027)	(0.026)	(0.032)	(0.013)
Northeast	−0.191***	−0.167***	−0.181***	−0.038
	(0.042)	(0.041)	(0.052)	(0.021)
Land developability	−2.60E−4	−3.39E−5	7.89E−5	4.99E−4*
	(4.06E−4)	(3.96E−4)	(4.61E−4)	(2.16E−4)
Constant	−1.119***	−0.953***	−0.967***	−0.101
	(0.160)	(0.157)	(0.174)	(0.094)
Spatial lag effect	–	0.254***	–	1.079***
		(0.026)		(0.019)
Spatial error effect	–	–	0.258***	−0.945***
			(0.027)	(0.026)
Diagnostic Test				
Moran's I (error)	0.10***	–	–	–
Lagrange Mult (lag)	105.07***	–	–	–
Robust LM (lag)	15.86***	–	–	–
Lag Mult (error)	90.13***	–	–	–
Robust LM (error)	0.92	–	–	–
Measures of Fit				
Log-likelihood	−2088.54	−2041.07	−2045.81	−1734.12
AIC	4215.08	4122.15	4129.62	3508.24
BIC	4329.88	4242.99	4244.41	3629.08

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.27 presents the results for spatial error model with lag dependence for Hispanic population change for all periods. The table presents results for only the 1990s and 2000s because data are not available for the other periods. The significant variables in both periods are spatial lag and spatial error effects. In both periods, the spatial lag effect is positive, and the spatial error effect is negative. The positive effect of spatial lag indicates the spatial dependency of the Hispanic population. The significant effect of the spatial error shows that the models are imperfect and can be improved by adding some important variables.

Table 5.27: SEMLD Results for Hispanic Population Change for All Periods

	SEMLD 1970-1980	SEMLD 1980-1990	SEMLD 1990-2000	SEMLD 2000-2010	SEMLD 1970-2010
Explanatory Variables					
Terminal density	–	–	−0.005	4.35E−4	–
			(0.003)	(0.003)	
Control Variables					
Highway density	–	–	0.001	−2.64E−4	–
			(0.002)	(0.002)	
Airport	–	–	0.003	0.007	–
			(0.004)	(0.004)	
Prev. decade Hispanic pop. change	–	–	–	−0.002	–
				(0.002)	
Young	–	–	−0.013	0.003	–
			(0.006)	(0.005)	
Old	–	–	−0.001	−0.003	–
			(0.002)	(0.002)	
High school diploma	–	–	4.73E−4	−0.001	–
			(0.001)	(0.001)	
Bachelor's degree	–	–	0.002	0.004	–
			(0.003)	(0.002)	
Graduate degree	–	–	−0.003	4.33E−4	–
			(0.003)	(0.003)	
White	–	–	3.47E−5	0.001*	–
			(4.25E−4)	(4.17E−4)	
Black	–	–	−0.001	−4.79E−4	–
			(4.69E−4)	(4.35E−4)	
Household income	–	–	−1.82E−7	−1.55E−6	–
			(1.54E−6)	(1.13E−6)	
Employment	–	–	−9.94E−5	4.20E−4	–
			(0.001)	(0.001)	
Metro	–	–	−0.008	0.027	–
			(0.014)	(0.015)	
West	–	–	0.004	−0.023	–
			(0.017)	(0.017)	
Midwest	–	–	−0.015	−0.025	–
			(0.013)	(0.013)	
Northeast	–	–	0.017	−0.038	–
			(0.021)	(0.021)	
Land developability	–	–	3.43E−4	4.99E−4*	–
			(2.08E−4)	(2.16E−4)	
Constant	–	–	0.032	−0.101	–
			(0.115)	(0.094)	
Spatial lag effect	–	–	1.057***	1.079***	–
			(0.012)	(0.019)	
Spatial error effect	–	–	−0.973***	−0.945***	–
			(0.026)	(0.026)	
Diagnostic Test					
Moran's I (error)	–	–	–	–	–
Lagrange Mult (lag)	–	–	–	–	–
Robust LM (lag)	–	–	–	–	–
Lag Mult (error)	–	–	–	–	–
Robust LM (error)	–	–	–	–	–
Measures of Fit					
Log-likelihood	–	–	−1729.62	−1734.12	–
AIC	–	–	3497.23	3508.24	–
BIC	–	–	3612.03	3629.08	–

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

SECTION 3: AGE VARIABLES

The relationship of freight rail with age variables is shown in nine tables in this section. The first six tables display the association of freight rail with the variable young, and the last six tables illustrate the relationship of freight rail with the variable old.

Young

Table 5.28 shows the relationship of freight rail with the young population for the period of 1970 to 1980. The diagnostic test of the first model, full ordinary least squares, indicates that the dependent variable, young population change, is spatially correlated. It further suggests that spatial lag and spatial error regressions are better than full ordinary least squares regression. But, based on the measures of fit, the fourth model, spatial error with lag dependence, is the best-fit model because of the highest value of log-likelihood (1863.22) and the lowest values of AIC (−3688.45) and BIC (−3573.65). Hence, the explanation for the association of freight rail with young population change is based on this model.

Freight rail is negatively associated with young population change. When freight rail terminal density increases young population decreases. Each additional percentage point increase in freight rail terminal density contributes to a 0.007 percent young population decline. Freight rail is strong enough to be significant and negative across all models. The relationship of the previous decade’s young population change is negative. Each additional percent young population growth contributes to a 0.003 percent young population decline.

All three education variables are significant for this decade. Two of the education variables, high school diploma and bachelor's degree, are positive; the third education variable, graduate degree, is negative. Each percent increase in high school diplomas and bachelor's degrees contributes to a 0.001 percent growth in the young population, whereas each percent increase in the graduate degree is associated with a 0.007 percent young population decline.

Both White and Black are negative and significant across all models. A one percent increase in both White and Black population contributes to a 0.002 percent decline in young population. Employment is negative, indicating that each additional one percent growth in employment contributes to a 0.001 percent young population decline.

The relationship of metro with young population is positive. Metropolitan counties have a 0.041 percent greater young population growth than nonmetropolitan counties. This metro variable is positive across all models. The West is negative, indicating that counties in the West observes 0.019 percent higher decline in the young population than counties in the South. The West is negative across all models. The Midwest and Northeast are not significant in the fourth model.

Spatial lag is positive, and the value suggests that a county experiences a 1.042 percent young population growth for each weighted additional percentage point increase in young population in surrounding counties. The spatial error effect suggests that the model can be improved by adding relevant control variables.

Table 5.28: Regressions of Terminal Density on Young Population Change from 1970 to 1980

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.016***	−0.013***	−0.012***	−0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	0.001	−0.001	−0.002	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.006**	0.004*	0.004*	0.001
	(0.002)	(0.002)	(0.002)	(0.001)
Prev. decade young change	0.002	4.89E−4	0.001	−0.003*
	(0.002)	(0.001)	(0.001)	(0.001)
Old	0.005***	0.002	0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
High school diploma	0.001*	0.001*	2.72E−4	0.001**
	(0.001)	(4.48E−4)	(0.001)	(2.40E−4)
Bachelor's degree	−0.006***	−0.003**	−0.002	0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	−0.002	−0.006**	−0.008***	−0.007***
	(0.002)	(0.002)	(0.002)	(0.001)
White	−0.003***	−0.003***	−0.004***	−0.002***
	(0.001)	(0.001)	(0.001)	(3.43E−4)
Black	−0.005***	−0.005***	−0.007***	−0.002***
	(0.001)	(0.001)	(0.001)	(3.52E−4)
Household income	2.83E−5***	1.88E−5***	2.36E−5***	3.45E−6
	(3.85E−6)	(3.41E−6)	(4.22E−6)	(2.01E−6)
Employment	−0.002***	−0.002***	−0.002*	−0.001**
	(0.001)	(0.001)	(0.001)	(3.49E−4)
Metro	0.111***	0.082***	0.077***	0.041***
	(0.008)	(0.007)	(0.007)	(0.005)
West	−0.073***	−0.055***	−0.069***	−0.019***
	(0.013)	(0.011)	(0.020)	(0.006)
Midwest	−0.127***	−0.071***	−0.125***	−0.001
	(0.009)	(0.008)	(0.014)	(0.004)
Northeast	−0.126***	−0.065***	−0.094***	0.003
	(0.015)	(0.013)	(0.025)	(0.006)
Land developability	−0.001***	−0.001***	−0.001***	6.43E−5
	(1.42E−4)	(1.26E−4)	(1.76E−4)	(6.88E−5)
Constant	0.467***	0.389***	0.559***	0.165***
	(0.064)	(0.056)	(0.065)	(0.035)
Spatial lag effects	–	0.521***	–	1.042***
		(0.020)		(0.012)
Spatial error effects	–	–	0.573***	−0.945***
			(0.020)	(0.026)
Diagnostic Test				
Moran's I (error)	0.29***	–	–	–
Lagrange Mult (lag)	802.23***	–	–	–
Robust LM (lag)	89.61***	–	–	–
Lag Mult (error)	715.70***	–	–	–
Robust LM (error)	3.09	–	–	–
Measures of Fit				
Log-likelihood	1153.40	1456.95	1447.33	1863.22
AIC	−2270.80	−2875.90	−2858.67	−3688.45
BIC	−2162.04	−2761.10	−2749.91	−3573.65

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.29 shows the values for the relationship of freight rail with young population for the period of 1980 to 1990. The diagnostic test in the first model indicates that young population is spatially correlated, and spatial lag and spatial error regressions are better than standard regression for this analysis. But, based on the measures of fit, the spatial error model with lag dependence is the best-fit model because the value of log-likelihood (2286.75) is the highest, and the values of AIC (−4535.50), BIC (−4420.70) are the lowest. Hence, the explanation for the relationship between freight rail and young population change is based on the fourth model.

Freight rail has a negative relationship with young population. Each percent increase in freight rail terminal density contributes to a 0.002 percent young population decline. Freight rail is negative across all models. The association of the previous decade’s young population change is positive, indicating that each percent increase in this variable contributes to a 0.046 percent growth in young population.

The variable old is negative, and each percent growth in the old population contributes to a 0.002 percent young population loss. The variable is significant across all models. The relationship of bachelor’s degrees with young population is positive. Each additional growth in bachelor’s degrees contributes to a 0.003 percent growth in young population. The other two education variables, high school diploma and graduate degree, are not significant.

Black is a stronger variable than White. The relationship of Black population with young population is negative, but the strength of the relationship is small. Each percent increase in Black population is associated with a 0.000431 percent young population decline. Black is significant in all three spatial regression models. The income is negative and significant. Each unit growth in median household income contributes to a 0.0000029 percent young population decline.

Metro is positive consistently across all models. The growth of young population in metropolitan counties is 0.014 percent greater than in nonmetropolitan counties. The regional variable West is negative: counties in the West lose young population at a rate of 0.017 percent greater than counties in the South. The Midwest and Northeast are not significant in the fourth model, but they are with the other models. Land developability is positive, but the strength of the relationship is small. Each additional percent growth in the land developability index is associated with a 0.000304 percent growth in young population.

The spatial lag effect is positive and indicates that a county grows in young population by 1.017 percent with each additional percentage point increase in weighted young population growth in surrounding counties. The spatial error effect means there is room for improvement in the fourth model by the addition of relevant control variables.

Table 5.29: Regressions of Terminal Density on Young Population Change from 1980 to 1990

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.003**	−0.003**	−0.003*	−0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	0.004***	0.002*	0.002	−3.78E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.008***	0.005***	0.004	0.001
	(0.002)	(0.002)	(0.002)	(0.001)
Prev. decade young change	0.241***	0.170***	0.169***	0.046***
	(0.012)	(0.011)	(0.012)	(0.007)
Old	−0.006***	−0.005***	−0.004***	−0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
High school diploma	2.00E−4	0.001	4.75E−4	0.001
	(0.002)	(0.001)	(0.002)	(0.001)
Bachelor's degree	−0.003	8.79E−5	1.03E−4	0.003**
	(0.002)	(0.002)	(0.002)	(0.001)
Graduate degree	0.008***	0.007***	0.008***	0.003
	(0.002)	(0.002)	(0.002)	(0.001)
White	3.70E−4	−1.65E−5	−0.001	−1.70E−5
	(4.15E−4)	(3.74E−4)	(4.72E−4)	(2.14E−4)
Black	−0.001	−0.001**	−0.002***	−4.31E−4*
	(4.37E−4)	(3.95E−4)	(0.001)	(2.16E−4)
Household income	−6.85E−6***	−5.56E−6***	−3.83E−6*	−2.90E−6***
	(1.35E−6)	(1.22E−6)	(1.53E−6)	(7.08E−7)
Employment	0.002	0.000	0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Metro	0.041***	0.029***	0.032***	0.014***
	(0.007)	(0.006)	(0.006)	(0.004)
West	−0.025*	−0.029**	−0.048**	−0.017***
	(0.011)	(0.010)	(0.016)	(0.005)
Midwest	−0.113***	−0.059***	−0.124***	0.006
	(0.007)	(0.007)	(0.012)	(0.004)
Northeast	−0.095***	−0.051***	−0.079***	0.001
	(0.012)	(0.011)	(0.020)	(0.005)
Land developability	1.18E−4	2.94E−4**	2.09E−4	3.04E−4***
	(1.22E−4)	(1.10E−4)	(1.50E−4)	(5.99E−5)
Constant	−0.194***	−0.085	−0.130*	0.018
	(0.057)	(0.051)	(0.065)	(0.029)
Spatial lag effects	−	0.476***	−	1.017***
		(0.020)		(0.013)
Spatial error effects	−	−	0.528***	−0.948***
			(0.021)	(0.026)
Diagnostic Test				
Moran's I (error)	0.24***	−	−	−
Lagrange Mult (lag)	616.49***	−	−	−
Robust LM (lag)	115.04***	−	−	−
Lag Mult (error)	501.63***	−	−	−
Robust LM (error)	0.18	−	−	−
Measures of Fit				
Log-likelihood	1682.64	1927.15	1904.11	2286.75
AIC	−3329.29	−3816.31	−3772.22	−4535.50
BIC	−3220.53	−3701.51	−3663.46	−4420.70

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.30 addresses the association of freight rail with young population for the 1990s. The significant values of the diagnostic test show the spatial dependency of young population. The measures-of-fit analysis indicate that the fourth model is the best fit, having the highest value of the log-likelihood (2391.24) and the lowest values of AIC (−4742.49) and BIC (−4621.65).

Freight rail is negative across all models. Each unit increase in freight rail terminal density is associated with a 0.004 percent young population decline. The previous decade’s young population change rate is strong and significant across all models. Each percent increase in the previous decade’s young population is associated with a 0.032 percent young population growth. The variable old is strong and significant across all models, but it changes direction in the fourth model, which controls for spatial lag and spatial error effects simultaneously. Each percent growth in old population is associated with a 0.001 percent decline in the young population.

Bachelor’s and graduate degrees are strong and significant across all models, but their directions of association are different, with the first positive and the second negative. Each percent growth in bachelor’s degrees is associated with a 0.004 percent growth in young population. Similarly, each percent growth in graduate degrees is associated with a 0.003 percent decline in young population. High school diploma is not significant in the fourth model. The value for employment indicates that each percent increase in the employment rate contributes to a 0.001 percent decline in young population.

Both metro and the West are significant across all models. Metro areas are associated with a 0.019 percent higher young population growth than nonmetropolitan areas. The West turns negative in the fourth model, indicating that it is associated with a 0.015 percent lower growth in the young population than the South. Spatial lag is positive and shows that a county gains a 1.028 percent young population for each weighted percentage point growth in young population in surrounding counties. The significant value of spatial error effect shows that the model can be improved by controlling for more relevant variables.

Table 5.30: Regressions of Terminal Density on Young Population Change from 1990 to 2000

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.008***	−0.007***	−0.005***	−0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	−0.002	−0.002	−0.002*	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.002	0.001	0.001	−2.05E−4
	(0.002)	(0.002)	(0.002)	(0.001)
Prev. decade young pop.	0.215***	0.135***	0.104***	0.032**
change	(0.020)	(0.018)	(0.021)	(0.011)
Old	0.007***	0.004***	0.004***	−0.001*
	(0.001)	(0.001)	(0.001)	(4.43E−4)
High school diploma	0.003***	0.002**	0.002*	3.37E−4
	(0.001)	(0.001)	(0.001)	(3.05E−4)
Bachelor's degree	0.015***	0.011***	0.012***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	−0.011***	−0.009***	−0.010***	−0.003**
	(0.002)	(0.001)	(0.002)	(0.001)
White	−0.002***	−0.001***	−0.002***	6.77E−5
	(4.46E−4)	(4.04E−4)	(4.80E−4)	(2.34E−4)
Black	−0.002***	−0.002***	−0.003***	−2.07E−4
	(4.73E−4)	(4.30E−4)	(0.001)	(2.40E−4)
Hispanic	−0.001	−0.001	−0.001	−2.28E−4
	(4.98E−4)	(4.49E−4)	(0.001)	(2.48E−4)
Household income	1.71E−6*	1.43E−6*	2.57E−6**	−1.38E−8
	(7.27E−7)	(6.56E−7)	(8.17E−7)	(3.80E−7)
Employment	0.003***	0.001	0.001	−0.001*
	(0.001)	(0.001)	(0.001)	(3.49E−4)
Metro	0.038***	0.031***	0.031***	0.019***
	(0.006)	(0.006)	(0.006)	(0.004)
West	0.111***	0.047***	0.124***	−0.015***
	(0.010)	(0.010)	(0.015)	(0.005)
Midwest	0.028***	0.010	0.018	−0.001
	(0.008)	(0.007)	(0.012)	(0.004)
Northeast	−0.068***	−0.036**	−0.063***	0.005
	(0.013)	(0.012)	(0.019)	(0.006)
Land developability	−2.37E−4*	−5.33E−5	−1.34E−5	8.57E−5
	(1.17E−4)	(1.05E−4)	(1.45E−4)	(5.43E−5)
Constant	−0.115*	−0.022	0.022	0.029
	(0.055)	(0.050)	(0.060)	(0.029)
Spatial lag effect	–	0.473***	–	1.028***
		(0.021)		(0.013)
Spatial error effect	–	–	0.514***	−0.997***
			(0.021)	(0.027)
Diagnostic Test				
Moran's I (error)	0.25***	–	–	–
Lagrange Mult (lag)	622.03***	–	–	–
Robust LM (lag)	100.32***	–	–	–
Lag Mult (error)	521.72***	–	–	–
Robust LM (error)	0.01	–	–	–
Measures of Fit				
Log-likelihood	1760.80	2002.27	1985.63	2391.24
AIC	−3483.60	−3964.54	−3933.27	−4742.49
BIC	−3368.80	−3843.70	−3818.47	−4621.65

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.31 presents regression results carried out between freight rail and young population for the 2000s. The significant values in the diagnostic test show that young population change for this period is spatially dependent. For this period, the fourth model is the best fit because the value of the log-likelihood is highest (1567.86) and the values for AIC (−3095.72) and BIC (−2974.87) are the lowest among all models.

Among transportation variables, airport is the strongest and positively significant across all models. Each unit increase in airport terminals contributes to a 0.003 percent young population growth. Old is the next strong variable and is negatively significant across all models, suggesting that each percent growth in old population is associated with a 0.003 percent decline in young population. Only bachelor's degree is significant across all models, and the value suggests that each percent growth in bachelor's degrees is associated with a 0.003 percent young population growth.

Both Black and Hispanic are strong and negatively significant across all models. Each percent growth in the Black and Hispanic populations contributes to a 0.001 percent young population decline. Similarly, each unit increase in median household income is associated with a 0.00000083 percent decline in young population.

Metro is positive, and such areas have a 0.017 percent higher young population growth than nonmetropolitan areas. The West is strong and significant across all models. The West is associated with a 0.016 percent lower growth in the young population than the South. Each percent increase in the land developability index is associated with a 0.000302 percent growth in young population. The direction of spatial lag and spatial error is opposite, with spatial lag positive and spatial error negative. A county observes a 1.045 percent young population growth as a result of each weighted percentage point growth of young population in surrounding counties. Spatial error effects inform us that we can improve the models by adding up more relevant variables in the model.

Table 5.31: Regressions of Terminal Density on Young Population Change from 2000 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.002	−0.002	7.17E−5	−0.002
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	0.003*	0.002	0.001	−3.67E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.008***	0.007***	0.006**	0.003**
	(0.002)	(0.002)	(0.002)	(0.001)
Prev. decade young change	0.022	−0.001	−0.003	−0.003
	(0.018)	(0.017)	(0.019)	(0.011)
Old	−0.006***	−0.006***	−0.007***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
High school diploma	4.86E−4	−5.65E−5	−0.001	−2.82E−4
	(0.001)	(0.001)	(0.001)	(4.46E−4)
Bachelor's degree	−0.010***	−0.005***	−0.003*	0.003***
	(0.002)	(0.001)	(0.002)	(0.001)
Graduate degree	0.013***	0.008***	0.006***	−3.09E−4
	(0.002)	(0.002)	(0.002)	(0.001)
White	−0.001	−0.001*	−0.002***	−3.73E−4
	(5.00E−4)	(4.77E−4)	(0.001)	(2.77E−4)
Black	−0.002***	−0.002***	−0.004***	−0.001***
	(0.001)	(4.99E−4)	(0.001)	(2.80E−4)
Hispanic	−0.001*	−0.001*	−0.002**	−0.001*
	(0.001)	(0.001)	(0.001)	(2.93E−4)
Household income	7.42E−6***	5.03E−6***	5.78E−6***	−8.30E−7*
	(6.35E−7)	(6.27E−7)	(7.10E−7)	(3.85E−7)
Employment	−9.79E−5	−3.60E−4	−3.06E−4	−0.001
	(0.001)	(0.001)	(0.001)	(4.39E−4)
Metro	0.050***	0.040***	0.039***	0.017***
	(0.008)	(0.008)	(0.008)	(0.005)
West	−0.088***	−0.070***	−0.088***	−0.016**
	(0.012)	(0.012)	(0.019)	(0.006)
Midwest	−0.127***	−0.088***	−0.120***	0.001
	(0.009)	(0.009)	(0.014)	(0.005)
Northeast	−0.085***	−0.065***	−0.050*	−0.009
	(0.015)	(0.014)	(0.024)	(0.007)
Land developability	1.26E−4	2.62E−4	0.001***	3.02E−4***
	(1.46E−4)	(1.39E−4)	(1.67E−4)	(7.41E−5)
Constant	−0.062	0.032	0.122	0.117***
	(0.059)	(0.057)	(0.064)	(0.033)
Spatial lag effect	–	0.346***	–	1.045***
		(0.023)		(0.016)
Spatial error effect	–	–	0.528***	−0.959***
			(0.033)	(0.026)
Diagnostic Test				
Moran's I (error)	0.15***	–	–	–
Lagrange Mult (lag)	236.31***	–	–	–
Robust LM (lag)	30.46***	–	–	–
Lag Mult (error)	206.21***	–	–	–
Robust LM (error)	0.37	–	–	–
Measures of Fit				
Log-likelihood	1126.90	1228.82	1226.41	1567.86
AIC	−2215.81	−2417.65	−2414.82	−3095.72
BIC	−2101.01	−2296.81	−2300.02	−2974.87

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.32 shows the relationship between freight rail and young population for the period of 1970 to 2010. The diagnostic statistics of the first model, full ordinary least squares, shows that the dependent variable, young population change, is spatially correlated. It also suggests that spatial lag and spatial error regressions are better than standard regression, the first model. The spatial error model with lag dependence, the fourth model, is the best-fit model based on the highest value of log-likelihood (−854.29) and the lowest values of AIC (1744.58) and BIC (1853.34). The regression coefficient of this model will be described to explain the relationship of railroad with young population change.

Freight rail is negative, indicating that each percentage point increase in freight rail terminal density contributes to a 0.014 percent decline in the young population. This variable is negative across all models. The relationship of old with young is negative. Rach additional percent growth in old population is associated with 0.005 percent decline in the young population.

The education variables high school diploma and bachelor's degree are positive. Each percent increase in high school diplomas contributes to a 0.002 percent growth in the young population. Similarly, each additional percent growth in bachelor's degrees contributes to a 0.003 percent growth in the young population. The race and ethnicity variables White and Black are negative and significant across all models. Each percent of White population growth and Black population growth contributes to a 0.003 and 0.005 percent decline in the young population, respectively. In addition, these variables are negative across all models.

The relationship between median household income and change in the young population is negative, but the strength of the relationship is small. Each unit increase in median household income contributes to a 0.0000181 percent decline in the young population. Metro is positive and significant across all models. Metropolitan counties have a 0.138 percent higher growth in the young population than nonmetropolitan counties. The West is negative; counties in the West have a 0.051 percent greater decline in young population the counties in the south. The Midwest and Northeast are not significant in the fourth model, but are in the other three.

The spatial lag effect is positive, indicating that a county sees a 1.032 percent growth in the young population as a result of each weighted percentage point growth in young population of surrounding counties. The spatial error effect suggests that the model is imperfect and can be improved by the addition of relevant control variables.

Table 5.32: Regressions of Terminal Density on Young Population Change from 1970 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.041***	−0.030***	−0.024***	−0.014***
	(0.004)	(0.003)	(0.003)	(0.002)
Control Variables				
Highway density	0.011***	0.002	−0.002	−0.001
	(0.003)	(0.003)	(0.003)	(0.002)
Airport	0.027***	0.018***	0.017***	0.005
	(0.006)	(0.005)	(0.005)	(0.003)
Old	0.013***	0.003	0.002	−0.005***
	(0.003)	(0.002)	(0.003)	(0.001)
High school diploma	0.005***	0.003**	0.001	0.002**
	(0.001)	(0.001)	(0.002)	(0.001)
Bachelor's degree	−0.014***	−0.003	0.002	0.003*
	(0.003)	(0.002)	(0.003)	(0.001)
Graduate degree	0.028***	0.011*	0.002	0.001
	(0.006)	(0.005)	(0.005)	(0.003)
White	−0.007***	−0.007***	−0.010***	−0.003***
	(0.002)	(0.001)	(0.001)	(0.001)
Black	−0.012***	−0.011***	−0.019***	−0.005***
	(0.002)	(0.001)	(0.002)	(0.001)
Household income	3.15E−5***	4.74E−6	1.23E−5	−1.81E−5***
	(9.89E−6)	(8.13E−6)	(1.05E−5)	(4.90E−6)
Employment	0.005**	0.002	0.002	4.45E−5
	(0.002)	(0.001)	(0.002)	(0.001)
Metro	0.372***	0.257***	0.245***	0.138***
	(0.019)	(0.016)	(0.017)	(0.011)
West	−0.059	−0.082**	−0.049	−0.051***
	(0.033)	(0.027)	(0.059)	(0.014)
Midwest	−0.395***	−0.158***	−0.173*	0.013
	(0.038)	(0.031)	(0.072)	(0.016)
Northeast	−0.381***	−0.167***	−0.331***	0.011
	(0.023)	(0.020)	(0.042)	(0.010)
Land developability	−0.002***	−0.001	3.25E−4	3.23E−4
	(3.64E−4)	(2.98E−4)	(4.50E−4)	(1.66E−4)
Constant	0.197	0.482***	0.889***	0.352***
	(0.164)	(0.134)	(0.160)	(0.085)
Spatial lag effects	−	0.614***	−	1.032***
		(0.017)		(0.011)
Spatial error effects	−	−	0.684***	−0.905***
			(0.017)	(0.029)
Diagnostic Test				
Moran's I (error)	0.35***	−	−	−
Lagrange Mult (lag)	1290.26***	−	−	−
Robust LM (lag)	210.78***	−	−	−
Lag Mult (error)	1079.95***	−	−	−
Robust LM (error)	0.47	−	−	−
Measures of Fit				
Log-likelihood	−1786.62	−1297.57	−1323.62	−854.29
AIC	3607.23	2631.15	2681.24	1744.58
BIC	3709.95	2739.91	2783.96	1853.34

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.33 presents the results of the spatial error model with lag dependence carried out between freight rail and young population change for all periods. Freight rail is associated with decline in the young population in the 1970s, 1980s, 1990s, and 1970 to 2010. The previous decade's young population change is negative in the 1970s but positive in the 1980s and 1990s. The variable old is strong, significant, and negative in the 1980s, 1990s, 2000s, and 1970 to 2010. Among education variables, bachelor's degree is the strongest and positive across all periods.

The race and ethnicity variable Black is stronger thanWhite and Hispanic and is negative across all periods. Income is negative in the 1980s, 2000s, and 1970 to 2010, whereas employment is significant and negative in the 1970s and 1990s. Metro is positive across all periods. The West is the only regional variable that is significant and negative across all periods. The Midwest and Northeast are not significant at all. Land developability is positive in the 1980s and 2000s. Spatial lag and spatial error effects are significant across all periods.

Table 5.33: SEMLD Results for Young Population Change for All Periods

	SEMLD 1970-1980	SEMLD 1980-1990	SEMLD 1990-2000	SEMLD 2000-2010	SEMLD 1970-2010
Explanatory Variables					
Terminal density	−0.007***	−0.002*	−0.004***	−0.002	−0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Control Variables					
Highway density	−0.001	−3.78E−4	−0.001	−3.67E−4	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Airport	0.001	0.001	−2.05E−4	0.003**	0.005
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Prev. decade young	−0.003*	0.046***	0.032**	−0.003	−
change	(0.001)	(0.007)	(0.011)	(0.011)	
Old	−0.001	−0.002***	−0.001*	−0.003***	−0.005***
	(0.001)	(0.001)	(4.43E−4)	(0.001)	(0.001)
High school	0.001**	0.001	3.37E−4	−2.82E−4	0.002**
diploma	(2.40E−4)	(0.001)	(3.05E−4)	(4.46E−4)	(0.001)
Bachelor's degree	0.001*	0.003**	0.004***	0.003***	0.003*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	−0.007***	0.003	−0.003**	−3.09E−4	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
White	−0.002***	−1.70E−5	6.77E−5	−3.73E−4	−0.003***
	(3.43E−4)	(2.14E−4)	(2.34E−4)	(2.77E−4)	(0.001)
Black	−0.002***	−4.31E−4*	−2.07E−4	−0.001***	−0.005***
	(3.52E−4)	(2.16E−4)	(2.40E−4)	(2.80E−4)	(0.001)
Hispanic			−2.28E−4	−0.001*	
			(2.48E−4)	(2.93E−4)	
Household income	3.45E−6	−2.90E−6***	−1.38E−8	−8.30E−7*	−1.81E−5***
	(2.01E−6)	(7.08E−7)	(3.80E−7)	(3.85E−7)	(4.90E−6)
Employment	−0.001**	−0.001	−0.001*	−0.001	4.45E−5
	(3.49E−4)	(0.001)	(3.49E−4)	(4.39E−4)	(0.001)
Metro	0.041***	0.014***	0.019***	0.017***	0.138***
	(0.005)	(0.004)	(0.004)	(0.005)	(0.011)
West	−0.019***	−0.017***	−0.015***	−0.016**	−0.051***
	(0.006)	(0.005)	(0.005)	(0.006)	(0.014)
Midwest	−0.001	0.006	−0.001	0.001	0.013
	(0.004)	(0.004)	(0.004)	(0.005)	(0.016)
Northeast	0.003	0.001	0.005	−0.009	0.011
	(0.006)	(0.005)	(0.006)	(0.007)	(0.010)
Land developability	6.43E−5	3.04E−4***	8.57E−5	3.02E−4***	3.23E−4
	(6.88E−5)	(5.99E−5)	(5.43E−5)	(7.41E−5)	(1.66E−4)
Constant	0.165***	0.018	0.029	0.117***	0.352***
	(0.035)	(0.029)	(0.029)	(0.033)	(0.085)
Spatial lag effects	1.042***	1.017***	1.028***	1.045***	1.032***
	(0.012)	(0.013)	(0.013)	(0.016)	(0.011)
Spatial error effects	−0.945***	−0.948***	−0.997***	−0.959***	−0.905***
	(0.026)	(0.026)	(0.027)	(0.026)	(0.029)
Measures of Fit					
Log-likelihood	1863.22	2286.75	2391.24	1567.86	−854.29
AIC	−3688.45	−4535.50	−4742.49	−3095.72	1744.58
BIC	−3573.65	−4420.70	−4621.65	−2974.87	1853.34

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Old

Table 5.34 presents the relationship between freight rail and old population for the period of 1970 to 1980. In the first model, full ordinary least squares regression, the diagnostic statistics suggest that the old population change is spatially correlated, and spatial lag and spatial error regressions are better than standard regression, the first model. In the table, the spatial error model with lag dependence is the best-fit model because it has the highest value of log-likelihood (3007.01) and the lowest values of AIC (−5976.02) and BIC (−5861.22). Hence, the following explanation is based on the fourth model.

Freight rail is negatively associated with old population change. Each additional percentage point growth in freight rail terminal density contributes to a 0.003 percent old population decline. In addition, freight rail is negative across all models. The highway variable is negative and suggests that with each percentage point growth in highway density, old population declines by 0.001 percent, on average. The previous decade’s old population change has a negative association, and each percent growth in the previous decade’s old population is associated with a 0.003 percent loss in old population.

Bachelor’s degree is stronger than the other two education variables, and it has a positive association with old population change. Each percent increase in bachelor’s degrees contributes to a 0.001 percent old population growth. High school diploma and graduate degree are not significant. The race and ethnicity variable White is positive and stronger than Black. Each percent increase in White population contributes to a 0.001 percent growth in the old population. Black is not significant in any model. Income is positive, indicating that each unit increase in median household income is associated with a 0.00000465 percent growth in the old population. Even though the coefficient is statistically significant, the strength is negligible.

Metro is positive, suggesting that a metropolitan county receives a 0.007 percent greater growth in the old population than a nonmetropolitan county. The West is negative, and a county in the West experiences a 0.019 percent higher old population decline than in the South. The Midwest and Northeast are not significant in the fourth model, but are in the other three models.

The spatial lag effect is positive and indicates that a county sees a 1.061 percent growth in the old population with each additional weighted percentage point increase in growth in the old population in surrounding counties. The spatial error effect indicates that the model can be improved by the addition of relevant control variables.

Table 5.34: Regressions of Terminal Density on Old Population Change from 1970 to 1980

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.012***	−0.009***	−0.008***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	4.87E−4	−0.001	−0.002*	−0.001**
	(0.001)	(0.001)	(0.001)	(4.91E−4)
Airport	0.012***	0.007***	0.005***	0.001
	(0.002)	(0.001)	(0.001)	(0.001)
Prev. decade old pop.	0.007***	0.001	−0.001	−0.003**
change	(0.002)	(0.002)	(0.001)	(0.001)
Young	−0.007***	−0.004**	−0.004**	−0.001
	(0.002)	(0.001)	(0.002)	(0.001)
High school diploma	2.03E−4	1.46E−4	3.68E−4	1.18E−5
	(3.68E−4)	(3.10E−4)	(4.38E−4)	(1.57E−4)
Bachelor’s degree	2.94E−4	0.001*	0.002**	0.001***
	(0.001)	(0.001)	(0.001)	(3.39E−4)
Graduate degree	−1.21E−4	−0.001	−0.001	−0.001
	(0.002)	(0.001)	(0.002)	(0.001)
White	0.001**	0.001***	0.001***	0.001*
	(4.52E−4)	(3.81E−4)	(4.23E−4)	(2.31E−4)
Black	0.001	0.001	2.12E−5	4.35E−4
	(4.84E−4)	(4.08E−4)	(4.98E−4)	(2.40E−4)
Household income	1.54E−5***	1.31E−5***	1.83E−5***	4.65E−6***
	(2.39E−6)	(2.02E−6)	(2.60E−6)	(1.13E−6)
Employment	−0.001	−3.36E−4	3.17E−4	−3.83E−4
	(4.85E−4)	(4.09E−4)	(4.70E−4)	(2.38E−4)
Metro	0.025***	0.012**	0.009	0.007*
	(0.006)	(0.005)	(0.005)	(0.003)
West	−0.082***	−0.064***	−0.078***	−0.019***
	(0.010)	(0.008)	(0.016)	(0.004)
Midwest	−0.133***	−0.069***	−0.134***	−0.002
	(0.007)	(0.006)	(0.011)	(0.003)
Northeast	−0.139***	−0.071***	−0.106***	0.001
	(0.011)	(0.009)	(0.020)	(0.004)
Land developability	−0.001***	−0.001***	−0.001***	−1.39E−6
	(1.04E−4)	(8.98E−5)	(1.29E−4)	(4.61E−5)
Constant	0.159**	−0.012	0.047	−0.071**
	(0.050)	(0.043)	(0.048)	(0.026)
Spatial lag effects	−	0.579***	−	1.061***
		(0.019)		(0.011)
Spatial error effects	−	−	0.648***	−0.982***
			(0.018)	(0.027)
Diagnostic Test				
Moran’s I (error)	0.35***	−	−	−
Lagrange Mult (lag)	1147.19***	−	−	−
Robust LM (lag)	78.56***	−	−	−
Lag Mult (error)	1084.35***	−	−	−
Robust LM (error)	15.73***	−	−	−
Measures of Fit				
Log-likelihood	2089.41	2503.81	2525.88	3007.01
AIC	−4142.81	−4969.62	−5015.77	−5976.02
BIC	−4034.06	−4854.82	−4907.01	−5861.22

AIC = Akaike’s information criterion. BIC = Schwartz’s Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.35 shows the association of freight rail with old population change for the 1980s. The diagnostic statistics of the first model, standard regression, suggest that the old population is spatially correlated. The diagnostic test also indicates that spatial lag and spatial error regressions are better than standard regression. The spatial error model with lag dependence is the best-fit model because the value for log-likelihood (3203.48) is the highest and the values for AIC (−6368.95) and BIC (−6254.15) are the lowest. Hence, the following explanation is based on the fourth model, spatial error model with lag dependence.

The relationship between freight rail and old population is negative. Each additional percentage point increase in freight rail terminal density contributes to a 0.002 percent old population decline. The value is negative across all models. The previous decade's old population change is positive. Each percent increase in the previous decade's old population is associated with a 0.229 percent growth in the old population. The value is negative across all models.

The association of young with old is positive. Each percent increase in young population contributes to a 0.007 percent growth in the old population. This variable is positive across all models. The association of education with the old population is very strong in the 1980s. All three education variables are positive across all models. Each percent increase in high school diplomas, bachelor's degrees, and graduate degrees contributes to a 0.006 percent, 0.01 percent, and 0.003 percent growth in the old population, respectively.

The relationship of employment with old population is stronger than the relationship of income with the old population. The direction of the impact is opposite, being income positive and employment negative. Each addition unit increase in median household income contributes to a 0.00000577 percent growth in the old population. On the other hand, each percent growth in employment contributes to a 0.005 percent old population decline.

Metro is positive, indicating that a metropolitan county has a 0.014 percent greater growth in the old population than a nonmetropolitan county. The variable metro is positive across all models. The West is negative; a county in the West observes a 0.015 percent greater old population decline than a county in the South.

The spatial lag effect is positive. A county has a 0.679 percent growth in the old population for each additional weighted percentage point increase in old population in surrounding counties. The spatial error effect indicates that the model is imperfect and can be improved by the addition of the relevant control variables.

Table 5.35: Regressions of Terminal Density on Old Population Change from 1980 to 1990

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.002*	−0.003***	−0.002**	−0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	3.57E−4	−2.35E−4	7.14E−5	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.001	0.001	0.002	−1.96E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Prev. decade old pop. change	0.409***	0.318***	0.308***	0.229***
	(0.010)	(0.010)	(0.011)	(0.009)
Young	0.007***	0.007***	0.004*	0.007***
	(0.002)	(0.002)	(0.002)	(0.001)
High school diploma	0.011***	0.009***	0.009***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Bachelor's degree	0.014***	0.013***	0.014***	0.010***
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	0.006***	0.005***	0.005***	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)
White	1.51E−4	1.89E−4	−3.66E−7	2.81E−4
	(2.79E−4)	(2.56E−4)	(3.16E−4)	(2.04E−4)
Black	−0.001*	−0.001*	−0.001***	−3.58E−4
	(2.91E−4)	(2.68E−4)	(3.55E−4)	(2.07E−4)
Household income	1.11E−5***	9.45E−6***	1.41E−5***	5.77E−6***
	(8.49E−7)	(7.91E−7)	(9.65E−7)	(6.31E−7)
Employment	−0.007***	−0.007***	−0.008***	−0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Metro	0.029***	0.018***	0.018***	0.014***
	(0.004)	(0.004)	(0.004)	(0.004)
West	0.025***	−0.007	0.011	−0.015**
	(0.007)	(0.007)	(0.011)	(0.005)
Midwest	−0.021***	−0.015	−0.045***	−0.004
	(0.005)	(0.005)	(0.008)	(0.003)
Northeast	−0.029***	−0.023	−0.049***	−0.009
	(0.008)	(0.007)	(0.013)	(0.005)
Land developability	−0.001***	−3.09E−4***	−4.50E−4***	−4.83E−5
	(8.30E−5)	(7.81E−5)	(1.03E−4)	(6.12E−5)
Constant	−0.370***	−0.328***	−0.265***	−0.273***
	(0.037)	(0.034)	(0.040)	(0.028)
Spatial lag effects	–	0.375***	–	0.679***
		(0.018)		(0.016)
Spatial error effects	–	–	0.534***	−0.464***
			(0.021)	(0.031)
Diagnostic Test				
Moran's I (error)	0.23***	–	–	–
Lagrange Mult (lag)	501.77***	–	–	–
Robust LM (lag)	111.12***	–	–	–
Lag Mult (error)	445.45***	–	–	–
Robust LM (error)	54.79***	–	–	–
Measures of Fit				
Log-likelihood	2910.83	3125.50	3125.70	3203.48
AIC	−5785.66	−6213.01	−6215.41	−6368.95
BIC	−5676.90	−6098.21	−6106.65	−6254.15

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.36 presents the regression results for the relationship between freight rail and old population change for the 1990s. The significant values in the diagnostic test indicate the spatial autocorrelation of old population. Similarly, the measures-of-fit analysis indicates the fourth model as the best fit based on the highest value of the log-likelihood (3441.85) and the lowest values of AIC (−6843.71) and BIC (−6722.87).

Freight rail is strong and significant across all models. Each unit increase in terminal density is associated with a 0.003 percent old population decline. The previous decade's population change is the next strong variable, being consistently significant across all models. Each percent increase in the previous decade's old population is associated with a 0.255 percent growth in old population. Graduate degree is the strongest and negative. Each percent growth in graduate degrees is associated with a 0.004 percent decline in old population.

Black is the strongest among the three race and ethnicity variables. Each percent growth in Black population is associated with a 0.002 percent old population decline. The association of median household income with old population is positive. Each unit increase in median household income is associated with a 0.00000468 percent growth in old population. Employment is also strong and positive, indicating that each percent growth is associated with a 0.003 percent old population growth.

Metro is positive, and the Midwest is negative. A metro area experiences a 0.018 percent higher old population growth than a nonmetropolitan area. On the other hand, the Midwest loses more of its old population (0.033 percent more) than the South. Land development is negatively associated with old population. It is a strong variabl,e its each percent growth is associated with a 0.000303 percent old population decline. Spatial lag indicates that a county observes a 0.915 percent decline in the old population when surrounding counties experience for each weighted percentage point growth in this population. The spatial error effect indicates that the model can be improved by adding relevant variables.

Table 5.36: Regressions of Terminal Density on Old Population Change from 1990 to 2000

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.007***	−0.007***	−0.006***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	−0.001	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.001	0.001	0.001	3.94E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Prev. decade old pop.	0.402***	0.351***	0.360***	0.255***
change	(0.010)	(0.010)	(0.011)	(0.010)
Young	0.010***	0.010***	0.007***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
High school diploma	0.001	0.001	2.74E−4	1.01E−4
	(4.12E−4)	(3.94E−4)	(4.96E−4)	(0.001)
Bachelor's degree	8.41E−5	0.001	0.001	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	−0.003**	−0.004***	−0.004***	−0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
White	2.32E−4	5.77E−5	−2.95E−4	−0.001*
	(2.74E−4)	(2.62E−4)	(2.93E−4)	(2.80E−4)
Black	−4.76E−4	−0.001*	−0.001***	−0.002***
	(2.94E−4)	(2.82E−4)	(3.32E−4)	(3.46E−4)
Hispanic	0.001***	4.95E−4	1.46E−4	−0.001
	(3.10E−4)	(2.97E−4)	(3.63E−4)	(4.10E−4)
Household income	2.78E−6***	2.26E−6***	4.13E−6***	4.68E−6***
	(4.84E−7)	(4.67E−7)	(5.41E−7)	(5.48E−7)
Employment	0.003***	0.003***	0.003***	0.003***
	(3.70E−4)	(3.58E−4)	(3.96E−4)	(3.73E−4)
Metro	0.016***	0.013***	0.015***	0.018***
	(0.004)	(0.004)	(0.004)	(0.003)
West	−0.031***	−0.035***	−0.024*	0.018
	(0.006)	(0.006)	(0.009)	(0.022)
Midwest	−0.051***	−0.038***	−0.060***	−0.033*
	(0.005)	(0.005)	(0.007)	(0.014)
Northeast	−0.046***	−0.032***	−0.051***	−0.036
	(0.008)	(0.008)	(0.012)	(0.026)
Land developability	−0.001***	−4.89E−4***	−0.001***	−3.03E−4**
	(7.41E−5)	(7.32E−5)	(9.14E−5)	(1.03E−4)
Constant	−0.276***	−0.242***	−0.214***	−0.096*
	(0.034)	(0.033)	(0.038)	(0.040)
Spatial lag effects	−	0.269***	−	−0.915***
		(0.018)		(0.033)
Spatial error effects	−	−	0.476***	0.923***
			(0.022)	(0.007)
Diagnostic Test				
Moran's I (error)	0.21***	−	−	−
Lagrange Mult (lag)	241.41***	−	−	−
Robust LM (lag)	7.75**	−	−	−
Lag Mult (error)	377.24***	−	−	−
Robust LM (error)	143.59***	−	−	−
Measures of Fit				
Log-likelihood	3219.91	3325.38	3388.55	3441.85
AIC	−6401.83	−6610.76	−6739.09	−6843.71
BIC	−6287.03	−6489.92	−6624.29	−6722.87

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors
in parentheses.

Table 5.37 shows the relationship between freight rail and old population for 2000 to 2010. The diagnostic statistics of the first model, full ordinary least squares, show the spatial dependency of the dependent variable. It also shows that the spatial lag and spatial error models are better than ordinary least squares regression. However, the fourth model, spatial error model with lag dependence, is the best-fit model based on the measures of fit because the value of log-likelihood (3255.88) is the highest and the values of AIC (−6471.76) and BIC (−6350.92) are the lowest. Therefore, the explanation is based on the fourth model.

Freight rail has a negative relationship with old population change. Each percentage point increase in freight rail terminal density brings a loss of 0.005 percent of the old population. Freight rail is a strong variable and significant across all models.

The previous decade’s old population change is positive, indicating that each percent increase in it contributes to a 0.347 percent growth in old population. This demographic variable is very strong and positive across all models. Young is another strong demographic variable and is positive across all models. Each percent increase in young population is associated with a 0.005 percent old population growth.

Education has no significant relationship with old population change. Among race and ethnicity variables, both Black and Hispanic have a negative association. The strength of association of both variables with the old population is equal. Each percent growth in Black and Hispanic populations contribute to a 0.001 percent old population decline. Income is positive: with each additional unit increase in median household income, the old population grows by 0.00000196 percent, on average.

Metro is positive, and the Midwest and Northeast are negative. A metropolitan county has 0.16 percent more old population than a nonmetropolitan county. The decline of old population in Midwest and Northeast counties is 0.017 percent greater than counties in the South. Land developability is positive, but the strength of association is small. Each additional percent growth in the land developability index contributes to a 0.000138 percent old population growth.

Spatial lag is positive, indicating that, the old population in a county grows by 0.555 percent for each additional weighted percentage point of old population growth in surrounding counties. The significant spatial error effect shows that the model can be improved by the addition of relevant control variables.

Table 5.37: Regressions of Terminal Density on Old Population Change from 2000 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.005***	−0.005***	−0.004***	−0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	3.15E−5	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	−3.16E−4	−9.17E−5	−2.28E−4	9.04E−5
	(0.001)	(0.001)	(0.001)	(0.001)
Prev. decade old pop.	0.473***	0.408***	0.406***	0.347***
change	(0.012)	(0.012)	(0.013)	(0.012)
Young	0.004**	0.005***	0.006***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
High school diploma	0.001	3.04E−4	3.56E−5	2.11E−4
	(4.71E−4)	(4.46E−4)	(0.001)	(3.82E−4)
Bachelor’s degree	−0.004***	−0.002**	−0.002**	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	0.003**	0.001	4.17E−5	−3.89E−4
	(0.001)	(0.001)	(0.001)	(0.001)
White	−2.03E−4	−2.32E−4	−3.79E−4	−1.58E−4
	(2.61E−4)	(2.47E−4)	(2.85E−4)	(2.20E−4)
Black	−4.99E−4	−0.001	−0.001*	−0.001**
	(2.78E−4)	(2.63E−4)	(3.20E−4)	(2.30E−4)
Hispanic	−0.001***	−0.001***	−0.001**	−0.001***
	(2.95E−4)	(2.79E−4)	(3.46E−4)	(2.43E−4)
Household income	3.27E−6***	2.79E−6***	4.42E−6***	1.96E−6***
	(3.66E−7)	(3.50E−7)	(4.13E−7)	(3.09E−7)
Employment	0.002***	0.001	0.001**	−3.48E−6
	(3.83E−4)	(3.65E−4)	(4.03E−4)	(3.35E−4)
Metro	0.022***	0.017***	0.018***	0.016***
	(0.004)	(0.004)	(0.004)	(0.004)
West	0.005	−0.004	0.007	−0.008
	(0.006)	(0.006)	(0.009)	(0.005)
Midwest	−0.051***	−0.032***	−0.053***	−0.017***
	(0.005)	(0.005)	(0.007)	(0.004)
Northeast	−0.064***	−0.036***	−0.056***	−0.017**
	(0.008)	(0.008)	(0.012)	(0.006)
Land developability	−3.38E−4***	−4.75E−5	−2.62E−4**	1.38E−4*
	(8.05E−5)	(7.80E−5)	(9.74E−5)	(6.75E−5)
Constant	−0.116***	−0.092**	−0.096*	−0.073*
	(0.034)	(0.032)	(0.038)	(0.029)
Spatial lag effects	−	0.318***	−	0.555***
		(0.019)		(0.019)
Spatial error effects	−	−	0.454***	−0.274***
			(0.023)	(0.031)
Diagnostic Test				
Moran’s I (error)	0.19***	−	−	−
Lagrange Mult (lag)	305.02***	−	−	−
Robust LM (lag)	50.35***	−	−	−
Lag Mult (error)	302.12***	−	−	−
Robust LM (error)	47.45***	−	−	−
Measures of Fit				
Log-likelihood	3075.89	3211.44	3219.07	3255.88
AIC	−6113.78	−6382.88	−6400.14	−6471.76
BIC	−5998.98	−6262.03	−6285.34	−6350.92

AIC = Akaike’s information criterion. BIC = Schwartz’s Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.38 focuses on the association of freight rail with old population for the overall study period, 1970 to 2010. The significant Moran's I in the first model suggests that the dependent variable is spatially dependent. Lagrange values for lag and error show that spatial lag and spatial error regressions are better than standard regression for this analysis. But the fourth model is the best-fit model because the log-likelihood value (−461.58) is the highest and AIC (959.17) and BIC (1067.92) are the lowest. Hence, the following explanation is based on this model.

Freight rail has a negative association with old population change. Each percentage point increase in freight rail terminal density contributes to a 0.021 percent decline in old population. Freight rail is significant across all models. Both transportation control variables, highway and airport, are significant. Highway is negative, indicating that each percentage point increase in highway density contributes to a 0.003 percent old population decline. On the other hand, each additional unit growth in airport terminal density helps grow the old population by 0.008 percent.

The relationship of bachelor's and graduate degrees with old population are opposite. Each percent growth in bachelor's degrees contributes to a 0.004 percent old population growth. On the other hand, each additional percent growth in graduate degrees brings a 0.007 decline of old population.

Race and ethnicity variables are not significant. Income is positive, but its strength is very small. Each additional unit increase in median household income contributes to a 0.0000246 percent old population growth. Income is significant across all models. Employment is negative, indicating that each percent increase in employment is associated with a 0.003 percent old population decline.

Metro is positive, which shows that the growth of old population is 0.093 percent greater in a metropolitan county than in a nonmetropolitan county. This variable is significant and positive across all models. On the other hand, all regional variables are negative, which indicates that the gain of old population is these regions is less than in the South. The growth in old population in the West is 0.091 percent less than the South. Similarly, in the Midwest the growth of old population is 0.040 less than the South, and in the Northeast the growth is 0.034 percent less than the South. For the entire period of 1970 to 2010, the growth of old population in the South is greater than any other regions.

The spatial lag effect is positive, showing that a county has a 0.991 percent old population growth for each weighted percentage point increase in old population in surrounding counties. The spatial error effect indicates the imperfection of the model, which can be improved by adding relevant control variables.

Table 5.38: Regressions of Terminal Density on Old Population Change from 1970 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.049***	−0.040***	−0.035***	−0.021***
	(0.003)	(0.003)	(0.003)	(0.002)
Control Variables				
Highway density	−0.001	−0.003	−0.007**	−0.003*
	(0.003)	(0.002)	(0.002)	(0.002)
Airport	0.027***	0.018***	0.013**	0.008**
	(0.005)	(0.004)	(0.004)	(0.003)
Young	0.016**	0.015***	0.010*	0.012***
	(0.005)	(0.004)	(0.004)	(0.003)
High school diploma	−0.001	2.19E−4	1.24E−4	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Bachelor's degree	−0.008***	0.001	0.003	0.004***
	(0.002)	(0.002)	(0.002)	(0.001)
Graduate degree	−0.008	−0.009*	−0.009	−0.007*
	(0.005)	(0.004)	(0.005)	(0.003)
White	−9.60E−5	−0.001	−0.002	−2.15E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Black	−0.002	−0.003*	−0.007***	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Household income	1.18E−4***	8.05E−5***	1.18E−4***	2.46E−5***
	(7.07E−6)	(6.02E−6)	(7.48E−6)	(3.82E−6)
Employment	0.001	−0.002	−0.003*	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Metro	0.220***	0.145***	0.138***	0.093***
	(0.016)	(0.014)	(0.014)	(0.010)
West	−0.082**	−0.132***	−0.013	−0.091***
	(0.028)	(0.023)	(0.052)	(0.013)
Midwest	−0.453***	−0.237***	−0.298***	−0.040**
	(0.032)	(0.027)	(0.064)	(0.015)
Northeast	−0.399***	−0.212***	−0.357***	−0.034***
	(0.019)	(0.017)	(0.036)	(0.009)
Land developability	−0.005***	−0.002***	−0.002***	−1.09E−4
	(3.08E−4)	(2.60E−4)	(3.78E−4)	(1.62E−4)
Constant	0.247	−0.014	0.261	−0.128
	(0.149)	(0.123)	(0.137)	(0.084)
Spatial lag effects	–	0.587***	–	0.991***
		(0.017)		(0.011)
Spatial error effects	–	–	0.716***	−0.819***
			(0.016)	(0.028)
Diagnostic Test				
Moran's I (error)	0.40***	–	–	–
Lagrange Mult (lag)	1297.25***	–	–	–
Robust LM (lag)	77.43***	–	–	–
Lag Mult (error)	1349.28***	–	–	–
Robust LM (error)	129.47***	–	–	–
Measures of Fit				
Log-likelihood	−1284.56	−790.52	−731.95	−461.58
AIC	2603.12	1617.04	1497.90	959.17
BIC	2705.83	1725.79	1600.62	1067.92

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.39 presents the results of the spatial error model with lag dependence analysis for the 1970s, 1980s, 1990s, 2000s, and 1970 to 2010. The regression values show the relationship between freight rail and old population change by controlling for many socioeconomic variables. The association is negative for all periods. Freight rail contributes to the old population decline.

Highway is negative in the 1970s and 1970 to 2010. Even though airport is not significant in the 1970s, 1980s, and 2000s, it is positive for the entire period 1970 to 2010. The nature of the relationship with old population varies by mode of transportation. In this case, highway is associated with the decline of old population, and airport is associated with the growth of old population. The previous decade's old population change is negative in the 1970s and positive in the 1980s, 1990s, and 2000s. The relationship of young with old population is positive in the 1980s, 1990s, 2000s, and for the period of four decades 1970 to 2010. The association is positive, perhaps because the young are dependent on older population.

Among the three education variables, bachelor's degree is the strongest and positive in the 1970s, 1980s, 1990s, and 1970 to 2010. High school diploma is positive only in the 1980s, whereas graduate degree is positive in the 1980s and negative in the 1990s and during the overall study period 1970 to 2010. For race and ethnicity variables, the direction of the association and time of the significance varies between White and minorities. White is positive in the 1970s and negative in the 1990s, whereas Black is negative in the 1990s and 2000s. Hispanic is negative in the 2000s. Income is positive across all periods, but the strength is weak. On the other hand, employment is negative during the 1980s and 1970 to 2010 and positive in the 1990s.

Metro is positive across all periods, indicating that a metropolitan county experiences greater old population growth than a nonmetropolitan county. In addition, the table shows that the growth of old population in all three regions, the West, Midwest and Northeast, is comparatively less than the South. The spatial lag effect is positive, indicating that old population is spatially correlated across all periods. The spatial error effect shows that the model can be improved by adding relevant control variables across all periods.

Table 5.39: SEMLD Results for Old Population Change for All Periods

	SEMLD 1970-1980	SEMLD 1980-1990	SEMLD 1990-2000	SEMLD 2000-2010	SEMLD 1970-2010
Explanatory Variables					
Terminal density	−0.003***	−0.002**	−0.003***	−0.005***	−0.021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Control Variables					
Highway density	−0.001**	−0.001	−0.001	−0.001	−0.003*
	(4.91E−4)	(0.001)	(0.001)	(0.001)	(0.002)
Airport	0.001	−1.96E−4	3.94E−4	9.04E−5	0.008**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Prev. decade old pop. change	−0.003**	0.229***	0.255***	0.347***	–
	(0.001)	(0.009)	(0.010)	(0.012)	
Young	−0.001	0.007***	0.004***	0.005***	0.012***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
High school diploma	1.18E−5	0.006***	1.01E−4	2.11E−4	0.001
	(1.57E−4)	(0.001)	(0.001)	(3.82E−4)	(0.001)
Bachelor's degree	0.001***	0.010***	0.002*	−0.001	0.004***
	(3.39E−4)	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	−0.001	0.003**	−0.004***	−3.89E−4	−0.007*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
White	0.001*	2.81E−4	−0.001*	−1.58E−4	−2.15E−4
	(2.31E−4)	(2.04E−4)	(2.80E−4)	(2.20E−4)	(0.001)
Black	4.35E−4	−3.58E−4	−0.002***	−0.001**	−0.001
	(2.40E−4)	(2.07E−4)	(3.46E−4)	(2.30E−4)	(0.001)
Hispanic	–	–	−0.001	−0.001***	–
			(4.10E−4)	(2.43E−4)	
Household income	4.65E−6***	5.77E−6***	4.68E−6***	1.96E−6***	2.46E−5***
	(1.13E−6)	(6.31E−7)	(5.48E−7)	(3.09E−7)	(3.82E−6)
Employment	−3.83E−4	−0.005***	0.003***	−3.48E−6	−0.003***
	(2.38E−4)	(0.001)	(3.73E−4)	(3.35E−4)	(0.001)
Metro	0.007*	0.014***	0.018***	0.016***	0.093***
	(0.003)	(0.004)	(0.003)	(0.004)	(0.010)
West	−0.019***	−0.015**	0.018	−0.008	−0.091***
	(0.004)	(0.005)	(0.022)	(0.005)	(0.013)
Midwest	−0.002	−0.004	−0.033*	−0.017***	−0.040**
	(0.003)	(0.003)	(0.014)	(0.004)	(0.015)
Northeast	0.001	−0.009	−0.036	−0.017**	−0.034***
	(0.004)	(0.005)	(0.026)	(0.006)	(0.009)
Land developability	−1.39E−6	−4.83E−5	−3.03E−4**	1.38E−4*	−1.09E−4
	(4.61E−5)	(6.12E−5)	(1.03E−4)	(6.75E−5)	(1.62E−4)
Constant	−0.071**	−0.273***	−0.096*	−0.073*	−0.128
	(0.026)	(0.028)	(0.040)	(0.029)	(0.084)
Spatial lag effect	1.061***	0.679***	−0.915***	0.555***	0.991***
	(0.011)	(0.016)	(0.033)	(0.019)	(0.011)
Spatial error effect	−0.982***	−0.464***	0.923***	−0.274***	−0.819***
	(0.027)	(0.031)	(0.007)	(0.031)	(0.028)
Measures of Fit					
Log-likelihood	3007.01	3203.48	3441.85	3255.88	−461.58
AIC	−5976.02	−6368.95	−6843.71	−6471.76	959.17
BIC	−5861.22	−6254.15	−6722.87	−6350.92	1067.92

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

SECTION 4: SOCIOECONOMIC STATUS

Section 4 deals with the relationship of freight rail with socioeconomic status. The socioeconomic variables are education and income. Education has three variables: high school diploma, bachelor's degree, and graduate degree. The twenty-four tables in this section pertain to high school diploma (Tables 5.40 to 5.45), bachelor's degree (Tables 5.46 to 5.51), graduate degree (Tables 5.52 to 5.57), and income (Tables 5.58 to 5.63).

High School

Table 5.40 shows the association of freight rail with the change in population with a high school diploma for the period of 1970 to 1980. The diagnostic statistics in the first model, full ordinary least squares, shows that the dependent variable, change in population with a high school diploma, is spatially dependent (Moran's I). The statistics suggest that spatial regressions (Lagrange multiplier, lag and error) are better-fit models than standard regression. The measures of fit indicate that spatial lag and spatial error models are better. Nonetheless, the best model is the fourth, spatial error model with lag dependence, because of the highest value of log-likelihood (1492.20) and the lowest values of AIC (−2948.40) and BIC (−2839.64). Accordingly, the following explanation is based on the fourth model.

Freight rail has a negative relationship with the change in population with a high school diploma. Each additional percentage point growth in freight rail terminal density contributes to a 0.009 percent decline in population with a high school diploma. The explanatory variable is negative across all models. Airport is positive, which means that each unit increase in public airport terminal contributes to a 0.006 percent growth in the population with a high school diploma.

The age variable old has a negative relationship with high school. With each additional percent growth in old population, there is a 0.005 percent decline in the population with a high school diploma. The variable old is negative across all models. The education variable bachelor's degree is negative, which suggests that each percent growth in bachelor's degrees associated with a 0.006 percent decline in the population with a high school diploma. Graduate degree is not significant in the fourth model, but is significant in the other three models. Incorporation of the spatial control variables, spatial lag and spatial error effects, affects the strength of association. Black is stronger than White among race and ethnicity variables. Both White and Black are negative, but Black is negative across all models. With each percent growth in White and Black populations, there is a 0.001 and 0.002 decline, respectively, in the population with a high school diploma.

Income and employment have an opposite association with high school diplomas, with income negative and employment positive. The strength of association of income is weaker in comparison to the association of employment. With each unit increase in median household income, there is a 0.0000118 percent decline in the population with a high school diploma. On the other hand, each percent growth in employment contributes to a 0.002 percent growth in the population with a high school diploma.

The geographic variable, metro is positive, which shows that a metropolitan county has a 0.037 percent higher growth in population with a high school diploma than a nonmetropolitan county. The variable metro is positive across all models. All three regional variables, the West, Midwest, and Northeast, are positive, indicating that growth in the population with a high school diploma in these regions is greater than in the South. A county in the West has a 0.025 percent greater population with a high school diploma, the Midwest 0.023 percent greater, and the Northeast 0.038 percent greater than a county in the South. The direction of the association completely changes from negative in the first model to positive in the fourth model. Simultaneously controlling for spatial lag and spatial error effects causes the change in the direction of the association.

Spatial lag is positive, indicating that a county experiences a 0.979 percent growth in the population with a high school diploma for each weighted percentage point growth in that population in surrounding counties. The spatial error effect indicates that the model can be improved by incorporating some relevant control variables.

Table 5.40: Regressions of Terminal Density on High School Diploma Population Change from 1970 to 1980

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.019***	−0.014***	−0.014***	−0.009***
	(0.002)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	0.005**	0.000	−0.003*	−0.002
	(0.002)	(0.001)	(0.001)	(0.001)
Airport	0.001	0.004*	0.003	0.006***
	(0.003)	(0.002)	(0.002)	(0.001)
Young	−0.007*	−0.005	−0.006*	−0.002
	(0.003)	(0.003)	(0.003)	(0.002)
Old	−0.031***	−0.017***	−0.023***	−0.005***
	(0.002)	(0.001)	(0.002)	(0.001)
Bachelor's degree	−0.022***	−0.015***	−0.015***	−0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	0.007**	0.005*	0.005*	0.002
	(0.003)	(0.002)	(0.002)	(0.002)
White	1.62E−4	−0.001*	−0.001	−0.001***
	(0.001)	(0.001)	(0.001)	(4.19E−4)
Black	−0.002**	−0.003***	−0.002**	−0.002***
	(0.001)	(0.001)	(0.001)	(4.32E−4)
Household income	−6.62E−5***	−3.91E−5***	−5.56E−5***	−1.18E−5***
	(4.52E−6)	(3.68E−6)	(4.69E−6)	(2.51E−6)
Employment	0.008***	0.006***	0.007***	0.002***
	(0.001)	(0.001)	(0.001)	(4.31E−4)
Metro	0.098***	0.071***	0.056***	0.037***
	(0.009)	(0.007)	(0.008)	(0.005)
West	−0.157***	−0.023	−0.151***	0.025***
	(0.015)	(0.012)	(0.028)	(0.007)
Midwest	−0.131***	−0.020*	−0.131***	0.023***
	(0.011)	(0.009)	(0.019)	(0.005)
Northeast	−0.199***	−0.024	−0.117***	0.038***
	(0.018)	(0.014)	(0.034)	(0.008)
Land developability	−0.001***	−2.45E−4	1.52E−5	1.16E−4
	(1.72E−4)	(1.36E−4)	(2.05E−4)	(8.28E−5)
Constant	0.965***	0.599***	0.823***	0.249***
	(0.088)	(0.070)	(0.078)	(0.050)
Spatial lag effects	−	0.616***	−	0.979***
		(0.016)		(0.010)
Spatial error effects	−	−	0.706***	−0.782***
			(0.016)	(0.029)
Diagnostic Test				
Moran's I (error)	0.42***	−	−	−
Lagrange Mult (lag)	1532.80***	−	−	−
Robust LM (lag)	148.47***	−	−	−
Lag Mult (error)	1495.03***	−	−	−
Robust LM (error)	110.70***	−	−	−
Measures of Fit				
Log-likelihood	571.01	1161.07	1157.70	1492.20
AIC	−1108.01	−2286.15	−2281.41	−2948.40
BIC	−1005.30	−2177.39	−2178.69	−2839.64

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.41 addresses the relationship of freight rail with the change in population with a high school diploma for the period of 1980 to 1990. The diagnostic test in the first model indicates the spatial dependency of the dependent variable. Additionally, the test suggests that spatial lag and spatial error models are better than standard regression for this analysis. However, the best fit is the spatial error model with lag dependence based on the values of log-likelihood (2146.36) and AIC (−4254.73) and BIC (−4139.93). Hence, the explanation is based on the fourth model.

Freight rail has a negative association with change in population with a high school diploma. Each additional percentage point increase in freight rail terminal density brings a growth of 0.008 percent, on average, of population with a high school diploma. The explanatory variable is negative across all models. The age variables, young and old, are negative, indicating that these variables are associated with a decline in the population with a high school diploma. Each percent growth in young and old populations contributes to a 0.004 and 0.002 percent decline in the population with a high school diploma, respectively.

The relationship of bachelor's degree and graduate degree with high school diploma is opposite. Bachelor's degree has a negative and graduate degree has a positive relationship with the change in the population with a high school diploma. Each unit growth in bachelor's degrees contributes to a 0.007 percent growth in thepopulation with a high school diploma, whereas each unit of graduate degree growth is associated with a 0.006 percent decline in the population with a high school diploma. Interestingly, bachelor's degree is significant across all models, and graduate degree is significant only with spatial models.

The race and ethnicity variables, White and Black, are both positive, and they are associated with growth in the population with a high school diploma. Each additional percent growth in the White and Black populations is associated with a 0.001 percent growth in the population with a high school diploma. Income has a positive and employment has a negative association with high school diplomas. Income is weaker variable than employment. Each unit increase in median household income is associated with a 0.00000583 percent growth in the population with a high school diploma. On the other hand, each percent increase in employment is associated with a 0.007 percent decline in the population with a high school diploma.

Metro is positive, indicating that a metropolitan county has 0.037 percent greater growth in its population with a high school diploma than a nonmetropolitan county. The West is negative, which shows that a county in the West sees a decline of 0.016 percent in its population with a high school diploma. The Midwest and Northeast are not even significant after controlling for spatial lag and spatial error effects. The South is the reference variable. The variable land developability is positive, but its strength is minor. Each percent increase in the land developability index contributes to a 0.000395 percent growth in the population with a high school diploma.

Spatial lag effect is positive, indicating the spatial dependency of the population with a high school diploma and that its strength is strong. A county has a 1.005 percent increase in population with a high school diploma for each weighted percentage point of growth in the population with a high school diploma in surrounding counties. The spatial error effect indicates the imperfection nature of the fourth model. To improve the model, some relevant control variables can be added.

Table 5.41: Regressions of Terminal Density on High School Diploma Population Change from 1980 to 1990

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.013***	−0.010***	−0.005***	−0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	−0.001	−0.001	−0.002	−3.91E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.007**	0.001	0.002	−0.002
	(0.002)	(0.002)	(0.002)	(0.001)
Prev. decade high school diploma pop. change	−0.039***	−0.005	0.028**	−0.002
	(0.011)	(0.009)	(0.011)	(0.006)
Young	−0.010***	−0.010***	−0.017***	−0.004*
	(0.003)	(0.002)	(0.002)	(0.002)
Old	0.003*	3.30E−4	−0.001	−0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Bachelor’s degree	0.009***	0.011***	0.016***	0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	−0.002	−0.005***	−0.003*	−0.006***
	(0.002)	(0.001)	(0.002)	(0.001)
White	0.005***	0.003***	0.004***	0.001***
	(4.83E−4)	(3.82E−4)	(4.68E−4)	(2.50E−4)
Black	0.002***	0.002***	−0.001	0.001***
	(0.001)	(3.94E−4)	(0.001)	(2.47E−4)
Household income	2.15E−5***	1.57E−5***	1.94E−5***	5.83E−6***
	(1.59E−6)	(1.27E−6)	(1.51E−6)	(8.53E−7)
Employment	−0.017***	−0.015***	−0.022***	−0.007***
	(0.001)	(0.001)	(0.001)	(3.90E−4)
Metro	0.084***	0.055***	0.042***	0.037***
	(0.007)	(0.006)	(0.006)	(0.004)
West	0.074***	0.007	0.092***	−0.016**
	(0.013)	(0.010)	(0.024)	(0.006)
Midwest	0.077***	0.019**	0.056***	−0.004
	(0.009)	(0.007)	(0.016)	(0.004)
Northeast	0.088***	0.033**	0.095***	0.005
	(0.014)	(0.011)	(0.029)	(0.006)
Land developability	−0.001***	8.42E−5	1.73E−4	3.95E−4***
	(1.43E−4)	(1.13E−4)	(1.60E−4)	(7.32E−5)
Constant	0.143	0.207***	0.453***	0.120**
	(0.073)	(0.058)	(0.064)	(0.041)
Spatial lag effects	−	0.633***	−	1.005***
		(0.015)		(0.010)
Spatial error effects	−	−	0.761***	−0.768***
			(0.014)	(0.029)
Diagnostic Test				
Moran’s I (error)	0.48***	−	−	−
Lagrange Mult (lag)	1590.51***	−	−	−
Robust LM (lag)	5.95***	−	−	−
Lag Mult (error)	2002.45***	−	−	−
Robust LM (error)	417.88***	−	−	−
Measures of Fit				
Log-likelihood	1229.88	1836.95	2020.63	2146.36
AIC	−2423.76	−3635.90	−4005.26	−4254.73
BIC	−2315.00	−3521.10	−3896.51	−4139.93

AIC = Akaike’s information criterion. BIC = Schwartz’s Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors
in parentheses.

Table 5.42 presents the results for the association of freight rail with the change in population with a high school diploma for 1990 to 2000. The diagnostic test of the first model, full ordinary least squares, suggests that the dependent variable, change in population with a high school diploma, is spatially dependent. The diagnostic test further suggests controlling for spatial lag and spatial error effects, which is done in the second (spatial lag) and third (spatial error), models, respectively. These two models are better than the first model, but the best-fit model is the fourth one, spatial error model with lag dependence, based on the measures-of-fit analysis. The value of log-likelihood (2873.29) is the highest and the values of AIC (−5706.58) and BIC (−5585.74) are the lowest across the models. Hence, the explanation is based on the fourth model.

The relationship between freight rail and change in population with a high school diploma is negative. Each percentage point increase in freight rail terminal density contributes to a 0.004 percent decline in the population with a high school diploma. The explanatory variable is negative across all models. The variable highway is also negative, suggesting that each unit increase in highway density contributes to a 0.001 percent decline in the population with a high school diploma. The variable highway is significant only after simultaneously controlling for spatial lag and spatial error effects. On the other hand, the association of the previous decade's change in population with a high school diploma vanishes after simultaneously controlling for spatial lag and spatial error effects.

The age variable old is negative, indicating that each percent increase in the old population contributes to a 0.001 percent decline in the population with a high school diploma. Old is negative across all models. The education variable graduate degree has negative relationship with the change in population with a high school diploma. Each percent increase in graduate degrees contributes to a 0.004 percent decline in population with a high school diploma. Another education variable, bachelor's degree, loses its relationship in the fourth model after controlling for spatial lag and spatial error effects.

All three race and ethnicity variables—White, Black, and Hispanic—have a negative association with the population that has a high school diploma. Each percent growth in these variables contributes to a 0.001 percent loss of population with a high school diploma. Income and employment are opposite, with income positive and employment negative. Each unit increase in median household income is associated with a 0.00000127 percent growth in the population with a high school diploma. However, each percent increase in employment contributes to a 0.002 percent decline in the population with a high school diploma. Employment is negative across all models.

Metro is positive. A metropolitan county sees a 0.013 percent greater growth in population with a high school diploma than a nonmetropolitan county. For the 1990s, all three regional variables are positive after controlling for spatial lag and spatial error effects. Otherwise, the association is negative. A county in the West sees a gain in population with a high school diploma of more than 0.009 percent compared with the South. Similarly, counties in the Midwest and Northeast have a higher growth in population with a high school diploma by 0.011 and 0.025 percent, respectively, than counties in the South.

The land developability index is positive, but the effect is small. Each percent increase in the land developability index is associated with a 0.000199 percent growth in the population with a high school diploma. The spatial lag effect is positive, indicating that a county sees a 1.051 percent increase in population with a high school diploma for each weighted percentage point increase in the population with a high school diploma in surrounding counties. Spatial error effect is negative, suggesting that the model can be improved by adding relevant control variables.

Table 5.42: Regressions of Terminal Density on High School Diploma Population Change from 1990 to 2000

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.010***	−0.008***	−0.007***	−0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	0.001	−2.30E−4	−0.001	−0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.002	0.001	0.002	4.54E−4
	(0.002)	(0.001)	(0.002)	(0.001)
Prev. decade high school diploma pop. change	0.074***	0.037***	0.025*	0.003
	(0.011)	(0.010)	(0.012)	(0.006)
Young	−0.003	−0.002	−0.004	2.78E−4
	(0.002)	(0.002)	(0.002)	(0.001)
Old	−0.009***	−0.007***	−0.010***	−0.001**
	(0.001)	(0.001)	(0.001)	(4.73E−4)
Bachelor's degree	−0.010***	−0.005***	−0.003**	4.35E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	0.002	−0.002	−0.005**	−0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
White	0.001*	−1.48E−5	2.78E−4	−0.001**
	(3.93E−4)	(3.45E−4)	(4.19E−4)	(2.05E−4)
Black	3.03E−4	−4.72E−4	−0.001	−0.001**
	(4.18E−4)	(3.67E−4)	(4.69E−4)	(2.12E−4)
Hispanic	−7.41E−5	−0.001	−0.001*	−0.001**
	(4.38E−4)	(3.85E−4)	(0.001)	(2.18E−4)
Household income	−7.82E−8	7.34E−7	−4.93E−7	1.27E−6***
	(6.77E−7)	(5.94E−7)	(7.44E−7)	(3.60E−7)
Employment	−0.002***	−0.002***	−0.004***	−0.002***
	(0.001)	(0.001)	(0.001)	(3.15E−4)
Metro	0.032***	0.025***	0.022***	0.013***
	(0.006)	(0.005)	(0.005)	(0.003)
West	−0.084***	−0.035***	−0.072***	0.009*
	(0.009)	(0.008)	(0.014)	(0.004)
Midwest	−0.132***	−0.059***	−0.127***	0.011***
	(0.006)	(0.006)	(0.010)	(0.003)
Northeast	−0.127***	−0.043***	−0.084***	0.025***
	(0.010)	(0.009)	(0.018)	(0.005)
Land developability	−3.65E−4***	−5.83E−7	5.82E−5	1.99E−4***
	(1.06E−4)	(9.36E−5)	(1.31E−4)	(5.08E−5)
Constant	0.507***	0.395***	0.663***	0.127***
	(0.057)	(0.051)	(0.059)	(0.031)
Spatial lag effects	−	0.527***	−	1.051***
		(0.020)		(0.012)
Spatial error effects	−	−	0.578***	−0.937***
			(0.020)	(0.026)
Diagnostic Test				
Moran's I (error)	0.29***	−	−	−
Lagrange Mult (lag)	793.85***	−	−	−
Robust LM (lag)	89.70***	−	−	−
Lag Mult (error)	705.40***	−	−	−
Robust LM (error)	1.25	−	−	−
Measures of Fit				
Log-likelihood	2148.17	2454.03	2442.79	2873.29
AIC	−4258.34	−4868.06	−4847.58	−5706.58
BIC	−4143.54	−4747.22	−4732.78	−5585.74

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.43 presents the relationship between freight rail and the change in population with a high school diploma from 2000 to 2010. Based on the diagnostic test, the dependent variable (change in population with a high school diploma) is spatially dependent. The test also suggests that spatial lag and spatial error models are better than standard regression. Based on the values of measures of fit, the fourth model is the best fit because the value of log-likelihood (2861.32) is the highest and the values of AIC (−5682.64) and BIC (−5561.80) are the lowest. Hence, the explanation is based on the fourth model.

Freight rail has a negative association with change in population with a high school diploma. Each unit increase in freight rail terminal density contributes to a 0.002 percent decline in the population with a high school diploma. The explanatory variable is negative across all models. Airport is positive, indicating that each additional unit of growth in public airport terminals is associated with a 0.002 percent growth in the population with a high school diploma. Airport is positive across all models.

The previous decade's change in population with a high school diploma is positive. Each percent growth in the previous decade's population with a high school diploma contributes to a 0.046 percent growth in the population with a high school diploma. This variable is positive across all models. Old has a negative relationship with the change in population with a high school diploma. Each percent increase in the old population is associated with a 0.002 percent decline in the population with a high school diploma. Old is negative across all models. Another age variable, young, is not significant in the fourth model when simultaneously controlling for spatial lag and spatial error effects.

The education variables bachelor’s degree and graduate degree have an opposite association with the population that has a high diploma. Each additional percent growth in bachelor’s degrees contributes to a 0.002 percent growth and each percent increase in graduate degrees is associated with a 0.002 percent decline in the population with a high school diploma. Employment is associated with a decline in population with a high school diploma. Each percent increase in employment contributes to a 0.001 percent decline in the population with a high school diploma. The economic variable employment is significant across all models. However, the economic variable income is not significant in the fourth model after simultaneously controlling for spatial lag and spatial error effects.

Metropolitan counties have a positive relationship with change in population with a high school diploma. Metropolitan counties see an increase of 0.009 percent in population with a high school diploma over nonmetropolitan counties. The Midwest and Northeast are positive, indicating that counties in those regions have higher growths (0.011 percent and 0.014 percent, respectively) in population with a high school diploma than the South. Both of these variables change the direction of association after simultaneously controlling for spatial lag and spatial error effects in the fourth model. Land developability index is positive: each percent growth in the index is associated with a 0.000209 percent growth in the population with a high school diploma. The variable becomes significant only after the simultaneously controlling for spatial lag and spatial error effects.

The spatial lag effect is positive. A county gains 1.012 percent growth in population with a high school diploma for each weighted percentage point growth in high school diplomas in surrounding counties. The spatial error effect suggests that the model can be improved by adding relevant control variables.

Table 5.43: Regressions of Terminal Density on High School Diploma Population Change from 2000 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.004***	−0.003***	−0.003***	−0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	0.001	0.001	0.001	−6.49E−5
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.004**	0.004**	0.004**	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Prev. decade HS	0.208***	0.176***	0.181***	0.046***
diploma pop. change	(0.014)	(0.014)	(0.014)	(0.010)
Young	0.006***	0.006**	0.005**	0.002
	(0.002)	(0.002)	(0.002)	(0.001)
Old	−0.005***	−0.005***	−0.006***	−0.002***
	(0.001)	(0.001)	(0.001)	(4.26E−4)
Bachelor’s degree	0.003**	0.003***	0.002*	0.002***
	(0.001)	(0.001)	(0.001)	(4.96E−4)
Graduate degree	−0.004***	−0.004***	−0.003**	−0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
White	2.05E−4	1.25E−4	1.81E−4	4.61E−5
	(3.16E−4)	(3.10E−4)	(3.37E−4)	(1.83E−4)
Black	1.37E−4	−2.62E−5	1.01E−4	−2.53E−4
	(3.31E−4)	(3.24E−4)	(3.57E−4)	(1.86E−4)
Hispanic	2.74E−4	1.68E−4	3.20E−4	−6.19E−5
	(3.47E−4)	(3.40E−4)	(3.77E−4)	(1.93E−4)
Household income	1.32E−6**	1.12E−6**	1.44E−6**	1.69E−8
	(4.31E−7)	(4.23E−7)	(4.60E−7)	(2.57E−7)
Employment	−0.002***	−0.002***	−0.002***	−0.001***
	(4.68E−4)	(4.59E−4)	(4.88E−4)	(2.90E−4)
Metro	0.017***	0.015**	0.016**	0.009**
	(0.005)	(0.005)	(0.005)	(0.003)
West	0.002	0.002	0.002	1.21E−4
	(0.008)	(0.008)	(0.009)	(0.004)
Midwest	−0.052***	−0.036***	−0.055***	0.011***
	(0.006)	(0.006)	(0.007)	(0.003)
Northeast	−0.053***	−0.035***	−0.055***	0.014**
	(0.009)	(0.009)	(0.011)	(0.005)
Land developability	−1.28E−4	−1.76E−5	−7.53E−5	2.09E−4***
	(9.38E−5)	(9.22E−5)	(1.04E−4)	(5.05E−5)
Constant	0.118**	0.106*	0.139**	0.024
	(0.042)	(0.041)	(0.044)	(0.026)
Spatial lag effects	–	0.232***	–	1.012***
		(0.025)		(0.020)
Spatial error effects	–	–	0.196***	−0.952***
			(0.027)	(0.028)
Diagnostic Test				
Moran’s I (error)	0.07***	–	–	–
Lagrange Mult (lag)	91.42***	–	–	–
Robust LM (lag)	82.40***	–	–	–
Lag Mult (error)	44.03***	–	–	–
Robust LM (error)	35.01***	–	–	–
Measures of Fit				
Log-likelihood	2545.17	2586.31	2567.72	2861.32
AIC	−5052.35	−5132.62	−5097.44	−5682.64
BIC	−4937.55	−5011.78	−4982.65	−5561.80

AIC = Akaike’s information criterion. BIC = Schwartz’s Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.44 focuses on the association of freight rail with the change in population with a high school diploma for the period of 1970 to 2010. The diagnostic test in the first model suggests that the dependent variable is spatially correlated, and spatial lag (second model) and spatial error (third model) regressions are better than the first model. Nevertheless, the fourth model, spatial error model with lag dependence, is the best fit because of the highest value of log-likelihood (−414.586) and the lowest values of AIC (865.172) and BIC (973.929). Therefore, the explanation is based on this model.

Freight rail has a negative relationship with the change in population with a high school diploma. Each unit increase in freight rail terminal density contributes to a 0.021 percent decline in the population with a high school diploma. The explanatory variable, freight rail, is negative across all models. Airport has a positive relationship with change in the population with a high school diploma. Each unit growth in public airport terminals is associated with a 0.009 percent growth in the population with a high school diploma. Airport is positive across the all models.

The education variables bachelor’s degree and graduate degree have a negative relationship with change in population with a high school diploma. Each percent increase in bachelor’s and graduate degrees contributes to a 0.003 and 0.010 percent decline, respectively, in the population with a high school diploma. Bachelor’s degree is negative across all models, whereas graduate degree is significant in the fourth model only after controlling for spatial lag and spatial error effects.

The race and ethnicity variables White and Black have a negative association with the change in population with a high school diploma. Each percent increase in the White and Black populations is associated with a 0.002 percent decline in population with a high school diploma. White is significant only in the fourth model after controlling for spatial lag and spatial error effects. On the other hand, Black is significant in all spatial models.

Employment is negative, indicating that each percent increase in employment is associated with decline in the population with a high school diploma. The economic variables income and employment behave differently. Employment is significant only in the fourth model. Income is not significant in the fourth model but is in the others. Metro is positive, suggesting that a metropolitan county has a 0.114 percent higher growth in population with a high school diploma than a nonmetropolitan county. Metro is positive across all models.

All three regional variables are positive, suggesting that growth in the population with a high school diploma is higher in these regions than the South. A county in the West observes a 0.039 percent greater growth in its population with a high school diploma than the South. Similarly, the Midwest and Northeast experience a 0.085 and 0.038 percent higher growths, respectively, in their populations with a high school diploma than the South. Land developability has a positive relationship with growth in population with a high school diploma. Each percent increase in the land developability index contributes to a 0.001 percent growth in the population with a high school diploma.

The spatial lag effect is positive and strong. A county has a 1.017 increase in population with a high school diploma for each weighted percentage point of growth in high school population with a diploma in surrounding counties. The spatial error effect indicates that the model is not perfect and can be improved by the addition of relevant control variables.

Table 5.44: Regressions of Terminal Density on High School Diploma Population Change from 1970 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.047***	−0.034***	−0.032***	−0.021***
	(0.003)	(0.003)	(0.003)	(0.002)
Control Variables				
Highway density	0.006	−0.003	−0.007**	−0.004
	(0.003)	(0.002)	(0.002)	(0.002)
Airport	0.020***	0.015***	0.013**	0.009***
	(0.005)	(0.004)	(0.004)	(0.003)
Young	0.002	0.003	−0.001	0.005
	(0.006)	(0.005)	(0.005)	(0.004)
Old	−0.020***	−0.011***	−0.021***	−0.002
	(0.003)	(0.002)	(0.003)	(0.002)
Bachelor's degree	−0.032***	−0.016***	−0.012***	−0.003**
	(0.002)	(0.002)	(0.002)	(0.001)
Graduate degree	0.006	−0.006	−0.008	−0.010***
	(0.005)	(0.004)	(0.005)	(0.003)
White	0.002	−0.001	−0.002	−0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Black	−0.002	−0.004**	−0.007***	−0.002**
	(0.002)	(0.001)	(0.001)	(0.001)
Household income	−4.41E−5***	−2.41E−5***	−6.13E−5***	−2.52E−6
	(8.71E−6)	(6.83E−6)	(9.01E−6)	(4.38E−6)
Employment	−0.001	−0.002	−0.003	−0.002**
	(0.002)	(0.001)	(0.001)	(0.001)
Metro	0.294***	0.204***	0.169***	0.114***
	(0.017)	(0.014)	(0.015)	(0.010)
West	−0.099***	0.016	−0.046	0.039**
	(0.029)	(0.023)	(0.056)	(0.012)
Midwest	−0.269***	0.002	−0.059	0.085***
	(0.034)	(0.027)	(0.069)	(0.014)
Northeast	−0.228***	−0.042*	−0.226***	0.038***
	(0.022)	(0.017)	(0.039)	(0.009)
Land developability	−0.004***	−0.001**	2.95E−4	0.001***
	(3.30E−4)	(2.59E−4)	(3.97E−4)	(1.57E−4)
Constant	1.392***	0.879***	1.569***	0.271**
	(0.169)	(0.133)	(0.150)	(0.091)
Spatial lag effects	–	0.655***	–	1.017***
		(0.016)		(0.010)
Spatial error effects	–	–	0.734***	−0.823***
			(0.015)	(0.028)
Diagnostic Test				
Moran's I (error)	0.40***	–	–	–
Lagrange Mult (lag)	1641.40***	–	–	–
Robust LM (lag)	256.67***	–	–	–
Lag Mult (error)	1392.00***	–	–	–
Robust LM (error)	7.26**	–	–	–
Measures of Fit				
Log-likelihood	−1464.30	−840.05	−860.96	−414.586
AIC	2962.60	1716.10	1755.91	865.172
BIC	3065.32	1824.86	1858.63	973.929

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.45 presents SEMLD results for all periods—the 1970s, 1980s, 1990s, 2000s, and 1970 to 2010. The explanatory variable, freight rail, has a negative relationship with the population that has high school diploma across all periods. Airport is comparatively stronger than highway. The highway is significant in only one period, whereas airport is significant in three out of five periods. The direction of the impact is also opposite: highway is negative and airport is positive.

The variable old is stronger than young. It is significant in all decades, but not the entire study period (1970 to 2010). The growth in old population is associated with a decline in the population with a high school diploma. For the entire study period (1970-2010), both education variables, bachelor's degree and graduate degree, are negative.

The association of the race and ethnicity variables White and Black are is negative with the population having a high school diploma. Employment is a stronger economic variable than income and is negative for all periods. Metro is positive for all periods, indicating higher growth in the population with a high school diploma in metropolitan counties than in nonmetropolitan counties.

All three regional variables are positive for the entire study period, 1970 to 2010. It suggests that growth in the population with a high school diploma is higher in the West, Midwest, and Northeast than in the South. The association of land developability with the population that has a high school diploma is positive across all periods, and its association is strong for the entire study period. The spatial lag effect is positive, and the spatial error effect is significant across all periods.

Table 5.45: SEMLD Results for High School Diploma Population Change for All Periods

	SEMLD 1970-1980	SEMLD 1980-1990	SEMLD 1990-2000	SEMLD 2000-2010	SEMLD 1970-2010
Explanatory Variables					
Terminal density	−0.009***	−0.008***	−0.004***	−0.002**	−0.021***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Control Variables					
Highway density	−0.002	−3.91E−4	−0.001*	−6.49E−5	−0.004
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Airport	0.006***	−0.002	4.54E−4	0.002*	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Prev. decade HS diploma pop. change	−	−0.002	0.003	0.046***	−
		(0.006)	(0.006)	(0.010)	
Young	−0.002	−0.004*	2.78E−4	0.002	0.005
	(0.002)	(0.002)	(0.001)	(0.001)	(0.004)
Old	−0.005***	−0.002*	−0.001**	−0.002***	−0.002
	(0.001)	(0.001)	(4.73E−4)	(4.26E−4)	(0.002)
Bachelor's degree	−0.006***	0.007***	4.35E−4	0.002***	−0.003**
	(0.001)	(0.001)	(0.001)	(4.96E−4)	(0.001)
Graduate degree	0.002	−0.006***	−0.004***	−0.002***	−0.010***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.003)
White	−0.001***	0.001***	−0.001**	4.61E−5	−0.002*
	(4.19E−4)	(2.50E−4)	(2.05E−4)	(1.83E−4)	(0.001)
Black	−0.002***	0.001***	−0.001**	−2.53E−4	−0.002**
	(4.32E−4)	(2.47E−4)	(2.12E−4)	(1.86E−4)	(0.001)
Hispanic	−	−	−0.001**	−6.19E−5	−
			(2.18E−4)	(1.93E−4)	
Household income	−1.18E−5***	5.83E−6***	1.27E−6***	1.69E−8	−2.52E−6
	(2.51E−6)	(8.53E−7)	(3.60E−7)	(2.57E−7)	(4.38E−6)
Employment	0.002***	−0.007***	−0.002***	−0.001***	−0.002**
	(4.31E−4)	(3.90E−4)	(3.15E−4)	(2.90E−4)	(0.001)
Metro	0.037***	0.037***	0.013***	0.009**	0.114***
	(0.005)	(0.004)	(0.003)	(0.003)	(0.010)
West	0.025***	−0.016**	0.009*	1.21E−4	0.039**
	(0.007)	(0.006)	(0.004)	(0.004)	(0.012)
Midwest	0.023***	−0.004	0.011***	0.011***	0.085***
	(0.005)	(0.004)	(0.003)	(0.003)	(0.014)
Northeast	0.038***	0.005	0.025***	0.014**	0.038***
	(0.008)	(0.006)	(0.005)	(0.005)	(0.009)
Land developability	1.16E−4	3.95E−4***	1.99E−4***	2.09E−4***	0.001***
	(8.28E−5)	(7.32E−5)	(5.08E−5)	(5.05E−5)	(1.57E−4)
Constant	0.249***	0.120**	0.127***	0.024	0.271**
	(0.050)	(0.041)	(0.031)	(0.026)	(0.091)
Spatial lag effects	0.979***	1.005***	1.051***	1.012***	1.017***
	(0.010)	(0.010)	(0.012)	(0.020)	(0.010)
Spatial error effects	−0.782***	−0.768***	−0.937***	−0.952***	−0.823***
	(0.029)	(0.029)	(0.026)	(0.028)	(0.028)
Measures of Fit					
Log-likelihood	1492.20	2146.36	2873.29	2861.32	−414.586
AIC	−2948.40	−4254.73	−5706.58	−5682.64	865.172
BIC	−2839.64	−4139.93	−5585.74	−5561.80	973.929

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Bachelor’s Degree

There are five tables addressing the relationship between freight rail and population with a bachelor’s degree. Table 5.46 is about the relationship between freight rail and change in population with a bachelor’s degree for the period of 1970 to 1980. The diagnostic test in the first model indicates that the dependent variable is spatially correlated, and spatial regression models are a better fit in this analysis. However, the fourth model is the best-fit model because the value of log-likelihood (329.80) is the highest, and the values of AIC (−623.60) and BIC (−514.85) are the lowest. Hence, the explanation is based on the fourth model.

The association of freight rail with change in the population with a bachelor’s degree change is negative. Each additional unit increase in freight rail terminal density is associated with a 0.006 percent decline in the population with a bachelor’s degree. Freight rail is negative across all models. The relationship of airport with the population having a bachelor’s degree is positive. Each additional unit increase in public airport terminals contributes to a 0.004 percent growth in the population with a bachelor’s degree. The association of airport is significant in the fourth model only after controlling for spatial lag and spatial error effects simultaneously.

Young and old have a negative relationship with the population with a bachelor’s degree. Each percent increase in young and old contributes to a 0.006 and 0.004 percent decline, respectively, in the population with a bachelor’s degree bachelor’s degree. The variable old is negative across all models. The association of high school diploma and graduate degree with bachelor’s degree is opposite: the former is positive and the latter is negative. Each percent growth in high school diplomas contributes to a 0.001 percent decline in the population with a bachelor's degree, and each percent growth in graduate degrees contributes to a 0.008 percent decline. Graduate degree is negative across all models.

Race and ethnicity variables are negative. Each percent growth in White and Black populations contributes to a 0.001 and 0.002 percent decline, respectively in the population with a bachelor's degree. Black is negative across all models, and White is significant only in the models that control for spatial effects. Income is negative and significant only in the fourth model after controlling for spatial lag and spatial error effects, though the strength of the association is very small. Each unit increase in median household income is associated with a 0.00000792 percent decline in the population with a bachelor's degree.

Metro is positive, suggesting that a metropolitan county experiences a 0.056 percent higher growth in population with a bachelor's degree than a nonmetropolitan county. The association of the Midwest is positive, indicating that the Midwest observes a growth in population with a bachelor's degree that is 0.017 percent higher than the South. The Midwest is significant across all models, but the direction changes in the fourth model after controlling for spatial lag and spatial error effects simultaneously.

The spatial lag effect is positive, indicating that the dependent variable is spatially correlated. A county experiences a 1.045 percent growth for each percentage point increase in weighted population with a bachelor's degree in surroundings counties. The spatial error effect shows the model can be improved by the addition of relevant control variables.

Table 5.46: Regressions of Terminal Density on Bachelor's Degree Population Change from 1970 to 1980

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.014***	−0.013***	−0.012***	−0.006***
	(0.002)	(0.002)	(0.002)	(0.001)
Control Variables				
Highway density	0.005*	0.003	0.001	2.72E−4
	(0.002)	(0.002)	(0.002)	(0.001)
Airport	0.006	0.006	0.004	0.004*
	(0.003)	(0.003)	(0.003)	(0.002)
Young	−0.012**	−0.009*	−0.006	−0.006*
	(0.004)	(0.004)	(0.004)	(0.003)
Old	−0.015***	−0.012***	−0.016***	−0.004***
	(0.002)	(0.002)	(0.002)	(0.001)
High school diploma	−0.002*	−0.001	−0.002*	0.001*
	(0.001)	(0.001)	(0.001)	(3.84E−4)
Graduate degree	−0.028***	−0.025***	−0.030***	−0.008***
	(0.003)	(0.003)	(0.003)	(0.002)
White	−0.002	−0.002*	−0.003**	−0.001*
	(0.001)	(0.001)	(0.001)	(0.001)
Black	−0.003**	−0.004***	−0.005***	−0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Household income	8.95E−6	1.62E−6	3.61E−6	−7.92E−6*
	(6.15E−6)	(5.76E−6)	(6.62E−6)	(3.43E−6)
Employment	0.003***	0.003***	0.005***	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Metro	0.147***	0.126***	0.133***	0.056***
	(0.012)	(0.011)	(0.011)	(0.007)
West	−0.027	−0.019	−0.008	−0.002
	(0.019)	(0.018)	(0.027)	(0.009)
Midwest	−0.132***	−0.074***	−0.132***	0.017*
	(0.014)	(0.014)	(0.020)	(0.007)
Northeast	−0.158***	−0.085***	−0.110***	0.014
	(0.023)	(0.021)	(0.033)	(0.010)
Land developability	−0.002***	−0.001***	−0.001***	1.64E−4
	(2.19E−4)	(2.08E−4)	(2.67E−4)	(1.10E−4)
Constant	0.830***	0.650***	0.874***	0.190**
	(0.112)	(0.106)	(0.116)	(0.066)
Spatial lag effects	–	0.396***	–	1.045***
		(0.022)		(0.014)
Spatial error effects	–	–	0.438***	−0.986***
			(0.023)	(0.025)
Diagnostic Test				
Moran's I (error)	0.20***	–	–	–
Lagrange Mult (lag)	374.86***	–	–	–
Robust LM (lag)	23.44***	–	–	–
Lag Mult (error)	357.35***	–	–	–
Robust LM (error)	5.92*	–	–	–
Measures of Fit				
Log-likelihood	−183.336	−34.07	−34.63	329.80
AIC	400.672	104.13	103.26	−623.60
BIC	503.387	212.89	205.97	−514.85

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.47 presents the association of freight rail with change in the population with a bachelor's degree from 1980 to 1990. The diagnostic test in the first model shows that the bachelor's degree population is spatially dependent, and spatial regression models are a better fit for this analysis. The fourth model, spatial error with lag dependence, is the best-fit model based on the highest value of log-likelihood (687.79) and the lowest values of AIC (−1337.58) and BIC (−1222.78). Hence, the explanation is based on the fourth model.

The relationship between freight rail and bachelor's degree is negative. Each additional unit growth of freight rail terminal density contributes to a 0.004 percent decline in population with a bachelor's degree. Freight rail is negative across all models. Airport is positive, indicating that each additional unit increase in public airport terminals is associated with a 0.004 percent growth in population with a bachelor's degree. Airport is significant across all spatial models.

Young and old are opposite, with young being positive and old negative. Each percent additional growth in young population is associated with a 0.008 percent growth in the bachelor's degree population. Young becomes significant in the fourth model after simultaneously controlling for spatial lag and spatial error effects. On the other hand, each percent growth in old is associated with a 0.002 percent decline in the bachelor's degree population.

The association of high school diploma and graduate degree with bachelor's degree is opposite. Each percent growth in the population with a high school diploma contributes to a 0.003 percent decline in the population with a bachelor's degree. High school diploma becomes significant only after simultaneously controlling for spatial lag and spatial error effects. On the other hand, graduate degree is positive across all models. Each percent growth in the populatin with a graduate degree contributes to a 0.015 percent growth in the population with a bachelor's degree.

The race and ethnicity variables White and Black are positive with the change in population having a bachelor's degree. Each percent growth in White and Black populations contributes to a 0.002 and 0.001 percent growth, respectively, in the population with a bachelor's degree. Both variables are consistently positive across all models. Income is negative, but the strength is small. Each unit increase in median household income is associated with a 0.00000343 percent decline in the population with a bachelor's degree. Income is significant across all models. It is positive in first three models but becomes negative after simultaneously controlling for spatial lag and spatial error effects in the fourth model.

Metro is positive: the population with a bachelor's degree in a metropolitan area is 0.034 percent higher than in a nonmetropolitan area. Metro is positive across all models. Each regional variable behaves differently. The West is significant across all models, the Midwest is significant only in the first three, and the Northeast is significant only in the fourth model. The Midwest is not significant after simultaneously controlling for spatial lag and spatial error effects, but the Northeast is. A county in the West experiences a decline in population with a bachelor's degree that is 0.037 percent higher than a county in the South, whereas the decline coefficient for the Northeast is 0.031 percent higher than the South.

The association of land developability with bachelor's degree is positive, but the strength is small. Each percent growth in the land developability index contributes to

0.000252 percent growth in the population with a bachelor's degree. The spatial lag effect is positive and strong. A county experiences a growth of 1.018 percent in its population with a bachelor's degree for each weighted percentage point growth in bachelor's degree population in surrounding counties. The spatial error effect indicates the imperfection of the model, which can be improved by adding relevant control variables.

Table 5.47: Regressions of Terminal Density on Bachelor's Degree Population Change from 1980 to 1990

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.012***	−0.010***	−0.008***	−0.004**
	(0.002)	(0.002)	(0.002)	(0.001)
Control Variables				
Highway density	0.005**	0.002	0.003	−0.001
	(0.002)	(0.002)	(0.002)	(0.001)
Airport	0.005	0.006*	0.006*	0.004*
	(0.003)	(0.003)	(0.003)	(0.002)
Prev. decade bachelor's	0.055***	0.040***	0.038***	0.008
degree pop. change	(0.008)	(0.007)	(0.007)	(0.005)
Young	0.006	0.006	−0.001	0.008**
	(0.004)	(0.004)	(0.004)	(0.003)
Old	0.009***	0.004*	0.002	−0.002*
	(0.002)	(0.002)	(0.002)	(0.001)
High school diploma	0.002	−0.001	−0.001	−0.003***
	(0.001)	(0.001)	(0.002)	(0.001)
Graduate degree	0.047***	0.039***	0.046***	0.015***
	(0.003)	(0.003)	(0.003)	(0.002)
White	0.002***	0.003***	0.003***	0.002***
	(0.001)	(0.001)	(0.001)	(3.67E−4)
Black	0.002***	0.002***	0.002*	0.001***
	(0.001)	(0.001)	(0.001)	(3.65E−4)
Household income	9.93E−6***	5.53E−6**	1.39E−5***	−3.43E−6**
	(2.19E−6)	(2.03E−6)	(2.45E−6)	(1.21E−6)
Employment	−0.006***	−0.005***	−0.010***	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Metro	0.119***	0.080***	0.071***	0.034***
	(0.010)	(0.010)	(0.010)	(0.007)
West	−0.155***	−0.122***	−0.178***	−0.037***
	(0.017)	(0.016)	(0.026)	(0.008)
Midwest	−0.093***	−0.056***	−0.106***	−0.001
	(0.012)	(0.011)	(0.019)	(0.006)
Northeast	0.020	−0.014	0.031	−0.031***
	(0.019)	(0.018)	(0.032)	(0.009)
Land developability	−0.001***	−2.98E−4	−4.77E−4*	2.52E−4*
	(1.98E−4)	(1.82E−4)	(2.43E−4)	(1.04E−4)
Constant	−0.765***	−0.447***	−0.408***	−0.116
	(0.106)	(0.097)	(0.112)	(0.063)
Spatial lag effects	–	0.444***	–	1.018***
		(0.021)		(0.014)
Spatial error effects	–	–	0.533***	−0.917***
			(0.021)	(0.027)
Diagnostic Test				
Moran's I (error)	0.25***	–	–	–
Lagrange Mult (lag)	524.50***	–	–	–
Robust LM (lag)	17.11***	–	–	–
Lag Mult (error)	553.69***	–	–	–
Robust LM (error)	46.30***	–	–	–
Measures of Fit				
Log-likelihood	183.15	390.77	421.57	687.79
AIC	−330.31	−743.55	−807.13	−1337.58
BIC	−221.55	−628.75	−698.38	−1222.78

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.48 addresses the association of freight rail with bachelor's degrees from 1990 to 2000. The diagnostic test in the first model suggests that the dependent variable, change in population with a bachelor's degree, is spatially correlated and that spatial regression analysis is a better fit over standard regression. The values of measures of fit also support this argument and suggest that the fourth model, spatial error model with lag dependence, is the best fit because the log-likelihood (1170.29) is the highest and AIC (−2300.57) and BIC (−2179.73) are the lowest. Hence, the explanation is based on the fourth model.

The association of freight rail with change in the population with a bachelor's degree is negative when controlling for many socioeconomic variables. With each additional unit growth in freight rail terminal density, the population with a bachelor's degree declines by 0.007 percent, on average. Freight rail is negative across all models. The previous decade's change in population with a bachelor's degree has a negative relationship, indicating that each percent growth contributes to a 0.023 percent decline in the population with a bachelor's degree.

The age variable old is negative across all models, which suggests that each percent growth in the old population contributes to a 0.002 percent decline in the population with a bachelor's degree. The education variable graduate degree has a negative relationship with change in population with a bachelor's degree. Each percent growth in graduate degrees is associated with a 0.002 percent decline in the the population with a bachelor's degree. The variable graduate degree is negative across all models. The association of Black with the bachelor's degree population is negative. Each additional percent growth in the Black population contributes to a 0.001 percent decline in the population with a bachelor's degreen. The variable Black is stronger than White and Hispanic and is negative across the models.

Economic variables behave differently: the association of income is positive and employment is negative for bachelor's degrees. Each unit growth in median household income is associated with a 0.00000127 percent growth in the population with a bachelor's degree. Income is positive across the models, whereas employment is significant only in the fourth model after simultaneously controlling for spatial lag and spatial error effects. Each percent increase in employment contributes to a 0.001 percent decline in the population with a bachelor's degree.

Metro is positive, indicating that the growth of the bachelor's degree population in a metropolitan county is 0.032 percent greater than in a nonmetropolitan county. The variable metro is positive across the models. The Northeast is positive, indicating that the growth of population with a bachelor's degree is 0.016 percent greater than the South. The association becomes positive only after simultaneously controlling for spatial lag and spatial error effects; otherwise, the association is negative for the first three models.

The spatial lag effect is positive and strong, suggesting that the growth of the population with a bachelor's degree in a county is 1.074 percent for each weighted percentage point growth in the population with a bachelor's degree in surrounding counties. The significant spatial error effect indicates that the model can be improved by the addition of relevant control variables.

Table 5.48: Regressions of Terminal Density on Bachelor's degree Population Change from 1990 to 2000

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.013***	−0.012***	−0.010***	−0.007***
	(0.002)	(0.002)	(0.002)	(0.001)
Control Variables				
Highway density	0.003*	0.001	0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	−0.004	−0.003	−0.002	0.001
	(0.003)	(0.002)	(0.003)	(0.001)
Prev. decade bachelor's	0.078***	0.028	−0.011	−0.023*
degree pop. change	(0.019)	(0.018)	(0.019)	(0.012)
Young	−0.004	−0.004	−0.005	−0.003
	(0.004)	(0.004)	(0.004)	(0.002)
Old	−0.007***	−0.006***	−0.008***	−0.002*
	(0.001)	(0.001)	(0.002)	(0.001)
High school diploma	0.005***	0.004***	0.005***	4.55E−4
	(0.001)	(0.001)	(0.001)	(4.23E−4)
Graduate degree	−0.006**	−0.006***	−0.006**	−0.002*
	(0.002)	(0.002)	(0.002)	(0.001)
White	0.000	−0.001	−0.001	−4.71E−4
	(0.001)	(0.001)	(0.001)	(3.46E−4)
Black	−0.002***	−0.002***	−0.003***	−0.001*
	(0.001)	(0.001)	(0.001)	(3.59E−4)
Hispanic	−0.001*	−0.001*	−0.002**	−4.98E−4
	(0.001)	(0.001)	(0.001)	(3.69E−4)
Household income	2.65E−6*	3.14E−6**	5.01E−6***	1.27E−6*
	(1.06E−6)	(1.00E−6)	(1.17E−6)	(6.07E−7)
Employment	2.82E−4	−0.001	−0.002	−0.001*
	(0.001)	(0.001)	(0.001)	(4.72E−4)
Metro	0.080***	0.070***	0.071***	0.032***
	(0.009)	(0.009)	(0.009)	(0.006)
West	−0.044**	−0.032*	−0.040*	−0.002
	(0.014)	(0.013)	(0.020)	(0.006)
Midwest	−0.074***	−0.054***	−0.091***	0.002
	(0.011)	(0.010)	(0.015)	(0.005)
Northeast	−0.172***	−0.107***	−0.161***	0.016*
	(0.017)	(0.017)	(0.026)	(0.008)
Land developability	−0.001***	−2.31E−4	−1.78E−4	1.61E−4
	(1.67E−4)	(1.58E−4)	(2.04E−4)	(8.41E−5)
Constant	0.356***	0.291***	0.441***	0.083
	(0.093)	(0.088)	(0.100)	(0.052)
Spatial lag effects	−	0.386***	−	1.074***
		(0.023)		(0.016)
Spatial error effects	−	−	0.452***	−0.982***
			(0.023)	(0.026)
Diagnostic Test				
Moran's I (error)	0.19***	−	−	−
Lagrange Mult (lag)	308.96	−	−	−
Robust LM (lag)	8.67**	−	−	−
Lag Mult (error)	309.70***	−	−	−
Robust LM (error)	9.41**	−	−	−
Measures of Fit				
Log-likelihood	715.40	843.61	860.11	1170.29
AIC	−1392.79	−1647.22	−1682.21	−2300.57
BIC	−1277.99	−1526.38	−1567.41	−2179.73

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.49 presents results for the association of freight rail with the population with a bachelor's degree for the 2000s. The significant values in the diagnostic test indicate that the population with the bachelor's degree is spatially correlated. The measures-of-fit analysis favors the fourth model because it has the highest value for log-likelihood (1219.73) and the lowest values for AIC (−2399.46) and BIC (−2278.61).

Freight rail is strong and significant across all models. Each unit increase in freight rail terminal density is associatged with a 0.003 percent decline in the population with a bachelor's degree. Graduate degree is the next strongest variable and is significant and negative across all models. Each percent growth in graduate degrees is associated with a 0.003 percent decline in the population with a bachelor's degree. Both median household income and employment are strong and opposite: income is positive and employment is negative. Each unit growth in median household income is associated with a 0.00000108 percent growth in the population with bachelor's degree. On the other hand, each percent growth in employment is associated with a 0.001 percent decline in the population with bachelor's degree.

Metro is positive and has a 0.026 percent higher growth in population with bachelor's degrees than a nonmetropolitan area. The spatial lag effect indicates that the population with a bachelor's degree has a strong spatial correlation. A county's population with a bachelor's degree grows by 1.021 percent with each weighted percentage point increase in that population in surrounding counties. The spatial error effect suggests that the model can be improved by adding some relevant variables.

Table 5.49: Regressions of Terminal Density on Bachelor's degree Population Change from 2000 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.004*	−0.004*	−0.003*	−0.003**
	(0.002)	(0.002)	(0.002)	(0.001)
Control Variables				
Highway density	0.001	2.55E−4	2.76E−4	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	0.007**	0.007**	0.007**	0.003
	(0.002)	(0.002)	(0.002)	(0.002)
Prev. decade bachelor's degree pop. change	0.039***	0.030**	0.023*	0.007
	(0.011)	(0.011)	(0.011)	(0.008)
Young	−0.002	−0.002	−0.003	0.001
	(0.003)	(0.003)	(0.003)	(0.002)
Old	−0.006***	−0.006***	−0.007***	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
High school diploma	0.003***	0.003**	0.003***	1.74E−4
	(0.001)	(0.001)	(0.001)	(4.72E−4)
Graduate degree	−0.004*	−0.004*	−0.003*	−0.003*
	(0.002)	(0.002)	(0.002)	(0.001)
White	0.002***	0.002**	0.002***	4.84E−4
	(0.001)	(0.001)	(0.001)	(3.32E−4)
Black	−0.001	−0.001	−0.001	9.13E−6
	(0.001)	(0.001)	(0.001)	(3.38E−4)
Hispanic	0.001*	0.001	0.001	2.89E−4
	(0.001)	(0.001)	(0.001)	(3.49E−4)
Household income	3.60E−6***	3.24E−6***	3.58E−6***	1.08E−6*
	(7.19E−7)	(7.09E−7)	(7.68E−7)	(4.59E−7)
Employment	−0.003***	−0.003***	−0.003***	−0.001*
	(0.001)	(0.001)	(0.001)	(4.67E−4)
Metro	0.063***	0.059***	0.061***	0.026***
	(0.009)	(0.008)	(0.009)	(0.006)
West	−0.052***	−0.041***	−0.048**	−3.61E−4
	(0.013)	(0.013)	(0.015)	(0.007)
Midwest	−0.062***	−0.049***	−0.061***	0.003
	(0.010)	(0.010)	(0.012)	(0.006)
Northeast	−0.080***	−0.062***	−0.079***	0.009
	(0.016)	(0.016)	(0.019)	(0.009)
Land developability	−4.24E−4**	−3.03E−4	−3.82E−4*	1.07E−4
	(1.59E−4)	(1.57E−4)	(1.77E−4)	(9.14E−5)
Constant	0.152*	0.128	0.168	−0.010
	(0.075)	(0.074)	(0.080)	(0.048)
Spatial lag effects	−	0.205***	−	1.021***
		(0.026)		(0.022)
Spatial error effects	−	−	0.211***	−0.836***
			(0.027)	(0.030)
Diagnostic Test				
Moran's I (error)	0.08***	−	−	−
Lagrange Mult (lag)	66.47***	−	−	−
Robust LM (lag)	8.81**	−	−	−
Lag Mult (error)	58.05***	−	−	−
Robust LM (error)	0.38	−	−	−
Measures of Fit				
Log-likelihood	899.79	930.27	927.97	1219.73
AIC	−1761.58	−1820.53	−1817.93	−2399.46
BIC	−1646.79	−1699.69	−1703.13	−2278.61

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.50 is about the relationship between freight rail and change in the population with a bachelor’s degree for the entire study period, 1970 to 2010. The diagnostic test of the first model indicates that the dependent variable is spatially correlated, and spatial regressions are better than ordinary least squares. Based on the measures-of-fit statistics, the fourth model is the best fit because the value of the log-likelihood (−1595.83) is the highest and the values of AIC (3227.65) and BIC (3336.41) are the lowest. Therefore, the following explanation is based on the fourth model.

The association of freight rail with change in the population with a bachelor’s degree is negative. Each additional unit increase in freight rail terminal density contributes to a 0.02 percent decline in the population with a bachelor’s degree. Freight rail is negative across the models. The association of airport with bachelor’s degree is positive. Each unit increase in public airport terminals contributes to a 0.010 percent growth in the population with a bachelor’s degree. The variable airport is significant in all three spatial models after controlling for spatial effects, but not in the first model.

The association of the age variable old with change in the population with a bachelor’s degree is negative. Each additional percent growth in the old population is associated with a 0.009 percent decline in the population with a bachelor’s degree. In addition, the variable old is negative across all models. The relationship of high school diploma with change in the population with a bachelor’s degree is positive. Each percent increase in the population with a high school diploma is associated with a 0.003 percent growth in the population with a bachelor’s degree. The relationship of high school diplomas to bachelor’s degrees becomes significant in the fourth model only after controlling for spatial lag and spatial error effects simultaneously.

The economic variable income is negative, but the strength is small. Each unit increase in median household income leads to a 0.0000277 percent decline in the population with a bachelor's degree. The variable income is significant only after simultaneously controlling for spatial lag and spatial error effects. The association of the metro variable with change in the population with a bachelor's degree is positive. It suggests that the growth of the population with a bachelor's degree is 0.19 percent greater in metropolitan counties than nonmetropolitan counies. The variable metro is strong enough to be significant across the models.

The Northeast is positive, which indicates the growth of the population with a bachelor's degree is 0.047 percent greater in the Northeast than the South. The association becomes positive only in the fourth model after simultaneously controlling for spatial lag and spatial error effects; otherwise, the association is negative in first three models.

The association of spatial lag is positive with change in the population with a bachelor's degree. A county experiences 1.033 percent growth in its population with a bachelor's degree for each weighted percentage point growth in that population in surrounding counties. The spatial error effect indicates that the model is imperfect and can be improved by the addition of relevant control variables.

Table 5.50: Regressions of Terminal Density on Bachelor's degree Population Change from 1970 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.049***	−0.040***	−0.036***	−0.020***
	(0.004)	(0.004)	(0.004)	(0.003)
Control Variables				
Highway density	0.015***	0.005	0.001	0.001
	(0.004)	(0.003)	(0.004)	(0.002)
Airport	0.013	0.015*	0.014*	0.010**
	(0.007)	(0.006)	(0.006)	(0.004)
Young	−0.013	−0.004	−0.001	0.002
	(0.009)	(0.007)	(0.007)	(0.005)
Old	−0.009*	−0.012***	−0.020***	−0.009***
	(0.004)	(0.004)	(0.004)	(0.002)
High school diploma	−0.003	0.001	−0.002	0.003***
	(0.002)	(0.001)	(0.002)	(0.001)
Graduate degree	−0.013*	−0.010	−0.016**	0.002
	(0.007)	(0.006)	(0.006)	(0.004)
White	0.002	0.001	4.97E−5	0.001
	(0.002)	(0.002)	(0.002)	(0.001)
Black	−0.001	−0.003	−0.008***	−0.001
	(0.002)	(0.002)	(0.002)	(0.001)
Household income	2.29E−5	−6.77E−6	−5.49E−6	−2.77E−5***
	(1.26E−5)	(1.07E−5)	(1.30E−5)	(6.63E−6)
Employment	0.002	−2.70E−4	−0.001	−0.001
	(0.002)	(0.002)	(0.002)	(0.001)
Metro	0.520***	0.386***	0.385***	0.190***
	(0.024)	(0.020)	(0.022)	(0.015)
West	−0.239***	−0.121***	−0.139	−0.013
	(0.039)	(0.033)	(0.068)	(0.017)
Midwest	−0.284***	−0.090*	−0.057	0.030
	(0.046)	(0.039)	(0.084)	(0.020)
Northeast	−0.296***	−0.104***	−0.277***	0.047***
	(0.030)	(0.026)	(0.049)	(0.013)
Land developability	−0.005***	−0.002***	−0.002**	3.24E−4
	(4.50E−4)	(3.86E−4)	(0.001)	(2.17E−4)
Constant	0.698**	0.465*	1.151***	0.039
	(0.231)	(0.196)	(0.225)	(0.127)
Spatial lag effects	−	0.574***	−	1.033***
		(0.018)		(0.011)
Spatial error effects	−	−	0.638***	−0.905***
			(0.018)	(0.027)
Diagnostic Test				
Moran's I (error)	0.32***	−	−	−
Lagrange Mult (lag)	1034.50***	−	−	−
Robust LM (lag)	176.94***	−	−	−
Lag Mult (error)	857.66***	−	−	−
Robust LM (error)	0.10	−	−	−
Measures of Fit				
Log-likelihood	−2422.42	−2025.02	−2053.49	−1595.83
AIC	4878.84	4086.05	4140.98	3227.65
BIC	4981.56	4194.80	4243.69	3336.41

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.51 presents the results of the spatial error model with lag dependence for the association of freight rail with change in the population with a bachelor's degree for all periods. The relationship between freight rail and change in the population with a bachelor's degree is negative across all periods. Freight rail is associated with a decline in the population with a bachelor's degree in the 1970s, 1980s, 1990s, 2000s, and entire study period of 1970 to 2010.

The transportation variable airport has a positive association with change in the population with a bachelor's degree for the 1970s, 1980s, and for the period of 1970 to 2010. For the total study period (1970 to 2010), the variable old is ultimately associated with a decline in the population with a bachelor's degree. The variable old is negative in all other decades, too. The education variable high school diploma has a positive association with change in the population with a bachelor's degree for the 1970s, and 1970 to 2010, though the relation is negative in the 1980s. Graduate degree is not significant for the entire study period, but it is positive in the 1980s and negative in the 1970s, 1990s, and 2000s.

The race and ethnicity variables White and Black are not significant for the entire study period. White is positive during the 1980s and negative during the 1970s. On the other hand, Black is positive during the 1980, but negative during the 1970s and 1990s. Both White and Black are positive during the 1980s. Of the economic variables income and employment, income is stronger than employment. The association of income with change in the population with a bachelor's degree is negative. It is also negative during the 1970s and 1980s, but it is positive during the 1990s and 2000s. Employment is negative in the 1990s and 2000s.

The variable metro is positive for all periods. Among regional variables, the Northeast is the strongest, being positive for the entire study period. For the entire period, no other regional variables are significant. The spatial lag effect is positive, and the spatial error effect is significant for all periods.

Table 5.51: SEMLD Results for Bachelor's Degree Population Change for All Periods

	SEMLD 1970-1980	SEMLD 1980-1990	SEMLD 1990-2000	SEMLD 2000-2010	SEMLD 1970-2010
Explanatory Variables					
Terminal density	−0.006***	−0.004**	−0.007***	−0.003**	−0.020***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Control Variables					
Highway density	2.72E−4	−0.001	−0.001	−0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Airport	0.004*	0.004*	0.001	0.003	0.010**
	(0.002)	(0.002)	(0.001)	(0.002)	(0.004)
Prev. decade bachelor's degree pop. change	−	0.008	−0.023*	0.007	−
		(0.005)	(0.012)	(0.008)	
Young	−0.006*	0.008**	−0.003	0.001	0.002
	(0.003)	(0.003)	(0.002)	(0.002)	(0.005)
Old	−0.004***	−0.002*	−0.002*	−0.001	−0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
High school diploma	0.001*	−0.003***	4.55E−4	1.74E−4	0.003***
	(3.84E−4)	(0.001)	(4.23E−4)	(4.72E−4)	(0.001)
Graduate degree	−0.008***	0.015***	−0.002*	−0.003*	0.002
	(0.002)	(0.002)	(0.001)	(0.001)	(0.004)
White	−0.001*	0.002***	−4.71E−4	4.84E−4	0.001
	(0.001)	(3.67E−4)	(3.46E−4)	(3.32E−4)	(0.001)
Black	−0.002***	0.001***	−0.001*	9.13E−6	−0.001
	(0.001)	(3.65E−4)	(3.59E−4)	(3.38E−4)	(0.001)
Hispanic	−	−	−4.98E−4	2.89E−4	−
			(3.69E−4)	(3.49E−4)	
Household income	−7.92E−6*	−3.43E−6**	1.27E−6*	1.08E−6*	−2.77E−5***
	(3.43E−6)	(1.21E−6)	(6.07E−7)	(4.59E−7)	(6.63E−6)
Employment	0.001	−0.001	−0.001*	−0.001*	−0.001
	(0.001)	(0.001)	(4.72E−4)	(4.67E−4)	(0.001)
Metro	0.056***	0.034***	0.032***	0.026***	0.190***
	(0.007)	(0.007)	(0.006)	(0.006)	(0.015)
West	−0.002	−0.037***	−0.002	−3.61E−4	−0.013
	(0.009)	(0.008)	(0.006)	(0.007)	(0.017)
Midwest	0.017*	−0.001	0.002	0.003	0.030
	(0.007)	(0.006)	(0.005)	(0.006)	(0.020)
Northeast	0.014	−0.031***	0.016*	0.009	0.047***
	(0.010)	(0.009)	(0.008)	(0.009)	(0.013)
Land developability	1.64E−4	2.52E−4*	1.61E−4	1.07E−4	3.24E−4
	(1.10E−4)	(1.04E−4)	(8.41E−5)	(9.14E−5)	(2.17E−4)
Constant	0.190**	−0.116	0.083	−0.010	0.039
	(0.066)	(0.063)	(0.052)	(0.048)	(0.127)
Spatial lag effects	1.045***	1.018***	1.074***	1.021***	1.033***
	(0.014)	(0.014)	(0.016)	(0.022)	(0.011)
Spatial error effects	−0.986***	−0.917***	−0.982***	−0.836***	−0.905***
	(0.025)	(0.027)	(0.026)	(0.030)	(0.027)
Measures of Fit					
Log-likelihood	329.80	687.79	1170.29	1219.73	−1595.83
AIC	−623.60	−1337.58	−2300.57	−2399.46	3227.65
BIC	−514.85	−1222.78	−2179.73	−2278.61	3336.41

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Graduate Degree

Graduate degree is the third education dependent variable. This section contains four tables on the association of freight rail with change in the population with a graduate degree for different period; one table is only for the best-fit model—the spatial error model with lag dependence—for all periods.

Table 5.52 is about the relationship between freight rail and change in the population with a graduate degree from 1970 to 1980. The diagnostic statistics of the first model suggests that change in the population with a graduate degree is spatially correlated. The diagnostic test also indicates that spatial regression models are better than standard regression. The second and third models in the table are spatial lag and spatial error models. The fourth model, spatial error with lag dependence, is the best-fit model because it has the highest value of log-likelihood (−1087.32) and the lowest values of AIC (2210.64) and BIC (2319.40). Hence, the following explanation is based on this model.

The association of freight rail with change in the population with a graduate degree is negative. Each unit increase in freight rail terminal density contributes to a 0.007 percent decline in the population with a graduate degree. Freight rail is negative across the models. The association of airport with change in the population with a graduate degree is positive. Each unit increase in public airport terminals contributes to a 0.007 percent growth in the population with a graduate degree. The transportation variable airport becomes significant only after controlling for spatial lag and spatial error effects simultaneously.

The age variables, young and old, are negative. Each percent growth in the young and old populations contributes to a 0.021 and 0.005 percent decline, respectively, in the population with a graduate degree. Both of these variables are negative across the models. The economic variable income is negative, and its strength is small. Each unit increase in median household income contributes to a 0.0000133 percent decline in the population with a graduate degree.

The geographic variable metro is positive, showing that a metropolitan county has a 0.055 percent greater population with a graduate degree than nonmetropolitan county. The variable metro is consistently significant across all models. The regional variable Midwest has a positive association with change in the population with a graduate degree. A county in the Midwest has a 0.025 percent greater population with a graduate degree than a county in the South. The direction of the association becomes positive only after controlling for spatial lag and spatial error effects simultaneously.

The spatial lag effect is positive and strong. A county sees a 1.041 percent growth in population with a graduate degree for each weighted percentage point growth of that population in surrounding counties. The spatial error effect indicates that the model can be improved by the addition of relevant control variables.

Table 5.52: Regressions of Terminal Density on Graduate Degree Population Change from 1970 to 1980

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.016***	−0.015***	−0.016***	−0.007**
	(0.003)	(0.003)	(0.003)	(0.002)
Control Variables				
Highway density	−3.42E−4	−0.001	−0.001	−0.002
	(0.003)	(0.003)	(0.003)	(0.002)
Airport	0.004	0.005	0.004	0.007*
	(0.005)	(0.005)	(0.005)	(0.003)
Young	−0.035***	−0.033***	−0.032***	−0.021***
	(0.006)	(0.006)	(0.006)	(0.004)
Old	−0.018***	−0.016***	−0.017***	−0.005**
	(0.003)	(0.003)	(0.003)	(0.002)
High school diploma	−0.004**	−0.002*	−0.003*	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Bachelor's degree	−0.016***	−0.014***	−0.016***	−0.002
	(0.002)	(0.002)	(0.002)	(0.001)
White	0.003*	0.002	0.002	7.38E−5
	(0.001)	(0.001)	(0.001)	(0.001)
Black	0.002	0.001	0.002	−2.25E−4
	(0.002)	(0.001)	(0.002)	(0.001)
Household income	−1.73E−5	−1.84E−5*	−1.59E−5	−1.33E−5*
	(8.96E−6)	(8.79E−6)	(9.66E−6)	(5.30E−6)
Employment	0.009***	0.008***	0.009***	0.002
	(0.001)	(0.001)	(0.002)	(0.001)
Metro	0.147***	0.137***	0.142***	0.055***
	(0.017)	(0.017)	(0.018)	(0.012)
West	0.057	0.056	0.053	0.019
	(0.029)	(0.029)	(0.035)	(0.015)
Midwest	−0.091***	−0.063**	−0.105***	0.025*
	(0.021)	(0.021)	(0.025)	(0.011)
Northeast	−0.064	−0.037	−0.068	0.030
	(0.034)	(0.033)	(0.040)	(0.016)
Land developability	−0.002***	−0.001***	−0.001***	1.86E−4
	(3.26E−4)	(3.21E−4)	(3.67E−4)	(1.79E−4)
Constant	1.097***	0.911***	1.040***	0.202
	(0.166)	(0.164)	(0.173)	(0.108)
Spatial lag effects	−	0.227***	−	1.041***
		(0.026)		(0.019)
Spatial error effects	−	−	0.228***	−0.914***
			(0.027)	(0.027)
Diagnostic Test				
Moran's I (error)	0.09***	−	−	−
Lagrange Mult (lag)	81.14***	−	−	−
Robust LM (lag)	10.40**	−	−	−
Lag Mult (error)	71.16***	−	−	−
Robust LM (error)	0.42	−	−	−
Measures of Fit				
Log-likelihood	−1417.68	−1381.05	−1384.71	−1087.32
AIC	2869.36	2798.11	2803.43	2210.64
BIC	2972.08	2906.86	2906.14	2319.40

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.53 presents the association of freight rail with change in the population with a graduate degree for 1980 to 1990. The first model shows the results for full ordinary least squares regression. The diagnostic statistics in the first model show the spatial dependency of the graduate degree population. It also indicates that spatial lag (second model) and spatial error (third model) are better than the first model. Based on the measures of fit, the fourth model (spatial error model with lag dependence) is the best fit because of the highest value of log-likelihood (22.610) and the lowest values of AIC (−7.219) and BIC (107.580). Therefore, the following explanation is based on this model.

The association of freight rail with change in the population with a graduate degree is negative. Each additional unit increase in freight rail terminal density is associated with a 0.005 percent decline in the population with a graduate degree. The variable is negative across the models. The previous decade's change in population with a graduate degree is associated with a decline in the population with a graduate degree. Each additional percent growth in the previous decade's population with a graduate degree contributes to a 0.012 percent decline in the population with a graduate degree. The variable is negative across the models.

Both education variables, high school diploma and bachelor's degree, are positive. Each percent growth in high school diplomas and bachelor's degrees contributes to a 0.006 and 0.013 percent growth, respectively, in the population with a graduate degree. Both variables are positive across all models. The variable employment is negative, suggesting that each percent growth in employment contributes to a 0.009 percent loss in the the population with a graduate degree. The variable is negative across the models.

Metro is positive, indicating that a metropolitan county has a 0.026 percent greater population with a graduate degree than a nonmetropolitan county. This variable is positive across the models. The land developability index is positive and shows that each percent growth in that index contributes to a 0.000285 percent growth in the population with a graduate degree. The land developability index becomes positive only after controlling for spatial lag and spatial error effects simultaneously.

The spatial lag effect is positive, showing the spatial dependency of the dependent variable. A county sees a 1.061 percent growth in population with a graduate degree for each weighted percentage point growth in that population in surrounding counties. The spatial error effect indicates that the model can be improved by adding relevant control variables.

Table 5.53: Regressions of Terminal Density on Graduate Degree Population Change from 1980 to 1990

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.016***	−0.012***	−0.009***	−0.005**
	(0.002)	(0.002)	(0.002)	(0.002)
Control Variables				
Highway density	0.010***	0.005**	0.004	1.36E−4
	(0.002)	(0.002)	(0.002)	(0.001)
Airport	−0.001	−0.002	7.79E−5	−0.002
	(0.004)	(0.004)	(0.004)	(0.002)
Prev. decade graduate	−0.010*	−0.014***	−0.017***	−0.012***
degree pop. change	(0.004)	(0.004)	(0.003)	(0.003)
Young	−0.011*	−0.010*	−0.010*	−0.003
	(0.005)	(0.005)	(0.005)	(0.003)
Old	0.001	0.002	0.002	0.001
	(0.002)	(0.002)	(0.003)	(0.001)
High school diploma	0.008***	0.010***	0.011***	0.006***
	(0.003)	(0.002)	(0.003)	(0.002)
Bachelor's degree	0.011**	0.019***	0.022***	0.013***
	(0.004)	(0.004)	(0.004)	(0.002)
White	0.003***	0.002**	0.003***	0.001
	(0.001)	(0.001)	(0.001)	(4.51E−4)
Black	0.003**	0.001	0.001	1.81E−4
	(0.001)	(0.001)	(0.001)	(4.50E−4)
Household income	1.12E−5***	9.96E−6***	1.46E−5***	2.89E−6
	(2.79E−6)	(2.62E−6)	(3.11E−6)	(1.48E−6)
Employment	−0.017***	−0.019***	−0.024***	−0.009***
	(0.003)	(0.002)	(0.003)	(0.001)
Metro	0.123***	0.093***	0.074***	0.026**
	(0.013)	(0.012)	(0.012)	(0.008)
West	−0.306***	−0.175***	−0.292***	−0.010
	(0.022)	(0.022)	(0.037)	(0.011)
Midwest	−0.196***	−0.107***	−0.194***	−0.003
	(0.015)	(0.015)	(0.026)	(0.007)
Northeast	−0.045	−0.044	−0.023	−0.015
	(0.024)	(0.023)	(0.045)	(0.011)
Land developability	−0.001***	−0.001*	−0.001**	2.85E−4*
	(2.52E−4)	(2.38E−4)	(2.87E−4)	(1.28E−4)
Constant	0.452***	0.255	0.470***	−0.022
	(0.140)	(0.131)	(0.145)	(0.079)
Spatial lag effects	−	0.543***	−	1.061***
		(0.031)		(0.015)
Spatial error effects	−	−	0.616***	−0.942***
			(0.031)	(0.026)
Diagnostic Test				
Moran's I (error)	0.20***	−	−	−
Lagrange Mult (lag)	396.07***	−	−	−
Robust LM (lag)	34.88***	−	−	−
Lag Mult (error)	361.43***	−	−	−
Robust LM (error)	0.25	−	−	−
Measures of Fit				
Log-likelihood	−558.61	−394.63	−388.92	22.610
AIC	1153.22	827.27	813.84	−7.219
BIC	1261.97	942.07	922.60	107.580

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.54 is about the impact of freight rail on change in population with a graduate degree from 1990 to 2000. The diagnostic statistics in the first model show spatial dependency of the change in the population with a graduate degree. Additionally, the diagnostic test suggests use of spatial regressions for this analysis. The third, fourth, and fifth columns in the table are spatial lag, spatial error, and spatial error model for lag dependence, respectively. In this table, the fourth model is the best-fit model based on the measures-of-fit statistics because it has the highest value of log-likelihood (232.82) and the lowest values of AIC (−425.63) and BIC (−304.79). Therefore, the following explanation is based on this the fourth model.

Freight rail has a relationship with change in the population with a graduate degree. Each additional unit growth in freight rail terminal density contributes to a 0.009 percent decline in the population with a graduate degree. The explanatory variable (freight rail) is negative across the models. The previous decade’s change in population with a graduate degree has a negative relationship. Each percent growth in the previous decade’s population with a graduate degree is associated with a 0.050 percent decline in that population.

Both age variables, young and old, are negative. Each percent growth in the young and old populations contributes to a 0.015 and 0.004 percent decline, respectively, in the population with a graduate degree. Both variables are negative across all models. High school diploma is positive, indicating that each percent growth in high school diplomas is associated with a 0.002 percent growth in graduate degrees. The variable high school diploma is positive across all models.

Employment is negative, suggesting that each additional percent growth in employment contributes to a 0.002 percent decline in population with a graduate degree. Employment becomes negative only in the fourth model after simultaneously controlling for spatial lag and spatial error effects. Metro is positive, and the coefficient value for this variable shows that a metropolitan county has a 0.032 percent higher growth in population with a graduate degree than a nonmetropolitan county. The variable metro is positive across all models. The coefficient value for the West is negative, indicating that a county in the West loses 0.44 percent more of its population with a graduate degree than a county in the South.

The spatial lag effect is positive. A county sees growth of 1.071 percent in its population with a graduate degree population for each weighted percentage point increase in that population in surrounding counties. The spatial error effect shows that the model can be improved by adding relevant control variables.

Table 5.54: Regressions of Terminal Density on Graduate Degree Population Change from 1990 to 2000

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.017***	−0.016***	−0.014***	−0.009***
	(0.002)	(0.002)	(0.002)	(0.001)
Control Variables				
Highway density	0.003	0.002	0.001	1.93E−4
	(0.002)	(0.002)	(0.002)	(0.001)
Airport	−0.005	−0.003	−0.002	0.001
	(0.003)	(0.003)	(0.003)	(0.002)
Prev. decade graduate	−0.044***	−0.061***	−0.082***	−0.050***
degree pop. change	(0.010)	(0.010)	(0.010)	(0.007)
Young	−0.025***	−0.025***	−0.027***	−0.015***
	(0.005)	(0.005)	(0.005)	(0.003)
Old	−0.008***	−0.008***	−0.009***	−0.004***
	(0.002)	(0.002)	(0.002)	(0.001)
High school diploma	0.004**	0.004***	0.004**	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Bachelor's degree	−0.001	0.001	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.001)
White	0.002	0.001	0.001	6.45E−6
	(0.001)	(0.001)	(0.001)	(4.91E−4)
Black	2.71E−4	−1.74E−4	−0.001	−2.23E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Hispanic	0.001	4.78E−4	7.83E−5	−9.79E−6
	(0.001)	(0.001)	(0.001)	(0.001)
Household income	3.69E−6**	3.10E−6*	4.25E−6**	2.99E−7
	(1.39E−6)	(1.35E−6)	(1.54E−6)	(8.18E−7)
Employment	0.002	4.03E−4	−0.001	−0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Metro	0.060***	0.056***	0.052***	0.032***
	(0.012)	(0.012)	(0.012)	(0.008)
West	−0.034	−0.060***	−0.048	−0.044***
	(0.019)	(0.019)	(0.027)	(0.010)
Midwest	−0.109***	−0.090***	−0.125***	−0.013
	(0.015)	(0.015)	(0.020)	(0.007)
Northeast	−0.158***	−0.121***	−0.145***	−0.005
	(0.023)	(0.023)	(0.033)	(0.011)
Land developability	−0.002***	−0.001***	−0.002***	−3.25E−5
	(2.22E−4)	(2.19E−4)	(2.50E−4)	(1.24E−4)
Constant	0.386**	0.354**	0.564***	0.202**
	(0.122)	(0.119)	(0.128)	(0.073)
Spatial lag effects	–	0.373***	–	1.071***
		(0.035)		(0.019)
Spatial error effects	–	–	0.440***	−0.910***
			(0.036)	(0.027)
Diagnostic Test				
Moran's I (error)	0.12***	–	–	–
Lagrange Mult (lag)	108.47***	–	–	–
Robust LM (lag)	0.31	–	–	–
Lag Mult (error)	121.64***	–	–	–
Robust LM (error)	13.49***	–	–	–
Measures of Fit				
Log-likelihood	−139.83	−81.95	−74.65	232.82
AIC	317.67	203.91	187.31	−425.63
BIC	432.47	324.75	302.11	−304.79

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.55 presents regression results between freight rail and graduate degree for the 2000s. The diagnostic test shows the spatial dependency of the population with a graduate degree. Based on the measures-of-fit analysis, the fourth model is the best-fit model because the value of log-likelihood (117.88) is the highest and the values of AIC (−195.75) and BIC (−74.91) are the lowest across all models.

Freight rail is negative and significant only in the fourth model after simultaneous application of spatial lag and spatial error effects. Each unit increase in freight rail terminal density is associated with a 0.003 percent decline in the population with graduate degree. The previous decade's change in population with a graduate degree is strong and significant across all models. Each percent growth in the previous decade's population with a graduate degree is associated with a 0.044 percent decline in the population with a graduate degree. Old is also negative and significant across all models. Each percent growth in the old population is associated with a 0.003 percent decline in the population with a graduate degree. On the other hand, bachelor's degree is positive and significant only in the fourth model. Each percent increase in bachelor's degrees contributes to a 0.004 percent growth of the population with a graduate degree.

Metro is strong, significant, and positive across all models. The growth of the population with a graduate degree in a metropolitan county is higher by 0.02 percent than in a nonmetropolitab area. Spatial lag is positive and strong. Each county sees a 1.051 percent gain in population with a graduate degree for each weighted percentage point increase in that population in surrounding counties. The spatial lag effect indicates that the model can be improved by adding some relevant variables.

Table 5.55: Regressions of Terminal Density on Graduate Degree Population Change from 2000 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.004	−0.004	−0.003	−0.003*
	(0.002)	(0.002)	(0.002)	(0.002)
Control Variables				
Highway density	−0.001	−0.002	−0.002	−0.002
	(0.002)	(0.002)	(0.002)	(0.001)
Airport	0.007*	0.007*	0.007*	0.003
	(0.003)	(0.003)	(0.003)	(0.002)
Prev. decade graduate	−0.038***	−0.043***	−0.050***	−0.044***
degree pop. change	(0.011)	(0.011)	(0.011)	(0.008)
Young	−0.013**	−0.013**	−0.013**	−0.006
	(0.005)	(0.004)	(0.005)	(0.003)
Old	−0.008***	−0.008***	−0.009***	−0.003***
	(0.002)	(0.002)	(0.002)	(0.001)
High school diploma	0.002	0.002	0.003*	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Bachelor's degree	0.001	0.001	0.001	0.004**
	(0.002)	(0.002)	(0.002)	(0.001)
White	4.72E−4	3.28E−4	2.10E−4	1.25E−4
	(0.001)	(0.001)	(0.001)	(4.68E−4)
Black	−0.001	−0.001	−0.001	−2.82E−4
	(0.001)	(0.001)	(0.001)	(4.75E−4)
Hispanic	−0.001	−0.001	−0.001	2.23E−4
	(0.001)	(0.001)	(0.001)	(4.98E−4)
Household income	3.49E−6***	3.05E−6**	3.73E−6***	−3.35E−7
	(1.03E−6)	(1.03E−6)	(1.10E−6)	(6.40E−7)
Employment	0.003**	0.003**	0.003*	2.36E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Metro	0.047***	0.044***	0.045***	0.020*
	(0.012)	(0.012)	(0.012)	(0.009)
West	−0.012	−0.014	−0.010	−0.015
	(0.018)	(0.018)	(0.021)	(0.010)
Midwest	−0.044**	−0.041**	−0.047**	−0.010
	(0.015)	(0.014)	(0.016)	(0.008)
Northeast	−0.076***	−0.068**	−0.077**	−0.016
	(0.023)	(0.023)	(0.026)	(0.012)
Land developability	−0.001***	−0.001**	−0.001**	−3.42E−7
	(2.27E−4)	(2.25E−4)	(2.48E−4)	(1.30E−4)
Constant	0.093	0.089	0.105	0.023
	(0.106)	(0.105)	(0.112)	(0.066)
Spatial lag effects	–	0.160***	–	1.051***
		(0.027)		(0.022)
Spatial error effects	–	–	0.173***	−0.860***
			(0.027)	(0.028)
Diagnostic Test				
Moran's I (error)	0.07***	–	–	–
Lagrange Mult (lag)	37.01***	–	–	–
Robust LM (lag)	0.30	–	–	–
Lag Mult (error)	37.72***	–	–	–
Robust LM (error)	1.01	–	–	–
Measures of Fit				
Log-likelihood	−188.66	−171.34	−170.29	117.88
AIC	415.33	382.67	378.59	−195.75
BIC	530.13	503.51	493.39	−74.91

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.56 presents the association of freight rail with change in the population with a graduate degree for 1970 to 2010. The first model presents the results of the full ordinary least squares. The diagnostic test of this model indicates that the dependent variable is spatially correlated. Also, the diagnostic test suggests that spatial regressions are better for this analysis. The second, third, and fourth models are spatial lag, spatial error, and spatial error model with lag dependence, respectively. Based on the measures-of-fit statistics, spatial lag and spatial error regressions are better. However, the best-fit model is the fourth one. The fourth model has the highest value of log-likelihood (−2315.99) and the lowest values of AIC (4667.98) and BIC (4776.74). Therefore, the following explanation is based on the fourth model.

Freight rail has a negative relationship with change in the population with a graduate degree. Each additional unit growth in freight rail terminal density contributes to a decline in the population with a graduate degree of 0.019 percent. The explanatory variable, freight rail, is negative across the models. The association of airport with the population with a graduate degree is positive. With each unit increase in public airport terminals, the population with a graduate degree grows by 0.01 percent, on average. The transportation control variable airport becomes significant in the fourth model only after simultaneously controlling for spatial lag and spatial error effects.

The age variables, young and old, are negative, indicating the association of these variables with a decline in the population with a graduate degree. Each percent growth in the young and old populations contributes to a 0.033 and 0.011 percent decline, respectively, in the population with a graduate degree. Both variables are significant across all models. The association of high school disploma is positive with change in the population that has a graduate degree. Each percent growth in population with a high school diploma is associated with a 0.004 percent growth in population with a graduate degree.

The economic variable income is negative with small strength. Each unit increase in median household income is associated with a 0.0000325 percent decline in the population with a graduate degree. Income becomes significant only in the fourth model, which controls for spatial lag and spatial error effects simultaneously. The geographic variable metro is positive. A metropolitan county experiences a 0.16 percent greater growth in its polpulation with a graduate degree than a nonmetropolitan county. The regional variable the Northeast is positive, indicating that the growth of population with a graduate degree in a Northeast county is 0.052 percent greater than in a county in the South. The association of the Northeast is positive only in the fourth model after controlling for spatial lag and spatial error effects.

The spatial lag effect is positive, suggesting the spatial dependency of the dependent variable. The growth of population with a graduate degree in a county is 1.031 percent for each weighted percentage point growth in that population in surrounding counties. The spatial error effect indicates that the model can be improved by adding relevant control variables.

Table 5.56: Regressions of Terminal Density on Graduate Degree Population Change from 1970 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.055***	−0.044***	−0.042***	−0.019***
	(0.005)	(0.005)	(0.005)	(0.003)
Control Variables				
Highway density	0.013**	0.004	0.001	−0.001
	(0.005)	(0.004)	(0.005)	(0.003)
Airport	0.009	0.012	0.014	0.010*
	(0.008)	(0.007)	(0.008)	(0.005)
Young	−0.050***	−0.048***	−0.047***	−0.033***
	(0.010)	(0.009)	(0.009)	(0.006)
Old	−0.017***	−0.016***	−0.020***	−0.011***
	(0.005)	(0.005)	(0.005)	(0.003)
High school diploma	−0.002	0.003	0.007**	0.004***
	(0.002)	(0.002)	(0.002)	(0.001)
Bachelor’s degree	−0.032***	−0.020***	−0.021***	0.001
	(0.003)	(0.003)	(0.003)	(0.002)
White	0.006*	0.002	0.002	4.50E−4
	(0.002)	(0.002)	(0.002)	(0.001)
Black	0.005	0.001	−0.002	−0.001
	(0.002)	(0.002)	(0.003)	(0.001)
Household income	4.74E−6	−2.07E−5	−1.85E−5	−3.25E−5***
	(1.49E−5)	(1.33E−5)	(1.66E−5)	(7.63E−6)
Employment	0.009***	0.004	0.002	−0.001
	(0.002)	(0.002)	(0.003)	(0.001)
Metro	0.467***	0.365***	0.362***	0.160***
	(0.029)	(0.026)	(0.027)	(0.017)
West	−0.166***	−0.078	−0.210**	0.003
	(0.049)	(0.044)	(0.076)	(0.021)
Midwest	−0.207***	−0.061	−0.130	0.046
	(0.056)	(0.050)	(0.092)	(0.023)
Northeast	−0.302***	−0.124***	−0.375***	0.052***
	(0.035)	(0.033)	(0.055)	(0.016)
Land developability	−0.006***	−0.003***	−0.003***	2.57E−4
	(0.001)	(4.89E−4)	(0.001)	(2.68E−4)
Constant	2.001***	1.374***	2.248***	0.402**
	(0.277)	(0.248)	(0.281)	(0.154)
Spatial lag effects	–	0.506***	–	1.031***
		(0.020)		(0.012)
Spatial error effects	–	–	0.552***	−0.968***
			(0.021)	(0.026)
Diagnostic Test				
Moran’s I (error)	0.26***	–	–	–
Lagrange Mult (lag)	717.90***	–	–	–
Robust LM (lag)	143.99***	–	–	–
Lag Mult (error)	576.44***	–	–	–
Robust LM (error)	2.52	–	–	–
Measures of Fit				
Log-likelihood	−2996.29	−2720.12	−2746.49	−2315.99
AIC	6026.58	5476.24	5526.98	4667.98
BIC	6129.29	5585.00	5629.69	4776.74

AIC = Akaike’s information criterion. BIC = Schwartz’s Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.57 shows the results of the fourth model, spatial error model with lag dependence, for the 1970s, 1980s, 1990s, 2000s, and 1970 to 2010. The association of freight rail with change in the population with a graduate degree is negative for all periods. The transportation variable airport is positive for the 1970s and the entire study period (1970 to 2010). Airport is not significant for the 1980s and 1990s.

For the overall study period (1970 to 2010), both age variables, young and old, have a negative relationship with change in the population with a graduate degree. Their association with the decline in population with a graduate degree population is also significant for the 1970s and 1990s. Old is significant in the 2000s, too. High school diploma is stronger than bachelor’s degree. The variable high school diploma is positive for the entire study period (1970 to 2010), as well as for the 1980s and 1990s. On the other hand, the variable bachelor’s degree is positive for the 1980s and 2000s.

The relationship of the economic variables, income and employment, with graduate degree population varies with the decade. For example, the variable income has an association with a decline in the population with a graduate degree for the entire study period (1970 to 2010). This variable is significant and negative for the 1970s, too. On the other hand, employment is negative for the 1980s and 1990s. The variable metro is positive and significant for all periods. Irrespective of the time, a metropolitan county observes greater growth in its population with a graduate degree than a nonmetropolitan county.

The association of regional variables with the population with a graduate degree varies with the time. Only the Northeast is significant and negative for the entire study period (1970 to 2010). The West is negative in the 1990s, and the Midwest is positive in the 1970s. The positive and negative values show the growth and decline of the population with a graduate degree in comparison to the South.

The association of land developability with the population with a graduate degree is significant and positive only in the 1980s. The spatial lag effect is positive for all periods, indicating the spatial dependency of that population. Additionally, the spatial error effect is significant, pointing to the imperfection of the model, which can be improved by the addition of some relevant control variables.

Table 5.57: SEMLD Results for Graduate Degree Population Change for All Periods

	SEMLD 1970-1980	SEMLD 1980-1990	SEMLD 1990-2000	SEMLD 2000-2010	SEMLD 1970-2010
Explanatory Variables					
Terminal density	−0.007**	−0.005**	−0.009***	−0.003*	−0.019***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.003)
Control Variables					
Highway density	−0.002	1.36E−4	1.93E−4	−0.002	−0.001
	(0.002)	(0.001)	(0.001)	(0.001)	(0.003)
Airport	0.007*	−0.002	0.001	0.003	0.010*
	(0.003)	(0.002)	(0.002)	(0.002)	(0.005)
Prev. decade graduate degree pop. change	−	−0.012***	−0.050***	−0.044***	−
		(0.003)	(0.007)	(0.008)	
Young	−0.021***	−0.003	−0.015***	−0.006	−0.033***
	(0.004)	(0.003)	(0.003)	(0.003)	(0.006)
Old	−0.005**	0.001	−0.004***	−0.003***	−0.011***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.003)
High school diploma	0.001	0.006***	0.002*	0.001	0.004***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Bachelor's degree	−0.002	0.013***	0.002	0.004**	0.001
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)
White	7.38E−5	0.001	6.45E−6	1.25E−4	4.50E−4
	(0.001)	(4.51E−4)	(4.91E−4)	(4.68E−4)	(0.001)
Black	−2.25E−4	1.81E−4	−2.23E−4	−2.82E−4	−0.001
	(0.001)	(4.50E−4)	(0.001)	(4.75E−4)	(0.001)
Hispanic	−	−	−9.79E−6	2.23E−4	−
			(0.001)	(4.98E−4)	
Household income	−1.33E−5*	2.89E−6	2.99E−7	−3.35E−7	−3.25E−5***
	(5.30E−6)	(1.48E−6)	(8.18E−7)	(6.40E−7)	(7.63E−6)
Employment	0.002	−0.009***	−0.002*	2.36E−4	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Metro	0.055***	0.026**	0.032***	0.020*	0.160***
	(0.012)	(0.008)	(0.008)	(0.009)	(0.017)
West	0.019	−0.010	−0.044***	−0.015	0.003
	(0.015)	(0.011)	(0.010)	(0.010)	(0.021)
Midwest	0.025*	−0.003	−0.013	−0.010	0.046
	(0.011)	(0.007)	(0.007)	(0.008)	(0.023)
Northeast	0.030	−0.015	−0.005	−0.016	0.052***
	(0.016)	(0.011)	(0.011)	(0.012)	(0.016)
Land developability	1.86E−4	2.85E−4*	−3.25E−5	−3.42E−7	2.57E−4
	(1.79E−4)	(1.28E−4)	(1.24E−4)	(1.30E−4)	(2.68E−4)
Constant	0.202	−0.022	0.202**	0.023	0.402**
	(0.108)	(0.079)	(0.073)	(0.066)	(0.154)
Spatial lag effects	1.041***	1.061***	1.071***	1.051***	1.031***
	(0.019)	(0.015)	(0.019)	(0.022)	(0.012)
Spatial error effects	−0.914***	−0.942***	−0.910***	−0.860***	−0.968***
	(0.027)	(0.026)	(0.027)	(0.028)	(0.026)
Measures of Fit					
Log-likelihood	−1087.32	22.610	232.82	117.88	−2315.99
AIC	2210.64	−7.219	−425.63	−195.75	4667.98
BIC	2319.40	107.580	−304.79	−74.91	4776.74

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Income

Tables 5.58 to 5.63 pertain to the association of freight rail with median household income for the different periods. Table 5.58 presents the results of standard and spatial regressions between freight rail and median household income for the 1970s. The first model presents the results of standard regression, or full ordinary least squares. The diagnostic test of the first model shows the spatial dependency of the dependent variable; it also indicates the superiority of spatial regression for this analysis. Spatial regression is represented by the second, third, and fourth models, which are spatial lag, spatial error, and spatial error model with lag dependence, respectively. According to the values of the measures of fit, the fourth model is the best-fit model because it has the highest value of log-likelihood (2995.88) and the lowest values of AIC (−5955.77) and BIC (−5847.01). Hence, the following explanation is based on the fourth model.

Freight rail has a negative relationship with median household income in the 1970s. Each additional unit growth in freight rail terminal density is associated with a 0.003 percent decline in median household income. The association is negative across all models. The age variable old is positive, indicating that each percent growth in the old population is associated with a 0.002 percent growth in median household income. The variable old is significant across the models.

The education variables bachelor’s degree and graduate degree have a negative relationship with median household income. Each additional percent growth in bachelor’s degrees and graduate degrees contributes to a 0.001 and 0.004 percent decline in median household level income, respectively. These two education variables are negative across all models. The economic variable employment is negative, suggesting that with each percent growth in employment, median household income declines by 0.000497 percent, on average. The variable employment is negative across all models.

The relationship of a metropolitan county is positive with median household income. A metropolitan county has a 0.018 percent greater median household income than a nonmetropolitan county. The association of regional variables is positive with median household income. Counties in the West, Midwest, and Northeast experience a 0.021, 0.008, and 0.023 percent greater median household income growth, respectively, counties in the South. The positive impact in the fourth model for the variables Midwest and Northeast is possible only after simultaneously controlling for spatial lag and spatial error effects.

The spatial lag effect is positive, indicating that the dependent variable is spatially correlated. A county grows by 0.987 percent in median household income for each weighted percentage point growth in median household income in surrounding counties. The spatial error effect suggests that the model is imperfect, and it can be improved by the addition of some relevant control variables.

Table 5.58: Regressions of Terminal Density on Median Household Income Change from 1970 to 1980

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.002**	−0.004***	−0.006***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	−0.003***	−0.002**	−0.002*	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Airport	−0.002	−0.001	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Young	0.001	0.001	0.002	−0.001
	(0.002)	(0.001)	(0.001)	(0.001)
Old	0.007***	0.006***	0.006***	0.002***
	(0.001)	(0.001)	(0.001)	(4.07E−4)
High school diploma	−0.001***	−0.001***	−0.002***	−1.10E−4
	(2.96E−4)	(2.74E−4)	(3.58E−4)	(1.59E−4)
Bachelor's degree	−0.002*	−0.002***	−0.003***	−0.001*
	(0.001)	(0.001)	(0.001)	(3.58E−4)
Graduate degree	−0.006***	−0.006***	−0.007***	−0.004***
	(0.001)	(0.001)	(0.001)	(0.001)
White	−1.14E−4	−3.56E−4	−0.001	−2.61E−4
	(3.86E−4)	(3.56E−4)	(3.84E−4)	(2.44E−4)
Black	4.51E−4	1.31E−4	−1.02E−4	−5.96E−5
	(4.14E−4)	(3.81E−4)	(4.39E−4)	(2.55E−4)
Employment	−0.004***	−0.003***	−0.003***	−4.97E−4*
	(3.88E−4)	(3.61E−4)	(3.99E−4)	(2.42E−4)
Metro	0.026***	0.030***	0.028***	0.018***
	(0.005)	(0.004)	(0.004)	(0.003)
West	−0.028***	0.004	−0.017	0.021***
	(0.008)	(0.008)	(0.012)	(0.004)
Midwest	−0.066***	−0.031***	−0.051***	0.008**
	(0.006)	(0.005)	(0.009)	(0.003)
Northeast	−0.113***	−0.043***	−0.088***	0.023***
	(0.009)	(0.009)	(0.014)	(0.005)
Land developability	4.97E−4***	3.44E−4***	4.45E−4***	5.49E−5
	(8.93E−5)	(8.28E−5)	(1.10E−4)	(4.79E−5)
Constant	0.983***	0.626***	1.039***	0.065*
	(0.046)	(0.046)	(0.046)	(0.031)
Spatial lag effects	−	0.415***	−	0.987***
		(0.021)		(0.014)
Spatial error effects	−	−	0.528***	−0.885***
			(0.021)	(0.029)
Diagnostic Test				
Moran's I (error)	0.28***	−	−	−
Lagrange Mult (lag)	496.38***	−	−	−
Robust LM (lag)	2.37	−	−	−
Lag Mult (error)	697.20***	−	−	−
Robust LM (error)	203.19***	−	−	−
Measures of Fit				
Log-likelihood	2595.64	2787.70	2860.81	2995.88
AIC	−5157.27	−5539.39	−5687.61	−5955.77
BIC	−5054.56	−5430.64	−5584.90	−5847.01

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.59 is about the association of freight rail with median household income for the 1980s. The diagnostic statistics in the first model shows that the dependent variable is spatially correlated. The diagnostic test also suggests that spatial lag and spatial error regressions are better-fit models than standard regression. The second, third, and fourth models are spatial lag, spatial error, and spatial error with lag dependence, respectively. Based on the values of the measures of fit, all spatial models are better than the first model (full ordinary least squares), but the best-fit model is the fourth one because of the highest value of log-likelihood (3606.69) and the lowest values of AIC (−7175.39) and BIC (−7060.59). Therefore, the following explanation is based on the fourth model.

Freight rail has a negative relationship with median household income. Each additional unit growth in freight rail terminal density contributes to a 0.003 percent decline in median household income. Freight rail is negative across all models. The relationship of airport with median household income is negative. Each percent increase in public airport terminals is associated with a decline in median household income of 0.002 percent. The association is negative in all three spatial regressions, which control for spatial effects.

The previous decade’s change in median household income is negatively associated with median household income change. Each percent growth in the previous decade’s median household income is associated with a 0.034 percent decline in median household income. The variable is negative across all models. The age variable young is negative, indicating that each percent growth in young population is associated with a

0.003 percent decline in median household income. The variable young is strong and negative across all models.

Amongthe three education variables, high school diploma is the only one that has a significant relationship with median household income. With each additional growth in high school diplomas, median household declines by 0.002 percent. High school diplomas become significant only in the fourth model after simultaneously controlling for spatial lag and spatial error effects. The association of the race and ethnicity variables White and Black is positive with median household income. Each percent growth in these variables contributes to a 0.001 percent growth in median household income. Both variables are positive across the models.

The geographic variable metro is positive, suggesting that a metropolitan county experiences a 0.011 percent higher growth in median household income than a nonmetropolitan county. The variable metro is strong and positive across the models. The land developability index is positive, suggesting that each percent growth in land developability is associated with a 0.000113 percent increase in median household income.

The spatial lag effect is positive, and its value shows that a county grows by 0.98 percent in median household income for each weighted percentage point growth in median household income in surrounding counties. The significant spatial error effect shows the imperfectability of the model. The model can be improved by the addition of some relevant control variables.

Table 5.59: Regressions of Terminal Density on Median Household Income Change from 1980 to 1990

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.011***	−0.007***	−0.005***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Control Variables				
Highway density	0.004***	0.002*	3.70E−4	3.58E−4
	(0.001)	(0.001)	(0.001)	(4.34E−4)
Airport	−0.002	−0.003**	−0.005***	−0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Prev. decade income	−0.133***	−0.083***	−0.075***	−0.034***
change	(0.007)	(0.006)	(0.006)	(0.004)
Young	−0.005*	−0.005**	−0.005**	−0.003**
	(0.002)	(0.002)	(0.002)	(0.001)
Old	0.006***	0.002*	0.001	−3.74E−4
	(0.001)	(0.001)	(0.001)	(4.24E−4)
High school diploma	2.77E−4	−0.002	−0.001	−0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Bachelor’s degree	−2.50E−4	1.61E−4	0.002	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Graduate degree	0.005**	0.001	−0.001	1.01E−4
	(0.002)	(0.001)	(0.001)	(0.001)
White	0.001***	0.001***	0.002***	0.001***
	(2.96E−4)	(2.39E−4)	(3.14E−4)	(1.49E−4)
Black	0.003***	0.002***	0.002***	0.001***
	(3.14E−4)	(2.54E−4)	(3.70E−4)	(1.54E−4)
Employment	0.002	0.001	−0.001	4.35E−4
	(0.001)	(0.001)	(0.001)	(0.001)
Metro	0.052***	0.027***	0.021***	0.011***
	(0.004)	(0.004)	(0.004)	(0.003)
West	−0.029***	−0.016*	−0.022	−0.005
	(0.008)	(0.006)	(0.014)	(0.004)
Midwest	−0.033***	−0.018***	−0.026**	−0.004
	(0.005)	(0.004)	(0.010)	(0.002)
Northeast	0.057***	0.018*	0.074***	−0.006
	(0.009)	(0.007)	(0.017)	(0.004)
Land developability	−2.41E−4**	3.16E−5	1.57E−4	1.13E−4**
	(8.87E−5)	(7.13E−5)	(1.06E−4)	(4.29E−5)
Constant	0.380***	0.204***	0.512***	0.068*
	(0.050)	(0.041)	(0.048)	(0.028)
Spatial lag effects	–	0.612***	–	0.980***
		(0.017)		(0.011)
Spatial error effects	–	–	0.713***	−0.808***
			(0.016)	(0.028)
Diagnostic Test				
Moran’s I (error)	0.37***	–	–	–
Lagrange Mult (lag)	1433.75***	–	–	–
Robust LM (lag)	241.22***	–	–	–
Lag Mult (error)	1206.71***	–	–	–
Robust LM (error)	14.17***	–	–	–
Measures of Fit				
Log-likelihood	2695.77	3239.83	3251.61	3606.69
AIC	−5355.54	−6441.67	−6467.23	−7175.39
BIC	−5246.78	−6326.87	−6358.47	−7060.59

AIC = Akaike’s information criterion. BIC = Schwartz’s Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.60 presents the regression results for the association of freight rail with change in median household income for the period between 1990 and 2000. The diagnostic test shows that median household income is spatially dependent. The measures-of-fit analysis show that the fourth model is the best-fit model because the value of log-likelihood (4169.44) is the highest and the values for AIC (−8298.88) and BIC (−8178.04) are the lowest.

Freight rail is strong and significant across all models. Each unit increase in freight rail terminal density is associated with a 0.002 percent decline in median household income. The variable young is negative and significant only in the last two models. Each percent growth in the young population is associated with a 0.002 percent decline in median household income.

Metro is positive across all models. The growth in median household income in metropolitan areas is 0.009 percent higher than in nonmetropolitan areas. The West is also positive and shows that growth in median household income is 0.007 percent higher than in the South. The Northeast is also positive, and this area has a 0.016 percent higher median household income than the South. The spatial lag is positive, showing the spatial autocorrelation of median household income. A county gains 1.048 percent median household income with each weighted percentage point increase in median household income in surrounding counties. The spatial error effect shows that the model can be improved by adding some relevant variables.

Table 5.60: Regressions of Terminal Density on Median Household Income Change from 1990 to 2000

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.005***	−0.004***	−0.004***	−0.002***
	(0.001)	(0.001)	(0.001)	(4.04E−4)
Control Variables				
Highway density	−1.47E−4	−3.48E−4	−0.001	−6.66E−5
	(0.001)	(0.001)	(0.001)	(3.33E−4)
Airport	−0.004***	−0.003**	−0.003*	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Prev. decade income	−0.020**	−0.019**	−0.028***	−0.004
change	(0.007)	(0.006)	(0.007)	(0.004)
Young	−0.001	−0.002	−0.003*	−0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Old	0.001*	0.001	0.001	3.37E−4
	(0.001)	(0.001)	(0.001)	(2.95E−4)
High school diploma	−2.05E−4	−2.65E−4	−4.64E−4	−1.89E−4
	(3.69E−4)	(3.35E−4)	(4.37E−4)	(1.71E−4)
Bachelor's degree	0.001	6.60E−5	−2.40E−4	−0.001
	(0.001)	(0.001)	(0.001)	(3.81E−4)
Graduate degree	−0.002*	−0.002	−0.002	3.27E−6
	(0.001)	(0.001)	(0.001)	(0.001)
White	−7.59E−5	−1.15E−4	−2.74E−4	−9.19E−5
	(2.49E−4)	(2.27E−4)	(2.66E−4)	(1.30E−4)
Black	2.06E−5	−7.87E−6	−3.48E−4	−2.88E−5
	(2.67E−4)	(2.43E−4)	(2.98E−4)	(1.36E−4)
Hispanic	−3.61E−6	−9.03E−5	−3.83E−4	−1.10E−4
	(2.79E−4)	(2.54E−4)	(3.24E−4)	(1.39E−4)
Employment	−0.002***	−0.002***	−0.002***	−3.48E−4
	(3.67E−4)	(3.35E−4)	(3.96E−4)	(1.95E−4)
Metro	0.013***	0.014***	0.013***	0.009***
	(0.004)	(0.003)	(0.003)	(0.002)
West	−0.007	0.001	−0.004	0.007**
	(0.006)	(0.005)	(0.008)	(0.002)
Midwest	0.032***	0.021***	0.028***	0.004
	(0.004)	(0.004)	(0.006)	(0.002)
Northeast	−0.050***	−0.014*	−0.040***	0.016***
	(0.007)	(0.007)	(0.011)	(0.003)
Land developability	4.55E−5	3.76E−5	1.71E−4*	3.45E−6
	(6.72E−5)	(6.11E−5)	(8.17E−5)	(3.15E−5)
Constant	0.557***	0.364***	0.609***	0.032
	(0.037)	(0.035)	(0.039)	(0.020)
Spatial lag effects	–	0.459***	–	1.048***
		(0.022)		(0.012)
Spatial error effects	–	–	0.500***	−0.991***
			(0.022)	(0.025)
Diagnostic Test				
Moran's I (error)	0.28***	–	–	–
Lagrange Mult (lag)	614.91***	–	–	–
Robust LM (lag)	1.32	–	–	–
Lag Mult (error)	669.04***	–	–	–
Robust LM (error)	55.44***	–	–	–
Measures of Fit				
Log-likelihood	3544.72	3766.21	3785.54	4169.44
AIC	−7051.43	−7492.42	−7533.09	−8298.88
BIC	−6936.63	−7371.58	−7418.29	−8178.04

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.61 presents results for the association of freight rail with median household income change for the 2000s. The diagnostic test shows that median household income is spatially dependent. The fourth model of the table is the best fit because the value of log-likelihood (71.29) is the highest and the values of AIC (−102.58) and BIC (18.26) are the lowest.

Freight rail has a positive relationship with median household income. Each unit increase in freight rail terminal density causes a 0.004 percent growth in median household income in the 2000s. The association is opposite in the 1990s, and the association is significant only in the fourth model after simultaneously controlling for spatial lag and spatial error effects. Airport is negative, indicating that each additional public airport contributes to a 0.005 percent decline in median household income. The previous decade's median household income change is also negative. Each percent growth in the previous decade's median household income is associated with a 0.048 percent decline in median household income.

Young and old are strong variables and positive across all models. Each percent increase in young and old populations is associated with a 0.009 and 0.006 percent median household income growth, respectively. Bachelor's degree is the strongest among the education variables. Each percent increase in population with a bachelor's degree is associated with a 0.008 percent decline in median household income. Graduate degree is positive, indicating each percent increase in the population with a graduate degree associates with a 0.004 percent growth in median household income. All race and ethnicity variables are negative. Each percent growth in White, Black, and Hispanic populations is associated with a 0.002, 0.001, and 0.002 percent decline in median household income, respectively. Employment is significant across all models and is negative. Each percent growth in employment is associated with a 0.002 percent decline in median household income.

Metro is strong and negative across all models. It shows that a metropolitan area experiences a median household decline by 0.026 percent. The West is positive and experiences a 0.018 percent growth in median household income. The spatial lag effect is positive. A county experiences a 0.922 percent growth in median household income for each weighted percentage point increase in median household income in surrounding counties. The spatial error effect is negative, indicating that the model can be improved by adding some relevant variables.

Table 5.61: Regressions of Terminal Density on Median Household Income Change from 2000 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	0.004	0.004	0.002	0.004*
	(0.002)	(0.002)	(0.002)	(0.001)
Control Variables				
Highway density	−0.005*	−0.003	−0.001	−0.001
	(0.002)	(0.002)	(0.002)	(0.001)
Airport	−0.008*	−0.006	−0.001	−0.005*
	(0.003)	(0.003)	(0.004)	(0.002)
Prev. decade income	−0.025	−0.059	−0.084*	−0.048*
change	(0.040)	(0.039)	(0.042)	(0.024)
Young	0.039***	0.031***	0.033***	0.009***
	(0.004)	(0.004)	(0.004)	(0.003)
Old	0.013***	0.013***	0.014***	0.006***
	(0.002)	(0.002)	(0.002)	(0.001)
High school diploma	−0.004**	−0.002	−0.003	−2.77E−4
	(0.001)	(0.001)	(0.002)	(0.001)
Bachelor's degree	−0.010***	−0.012***	−0.012***	−0.008***
	(0.002)	(0.002)	(0.002)	(0.001)
Graduate degree	−0.006*	−3.96E−4	−0.001	0.004*
	(0.003)	(0.003)	(0.003)	(0.002)
White	−0.002**	−0.003***	−0.003***	−0.002***
	(0.001)	(0.001)	(0.001)	(4.44E−4)
Black	−0.002*	−0.002*	−0.001	−0.001*
	(0.001)	(0.001)	(0.001)	(4.50E−4)
Hispanic	−0.003***	−0.003***	−0.002	−0.002***
	(0.001)	(0.001)	(0.001)	(4.68E−4)
Employment	−0.014***	−0.011***	−0.012***	−0.002*
	(0.001)	(0.001)	(0.001)	(0.001)
Metro	−0.083***	−0.067***	−0.053***	−0.026***
	(0.012)	(0.012)	(0.012)	(0.008)
West	−0.082***	−0.027	−0.068*	0.018*
	(0.019)	(0.019)	(0.028)	(0.009)
Midwest	−0.073***	−0.026	−0.047*	0.005
	(0.015)	(0.014)	(0.021)	(0.007)
Northeast	−0.079***	−0.025	−0.090*	0.016
	(0.023)	(0.023)	(0.036)	(0.011)
Land developability	1.47E−4	−1.31E−5	−1.10E−4	−1.64E−4
	(2.30E−4)	(2.21E−4)	(2.62E−4)	(1.20E−4)
Constant	1.152***	0.886***	1.047***	0.246***
	(0.109)	(0.107)	(0.116)	(0.066)
Spatial lag effects	–	0.376***	–	0.922***
		(0.028)		(0.016)
Spatial error effects	–	–	0.492***	−0.970***
			(0.034)	(0.026)
Diagnostic Test				
Moran's I (error)	0.11***	–	–	–
Lagrange Mult (lag)	174.51***	–	–	–
Robust LM (lag)	71.72***	–	–	–
Lag Mult (error)	107.09***	–	–	–
Robust LM (error)	4.31*	–	–	–
Measures of Fit				
Log-likelihood	−245.55	−152.47	−160.91	71.29
AIC	529.10	344.94	359.81	−102.58
BIC	643.90	465.78	474.61	18.26

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.62 is about the association of freight rail terminal with median household income from 1970 to 2010. The diagnostic test shows the spatial dependency of median household income. The fourth model is the best fit because it has the highest value of log-likelihood (−66.19) and the lowest values of AIC (168.38) and BIC (277.14).

Freight rail is significant in only two spatial models, spatial lag and spatial error. Highway is negative, indicating that each unit increase in highway density is associated with a 0.003 percent decline in median household income. Both the young and old variables are strong, significant, and positive across all models. Each percent increase in young and old populations is associated with a 0.01 and 0.015 percent growth, respectively, in median household income.

The education variables are strong, significant, and negative across all models. Each percent increase in high school diplomas, bachelor's degrees, and graduate degrees is associated with a 0.004, 0.004, and 0.008 percent decline in median household income, respectively. White is negative (i.e., each percent increase in the White population is associated with 0.002 percent decline in median household income). Similarly, each percent increase in employment contributes to a 0.005 percent decline in median household income.

Metropolitan areas experience a decline in median household income by 0.027 percent in comparison to the non-metropolitan areas. The West and Midwest experience a 0.035 and 0.026 percent growth in comparison to the South in median household income, respectively. On the other hand, the Northeast experiences a decline in median household income by 0.02 percent than the South. Spatial lag is positive and spatial error is negative. A county sees a 0.711 percent increase in median household income for each weighted percentage point increase in median household income in surrounding counties. The spatial error effect shows the model can be improved by adding some relevant variables.

Table 5.62: Regressions of Terminal Density on Median Household Income Change from 1970 to 2010

	Full OLS	SLM	SEM	SEMLD
Explanatory Variables				
Terminal density	−0.004	−0.005*	−0.005*	−0.003
	(0.002)	(0.002)	(0.002)	(0.002)
Control Variables				
Highway density	−0.005**	−0.004*	−0.003	−0.003*
	(0.002)	(0.002)	(0.002)	(0.001)
Airport	−0.005	−0.004	−0.001	−0.004
	(0.003)	(0.003)	(0.003)	(0.002)
Young	0.021***	0.018***	0.018***	0.010**
	(0.004)	(0.004)	(0.004)	(0.003)
Old	0.029***	0.027***	0.029***	0.015***
	(0.002)	(0.002)	(0.002)	(0.001)
High school diploma	−0.010***	−0.008***	−0.010***	−0.004***
	(0.001)	(0.001)	(0.001)	(4.85E−4)
Bachelor's degree	−0.004*	−0.005***	−0.006***	−0.004***
	(0.001)	(0.001)	(0.002)	(0.001)
Graduate degree	−0.018***	−0.014***	−0.014***	−0.008**
	(0.004)	(0.004)	(0.004)	(0.003)
White	−0.004***	−0.004***	−0.004***	−0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Black	−4.26E−4	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Employment	−0.013***	−0.011***	−0.012***	−0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Metro	−0.069***	−0.059***	−0.049***	−0.027**
	(0.011)	(0.011)	(0.011)	(0.009)
West	−0.059**	0.001	−0.054*	0.035**
	(0.020)	(0.020)	(0.026)	(0.012)
Midwest	−0.115***	−0.035	−0.117***	0.026*
	(0.022)	(0.023)	(0.031)	(0.013)
Northeast	−0.125***	−0.074***	−0.105***	−0.020*
	(0.014)	(0.014)	(0.019)	(0.008)
Land developability	3.64E−4	2.06E−4	1.39E−4	2.17E−5
	(2.19E−4)	(2.14E−4)	(2.48E−4)	(1.39E−4)
Constant	2.928***	2.282***	2.940***	0.999***
	(0.112)	(0.127)	(0.114)	(0.095)
Spatial lag effects	−	0.268***	−	0.711***
		(0.026)		(0.018)
Spatial error effects	−	−	0.413***	−0.726***
			(0.036)	(0.029)
Diagnostic Test				
Moran's I (error)	0.10***	−	−	−
Lagrange Mult (lag)	99.16***	−	−	−
Robust LM (lag)	25.24***	−	−	−
Lag Mult (error)	76.20***	−	−	−
Robust LM (error)	2.28	−	−	−
Measures of Fit				
Log-likelihood	−185.84	−129.03	−125.91	−66.19
AIC	405.67	294.06	285.83	168.38
BIC	508.39	402.82	388.54	277.14

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

Table 5.63 presents the results of the spatial error model with lag dependence for the 1970s, 1980s, 1990s, 2000s, and 1970 to 2010. The table shows freight rail is negative in the 1970s, 1980s, and 1990s, and is positive in the 2000s. The transportation variable airport has a negative relationship with median household income in the 1980s and 2000s. The variable highway is significant only from 1970 to 2010. The variable young is significant and negative in the 1980s and 1990s, and is positive in the 2000s and 1970 to 2010. The variable old is significant and positive in the 1970s, 2000s, and 1970 to 2010.

The education variables are significant, and their values are negative except for graduate degree in the 2000s. High school diploma is negative in the 1980s and 1970 to 2010, whereas bachelor's and graduate degrees are negative during the 1970s, and 1970 to 2010. Bachelor's degree is negative in the 2000s, too. The race and ethnicity variables White and Black are positive during the 1980s and 2000s. White is negative in 1970 to 2010, too. Hispanic is negative in the 2000s. Employment is negative during the 1970s, 2000s, and 1970 to 2010. The geographic variable metro is positive during the 1970s, 1980s, 1990s, and negative in the 2000s, and 1970 to 2010. But the regional variables the West, Midwest, and Northeast are mostly positive except the Northeast is negative in 1970 to 2010. The land developability index is positive in the 1980s. Spatial lag and spatial error effects are significant in the 1970s and 1980s.

Table 5.63: SEMLD Results for Median Household Income Change for All Periods

	SEMLD 1970-1980	SEMLD 1980-1990	SEMLD 1990-2000	SEMLD 2000-2010	SEMLD 1970-2010
Explanatory Variables					
Terminal density	−0.003***	−0.003***	−0.002***	0.004*	−0.003
	(0.001)	(0.001)	(4.04E−4)	(0.001)	(0.002)
Control Variables					
Highway density	−0.001	3.58E−4	−6.66E−5	−0.001	−0.003*
	(0.001)	(4.34E−4)	(3.33E−4)	(0.001)	(0.001)
Airport	0.001	−0.002*	−0.001	−0.005*	−0.004
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Prev. decade income change	−	−0.034***	−	−0.048*	−
		(0.004)		(0.024)	
Young	−0.001	−0.003**	−0.002*	0.009***	0.010**
	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)
Old	0.002***	−3.74E−4	3.37E−4	0.006***	0.015***
	(4.07E−4)	(4.24E−4)	(2.95E−4)	(0.001)	(0.001)
High school diploma	−1.10E−4	−0.002**	−1.89E−4	−2.77E−4	−0.004***
	(1.59E−4)	(0.001)	(1.71E−4)	(0.001)	(4.85E−4)
Bachelor's degree	−0.001*	−0.001	−0.001	−0.008***	−0.004***
	(3.58E−4)	(0.001)	(3.81E−4)	(0.001)	(0.001)
Graduate degree	−0.004***	1.01E−4	3.27E−6	0.004*	−0.008**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)
White	−2.61E−4	0.001***	−9.19E−5	−0.002***	−0.002***
	(2.44E−4)	(1.49E−4)	(1.30E−4)	(4.44E−4)	(0.001)
Black	−5.96E−5	0.001***	−2.88E−5	−0.001*	−0.001
	(2.55E−4)	(1.54E−4)	(1.36E−4)	(4.50E−4)	(0.001)
Hispanic	−	−	−1.10E−4	−0.002***	−
			(1.39E−4)	(4.68E−4)	
Employment	−4.97E−4*	4.35E−4	−3.48E−4	−0.002*	−0.005***
	(2.42E−4)	(0.001)	(1.95E−4)	(0.001)	(0.001)
Metro	0.018***	0.011***	0.009***	−0.026***	−0.027**
	(0.003)	(0.003)	(0.002)	(0.008)	(0.009)
West	0.021***	−0.005	0.007**	0.018*	0.035**
	(0.004)	(0.004)	(0.002)	(0.009)	(0.012)
Midwest	0.008**	−0.004	0.004	0.005	0.026*
	(0.003)	(0.002)	(0.002)	(0.007)	(0.013)
Northeast	0.023***	−0.006	0.016***	0.016	−0.020*
	(0.005)	(0.004)	(0.003)	(0.011)	(0.008)
Land developability	5.49E−5	1.13E−4**	3.45E−6	−1.64E−4	2.17E−5
	(4.79E−5)	(4.29E−5)	(3.15E−5)	(1.20E−4)	(1.39E−4)
Constant	0.065*	0.068*	0.032	0.246***	0.999***
	(0.031)	(0.028)	(0.020)	(0.066)	(0.095)
Spatial lag effects	0.987***	0.980***	1.048***	0.922***	0.711***
	(0.014)	(0.011)	(0.012)	(0.016)	(0.018)
Spatial error effects	−0.885***	−0.808***	−0.991***	−0.970***	−0.726***
	(0.029)	(0.028)	(0.025)	(0.026)	(0.029)
Measures of Fit					
Log-likelihood	2995.88	3606.69	4169.44	71.29	−66.19
AIC	−5955.77	−7175.39	−8298.88	−102.58	168.38
BIC	−5847.01	−7060.59	−8178.04	18.26	277.14

AIC = Akaike's information criterion. BIC = Schwartz's Bayesian information criterion. * Significant at $p \leq 0.05$ for a two-tail test; ** significant at $p \leq 0.01$ for a two-tail test; *** significant at $p \leq 0.001$ for a two-tail test; standard errors in parentheses.

CHAPTER SIX

SUMMARY AND CONCLUSION

This dissertation examined the relationship of freight rail with demographic and socioeconomic change in the United States for the period of 1970 to 2010. The analysis has been done for five periods—four at decade level (the 1970s, 1980s, 1990s, and 2000s) and one for the entire forty-year period (1970 to 2010). For this dissertation, the independent or explanatory variable is freight rail terminal density. The eleven dependent variables used in this research can be grouped into demographic (population and age), social (race and ethnicity, and education), and economic (employment and income) categories. Overall, the findings indicate that freight rail has a negative association with the dependent variables irrespective of the periods after controlling for other modes of transportation, demographic and socioeconomic variables, land developability, and spatial effects.

SECTION 1: A SUMMARY OF RESEARCH

Association for the period of 1970 to 1980

For the period of 1970 to 1980, freight rail is significantly related to nine out of the eleven dependent variables. Table 6.1 shows the negative relationship of freight rail with population, employment, White, young, old, high school diploma, bachelor’s degree, graduate degree, and income at the aggregated level. At the metro level, the relationship is positive. The relationships at the regional level vary. The West has a negative association with six dependent variables (population, employment, White, Black, young, and old), whereas the Midwest has a positive association with five dependent variables (employment, high school diploma, bachelor's degree, graduate degree, and income). Spatial lag is positive and spatial error is negative with all dependent variables.

Table 6.1: Impact of Freight Rail on Dependent Variables for the Period of 1970 to 1980

Variables	Pop	Emp	White	Black	Hisp	Young	Old	High school dipl.	Bach deg.	Grad deg.	Income
Freight rail	−	−	−		NA	−	−	−	−	−	−
Metro	+	+	+	+	NA	+	+	+	+	+	+
West	−	−	−	−	NA	−	−	+			+
Midwest		+			NA			+	+	+	+
Northeast			+		NA			+			+
Spatial lag	+	+	+	+	NA	+	+	+	+	+	+
Spatial error	−	−	−	−	NA	−	−	−	−	−	−

Association for the period of 1980 to 1990

For the period of 1980 to 1990, freight rail has a significant relationship with nine dependent variables (population, employment, White, young, old, high school diploma, bachelor's degree, graduate degree, and median household income). Table 6.2 shows metro is positive. Out of three regions, the West is the strongest variable and shows a negative association with most of the dependent variables. Spatial lag is positive and spatial error is negative.

Table 6.2: Impact of Freight Rail on Dependent Variables for the Period of 1980 to 1990

Variables	Pop	Emp	White	Black	Hisp	Young	Old	High school dipl.	Bach degree	Grad degree	Income
Freight rail	−	−	−		NA	−	−	−	−	−	−
Metro	+	+	+		NA	+	+	+	+	+	+
West	−		−	−	NA	−	−	−	−		
Midwest	+	+	+	−	NA						
Northeast	+		+		NA				−		
Spatial lag	+	−	+	+	NA	+	+	+	+	+	+
Spatial error	−	+	−	−	NA	−	−	−	−	−	−

Association for the period of 1990 to 2000

Freight rail is significant and has a negative relationship with ten of the eleven dependent variables at the aggregate level for the period of 1990 to 2000. Table 6.3 shows a negative relationship of freight rail with population, employment, White, Black, young, old, high school diploma, bachelor’s degree, graduate degree, and median household income. At the metro level, the relationship is positive. High school diploma is the only dependent variable that is positive across all three regions (the West, Midwest, and Northeast). Spatial lag is positive and spatial error is negative.

Table 6.3: Impact of Freight Rail on Dependent Variables for the Period of 1990 to 2000

Variables	Pop	Emp	White	Black	Hisp	Young	Old	High school dipl.	Bach degree	Grad degree	Income
Freight rail	−	−	−	−		−	−	−	−	−	−
Metro	+	+	+			+	+	+	+	+	+
West			+			−		+		−	+
Midwest				−			−	+			
Northeast								+	+		+
Spatial lag	+	+	−	+	+	+	−	+	+	+	+
Spatial error	−	−	+	−	−	−	+	−	−	−	−

Association for the period of 2000 to 2010

For the period of 2000 to 2010, the association of freight rail is significant with six out of the eleven dependent variables at the aggregate level. Table 6.4 shows that freight rail has a negative relationship with White, old, high school diploma, bachelor's degree, and graduate degree. Also, freight rail has a positive relationship with median household income. At the metro level, freight rail has a positive relationship with most of the dependent variables. The regional variables are not very strong. Spatial lag is positive and spatial error is negative for both dependent variables.

Table 6.4: Impact of Freight Rail on Dependent Variables for the Period of 2000 to 2010

Variables	Pop	Emp	White	Black	Hisp	Young	Old	High school dipl.	Bach degree	Grad degree	Income
Freight rail			−				−	−	−	−	+
Metro	+	+	+			+	+	+	+	+	−
West	−	−	−			−					+
Midwest	−		−				−	+			
Northeast	−	+					−	+			
Spatial lag	+	+	+	+	+	+	+	+	+	+	+
Spatial error	−	−	−	−	−	−	−	−	−	−	−

Association for the period of 1970 to 2010

Table 6.5 presents the association of freight rail with dependent variables on the aggregate, metro, and regional levels. The table also shows the direction of the association for spatial lag and spatial error effects. At the aggregate level, nine out of the eleven dependent variables have a negative relationship with freight rail. Median household income is not significant. The direction of the relationship is opposite (positive) at the metro level. At the regional level, the association varies by dependent variable. In the West, freight rail has a negative impact on population, employment, Black, young, and old; and freight rail has a positive impact on employment, high school diploma, bachelor's degree, and graduate degree in the Northeast. The direction of the spatial lag effect is positive, whereas the direction is negative for the spatial error effect. For the period of 1970 to 2010, the association of freight rail with income is not significant, and the data for the Hispanic population are not available.

Table 6.5: Impact of Freight Rail on Dependent Variables for the Period of 1970 to 2010

Variables	Pop	Emp	White	Black	Hisp	Young	Old	High school dipl.	Bach degree	Grad degree	Income
Freight rail	−	−	−	−	NA	−	−	−	−	−	
Metro	+	+	+	+	NA	+	+	+	+	+	−
West	−	−		−	NA	−	−	+			+
Midwest			+		NA		−	+			+
Northeast		+		−	NA		−	+	+	+	−
Spatial lag	+	+	+	+	NA	+	+	+	+	+	+
Spatial error	−	−	−	−	NA	−	−	−	−	−	−

Overall association

Table 6.6 shows the overall association of freight rail with the eleven dependent variables for all periods used in this study. The table is based only on the results of the spatial error model with lag dependence (SEMLD). The table presents the direction of the significant relationship between freight rail and the dependent variables, controlling for the other modes of transportation, such as highways, airports; other demographic and socioeconomic variables; and the land developability variable. Most of the dependent variables have a negative relationship with freight rail. Most dependent variables are either negative or not significant at all, except for income in the 2000s. Some periods lack data for the Hispanic population.

The association of freight rail with different races and ethnicities is not consistent, and inequality in the association is obvious. The table shows freight rail has a negative relationship with the White population. For the Black population, freight rail is negative in the 1990s and 1970 to 2010. Freight rail does not have any significant relationship with the Hispanic population.

Similarly, the association of freight rail with young and old age is similar. Comparatively, the association is more frequent for old than young. In other words, old is stronger than young. Freight rail has a negative relationship with the variable old in all periods, whereas young is significant in four out of five periods. Education variables are strong and negative across all periods. Income is negative for the 1970s, 1980s, and 1990s, and positive for the 2000s.

Table 6.6: Overall Impact of Freight Rail on Dependent Variables

Dependent Variables:	**Terminal Density**				
	1970-1980	**1980-1990**	**1990-2000**	**2000-2010**	**1970-2010**
Population change	–	–	–		–
Employment change	–	–	–		–
White pop. change	–	–	–	–	–
Black pop. change			–		–
Hispanic pop. change	NA	NA			NA
Young pop. change	–	–	–		–
Old pop. change	–	–	–	–	–
High school dipl. pop. change	–	–	–	–	–
Bachelor pop. change	–	–	–	–	–
Graduate pop. change	–	–	–	–	–
Income change	–	–	–	+	

SECTION 2: A SUMMARY OF DATA AND METHODOLOGY

This dissertation implemented the integrated spatial regression methods (Chi 2010, 2012; Voss and Chi 2006) for studying transportation and regional development. This study used four kinds of regression models: a (full) ordinary least squares (FOLS) regression, spatial lag regression (SLM), spatial error regression (SEM), and spatial error model with lag dependence (SEMLD). The results of the analyses are presented in sixty-three tables in Chapter Five. Each table presents results from four models, i.e., full ordinary least squares (first model), spatial lag regression (second model), spatial error regression (third model), and spatial error model with lag dependence (fourth model). Each dependent variable is tested against freight rail terminal density for five periods. Eleven out of the sixty-three tables represent the results of spatial error models with lag dependence only. These tables (numbered 5.6, 5.12, 5.18, 5.24, 5.27, 5.33, 5.39, 5.45, 5.51, 5.57, and 5.63) are for dependent variables, each representing one dependent variable.

In fact, I ran regression against five independent variables (i.e., the number of freight rail terminals, freight rail terminal density, accessibility to the freight rail terminal, length of the railroad line, and railroad line density). In this dissertation, I presented the results of only freight rail terminal density because those results turned out to be the best of the five independent variables. In other words, most of the dependent variables are more significantly related to freight rail terminal density than to the other independent variables. Hence, I chose to present the results of freight rail terminal density only.

The significant value of Moran's I in full ordinary least squares regression (first model) indicates the spatial dependency of the dependent variable. Similarly, the

Lagrange multiplier and robust Lagrange multiplier of lag and error give some hints about which spatial regression model is a better fit. The measures-of-fit statistics in all models help to identify the best-fit model. The best-fit model is determined by the highest log-likelihood values and the lowest values of Akaike's information criterion (AIC) and the Bayesian information criterion (BIC). Freight rail terminal density is determined by dividing the total number of terminals by the square root of a county's area. Data for this study were obtained from the National Transportation Atlas Database, the Bureau of Labor Statistics, National Historical Geographic Information System (NHGIS), the Cartographic Boundary Shapefiles, the land developability index, and the decennial censuses of 1970, 1980, 1990, 2000, and 2010.

SECTION 3: DISCUSSION

This dissertation research tested the relationship of freight rail with eleven dependent variables, and all turned out to be negative, except one, which is positive. The results are negative at the decade level as well as at the entire study period. One possible explanation is the overall decline in internal migration in the United States (Molloy, Smith, and Wozniak 2011). Since the 1980s, internal migration has fallen and remained steady for thirty years for most geographic areas, demographic and socioeconomic groups, and distances.

Another explanation could be related to the economic impact of transportation investment. Investment in transportation moves away financial resources that could have been used to create jobs in the absence of transportation investment. The overall effect is negative because it creates fewer jobs (Iacono 2013). By contrast, because the major transportation networks are already built, investment in the transportation infrastructure is less, allowing the other sectors or industries to get more resources that create more jobs (Glaeser and Kholhase 2004; Iacono 2013). The distributive nature of the transportation infrastructure could also be the reason for the negative relationship because transportation infrastructure extends access and spreads economic growth that helps to redistribute population.

The findings of this research are consistent with other studies. Modes of transportation other than railroads—such as highways—could have a negative relationship with the growth of people and firms. Haughwout (1999a, b) shows that an increase in highway investment has a negative association with the distribution of economic growth. In other words, an increase in the investment of transportation reduces the density of people and employment firms. However, all these studies have limited dependent variables. I think the negative relationship between freight rail and dependent variables in all periods as discussed in this dissertation indicates that a major force is influencing the association of freight rail, such as migration from rural to urban areas or the process of urbanization and suburbanization.

The association of freight rail with dependent variables at the metropolitan level supports this argument. In this study, the association at the metropolitan level is positive at the decade level and for the entire study period. The positive relationship at the metropolitan level suggests that population growth at the metropolitan level is higher than for nonmetropolitan areas. The size of the population, irrespective of age, education level, race and ethnicity, and economy, is growing in counties that have at least one metropolitan area with a population size of 50,000 or over.

The process of urbanization in the United States has been occurring throughout the country's history. Urbanization and suburbanization have never stopped in the United States. The rate of urbanization has increased tremendously in the past two centuries and transformed the nation from predominantly rural to urbanized. Now, urban areas hold 80.7 percent of the U.S. population (USCB 2012), up from 73.6 percent in 1970 (USCB 1995). The United States observed a 7.1 percent growth in urban population during the study period. The population in rural areas is declining continually.

The positive association of freight rail at the metropolitan level is consistent with what has been found in other studies. Such studies suggest that urban areas receive relatively more advantages from transportation projects than do the less urban areas (Stephanedes and Eagle 1987; Rephann and Isserman 1994; Boarnet and Haughwout 2000). Transportation infrastructures have a relatively greater influence on growth of the economy and population in metropolitan areas than in nonmetropolitan ones.

At the regional level, the old population and the population with a high school diploma are the only two variables that show a consistently significant relationship with freight rail. The variable old is negative and high school diploma is positive in all regions: the West, Midwest, and Northeast. The opposite association of freight rail is seen with two different variables. In the case of aging, freight rail is associated with population decline, but with high school diplomas, freight rail is associated with population growth. The negative relationship at the regional level indicates that in all regions (the West, Midwest, and Northeast), freight rail is associated with a decline in population of age 65 and over in comparison to the South. In the forty years between 1970 and 2010, the South continuously attracted elderly population.

This phenomenon could represent the regional distribution of the older population. The South is the home to the most of the older population (West et al. 2014). There are some possible explanations for this regional differential growth. Many consider the South as a retirement destination because of the higher average temperature, lower income tax, and higher percentage of recreational employment (Cowper et al. 2000; Longino and Bradley 2003; AARP 2005; West et al. 2014). “Brain drain” or the imminent departure of senior workers (managers, the educated labor force) and retirement-eligible employees could be another possible explanation for the negative relationship (Mayer 2014; Stinson 2014; Wiltz 2016). Freight rail has a positive relationship with high school diplomas in all three regions. It indicates that freight rail contributes to attracting a population with high school diplomas in all three regions (the West, Midwest, and Northeast) in comparison to the South. In other words, the South lost high school graduates over the period of forty years.

The spatial lag effect is positive for all demographic and socioeconomic dependent variables for the most of the periods. It indicates that growth of these variables in a county can be influenced by growth in surrounding counties. Similarly, a decline in surrounding counties causes a decline in these variables in a surrounded county. This phenomenon can be explained by the spread effect of growth pole theory. This research statistically shows the spatial effect of dependent variables.

This research hypothesizes that freight rail, as an additional mode of transportation, plays important roles in supporting and maintaining the economy. A location with a strong economy offers jobs and attracts workers. In this research, the relationship of freight rail with population, employment, education, income, age, and race and ethnicity are predicted based on the contribution of freight rail on the economy. Hence, the research hypothesizes a positive relationship with population, employment, education, income, age (young) and race (White); and a negative relationship with age (old) and minorities (Black and Hispanic). Table 6.7 summarizes the results of the hypothesis test for this dissertation. All hypotheses are rejected except old and minorities. Most of the variables (population, employment, education, income, young, and White) have a negative relationship with freight rail. The research supports only the hypotheses related to the variable old and the variable Black. The variable Hispanic is not significant.

The rejection of all hypotheses clearly shows that the assumption of the economic contribution of freight rail is not true and is overshadowed by other powerful factors. Freight rail turns out to be a distributive rather than a growth factor. Importantly, the control variable metro is positive for all dependent variables in almost all periods. It indicates that metropolitan areas experience a greater demographic and socioeconomic change than nonmetropolitan areas. The process of urbanization and suburbanization could have affected or overshadowed the relationship between freight rail and the dependent variables (population, employment, education, income, young, and White). Hence, this study rejects the research hypothesis and opens up new possibilities for future research.

Table 6.7: Hypotheses Test Result

Hypothesis	**Tables that address the hypothesis**	**Support or reject**
Railroads have a positive association with population and employment change.	5.1 to 5.12	Reject

Railroads have a positive association with White population and negative associations with minority populations (Black and Hispanic).	5.13 to 5.27	Reject
Railroads have a positive association with the young and a negative association with the old population.	5.28 to 5.39	Reject young Support old
Railroads have a positive association with educational attainments.	5.40 to 5.57	Reject
Railroads have a positive association with median household income.	5.58 to 5.63	Reject

SECTION 4: CONTRIBUTIONS

This study contributes to the existing freight rail literature.

At the national level, freight rail is a distributive not a growth factor.

Most transportation research focuses on the relationship between the mode of transportation and a couple of dependent variables. For consistency of association, this study seeks the relationship of freight rail with eleven dependent variables at four separate decade levels and one forty-year period. Initially, I assumed that the relationship would vary with the dependent variables in different periods. The use of standard regression and spatial analysis enabled more robust control of spatial effects in the models. Even after controlling for other two public modes of transportation (highways and airports), many demographic and socioeconomic variables, and spatial lag and spatial error effects, the association is consistently negative for all dependent variables. Hence, the distributive role of freight rail is obvious. This is the benefit of having many dependent variables in the research design. This study clearly shows freight rail is a distributive factor after analyzing the association at a large scale—specifically, the number of variables and time periods.

Freight rail contributes to the urbanization and suburbanization process.

At the metro level, the association of freight rail is positive, irrespective of dependent variables and periods. It indicates that metropolitan areas experience greater growth of the dependent variables than nonmetropolitan areas. Metro consistently being positive provides a hint that freight rail has contributed tremendously in the process of urbanization and suburbanization in the United States.

Freight rail facilitates demographic and socioeconomic change.

This study measures the spatial lag effects for the dependent variables and predicts the effects of surrounding counties. The research method is based on the work of Chi (2010a, 2010b, 2012) and Voss and Chi (2006). This study used their integrated spatial regression approach for highways and population research and applied it to the association of freight rail with many demographic and socioeconomic variables. The results show a clear spatial lag effect on dependent variables. A dependent variable in a county is affected by surrounding counties. Freight rail plays an indirect or facilitator role in this process.

Freight rail has a differential demographic and socioeconomic association at the regional level.

For the period of 1970 to 2010, the association of freight rail with dependent variables varies at the regional level. The association is negative in the West for population, employment, Black, young, and old, but it is positive for high school diploma and income. On the other hand, the association is positive for employment and education in the Northeast. Freight rail has a consistent negative association with old and a positive association with high school diploma, irrespective of the region. Hence, the association of freight rail with differential demographic and socioeconomic variables varies at the regional level.

Methodological contributions

This dissertation research offers a methodological contribution. The findings of this research are a product of the application of standard as well as spatial regression analysis. of transportation research uses a standard regression method that does not consider spatial effects in the analysis. Not controlling for spatial effects violates the fundamental assumption of independence and produces unreliable results. This study explores spatial effects and addresses them systematically. The integrated spatial regression model used in this research controls for spatial lag and spatial error effects separately and simultaneously. This robust analytical method produces more reliable results, and the predictions based on this method are more likely to be accurate. In my knowledge, no railroad research has been done using this statistical method. In addition, even though the integrated spatial regression model in this dissertation research is used at county level, it can be used at any geographic scale.

Comprehensive research

This dissertation research is comprehensive from many angles. From the perspective of the variable, most studies have a limited number of dependent variables. This dissertation research has eleven dependent variables. Even though just one explanatory variable (terminal density) is presented in this study, analysis was done for five independent variables. The other four variables are terminal number, railroad length, accessibility, and railway density.

From the perspective of time, most research is focused on a limited time period, but this study tested the impact for forty years total, as well as for each decade from 1970 to 2010. In such research, most studies are limited to the impact on population and employment but this research goes beyond that and explores the association with age (young and old), education (high school diploma, bachelor's degree, and graduate degree), income, and race and ethnicity (White, Black, and Hispanic). This dissertation uses the standard as well as spatial regression methods; it not only measures the direct association, but it also looks at the indirect association. To the best of my knowledge, such research has never been conducted about railroads specifically.

Longitudinal database

This dissertation research contributes to building a longitudinal (1970, 1980, 1990, 2000, and 2010) data infrastructure that contains county-level demographic, social, economic, environmental, and transportation information of the continental United States. Besides meeting the goal of the dissertation research (i.e., looking at the demographic and socioeconomic association of freight trains), this data can be applied to explore the demographic and socioeconomic impact of highways and airports. Hence, this database is useful for exploring the impact of public transportation in the United States from 1970 to 2010. Additionally, the impact can be detected at different geographic levels, such as rural/urban, state, and regional.

SECTION 5: POLICY IMPLICATIONS

The findings of this dissertation research inform planners and policy makers in many ways. First, all dependent variables are spatially correlated, indicating that adjacent locations are closely connected physically, demographically, socially, and economically. Transportation modes, such as freight rail, help to integrate an individual county into a larger economic and development area. Hence, changes in these variables in surrounding counties influence each other. Generally, planners and policy makers plan exclusively for their geographic area and do not consider surrounding areas in their planning. This research shows that considering surrounding counties during the planning process will be beneficial.

Second, the findings of this dissertation research show that the influence of freight rail varies across national, metropolitan, and regional levels. The research shows that the overall association of freight rail with dependent variables is negative, but the association is positive at the metropolitan level. At the regional level, the association varies, resulting in positive, negative, and no significant associations. This finding suggests that freight rail plays different role at different geographic levels. Variation in the association is caused by the variation in the effect of other control variables, such as other modes of transportation (highways and airports), demographic composition (population, age), areal characteristics (metropolitan, land developability), and economic contexts (employment and income). At one time, the railroad was considered as an economic force (Jenks 1944), but now planners and policy makers should keep in mind that there is no universal strategy for the best use of transportation infrastructure for optimum economic growth and development (Chi 2012).

Third, the dissertation findings show that freight rail is a distributive force—not a growth factor. Loukaitou-Sideris et al. (2013) noted that the mode of transportation, such as freight rail, is not a magic wand that creates growth; rather, its effect is similar to a fertilizer’s effect on plant growth. Transportation infrastructure is an important factor that could stimulate growth, but other factors are essential too. Growth depends on several factors, such as transportation network, distance from nearby big cities, existing assets, the strength of the local economy, demographic and income distribution, and real estate market conditions. Planners and policy makers should understand that mere heavy capital investment in the transportation infrastructure may not result in the desired growth. In the absence of other essential factors, transportation infrastructure could play a distributive role. Planners and policy makers should not consider any single mode of transportation as a growth factor.

Fourth, being a distributive force, freight rail helps in the demographic and socioeconomic distribution of already-achieved growth, contributing to sustainability and promoting social equity. Conventional understanding argues for unlimited growth or supply, but without effective distribution, mere production or growth cannot bring desired changes in the quality of life (Kysar 2001). But there are challenges in the construction and maintenance of the railroad infrastructure. Some challenges are the requirement of large investment and a long period for revenue return (Li and Loo 2015). The huge public investment might be impractical because it may create a conflict among different interest groups. Planners and policy makers can address these issues through public and private partnership strategies. The private sector can contribute to both construction and services. Planners and policy makers can contribute to the development of legal frameworks that eliminate obstacles and enhance effectiveness and efficiency of the private sector in operation.

Finally, in this study the association of freight rail is significant mostly with the White population, not Black or Hispanic. This is a county-level national study for the continental United States. The impacts of transportation on minorities were observed in a small geographic-level study carried out for a state. Chi and Parisi (2011) in their block-level study in Wisconsin clearly show the impact of highway expansion on distribution and redistribution of minorities. Planners and policy makers should consider the scale effects (Kotavaara, Antikainen and Rusanen 2012) while dealing with race and ethnicity. Not considering race and ethnicity during analysis allows the behavior of the White population to overshadow that of ethnic minorities (Giuliano 2003); this is because White people comprise three-fourths of the United States population.

SECTION 6: LIMITATIONS AND FUTURE RESEARCH

As in any study, there are limitations. One of the limitations in this study is the data unavailability for freight rail for the different periods. A national-level complete dataset for freight rail at the county-level was released for first time, in 2013, by the U.S. Department of Transportation. I have used this data across all periods to regress against the dependent variables. The number of freight rail terminals could have changed over the different decades. Hence, this is not the ideal data for running an analysis across different periods.

Similar to the first limitation, the next limitation of the study is related to the unavailability of race and ethnicity data. Data for the Hispanic population are not available for all periods. Because of this limitation, some models lack control for the Hispanic group. That affects the consistency of the models as well as the results.

The change in county boundaries over time could have some effects on the analysis. Many counties changed their boundaries: some counties disappeared, and some new counties emerged during the period between 1970 and 2010. For the sake of consistency, I used the latest county boundaries as a standard and applied them in every decade. Doing so may have affected the results of the analysis.

This study focuses in only one direction of impact—i.e., the impact of freight rail on different demographic and socioeconomic variables. It does not consider impact in the reverse direction. In reality, both dependent and independent variables influence each other. It leaves room for improvement in this research. Hence, the issues of reverse causality should be considered in the future research.

The association of freight rail is statistically significant primarily with the White population. It would be interesting for future research to investigate why Black and Hispanic populations are not significant with freight rail. It could be because of the mismatch of the scale (Wrigley et al. 1996; Kotavaara, Antikainen and Rusanen 2012). My dissertation research is a national-level study that explores the effect of freight rail using county-level data. There is a possibility that the effect occurs at a different scale, such as block, metropolitan, municipal, and neighborhood levels. Because of this mismatch, the association of freight rail with Black and Hispanic populations would not have appeared significant.

This study examines the overall relationship of freight rail with race and ethnicity without considering proximity to transportation infrastructures. Future research should consider proximity issues. The literature shows that distance to transportation infrastructures plays a role in racial distribution and redistribution (Chi and Parisi 2011). However, this area of research is not well developed, and there are no established rules about how to measure distance. Future research can divide counties into different categories, such as within 1 mile, 2 miles, etc., then explore the racial impact of freight rail.

The consistent negative association of freight rail could be because of a larger force, such as the overall decline in internal migration, reduced transportation investment, distributive nature of transportation infrastructures, and the urbanization process. Since the 1980s, internal migration has fallen and remained steady for thirty years for most geographic areas, demographic and socioeconomic groups, and distances (Molloy, Smith, and Wozniak 2011). Similarly, less investment in transportation infrastructures may have allowed other sectors to create more jobs (Glaeser and Kholhase 2004; Iacono 2013). The distributive nature of transportation infrastructure could also be the reason for the negative relationship because transportation infrastructure extends access and spreads economic growth that helps to redistribute population and employment. Moreover, in the United States, the process of urbanization has been taking place for centuries. The effect of freight rail could be overshadowed by the processes of urbanization and suburbanization. Future research should control for these factors, which will help reveal the actual association of freight rail with different demographic and socioeconomic variables.

The negative association of freight rails possibly related to the decline in goods production industries. During the study period, the goods share of GDP to total GDP has declined in comparison to the service share of GDP (BTS, n.d.). Because freight rail is more closely associated with goods production industries than to services production industries, the negative association could be the effect of the decline in goods production industries, such as agriculture, forestry, fishing and hunting, construction, manufacturing, and mining. Future research should explore the association of freight rail with these industries.

The research design of this study can be applied to other modes of transportation, too. Future research should explore the association of railroads, highways, and airports with other dependent variables that affect demographics, such as property values at the national level. Such studies will bring a broader picture of impacts at the national level of different modes of public transportation. By using a robust research method and controlling for spatial effects, this research produces accurate and reliable results that would be beneficial in national and regional policy making.

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