HIGHWAY INVESTMENT AND ECONOMIC DEVELOPMENT: THE GA-316 CORRIDOR

by

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(Under the Direction of Steven Holloway)

ABSTRACT

Highway investment has been considered a highly important factor that enables regional economic development. By focusing on Georgia Highway 316 (GA-316), this study examines how highway investment impacts economic activity by changing accessibility patterns. This Atlanta-area highway is an interesting case study given Atlanta's focus on creating accessibility by enabling high mobility through relatively ubiquitous road and highway networks. This project shows that even though GA-316 reduces area travel times, the primarily rural areas that most benefit from increased accessibility do not have associated increases in employment. Instead, GA-316 enables the continuation of existing development trends and economic activity is not redistributed into areas benefiting from improved accessibility. These findings demonstrate the need to question whether traditional notions of highway investment as stimulating economic development still hold in developed nations with advanced economies and relatively ubiquitous road networks.

INDEX WORDS: economic development, highway investment, Georgia highway 316, Athens, Atlanta, accessibility

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CHAPTER 1:

INTRODUCTION

Highway Investment and Economic Development

Investment in transportation infrastructure traditionally has been seen as an important enabling factor that helps to explain the spatial distribution of economic development (Wheeler, 1977). While planners sometimes use the projected economic impact of building transportation infrastructure to help justify the building of particular projects (e.g., Appalachian Regional Commission, 1998; Rephann and Isserman, 1994), the exact impacts on economic development at any given spatial scale are poorly understood. While transport investment traditionally allowed previously inaccessible regions to increase economic development, this relationship is no longer so straightforward in developed nations with ubiquitous transport systems and advanced economies (Banister and Berechman, 2000). While adding new links to already well-developed transportation networks can offer time savings to travelers, research in developed nations indicates that these relatively small changes do not always translate into a significant relocation of economic activity (Banister and Berechman, 2000; SACTRA, 1977). Due to the complex and multi-scaled economic competition between spaces, previous studies have found that the impact of transport investment on economic activity in developed nations has become increasingly more difficult to understand. In order to reexamine the impact of transport investment -and highway investment in particular- on economic activity, I examine a highway constructed as an extention of Atlanta's northeastern suburban growth. By concentrating on the example of Georgia Highway 316 (GA-316), I highlight changes in accessibility patterns as an important factor in explaining the complex relationship between highway investment and economic development.

Examining the role of GA-316 in the Atlanta metropolitan area is particularly intriguing because of Atlanta's status as a poster child exemplifying urban sprawl and undesirable car-based growth (Bullard, 2000). The Atlanta metropolitan area has been well known for its efforts to deal with congestion and facilitate growth by building extensive road systems and spreading into vast suburbs and exurbs (Brookings Institute, 2000). Critics claim that Atlanta has defined its outward economic development and suburbanization by focusing almost exclusively on road-building (Jaret, 2000). GA-316 is one such road that was supposedly constructed in order to counter congestion and eroding travel times during the 1990's (Turner, 1986), one of the peak periods of the exploding growth in the Atlanta suburbs. Atlanta growth has largely been enabled by fierce local competition between counties for federal road building and suburban economic development. However, congestion problems and rapid car-oriented growth in all directions has stretched the capacities of planning commissions and emphasized the weaknesses of their organizational structures. Conflict between different interests competing for control over urban growth trends culminated when Atlanta failed to meet federal air quality regulations in 1998. Facing the discontinuation of federal support for highway construction, Georgia Governor Roy Barnes created the Georgia Regional Transportation Authority (GRTA), a metropolitan planning commission with overarching authority in 13 Atlanta-area counties (Jaret, 2000). Highways and other roads have played an important role for Atlanta in facilitating the rapid suburban expansion in this high-growth area. The debate on how transportation patterns influence the economic vitality of the Atlanta region remains a politically charged issue and provides an interesting example for empirical study.

Research Purpose

In this project, I use the case study of the GA-316 corridor in order to investigate the means through which highway investment affects local economic activity. The GA-316 case allows me to ask more detailed questions about the means through which highway investment influences economic development. Using multivariate regression, I concentrate on two interrelated research questions: 1. What role do changed accessibility patterns play in explaining exactly how highway investment shapes the economic landscape? 2. How do *different types of economic activity react differently* to highway investment and changed accessibility patterns? Through separately modeling 1992-2000 changes in employment in nine economic sectors, I examine the nature of highway investment's impact on different types of economic activity. In addition, I use employment data aggregated to the census block group level, a detailed measure of economic development that examines changes at a very local scale.

This research questions whether traditional understandings of highway investment stimulating economic development still applies in developed nations with advanced economies. The GA-316 corridor analysis presented here demonstrates that increased accessibility through transport investment may not have the same impacts on economic activity that traditional notions of this process imply. Other ways of approaching this relationship may contribute to a better understanding of economic reactions to transportation investment. Banister and Berechman (2000) suggest that one way of approaching this relationship may be that transportation network improvements contribute collectively to the competitiveness of a region, rather than produce focused impacts within a region. Alternatively, changes in accessibility patterns caused by transport investment may simply enhance existing trends of economic development (Banister and Berechman, 2000) –an approach that appears to be verified in the GA-316 case study.

Thesis Design

In Chapter 2 I review previous research on the impacts of highway investment on economic development. Because this subject has been approached from a variety of angles, I briefly review some of the different research purposes and scales used to investigate this topic. I then focus on research using specific highway corridors to look at explanatory factors describing why highway investment shapes the economic landscape in varying ways. As this project uses changed accessibility patterns as one such explanatory factor, I then examine why accessibility provides such an important way of explaining how transport investment impacts economic activity.

I use Chapter 3 to describe the GA-316 corridor and to introduce the methodology that I use to investigate how this highway has impacted economic activity. Being at the edges of the quickly growing Atlanta region, the GA-316 corridor provides an excellent example to see how a highway shapes the surrounding economic landscape. In the methodology section, I introduce multivariate regression as an effective method of determining the influence of changed accessibility patterns through highway investment on economic development.

As this study focuses on the relationship between highway-induced accessibility change and economic growth, Chapter 4 explains these two variables in much more detail. I first describe the economic changes that occur within the study area from 1992 to 2000. Then I present my analysis of accessibility change and show how GA-316 changed accessibility patterns in the study area. Finally, I look at the links between these two variables by comparing the spatial distribution of employment change with the accessibility improvements in the corridor.

I present the results of my multivariate regression analysis in Chapter 5. I first go over the basic findings of this research before revealing patterns of employment redistribution from

1992 to 2000. I then present my findings of how the effects of the pre-GA 316 employment variable, the control variables, and the accessibility change variable differs across the varying economic sectors.

In Chapter 6 I place the findings of this study in the context of the broader body of research to which this project intends to contribute. Then, while I summarize my basic findings I also address some of the questions and issues that were brought up by this research. Finally, I review some of the limitations of this study and suggest future avenues that should be considered in order to better understand how transport investment impacts economic development.

CHAPTER 2:

LITERATURE REVIEW

Highway Investment and Economic Development

Researchers and planners have long studied the influence of highway investment on economic activity. Because of the different goals of each study, some have focused on macroeconomic impacts while others have focused on state-wide or interchange-specific effects. Studies at the macroeconomic scale have been the most frequent and have implied strong causality because developed nations with high gross domestic products also tend to invest more in transportation infrastructure (Banister and Berechman, 2000). The generalized results of these macroeconomic studies have strengthened traditional understandings of the effect of transportation investment on economic development as an *enabling or causal factor* (Banister and Berechman, 2000). These studies revealed that previous transportation investment allowed formerly-isolated areas of the United States to be accessible to the population at large, allowing economic growth. Thinking of transportation investment as an enabling factor for economic development –given the presence of other necessary conditions- is a useful way to approach this issue (Wheeler, 1977). However, there has been much evidence that this relationship changes as both an economy and transportation system reach maturity (Banister and Berechman, 2000). Focusing in on localized studies reveals more specific ways in which highway investment changes economic activity, confirming that this relationship is neither simple nor static (EDRG, 2001).

Because of the importance and applicability of studies on the economic impact of highway investment, researchers have developed two different research approaches: predictive cost-benefit studies forecasting potential impacts, and after-the-fact research that measures the actual results. While predictive studies are important for initial planning, after-the-fact studies provide the only means of empirically measuring the actual impacts of transport investment. These studies have asked a variety of research questions at many spatial scales. However, when choosing the scale at which a researcher investigates the transportation investment-economic development relationship, the researcher must weigh the benefits and disadvantages of various spatial scales (EDRG, 2001). According to Banister and Berechman (2000), macroeconomic studies are able to find general trends but tend to overestimate the relationship without being able to establish explanatory relationships. In comparison, localized studies are able to investigate important explanatory factors that cannot always be transferred to other circumstances (Banister and Berechman, 2000).

Some local studies concentrate on very specific areas, examining both positive and negative impacts of transportation projects on local economic activity. For example, several small-scale studies (e.g. Wisconsin DOT, 1998; Burress, 1996; Anderson and Otto; 1991) use quantitative and qualitative data to assess the positive and negative impacts of new highway bypasses and access restrictions on small communities. Many of these studies have found that a one-time sudden change occurs in which traffic-oriented businesses suddenly appear immediately after highway construction. Other studies focus on growth in highway-oriented businesses near new interchanges (EDRG, 2001).

In contrast to these extremely localized studies, other research asks questions at various broader scales. One type of study has concentrated on the *impacts of rural highway systems* on the surrounding counties, often using a control group of counties (EDRG, 2001). Other studies concentrate on the *impacts of regional development programs*, in which state Departments of Transportation (DOTs) build highways, attempting to stimulate economic development in underdeveloped regions (e.g. Appalachian Regional Commission, 1998; Rephann and Isserman, 1994). Both of these studies usually use county-level data on employment to compare levels of economic development before and after highway investment (e.g. Miller, 1979; Broder, 1992).

Another group of studies, under which this research falls, concentrates on the effects of *specific highway corridor construction or improvements* on the economic development in the surrounding area (e.g. Moon, 1988; Orus, 1996; Parantainen, 1999; Anderstig, 1999). Through using a specific highway project and impacted corridor, these studies give insight into site-specific explanatory factors (EDRG, 2001). In looking at the impacts of M25, London's outer beltway, on retail development, Gould (1987) found that 75% of retailers were not impacted. The customers of these smaller retailers generally lived within a 10 minute drive of the retailer, and were thereby unlikely to change their activity patterns due to M25. However, M25 served to increase the catchment areas for large regional shopping destinations, thereby increasing the number and volume of large retail centers (Gould, 1987).

In an older corridor-specific study, Dodgson (1974) examined the economic impacts of the M62 Trans-Pennine Motorway on economic activity by focusing on accessibility patterns as an important explanatory variable. After determining the areas that most benefited from increased accessibility, Dodgson (1974) found that these areas also experience the greatest increase in economic development (between 1961 and 1966). More recently, Linneker and Spence (1996) found mixed results when examining the impact of M25 on economic development through changing accessibility patterns. While controlling only for accessibility increases attributed to M25, the authors found a significant relationship between areas with increased accessibility and increased levels of economic development. However, when adjusting the measurement for changes in other network links, they found a significantly negative impact of increased accessibility on economic development. Comparing the results of these two studies gives an indication of the general changing relationship between highway investment and economic development. Dodgson (1974) is representative of traditional understandings of highway investment as enabling regions with increased accessibility to benefit from economic development. In contrast, Linneker and Spence (1996) demonstrate that the relationship between highway investment and economic development has become more difficult to understand.

Research on the macroeconomic impacts of transport investment on economic activity supports a strong link between transportation infrastructure and economic development. Local corridor-specific studies in developed nations historically have demonstrated similar results. However, changing economic structures, ubiquitous transport systems, and the falling proportion of transport costs in total business costs make it important to reexamine the traditional concept of transportation investment as an enabling factor for economic development in industrialized nations (Banister and Berechman, 2000).

As early as 1977, the British Standing Advisory Committee on Trunk Road Assessment (SACTRA) argued that the impacts of road projects on the relocation tendencies of firms and on the spatial location of economic activity are weak, if even existent (SACTRA, 1977). SACTRA went on to claim that the primary benefits of highway investment to businesses were time savings (SACTRA, 1977). Given the reduced importance of transportation costs in the total costs of conducting business in developed nations (Chapman, 1990), these time savings negligibly influenced location decisions by firms (SACTRA, 1977).

In a highly comprehensive analysis detailing the changing way in which transport investment has impacted economic development over time, Banister and Berechman (2000) build upon criticisms made by SACTRA (1977), and call for a new understanding of this dynamic relationship. They comment on the traditional notion of transport investment as enabling economic development.

> "We have no fundamental disagreement with these arguments. Our contention is to establish whether the same arguments are still relevant in advanced economies where the infrastructure is already well developed, where more complex market systems are in operation and where transport costs play a less important role in the total production costs. We are also addressing the new forms of production based on post-industrial and technological developments, with high levels of car ownership and mobility, and high levels of employment in service industries… we ask whether the arguments used nearly two hundred years ago are still relevant today (Banister and Berechman, 2000, p. 7)."

Banister and Berechman (2000) ask important questions about the way in which transport investment could impact economic development in developed nations. They question the impact of one additional link to an already relatively ubiquitous transport system. In addition, they investigate whether the decreasing proportion of total production costs that transport costs make up may contribute to reduced sensitivity by businesses to improved travel times. Finally, the authors conclude that transport investment neither causes nor is necessary for economic development in developed nations; instead, it acts as a supporting role that augments other necessary conditions (see Figure 2.1) (Banister and Berechman, 2000).

In the context of this changing relationship between transport investment and economic development in developed nations, I use the GA-316 case study to reexamine this dynamic

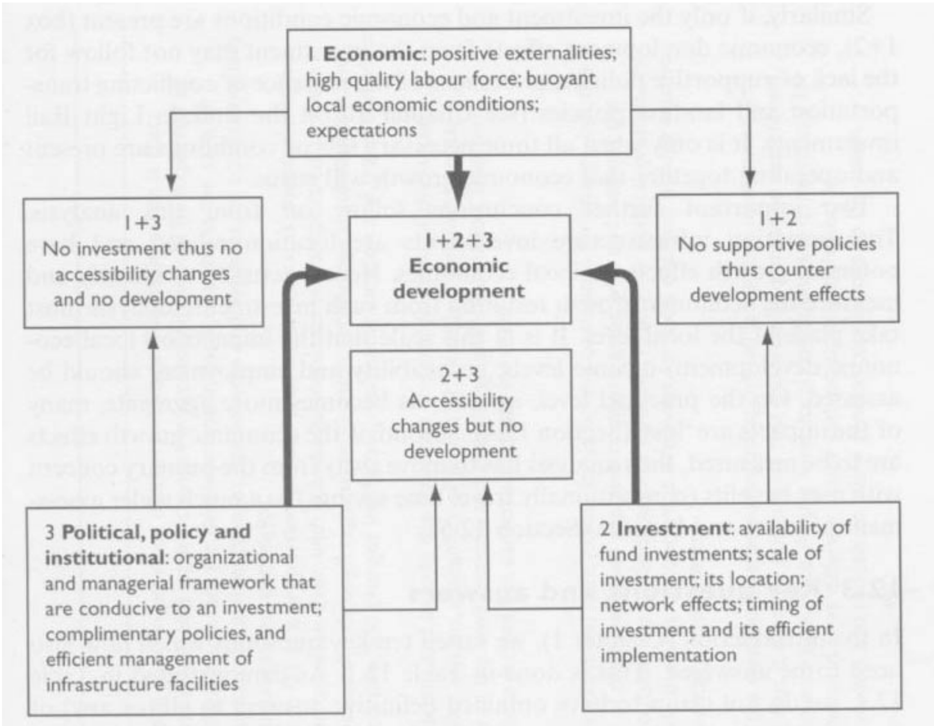

Figure 2.1: Necessary Conditions for Transport Investment to Contribute to Economic Development (Banister and Berechman, 2000, p. 319).

spatial process. In order to empirically measure the influence of highway investment on economic activity in the surrounding corridor, I rely on an important explanatory concept that is the fundamental goal of transport investment: changing accessibility patterns. Dodgson (1974), Botham (1980), and Linneker and Spence (1996) similarly examined changes in accessibility patterns as the means through which transport investment impacts economic development.

Theoretical Framework: Accessibility

Accessibility, broadly defined as the "potential of various opportunities for interaction (Song, 1996, p. 474)," plays an important factor in urban form, individuals' quality of life, and economic activity. Researchers emphasize accessibility as an important explanatory factor, even if not the most important explanatory factor, in shaping urban form and function (e.g. Koenig, 1980; Hanson and Schwab, 1987; Song, 1996; Kwan, 1998).

Key to any understanding of accessibility are two primary components: *mobility*, or the facility of movement in space, and the spatial distribution of opportunity locations, *land-use* (Bhat, 2002; Hanson and Schwab, 1987; Geertman and van Eck, 1995, Kwan, 1998). Mobility makes it easier to overcome large distances while land-use patterns determine distances that need to be overcome in order for interaction to occur. Both of these primary components of accessibility shape the decisions of residents and businesses to locate in certain areas, resulting in different spatial patterns of development. First l*and-use patterns* influence accessibility and allow metropolitan areas to act as economies of agglomeration. In this way, residents and businesses benefit from the clustering effect and physical proximity of opportunity locations. Secondly accessibility is influenced directly by the *mobility* (the facility of movement in space) that is afforded through transportation networks. While accessibility and mobility are often used interchangeably in casual conversation, the distinction is important. Mobility is a crucial component of accessibility that enables the expansion of individuals' activity spaces, shapes travel demand, and ultimately affects the spatial distribution of activity spaces (Bhat *et al.*, 2002). Policy makers thus have two important strategies to which they can turn in order to shape accessibility patterns. Land-use policies such as zoning are designed to affect the distribution of opportunity locations while transportation investment, such as building highways, enables increased mobility.

Building GA-316 is an example of changing accessibility patterns through increased mobility. In order to evaluate the effect of this highway on economic development through changed accessibility patterns, I use a definition of accessibility proposed by Dalvi (1978) as referred to by Koenig (1980) and O'Sullivan *et al.* (2000). Dalvi writes that accessibility "denotes the ease with which any land-use activity can be reached from a particular location, using a particular transport system (O'Sullivan *et al.,* 2000, p. 86)". O'Sullivan *et al.* (2000) uses this definition to study place accessibility by public transportation. In this way, by breaking accessibility into three components: land-use activity, starting location, and transportation system, one can use this definition in accessibility measurements designed for more specific applications.

While it is clear that highway investment can serve as an important catalyst for improving accessibility, its role in affecting surrounding economic development patterns is not so clear. Studies have found that the relationship between highway investment and economic growth varies across scales and changes depending on the existing state of the local transportation network and economic conditions. Much of this controversy has been over whether the existing notion of transportation investment causing economic development still holds true in urban areas in developed nations with complex economies and already high levels of mobility. In this study I will further explore this issue by examining a highway northeast of Atlanta, a metropolis characteristic of the growing U.S. Sunbelt cities with high levels of car-based mobility and booming economic growth.

CHAPTER 3:

STUDY AREA AND METHODOLOGY

Research on the impacts of transportation investment on economic development has explored this question using both a variety of scales and numerous methodological approaches. In this project, I use the specific example of GA-316 in order to gain a detailed understanding of how this specific highway affects the spatial distribution of regional economic activity. In order to contrast my results with other research and extrapolate general patterns that can assist the planning process elsewhere, I employ multivariate regression, a technique that allows maximal comparability while enabling detailed explanation. In the following section, I will describe the GA-316 case study and show the research methods that I use to explore the complex and dynamic relationship between highway investment and economic development.

Case Study: the GA-316 Corridor

Situated northeast of the Atlanta metropolitan area, GA-316 connects the growth hotspot of northeastern Atlanta with the college town of Athens, GA in the east. Sections of GA-316 were built between 1968 and 1995 sequentially from west to east –that is, from I-85 in northeast Atlanta to the Athens perimeter (see Table 3.1, McMurry, 2003). Stretching east from some of the fastest-growing parts of northern Atlanta, GA-316 provides a particularly interesting example given Atlanta's reputation as the urban sprawl poster child (Bullard, 2000).

Atlanta receives criticism for continuously building its way from congestion problems and focusing on increased mobility almost exclusively by constructing roads (Jaret, 2002). Developers have taken advantage of these road projects by constructing car-based developments

Table 3.1: The chronological building of GA-316

Stretch of GA-316 From (west)	To (east)	Open to traffic	Length
I-85	SR-120	5/1968	5.2 miles
SR-120	US-29	6/1981	5.6 miles
US-29	SR-11	10/1991	13.0 miles
SR-11	SR-10/US-78	7/1993	12.6 miles
SR-10/US-78	SR-10 loop	8/1995	3.6 miles

in Atlanta's suburban and exurban areas (Bullard, 2000). The Atlanta region exemplifies the new type of city that has grown drastically in the southern and western parts of America. It experienced population growth between 1990 and 2000 in excess of 38.9% (Jaret, 2002). The metropolitan area's sprawling suburbs produced much of this development, resulting in Atlanta's ten-county metropolitan area containing four of the ten fastest-growing counties in the U.S. between 1990 and 1998 (Brookings Institution, 2000).

The Atlanta real estate and transportation professionals had constructed a finely-tuned growth machine in the 1980's and 1990's. However, the lack of broad planning control by Atlanta's planning organizations (e.g. the Atlanta Regional Commission) and the fractured nature of Georgia counties vying for political power demonstrated the need for better transportation planning and growth management. The federal government withheld federal highway funds from the Atlanta region starting in 1998 because of noncompliance with federal air quality regulations. As a result, Governor Roy Barnes created the Georgia Regional Transportation Authority (GRTA) as a central transportation planning organization with overarching planning power over the 13 counties that had failed federal clean air regulations. However, GRTA's capacity to solve transportation problems through coordinated regional planning has been hampered by continuously redefined mission statements and a constantly changing board of directors subject to political shifts (Saporta, 2003).

In the region, Athens and Atlanta act as identifiable centers to which businesses and population are attracted by accessibility to employment, labor, and customer bases. While neither urban core is growing at rates as high as their suburbs, they offer labor, customers, and economic activities to which further suburban development needs to have access. Improving accessibility by increasing mobility through transportation networks has not only allowed the Atlanta metropolitan area to economically dominate Georgia, but also to play a strong role in the southeastern U.S. In comparison, Athens acts as a strong regional player in northeastern Georgia, concentrating on enabling local and regional accessibility by modest state roads, a perimeter loop, and agglomeration of population and economic activity.

While Atlanta also serves as a center for agglomerated economic activity, Atlanta has concentrated on *creating accessibility* and enabling economic development through transportation infrastructure that *increases mobility*. This distinction is important because some urban systems have relied on enabling denser land use, coupled with mobility as their means to creating accessibility. Accessibility patterns to and within Atlanta have largely been a function of high mobility through Atlanta's role as a transportation hub. Much of Atlanta's economic success has also been a function of the interstate and regional traffic coming through Atlanta because of its status as an area of high mobility. Interstate ground traffic often passes through Atlanta on one of the three converging major interstates (I-20, I-85, and I-75). I-285 then functions as a perimeter belt that enables traffic to bypass Atlanta's downtown. Through these highly-developed transportation networks, Atlanta functions as a zone of high mobility whose area of influence has spread rapidly into the suburbs, seemingly wanting to test notions of space-time convergence.

Within Atlanta's history of swift suburban growth and expanding transportation networks, GA-316 was built in five sections between 1968 and 1995. The first 11 miles were constructed in two sections before 1981, primarily in response to the pressures of Atlanta's economic and population growth. These first sections periodically have been improved and expanded and are currently high-speed limited access highways. The last 29 miles–upon which this study focuses- completed the Athens-Atlanta connection and were built between 1991 and 1995. According to Turner (1986), planners designed the new sections of GA-316 in response to growth-induced congestion on US 29, the historical transportation link connecting northern Atlanta with Athens. While planners and policy makers long wanted to make the newest sections of GA-316 limited access highways as well, budget restrictions in the early 1990's prevented the necessary funds from being invested. As a result, a compromise was reached in which the new sections of GA-316 were not limited access, and instead had traffic lights and high speed limits (usually 55 or 65 miles per hour). While planners considered creating a rail link between Athens and Atlanta in order to relieve congestion and supplement US 29's road capacity with a public transportation option, extending highway GA-316 to Athens was ultimately chosen.

Based on the comments of planners and politicians in the ultimate public meeting discussing the final sections of GA-316, this new highway was designed to provide additional capacity by augmenting the existing transportation network and reducing east-to-west and west-to-east travel times (Turner, 1986). At the same time, newspapers publicized these new sections of GA-316 as giving Atlanta residents quicker access to extracurricular amenities and sporting events at the University of Georgia in Athens (see Grizzard, 1991, Grizzard, 1993, or McCarthy, 1995). GA-316 has remained a politically sensitive issue for area residents and the idea of turning GA-316 into a high-tech research corridor has repeatedly been publicized. The potential for GA-316 to be upgraded to a limited-access highway has remained an option since its construction, resulting in uncertainty surrounding the corridor.

By using GA-316 as a case study, I will concentrate on changing accessibility patterns as the means through which building highways impacts the spatial distribution of economic activity. Traditional notions of this relationship indicate that higher accessibility change should significantly increase levels of economic development (Botham, 1980; Dodgson, 1974). Before investigating whether this relationship still holds, I outline the methodology that I use to study the impact of changed accessibility through highway investment on economic activity.

Methodology

Research on the influences of transportation investment on economic development has used a wide variety of approaches to determine how economic activity is impacted by changing transportation networks. Different methodologies have included qualitative analysis, inferential quantitative methods, or combinations of interviews and quantitative analysis. While extremely localized approaches that focus on establishing causal relationships have been difficult to apply across the board, generalized macroeconomic studies are badly suited for understanding the complexities of this dynamic relationship. In this study of the GA-316 corridor, I concentrate on the impact of highway investment on different economic-sectors using multivariate regression to examine explanatory variables that can then be compared with similar studies. By using this approach, I isolate accessibility as an important explanatory variable often used to describe ***how*** highway investment influences development in different economic sectors (for similar studies, see Botham, 1980, Dodgson, 1974, or Linneker and Spence, 1996). Accompanying the multivariate regression results for each economic sector, I present maps showing some of the key changes in the spatial distribution of economic activity.

Using census block groups as observations (N=301), I use weighted least squares (WLS) regression to estimate job growth models. I estimate one model for overall economic activity and nine sector specific models based on the major Standard Industrial Classification (SIC) divisions. In each model, the level of 2000 employment serves as the dependent variable measuring post-316 economic development, while 1992 employment, labor availability, labor talent, and accessibility change serve as the independent variables. Using these regression equations, one can compare the different impacts of changed accessibility due to GA-316 on each economic sector, while controlling for existing levels of economic activity and the other important factors. Before discussing the multivariate regression equation, I review some important methodological considerations.

Spatial Scale

When studying the economic impacts of transportation investment, one must carefully think about the spatial scale at which regions would be affected. National highway systems, local highway bypasses, or intermediately-sized projects need to be studied at different scales due to their different transportation goals and areas of influence. While GA-316 is not designed to meet the needs of interstate traffic, its goal of enabling faster and easier interaction between two metropolitan areas causes it to influence accessibility patterns along a large corridor. In light of GA-316's purpose of allowing quicker travel times between Athens and Atlanta, areas along US 29 and US 78 were also included in the area that was potentially affected. The study area is thus a band of roughly ten miles on either side of GA-316 (see Figure 3.1).

Both accessibility and economic development are location-specific concepts. As a result, it is important to aggregate the study area into sufficiently small spatial units to capture subtle accessibility and economic differences between areas. In addition, because it is important to control for other demographic variables, the study area is divided into 301 *census block groups* – for which data are available from the United States Census Bureau (see Figure 3.1).

Temporal Scale

Because road investment has high upfront costs and is spatially fixed, highway projects and their influences on surrounding activity are long-term in nature (Linneker and Spence, 1996). However, the timing of when highway projects impact varying types of economic activity differently is not well understood. Many studies have found a one-time sudden change in which traffic-oriented businesses suddenly appear immediately after highway construction (e.g. Anderson and Otto, 1991; Burress, 1996). According to EDRG (2001), there must be more research studying the time lag of economic reactions to transport investment.

Banister and Berechman (2000) outline an effective approach to the temporal dynamics of transportation investment's influence on economic development. In order to promote comparability among studies, the authors advocate streamlining studies on the influence of transport investment on economic development. They claim that one should have either short-to-medium term studies that are up to 10 years after investment or medium to-long term studies that occur over 10 years after infrastructure construction (Banister and Berechman, 2000). This study is a short-to-medium term study that uses an eight-year lapse time in order to measure economic change between 1992 and 2000.

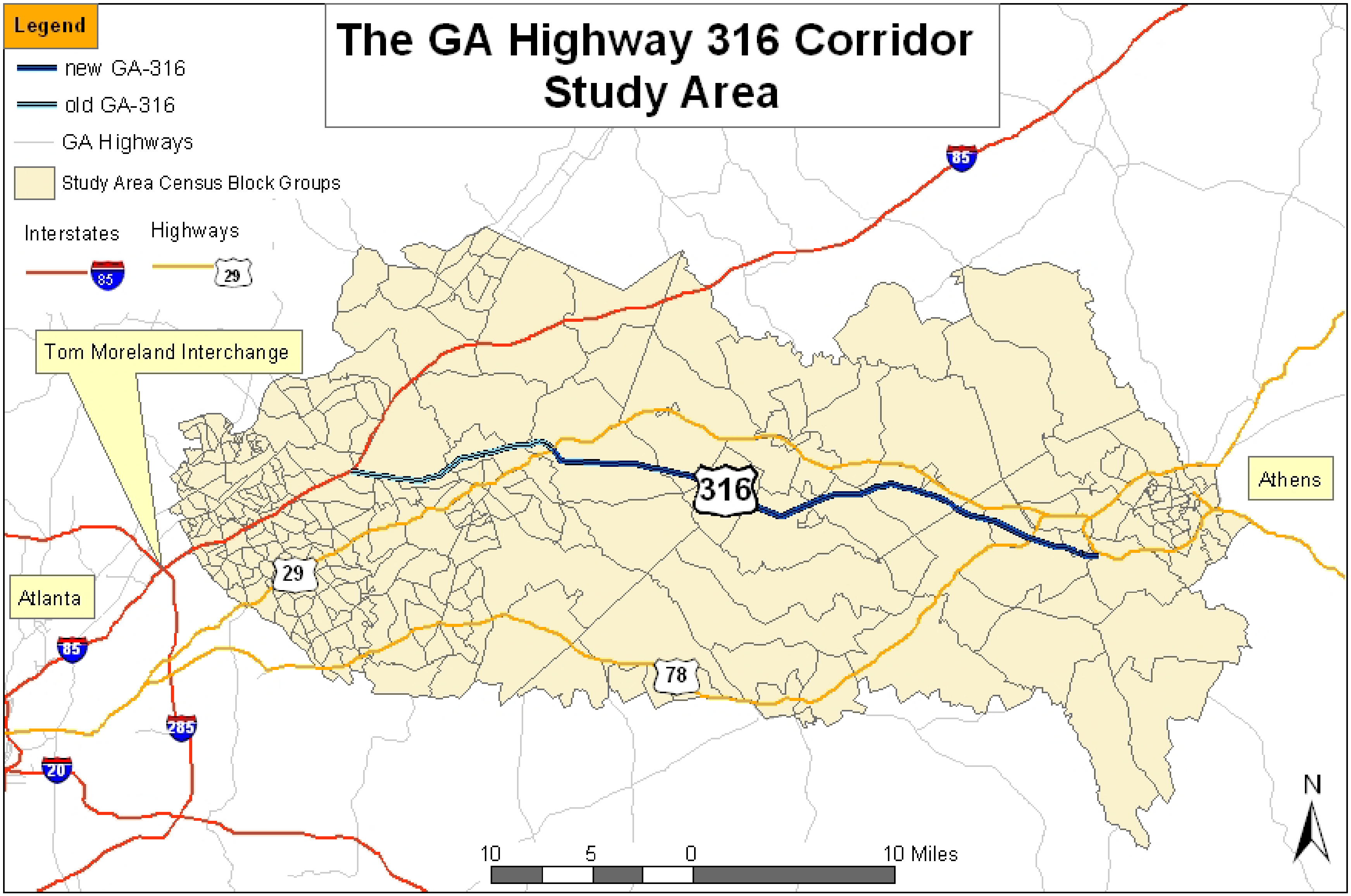

Figure 3.1: The GA-316 Corridor Study Area, including US 29 and US 78

Differentiating amongst economic sectors

While I have spoken about the relationship between highway investment and economic development as if economic development were a simple linear concept that could be increased or decreased with accessibility changes, this is not the case. As documented in much previous research (EDRG, 2001 or Eyerly *et al.*, 1987), it is important to understand how economic sectors react differently to highway investment. While some types of activity may benefit tremendously from transport investment, others may be negatively impacted. Researchers studying sector-specific reactions to highway investment have highlighted some important distinctions, within which this study hopes to evaluate even further differences.

According to Kanaroglou *et al.* (1998), distinguishing between *export-oriented sectors* and *highway-dependent sectors* is important for better understanding how highway investment changes the spatial distribution of economic activity. Export-oriented sectors are generally made up by the primary, manufacturing, wholesale distribution, and transportation-industry sectors. These businesses benefit from their own increased accessibility to external markets through reduced travel times and costs, and thereby gain advantages over competing businesses (Kanaroglou *et al*., 1998). In contrast, highway-dependent sectors generally entail service-sector businesses that gain much of their customer base from being conveniently located within the activity spaces of their customers. In order to be conveniently located for their customers, highway-dependent sectors are generally located adjacent to a highway between the home and work locations of potential customers. Highway-dependent sectors are sensitive to their customers' locations of residence and travel behavior, resulting in the need to be flexible in reacting to the redistribution of traffic (Kanaroglou *et al.*, 1998).

In this analysis, I expand on Kanaroglou *et al.*'s (1998) insight by further subdividing economic activity into nine groups representing nine of the primary SIC groups. The tenth major SIC group, mining, was eliminated due to the small amount of such activity occurring in the study area. My multivariate regression models thus estimate the impacts of accessibility change due to highway investment separately on each of the nine economic sectors (See Table 3.2).

Table 3.2: Economic Sectors being evaluated

SIC Division	**Title**
A	Agriculture
B	*Mining (omitted due to the lack of such activity in the study area)*
C	Construction
D	Manufacturing
E	Transportation, Communications, Electric, Gas, and Sanitary Services
F	Wholesale Trade
G	Retail Trade
H	Finance, Insurance, and Real Estate (FIRE)
I	Services
J	Public Administration

Regression Variables

In the multivariate regression equations, I concentrate on the relationship between economic development and accessibility, while controlling for other site-specific factors. Both pre-GA-316 (1992) and post GA-316 (2000) economic activity are measured in terms of employment from the Bureau of Labor Statistics ES-202 employer-level disaggregate data. Accessibility change is measured by using the change in a conventional distance measurement of accessibility. Finally, labor availability and labor talent are included in order to control for these factors that are often influential. Appendix A provides descriptive statistics for the variables used in the models.

Measuring Economic Development

Previous studies have most frequently measured economic development in terms of employment, population, personal income/earnings, or business sales –among others (EDRG, 2001). In this study I measure economic development in terms of employment (similarly to Botham, 1980, Linneker and Spence, 1996), for the years 1992 (as a proxy for pre-GA-316) and 2000 (after its construction) using *Employment Security (ES) 202 Covered Employment and Wages* (ES-202) data. ES-202 data are collected by the Department of Labor- Bureau of Labor Statistics when employers apply for unemployment insurance. I use employer-level ES-202 disaggregate data available for Clarke, Oconee, Barrow, Walton, Jackson, and Gwinnett counties in Georgia.

Public ES-202 data are available aggregated to the county level while the disaggregate data are divided by each individual employer. These employer-level disaggregate data are only available to university researchers and for other special purposes via special agreement with the Bureau of Labor Statistics. Attribute information is available for each employer on physical address, mailing address, SIC division, number of months in business, number of employees over this time period, and total earnings of the employees –among other potential variables. In order to use these data for detailed geographic analysis, one must determine the exact spatial location of each employer in the disaggregate data. As a result, the physical addresses of the employers were geocoded into a geographic information system in order to determine block group membership.

While mailing and physical addresses of employers are available for both 1992 and 2000, data collection techniques improved between 1992 and 2000, resulting in a difference in the quality of the address information between the two time periods. In order to compensate for missing addresses, I used online telephone directories to find 2000 addresses of companies in the ES-202 data. Minor corrections to the 1992 data, such as correcting the spelling of a street or determining the ZIP code, could similarly be accomplished with online telephone directories. However, determining the locations of 1992 businesses with missing or largely incomplete addresses required visits to regional libraries with historic telephone books and city directories.

Some inaccuracies in ES-202 addresses were present for all types of employers. However, other researchers indicated that large multi-national companies were significantly less likely to be correctly geocoded. According to Dr. Ed Feser, a professor at the University of North Carolina-Chapel Hill, large multi-national companies are often undercounted because of their tendency to list their headquarters address as the physical address (Feser, 2003). In this way, branch offices are often not counted as part of local economic activity. Because this particular study does not attempt to statistically correct for the undercounting of satellite divisions of large multinational companies, this must be considered when reviewing the results of this study.

Because of the better address information used to geocode the 2000 data, I had a final 2000 ES-202 hit-rate of 84% while I could only reach a 79% return for the 1992 ES-202 data. As a result the measurement of total yearly employment used in the regression models had to be statistically modified in order not to overestimate the employment change. The study area does not perfectly coincide with the six counties with which it overlaps. However, by comparing the original ES-202 microdata with that portion of the data whose addresses were successfully matched, one can see any systematic inaccuracies generated in the geocoding process. Figure 3.2 is useful to both assess the general representativeness of the geocoding and to compare any shifts in economic activity from 1992 to 2000. When comparing the total 1992 and 2000 employment with the geocoded 1992 and 2000 employment, one sees that there is a tendency for the geocoded data to overcount retail and service-sector jobs in 1992 and 2000. At the same time, manufacturing, public administration, and transportation, communication, and electricity-related jobs were equally likely to be undercounted by the geocoded data in both 1992 and 2000. However, because both the geocoded data and the complete ES-202 microdata estimate similar proportions of employment change in each sector, this gives an excellent measure of employment change. The only noticeable differences are that the geocoded data underestimates the change in construction employment, while overestimating the change in wholesale employment.

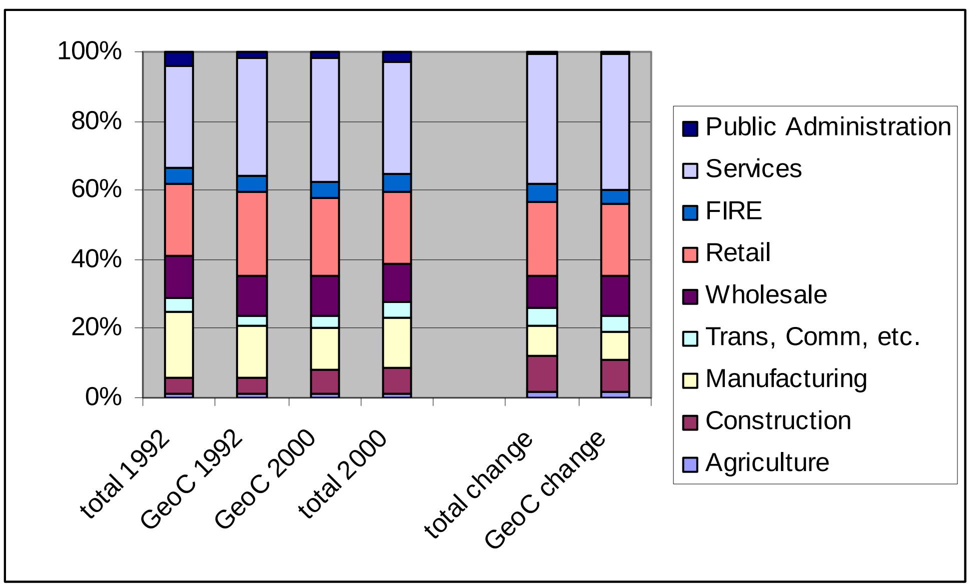

Figure 3.2: Economic Sector Proportion of 1992 and 2000 employment according to ES-202 microdata, comparing complete and geocoded data

Measuring Accessibility

In order to examine how changed accessibility patterns can impact the restructuring of economic activity, I devise an index that measures the change in accessibility that is specifically due to GA-316. This measurement of accessibility, categorized as a conventional distance measurement, measures the travel time to the intersection of I-85 and I-285 (officially called the Tom Moreland Interchange, but locally called Spaghetti Junction) from the centroid of each census block group. I use a current road network with GA-316 and one without GA-316 to compute the difference between 2000 travel time to Tom Moreland interchange with GA-316 and without GA-316, simulating what might have happened if GA-316 had not been built. In this way, the measurement determines the percent change in accessibility that is strictly due to GA-316, while controlling for all other changes to the road network.

The conventional distance measurement (in this case using travel time) is appropriate for this study because it involves one urban area (Atlanta) that dominates most economic activity. I chose the Tom Moreland Interchange as the 'opportunity location', or destination, for two primary reasons. First, it serves as a proxy for northern Atlanta, the region's booming center of growth. Second, the Tom Moreland Interchange is a key transportation node through which much northeastern outgoing and incoming local and inter-state traffic must pass. I use TransCAD, a GIS designed for transportation analysis, to generate these measurements of changed accessibility.

This accessibility measurement effectively measures the changed ability for somebody to travel from each of the block groups to northeastern Atlanta, assuming that this is the opportunity location of most interest. However, this measurement inherently concentrates on the mobility component of accessibility and does not consider the spatial distribution of other activity locations. I ignored the land use element of accessibility because employment is often the "opportunity type" used to account for this component, but cannot be used because employment serves as the dependent variable in my models. Even though this is a weakness of my accessibility measurement, the final accessibility results were essentially identical to test results in which I accounted for land use by using the spatial distribution of block groups to weight the changed accessibility of each block group to one another[1].

Controlling for Labor Availability and Labor Talent

In order to isolate the impact of accessibility change on economic development, it is also important to control for other factors that influence the likelihood of economic development occurring in a particular area. According to previous literature, labor availability and labor talent are important factors that can affect the spatial distribution of economic development (EDRG, 2001). I use 1990 STF-3 U.S. census data as the source for my measurements of both of these control variables. In order to measure *labor availability*, I use the 1990 block group population. The population in the entire study area is just over 450,000, about 1,520 individuals per block group. I measure *labor talent* using the percent of the population within a block group that has a Bachelor's degree or above in 1990. On average, 17.9% of the individuals in a block group have a Bachelor's degree or above. For detailed descriptive statistics for all variables, see Appendix A.

Basic Multivariate Regression Model

Using the variables described above, a multivariate regression equation is estimated for each of the nine economic sectors and for overall employment in the study area. The basic multivariate regression equation for each of the models is:

$$O_{aij} = \beta_1 O_{bij} + \beta_2 A_i + \beta_3 P_i + \beta_4 G_i + \beta_5 U_i + \beta_{oj} + E$$

where:

O_{aij} = log of # of employees in block group i working in SIC code sector j in 2000, measuring post-316 economic development

O_{bij} = centered log of # of employees in block group i working in SIC code sector j in the base year 1992, measuring pre-316 economic development

A_i = centered percent change in accessibility due to GA-316 in block group i

P_i = centered ln of population in block group i

G_i = centered proportion of population in block group i with a Bachelor's degree or above in 1990

β_{oj} = constant for the model of economic sector j

E = error term

Initial Diagnostics

Having calculated the regression variables, a preliminary model was examined for violations in basic assumptions and nonlinear functional forms. White's test revealed significant heteroskedasticity. Accordingly, the logarithm was taken of the independent variable representing pre GA-316 levels of economic development, the dependent variable of 2000 economic development, and the measurement of population (plus a small constant). While none of the other variables were transformed, I centered all independent variables around their mean so that I could interpret the y-intercept as applying to a block group with the mean logged employment levels and with the mean characteristics on all other independent variables. I included each independent variable in all multivariate regression models (even when the variable was not significant) in order to permit comparison of the models.

However, heteroskedasticity remained after transformation, and I pursued Weighted Least Squares (WLS) estimation to improve model efficiency. I weighted all regression equations by the log of the total base-year employment (1992) in order to emphasize block groups about which more was known. In the final regression equations N decreases from 301 to

295 because block groups that have no 1992 employment are eliminated by the weight. By estimating the weighted regression equations, model efficiency was improved as indicated by reduced standard errors. These equations also yielded similar parameter estimates to those based on the initial unweighted regression equations, indicating stability.

In contrast to the heteroskedasticity, multicollinearity does not pose a problem. Scatterplots of the regression equations show no systematic error terms that would indicate that the relationship between the variables may be non-linear. Low variance inflation factors and low correlation coefficients between variables included in the models do not cause concern for multicollinearity. As a result, the multivariate regression models satisfactorily passed the diagnostic tests needed for effective research interpretation.

Having constructed an effective weighted least squares regression model, in the next chapter I will look at the descriptive statistics on the employment and accessibility variables in much more detail. These two variables are the focus of the regression models and should be thoroughly examined. Finally, the functional form and results of the regression models are presented in the results section.

CHAPTER 4

DESCRIPTIVES

The core objective of this study is to determine the relationship between changed accessibility patterns and economic development. My measurement of economic development is measured in terms of employment and is aggregated at the census block group-level. A simulated measurement of changed accessibility strictly due to GA-316 provides an effective means of looking at how highway investment can impact economic development. Because accessibility change and economic development are such an integral part of this research, I would like to examine these two variables in much more detail. Good understanding the measurements of economic development and accessibility will improve substantive interpretation of the models presented in Chapter 5.

Economic Development

Total study area employment increased from 168,801 in 1992 to 308,946 in 2000 based on the geocoded ES-202 data. Figure 4.1 compares the employment levels in 1992 and in 2000 (83% growth) for each of the economic sectors. Service sector and retail employment clearly make up the largest share of employment in both 1992 and 2000. Both sectors grew tremendously from 1992 to 2000. Service-sector employment experienced enormous growth, almost doubling from 56,696 employees in 1992 to 111,113 employees in 2000. Similarly, retail employment grew from 40,372 employees in 1992 to 69,966 employees in 2000. In contrast, public administration and agriculture make up the smallest share of total employment in both

1992 and 2000. Figure 4.1 indicates that retail and service-sector employment continue to make up the largest share of jobs in the study area.

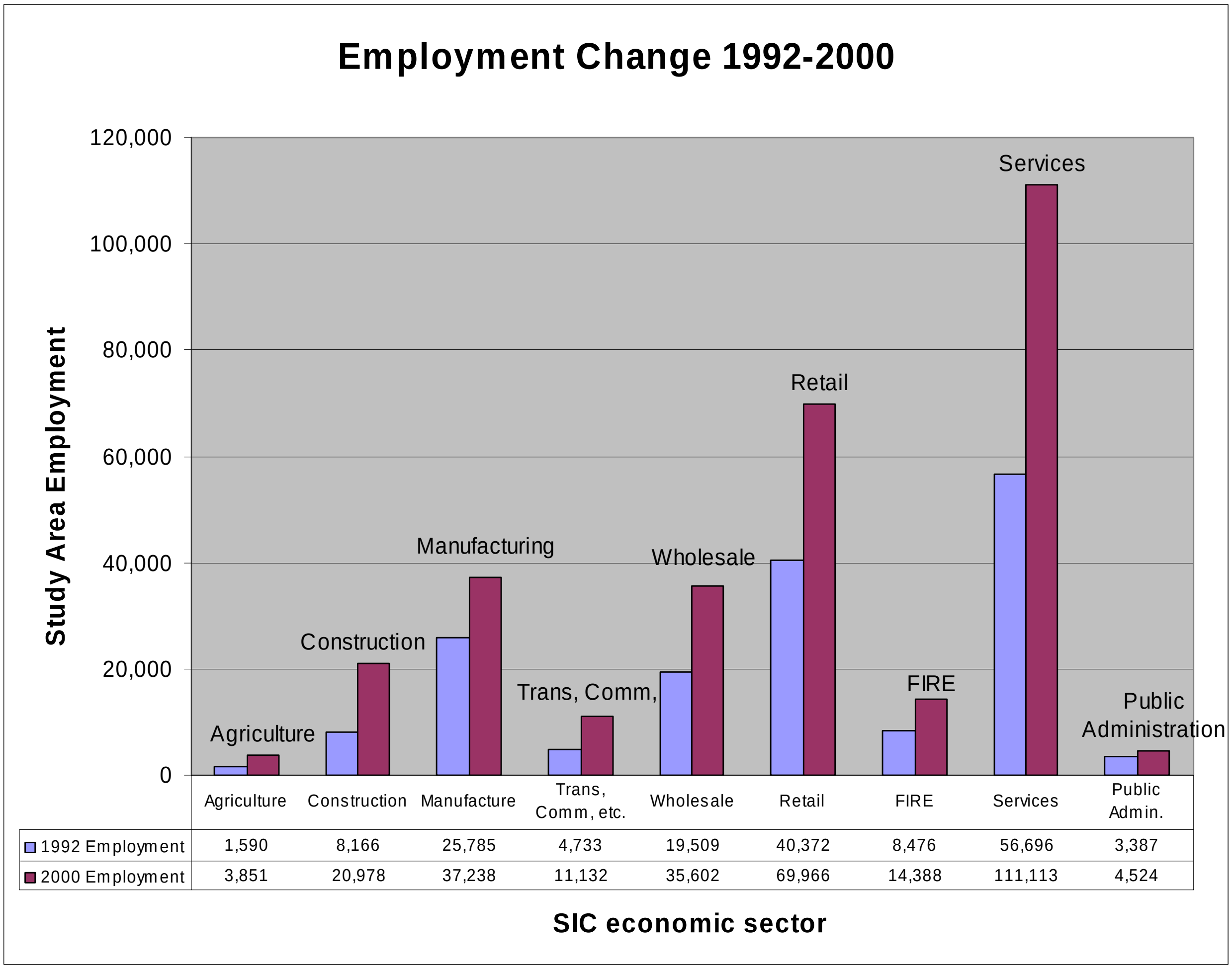

Figure 4.1: Sector-specific employment in 1992 and 2000 in the study area

Figure 4.2 shows the percent increase in employment for each economic sector from 1992 to 2000. Compared to the percent increase in overall employment in the entire study area (83%), each economic sector increased at different rates. Three of the sectors that make up the smallest share of total employment grew at rates significantly higher than the total percent growth. From 1992 to 2000, employment in the construction, agriculture, and transportation, communication, and utility sectors more than doubled; employment increased 157%, 142%, and 135% respectively in these sectors. Because these three sectors make up smaller proportions of total employment, small absolute increases in these sectors can translate in huge leaps in their relative importance in the study area. Even though public administration and manufacturing were the slowest growing sectors in the study area, they still accounted for astounding economic growth compared to many other regions. Public administration employment grew by only 34% while manufacturing employment grew by 44% over the eight-year period. While a 44% increase in manufacturing employment in only eight years is remarkable, the slower growth in

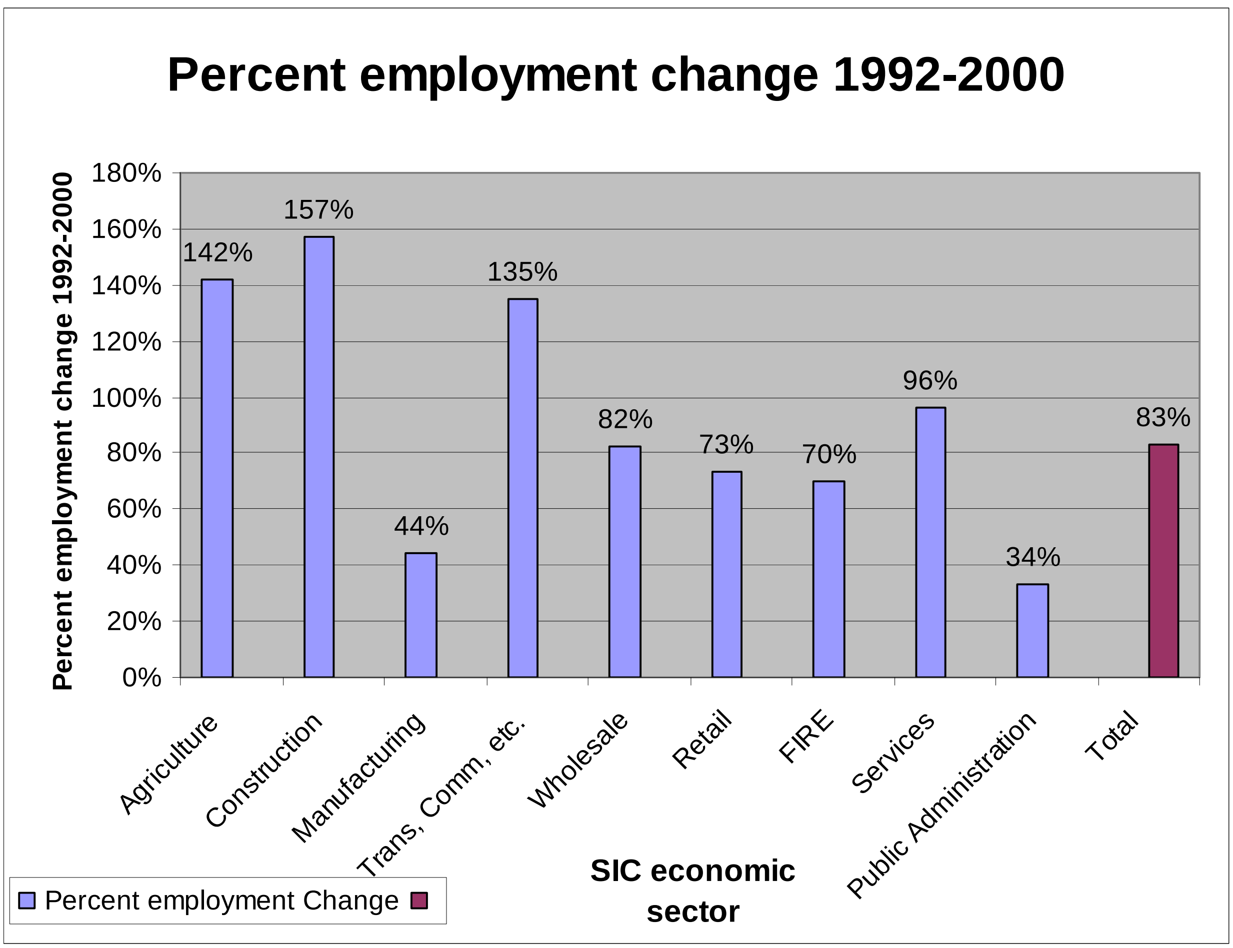

Figure 4.2: Sector-specific percent employment change from 1992 to 2000 in study area

manufacturing than in other sectors reflects the continuing trend of the U.S. economy to become more service-oriented and less focused on manufacturing. Slower growth in public administration employment, on the other hand, reflects that these often-government jobs do not generally fluctuate or grow as fast as private sector industries.

Shifting from a look at the types of economic activity in the study area in the eight year period from 1992 to 2000, Figures 4.3 and 4.4 show the spatial distribution of businesses. In both 1992 and 2000 the largest clustering of economic activities occurred in Clarke County in the east and Gwinnett County in the west. At the same time, smaller clusters emerge in intermediate areas that represent small towns. Because Figures 4.3 and 4.4 show the exact physical locations of businesses in 1992 and 2000, one can see how there are often long clusters of businesses along significant roads or regional highways. For example, there are distinct corridors with business concentrations along highways directly to the west and to the southeast of Athens. However, when looking at Figure 4.4, one does not yet notice a significant corridor with business concentrations along GA-316, indicating that the economic impact may not yet have been felt.

Figure 4.5 depicts the spatial distribution of total block group employment change. The red circles represent varying degrees of employment growth from 1992 to 2000 that are primarily clustered in Gwinnett County in the west and in Athens, in the east. In the west, Gwinnett County seems to have functioned not only as the focus of most economic activity in 1992, but also as the site of most employment growth in the study area. In the east, Athens seems to have similarly functioned as the focus of most 1992 employment and also experienced the greatest concentration of employment growth. In contrast to the spatial patterns of employment growth,

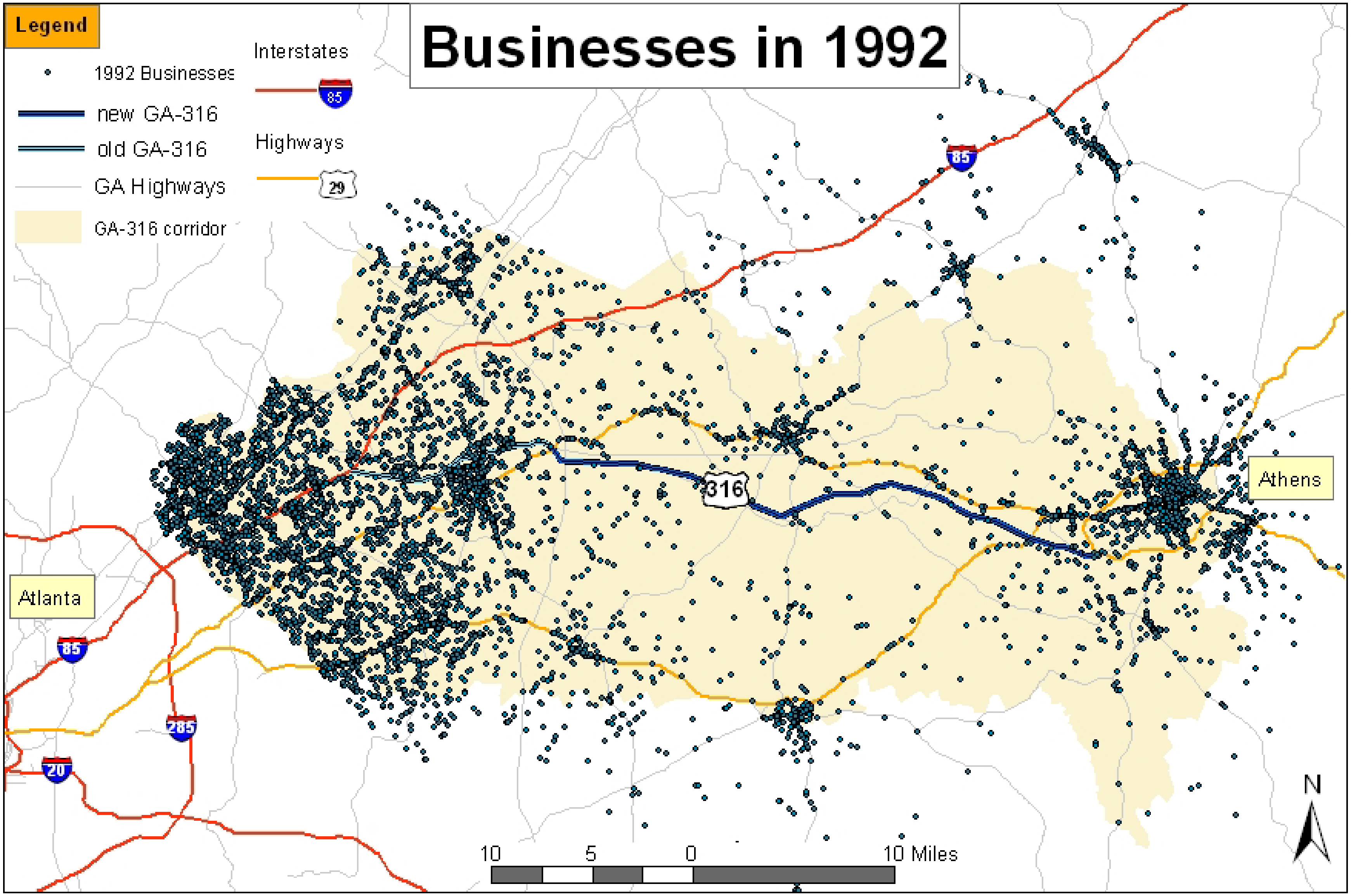

Figure 4.3: Businesses in 1992 based on ES-202 disaggregate data

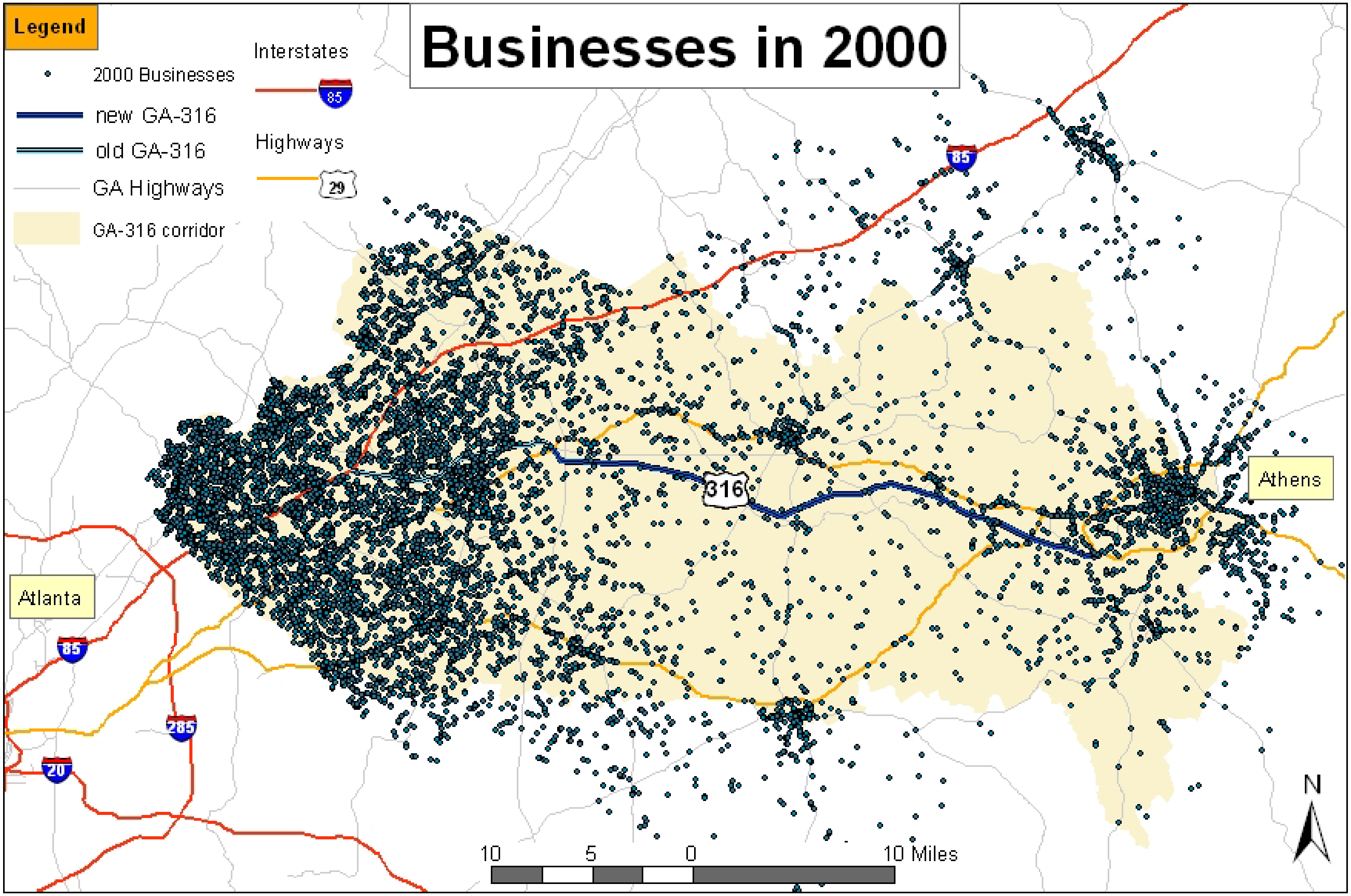

Figure 4.4: Businesses in 2000 based on ES-202 disaggregate data

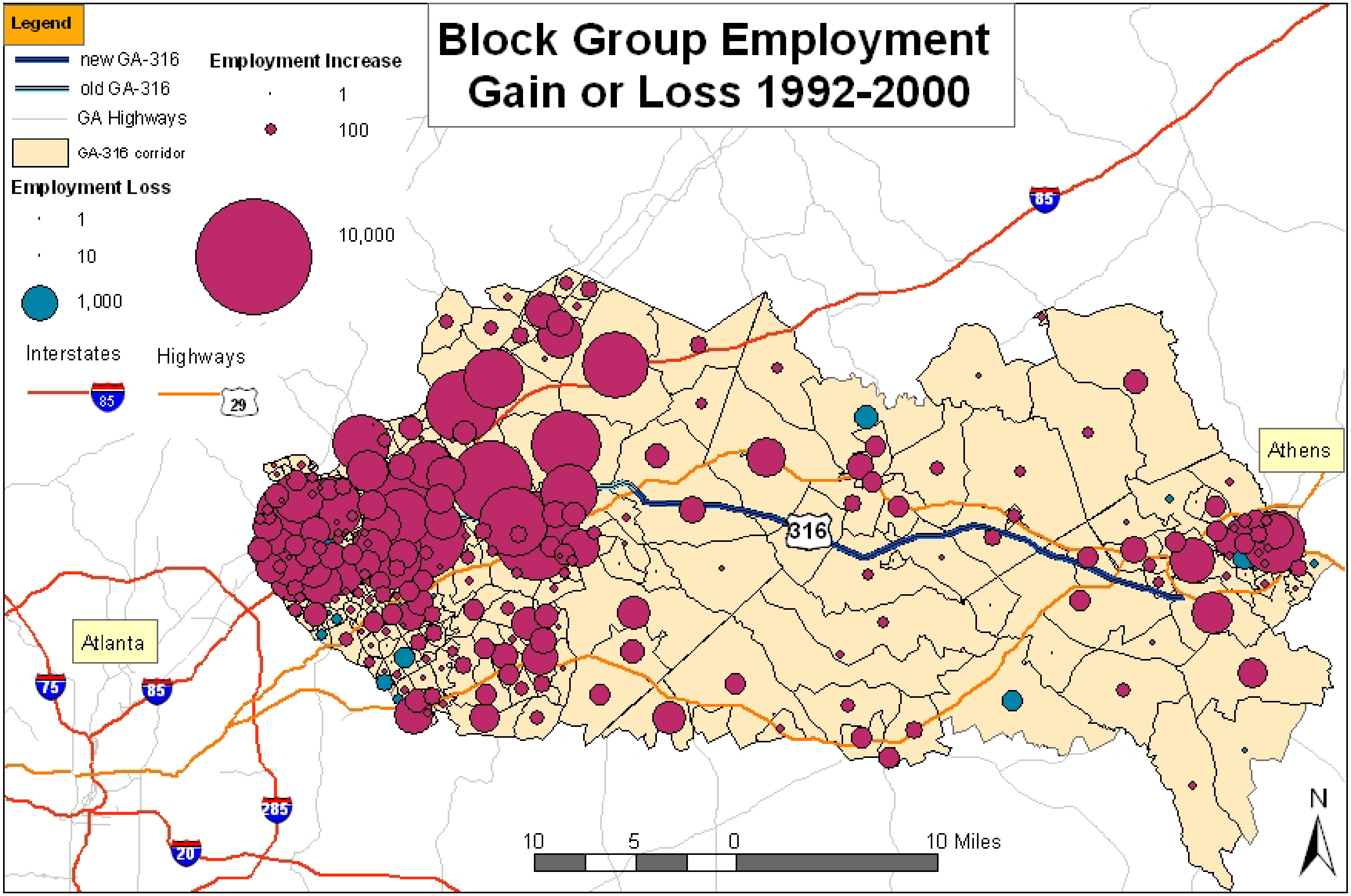

Figure 4.5. Block Group Employment Change in the GA-316 corridor

the blue circles that depict block groups with employment loss do not show very pronounced clustering.

Accessibility Change

Figures 4.6 and 4.7 demonstrate that areas further west have higher measurements of accessibility both in the real 2000 network and in the 2000 network without GA-316. In the simulated environment in which GA-316 did not exist, the mean travel time to Tom Moreland Interchange was 26.1 minutes. This number improves to a mean of a 23.3-minute travel time with GA-316. Because many of the block groups do not have improved travel times, this three minute improvement in travel time is more pronounced for those areas that benefit from GA-316. After transforming these changes in travel time into percent changes in accessibility, the maximum percent accessibility change becomes 17.0% while the minimum is 0.0%. A 0.0% change would indicate that travel times for that block group did not change due to GA-316. Conversely, a 17.0% accessibility change would indicate a 17% improvement in travel time due to GA-316. The mean percent accessibility change for the study area is a 2.2 % improvement in travel time for the study area block groups.

The map of accessibility change (Figure 4.8) shows the greatest change in accessibility along the corridor itself and in the eastern portions of the study area. Because the measurement of change uses the percent change in accessibility, this results in areas with great time improvements in accessibility and with originally low travel times having the highest percentage accessibility change. Measuring accessibility in this way assumes that reducing a 30 minute travel time by 10 minutes is more significant than reducing a 90 minute travel time by 10 minutes. One can thus see a cluster of the highest percentage of accessibility improvement directly in the center of the study area immediately along GA-316.

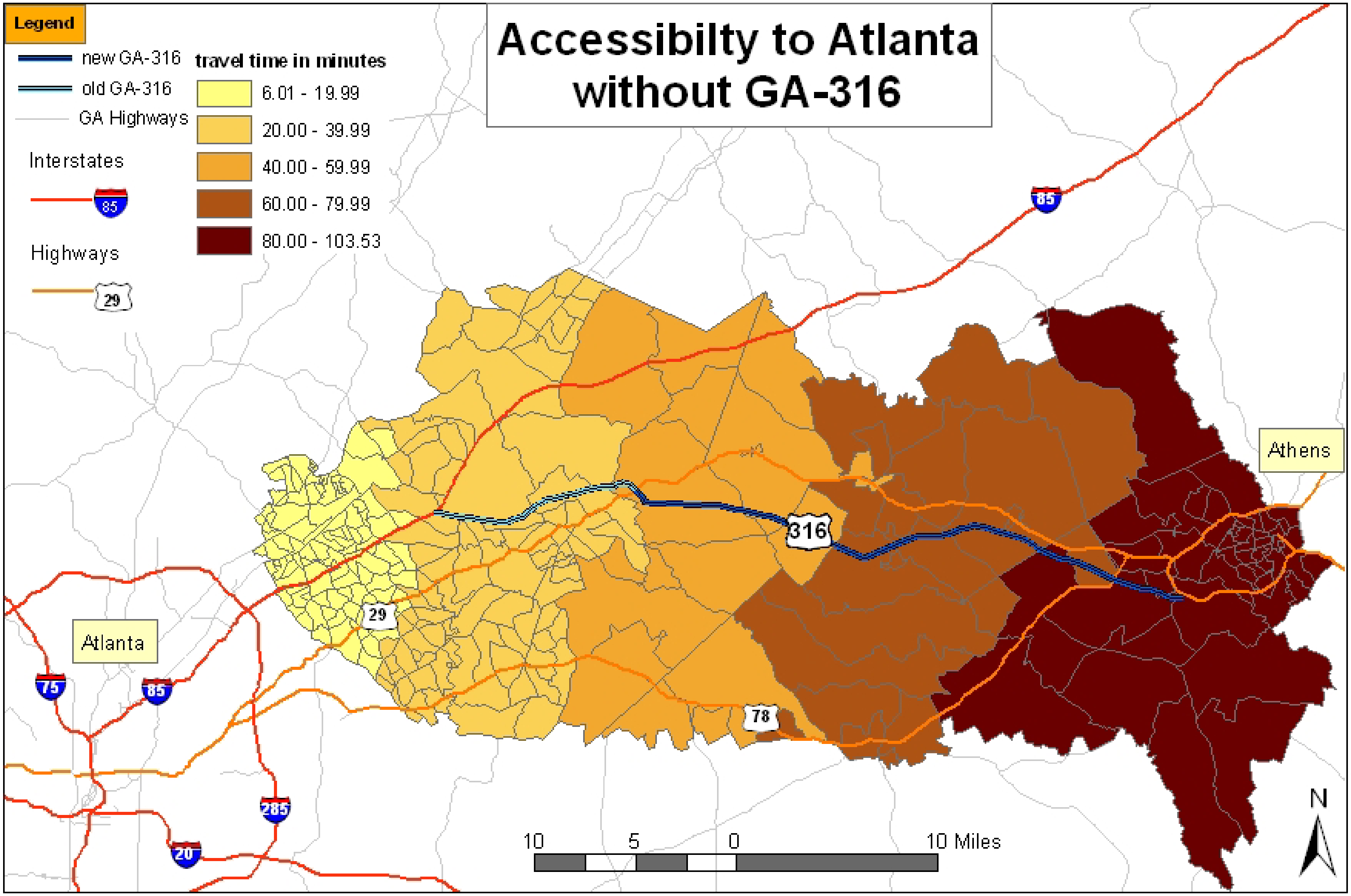

Figure 4.6: Simulated Accessibility to Tom Moreland Interchange without GA-316 (travel time in minutes)

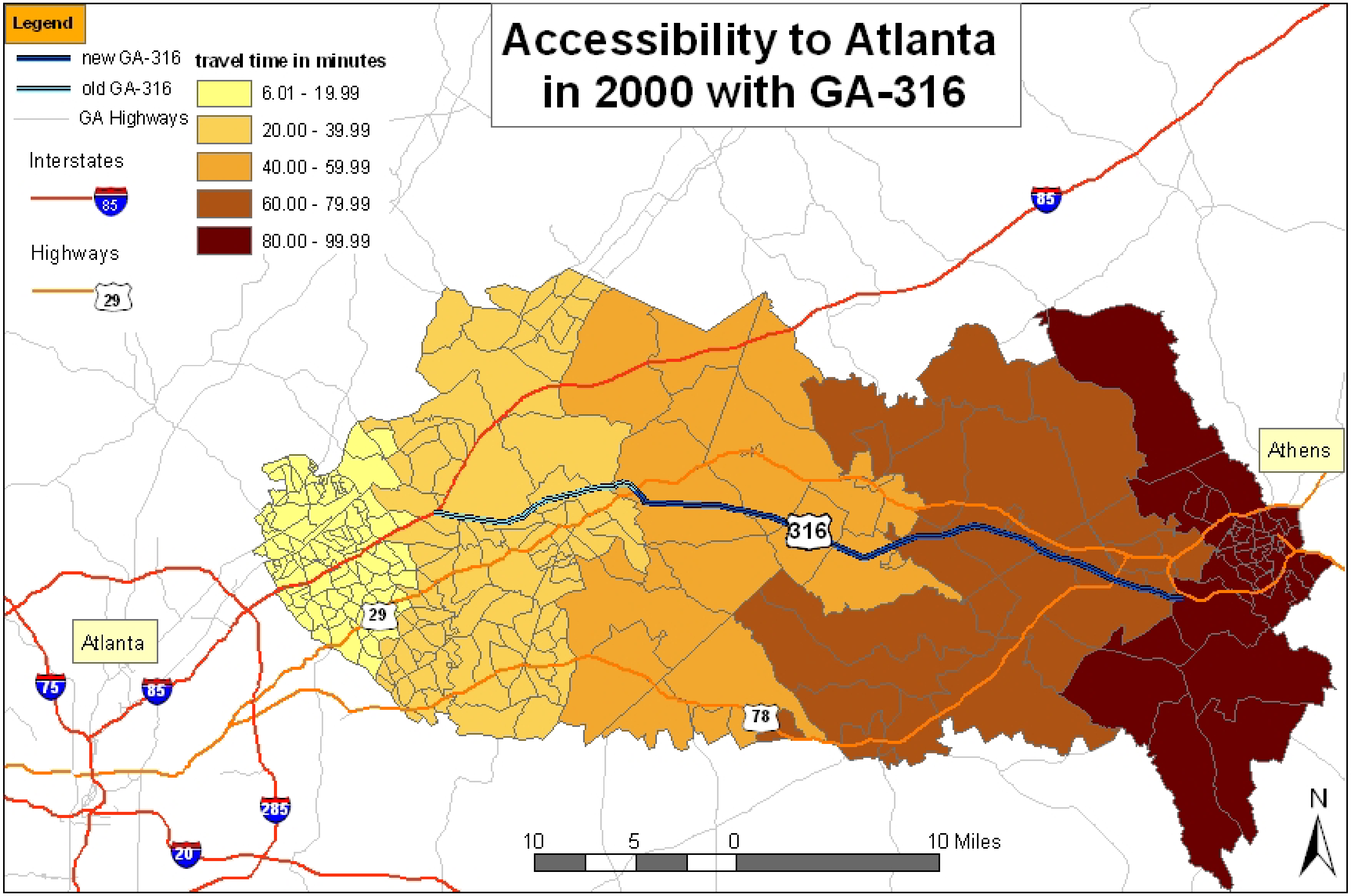

Figure 4.7: Accessibility to Tom Moreland Interchange in 2000 with GA-316 (travel time in minutes)

Comparing this cluster of high accessibility change along GA-316 in Figure 4.8 to the actual spatial distribution of employment change in Figure 4.5 reveals that this area is highly rural and has very little economic growth. Given this simple visual observation, one would predict that improved accessibility would have an insignificant or negative relationship on increased economic activity. For better comparison of these two maps, Figure 4.9 overlays a dot map representation of total employment change over a choropleth map of accessibility change. In Figure 4.9, the areas with the greatest improvement in accessibility to Atlanta seem to have gained from the smallest increases in employment from 1992 to 2000. Western portions of the study region, and northern Gwinnett County in particular, have the biggest concentrations of increased employment. Clarke County in the east also shows higher levels of employment, especially in northern Clarke County (downtown Athens). However the growth in the east is very small compared to that in the west. Along GA-316 in the areas that most benefited from increased accessibility, one can also see scattered increases in employment, but no large clusters such as Gwinnett County's growth hot spots. Given these spatial patterns, one begins to question how GA-316 has changed the economic landscape of the corridor. In the next chapter I will explore this question in more depth by reviewing the multivariate regression results.

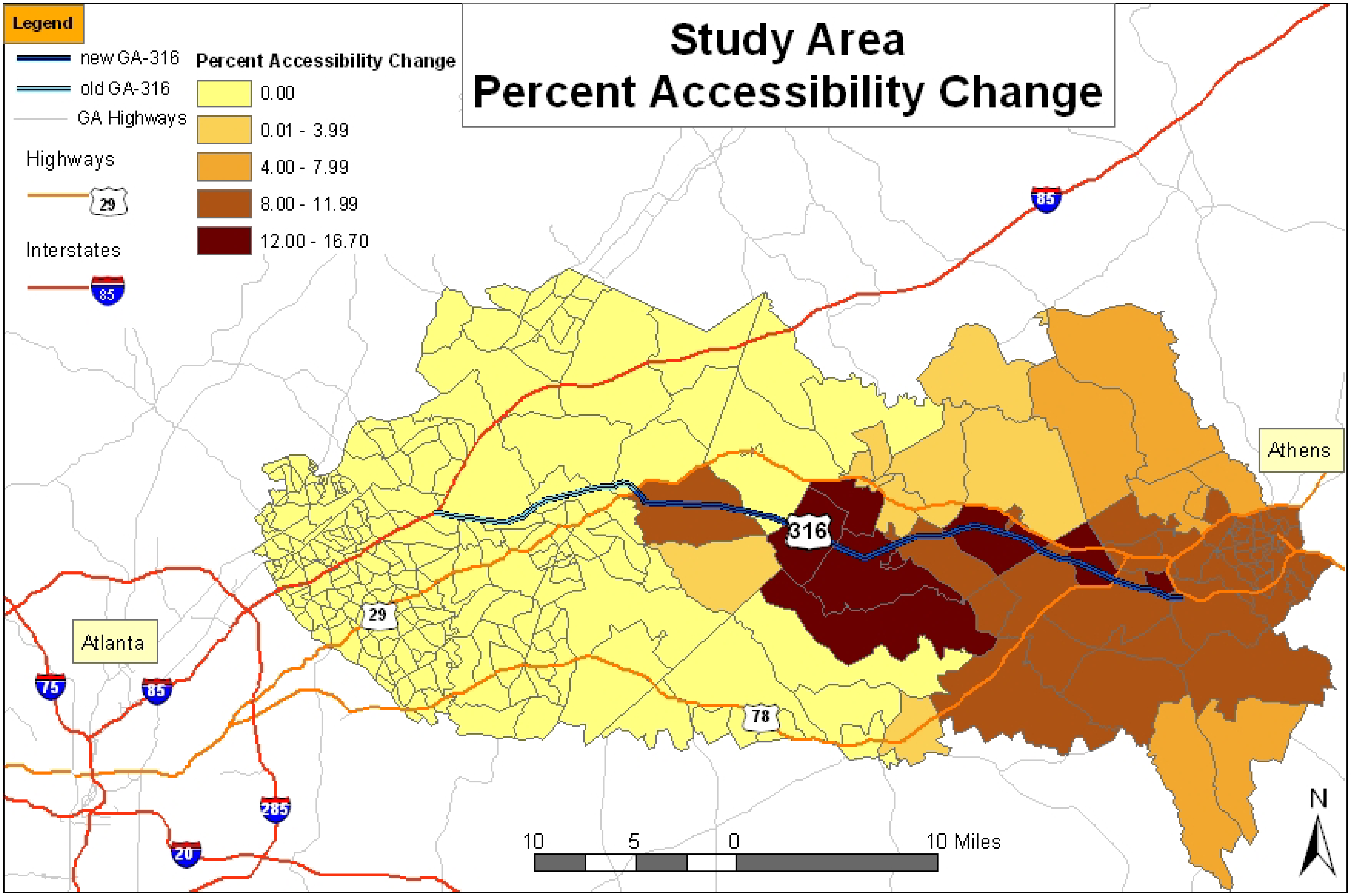

Figure 4.8: Percent Accessibility Change due to GA-316

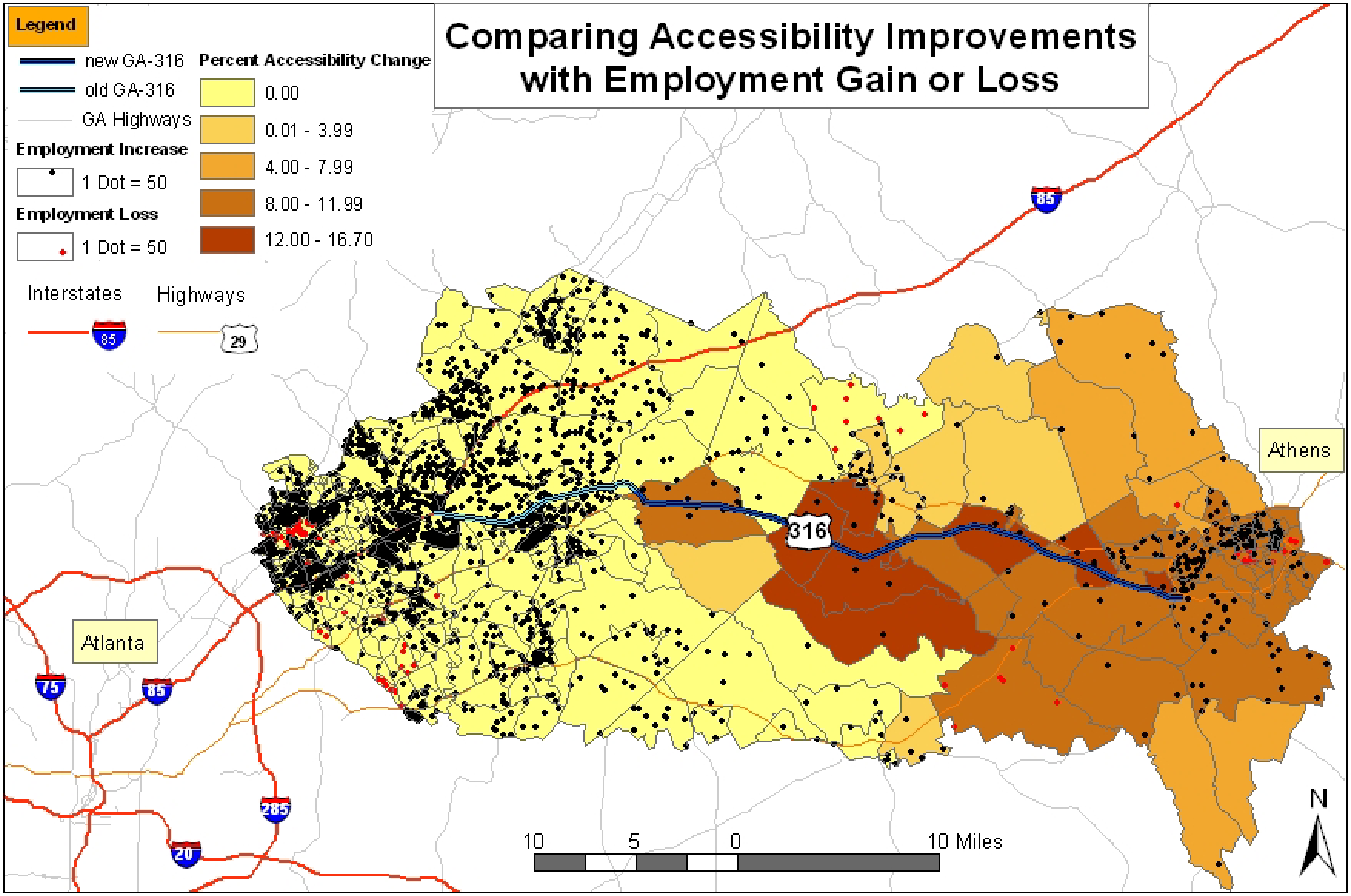

Figure 4.9: Comparing Employment Growth (and Loss) with Accessibility Improvement

CHAPTER 5

RESULTS

I use multivariate regression to examine the relationship between changed accessibility patterns and economic development patterns in the GA-316 corridor. In the following section I will discuss the results from my multivariate regression analysis as described in the methodology section. I first briefly introduce the functional form of the regression models so that the reader can better understand how to most effectively interpret the growth models. Then I review the results that reveal the general patterns of employment growth across the study area before focusing in on the variations between economic sectors. Next, I look at the impacts of the control variables on the model in general and on the specific economic sectors. Finally, I concentrate on the accessibility change variable and examine what the relationship is between accessibility change and employment growth.

Regression Model Functional Form

Because the logarithm is taken of both the 1992 and 2000 employment variables for the multivariate regression analysis (due to heteroskedasticity), the models are more difficult to interpret than typical growth models. The log-log specification makes the estimates of employment growth highly sensitive to the parameter estimate and the y-intercept. Figures 5.1 and 5.2 are line graphs that isolate the impacts of base year employment on predicted employment, showing the separate effects of the y-intercept (B_0) and the coefficient (B_1) on growth estimates. While Figures 5.1 and 5.2 are only examples, they demonstrate how the values used in the regression equations can be back transformed from their log forms into a rational metric to show the predicted values. As described in Chapter 4, all economic sectors experienced extraordinary growth in the study area between 1992 and 2000. This increase in employment is reflected by the positive y-intercepts in each growth model. The magnitude of employment change is highly sensitive to the y-intercept, resulting in models with parameter estimates less than 1.0 predicting employment gain at lower base year values before predicting employment loss at higher values (e.g., B_0=1.0 in Figure 5.1). Such models that begin predicting employment loss at higher base year values within the maximum variable range indicate employment deconcentration. Conversely, if a model has a parameter estimate greater than 1.0 (e.g., B_1=1.1 in Figure 5.2), this means that growth rates are rising as base year employment increases and that employment is becoming more concentrated.

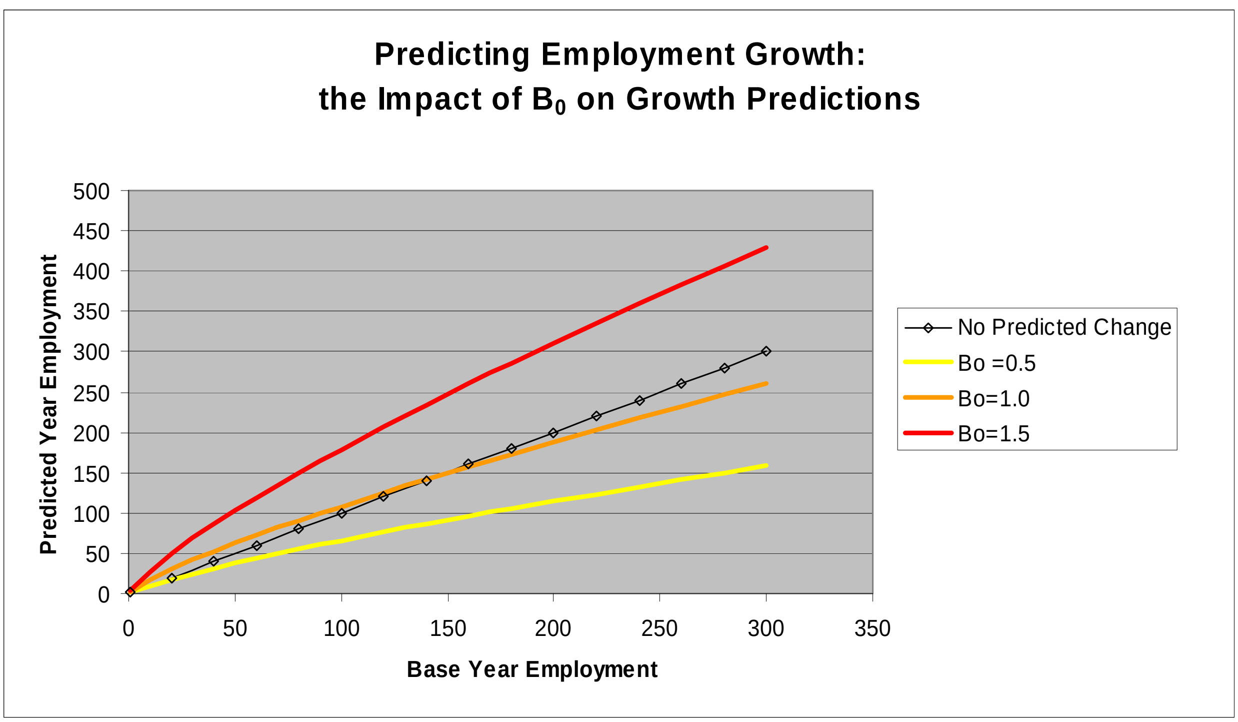

Figure 5.1: The impact of B_0 on employment growth predictions (B_1=0.80)

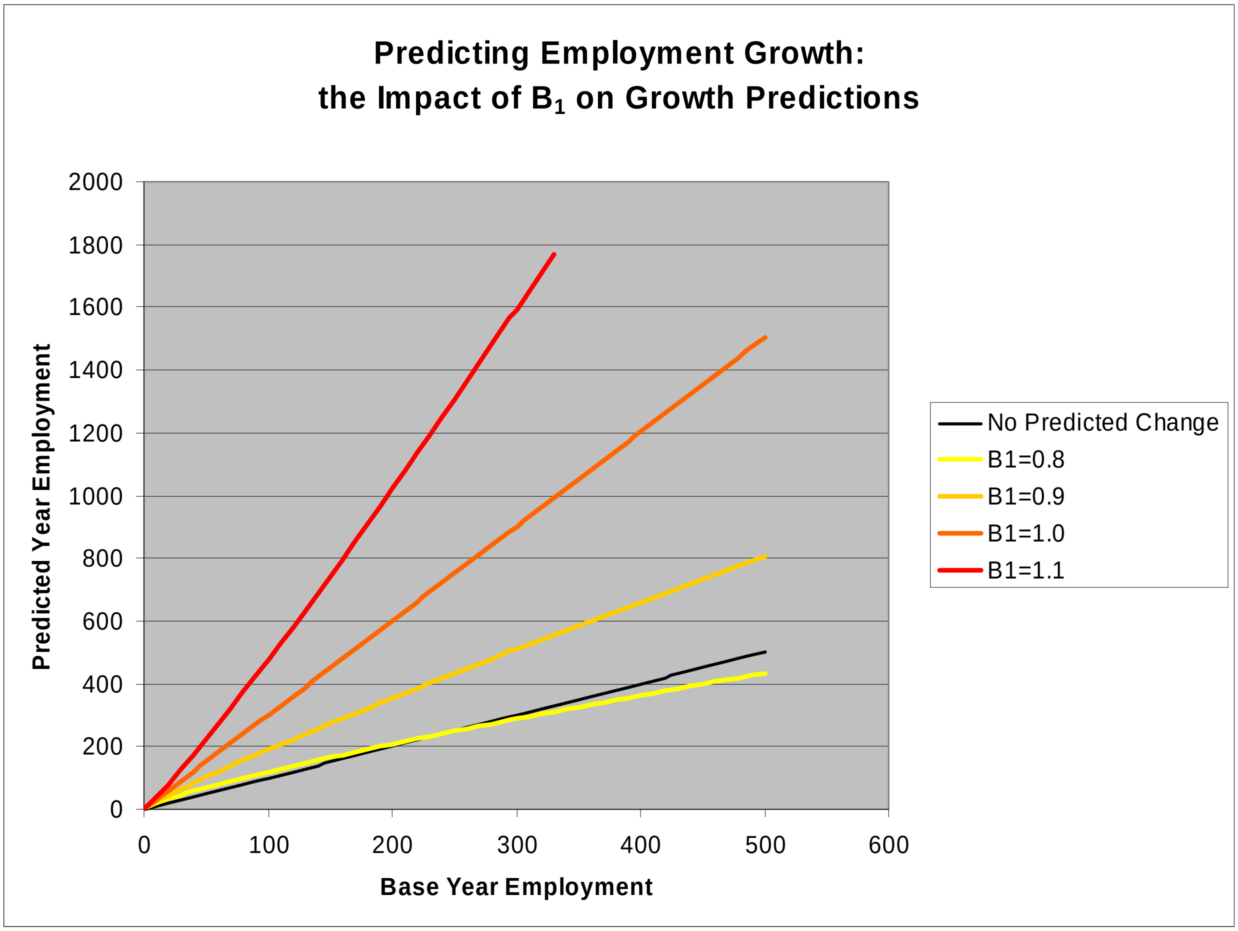

Figure 5.2: The impact of B_1 on employment growth predictions (B_0=1.1)

Regression Results

Displayed in Table 5.1 are the regression results estimating the impact of accessibility change on economic activity overall and on economic activity divided into the nine major sectors. Employment in each economic sector reacts differently to the accessibility changes resulting from GA-316. Contrary to much previous research in other study areas, however, the results presented here indicate that improved accessibility due to GA-316 either negatively impacted or had no effect on employment growth. In no economic sector did increased accessibility due to GA-316 correspond with increased employment.

The R^2 values for the ten models range from .511 to .916, demonstrating that the regression equations are more efficient at predicting employment growth in some economic sectors than others. The constant (B_0) and the 1992 employment were the only two variables that were statistically significant in all ten regression models. The parameter estimate for the 1992 employment variable ranged from 0.816 to 1.021, but was only greater than 1.0 in one case. Because of the frequency of parameter estimates less than 1.0, total employment growth is primarily reflected in the positive y-intercepts. Percent accessibility change was statistically significant in the total employment model and five of the other nine sector-specific models. However the parameter estimates all indicated a negative association between accessibility change and 2000 employment. The control variables revealed varied effects among the

Table 5.1: Weighted Least Squares Multivariate Regression Findings

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Constant	5.611	1.276	2.980	2.152	1.772	2.636	3.588	2.286	4.448	.416
1992_EC*a*	.922	.903	.915	.916	.820	.930	.831	.816	.837	1.021
Population	-.013	.139	-.054	-.119	-.095	.010	.072	-.030	-.018	.018
Education	-.784	-.391	-1.871	-.611	-.996	-1.090	-2.733	.381	-.494	-.336
Δ access	-2.524	-.806	-2.666	-1.840	-2.053	-4.755	-.814	-2.147	-2.800	.870
R Square	.842	.596	.702	.792	.511	.766	.690	.602	.777	.916

Dependent Variables: (ln) 2000 block group employment in that economic sector
Independent Variables: (ln, centered) 1992 block group employment in that economic sector, (ln, centered) population, (centered) education, (centered) percent accessibility change
Unstandardized Coefficients are used.
a. 1992_EC signifies the log of the 1992 level of employment for that particular sector
= significant at the .05 level, = significant at the .01 level (two-tailed test)

Model 1: Total employment
Model 2: Agriculture-related employment
Model 3: Construction employment
Model 4: Manufacturing employment
Model 5: Transportation, electric, communications, or utility-related employment
Model 6: Wholesale employment
Model 7: Retail employment
Model 8: Finance, Insurance, and Real Estate (FIRE) employment
Model 9: Service-sector employment
Model 10: Public Administration employment

regression models. Block group population was only statistically significant in two of the sector-specific models, having a negative coefficient in one and a positive coefficient in the other. On the other hand, the block group education rate was statistically significant in the total employment model and in three of the sector specific models, all of whose parameter estimates showed a negative association between block group education and employment growth.

Patterns of Employment Growth

The 1992 employment variable is statistically significant in each of the ten regression models and is the most significant predictor of 2000 employment. The coefficients range from 0.816 to 1.021 (<.01), showing varying patterns of employment distribution. The base year employment variable has a coefficient less than 1.0 in all models except one, public administration. To visualize the employment change predictions, I created the line graphs in Figure 5.3 by using the slope and parameter estimates for each of the regression models and back transforming the logged variables. Figure 5.3 isolates the impact of base year employment on employment growth predictions, showing the general patterns of employment change from 1992 to 2000. A line representing no employment change is included in each line graph for comparison with the growth predictions. While Figure 5.3 depicts the entire range of block group employment values, in order to see the prediction for the "average" 1992 block group, I have also identified the predicted employment values for the block group with the mean 1992 employment.

In Figure 5.3 most models predict employment gain across the entire range of block group employment values despite the fact that all models except for public administration have a base year employment coefficient less than 1.0. These predictions of employment gain are due to the strong influence of the positive y-intercept. There are two primary differences between the

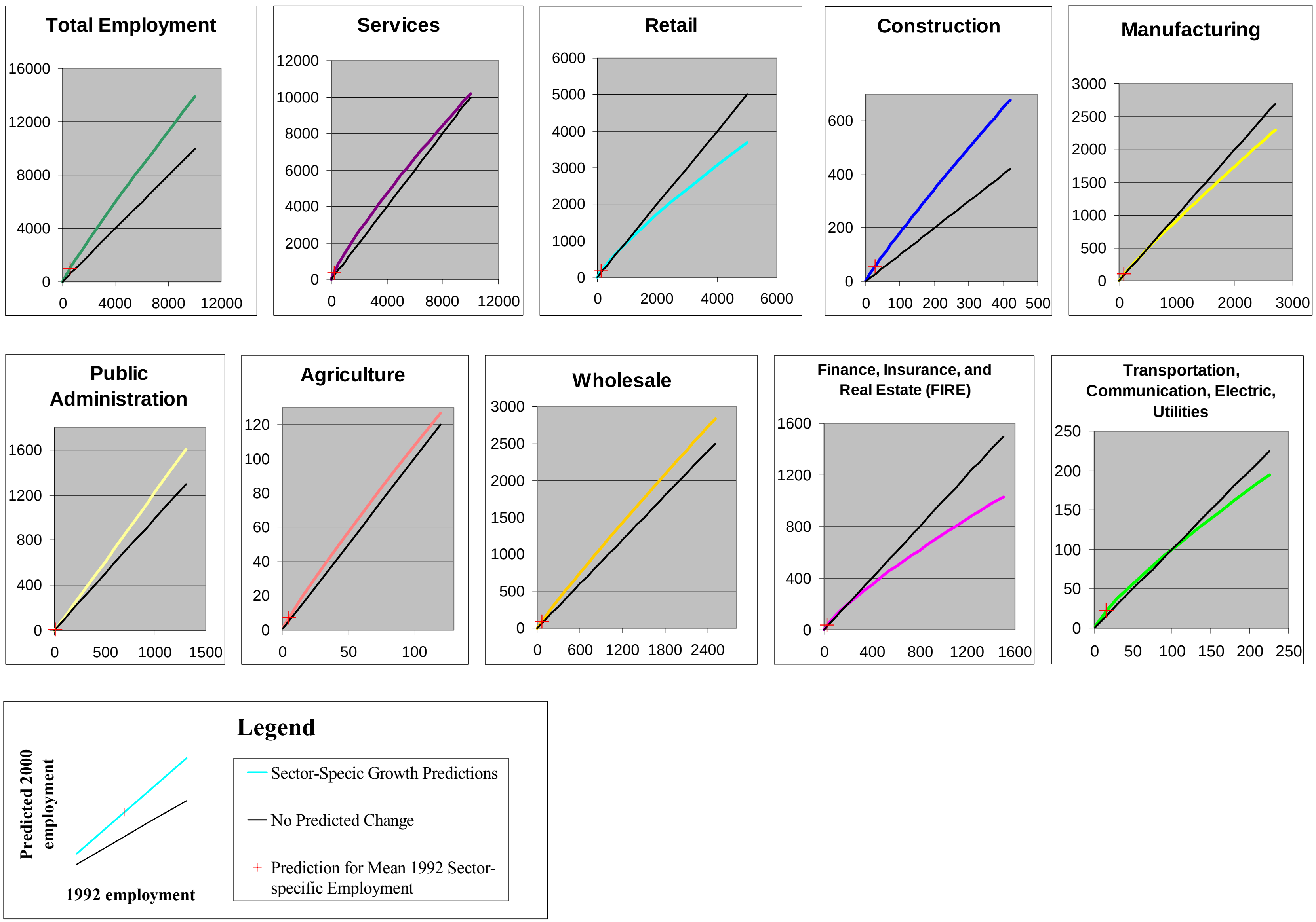

Figure 5.3: Predicting Employment Growth using 1992 employment (axes back transformed into rational metrics)

patterns of economic redistribution for the economic sectors. The first distinction is whether the parameter estimate is higher than 1.0, which would imply employment concentration. Finally, the most important distinction is amongst those models in which the parameter estimate was below 1.0. Some of these models predict increased growth rates with higher base year employment levels; others predict employment gain at lower base year employment levels before predicting employment *loss* at higher base year employment levels. In this second case, this pattern implies general employment deconcentration.

The models of total employment (B_1=.922), construction (B_1=.915), and wholesale (B_1=.930) employment have coefficients less than 1.0. These models predict that block groups will experience employment growth at an increasing rate with higher values of base year employment. These predictions of increasing growth rates are due to the high y-intercepts for these three models. Similarly, the model of public administration shows increased growth with higher values of 1992 employment. However, because the public administration model has a parameter estimate of 1.02, this model would never predict employment loss even if the value range were extended infinitely. This indication of public administration employment becoming more concentrated is logical given the fact that government and public offices tend to stay in the same locations and simply gain employment, rarely being subject to market forces that would encourage spatial redistribution.

The other models do not exhibit increased growth rates with higher values of base year employment. Predictions of service-sector and agriculture-related employment show initial increasing rates of employment gain that begin to approach the threshold of no growth near higher values of base year employment. In comparison, the models of retail, manufacturing, finance, insurance, or real estate (FIRE), and transportation, communication, or electric-related employment all show employment growth at lower base year employment levels before predicting employment *loss* at higher values. For these four sectors, the 1992 employment level above which one would begin predicting block group employment loss varies by sector: retail (833), manufacturing (399), FIRE (197), and transportation, communication, and electric (100). This growth at lower base year employment levels and decline at higher employment levels indicates employment deconcentration in these economic sectors across the study area. For these models, block groups acting as employment centers in 1992 become relatively less important, leaving the distribution of employment less concentrated.

Especially in the cases of the four models that predict employment deconcentration, it is important to keep the predicted employment growth for the mean block group in mind. Within the study area, most block groups have no employment in one or a number of the economic sectors. As a result, the mean block group has far fewer employees in 1992 than the range of the values indicates. All models, including those that show deconcentration, predict employment growth for the mean block group. Thus, when looking at the sector-specific redistribution of employment, one must remember that most observations occur around the mean and thereby predict employment growth.

Control Variables

Along with the employment and accessibility variables, I include other factors that are important to control when using regression models to predict employment growth. Previous literature documenting factors needed for economic development has emphasized the importance of both adequate labor and a talented labor force. However, when looking at the models in this study, one must understand that the detailed spatial scale using block groups inherently makes this a local study. This is to say that even while there may be few potential workers or few educated individuals in individual block groups, these resources may be easily available in other block groups. At this local scale, I found that population and labor education were not significant predictors of employment growth in all regression models. However, there were some interesting differences between the findings describing the relationship between population or labor education and economic development in the varying economic sectors.

The labor pool education variable has a significant negative relationship in the total employment model and three of the sector-specific models, was never significant and positive, and was insignificant in the remaining models. The total employment model and construction, wholesale, and retail models indicate a significant and negative relationship between labor pool education and 2000 employment levels. This may be a result of better educated individuals that often have higher incomes living in residential neighborhoods that are separate from these types of economic activity. Future studies may consider controlling for block group affluence in order to further test this hypothesis.

The total block group population variable proved to have a significant relationship with 2000 employment levels in only two of the regression equations. A block group's population had a significant and positive relationship with the agriculture-related employment. In comparison, 2000 manufacturing employment had a significant and negative relationship with block group population. While the negative relationship between manufacturing activity and population is probably a result of individuals tending to avoid living near manufacturing areas, the positive relationship with the agriculture sector would be more difficult to explain.

Accessibility Change

Focusing on the relationship between accessibility change and employment growth, the results of the regression models reveal that accessibility change impacts each of the economic sectors differently. The base model and the wholesale, construction, service-sector, and retail models show a significant negative relationship between changed accessibility and employment change. In addition, accessibility change is not significantly related to employment change in the agriculture, manufacturing, public administration, FIRE, and transportation, communication, and electricity-related sectors. In no economic sector was there a significant positive relationship between accessibility change and employment growth.

Looking at the economic sectors with significant and negative relationships between accessibility change and 2000 employment levels, some sectors are more strongly impacted than others. In Figure 5.4, I created line graphs that isolate the impact of accessibility change on predicted 2000 employment for the block groups with mean 1992 employment, population, and education. I back transformed the centered, log-transformed employment values and show the difference in predicted employment based on percent accessibility change. Among the five models of accessibility change, the highest coefficient is -4.755, three models have coefficients between -2.5 and -2.8, and the lowest coefficient is -0.814. These parameter estimates give an indication of the relative impact of accessibility change on sector-specific employment growth, shown in Figure 5.4 as the slope of the line. However, similar to plotting the impact of base year employment on predicted employment growth, the predicted employment values in Figure 5.4 are also highly sensitive to the y-intercept and not only to the parameter estimates.

In the total employment model in Figure 5.4, predicted employment falls from 289.2 in block groups with 0.0% accessibility change to 188.3 employees in block groups with a 17.0% improvement in accessibility. This represents the largest absolute decrease in predicted employment even though the accessibility change parameter estimate is not the greatest in magnitude (-2.524). The service-sector model has a similar parameter estimate (-2.800).

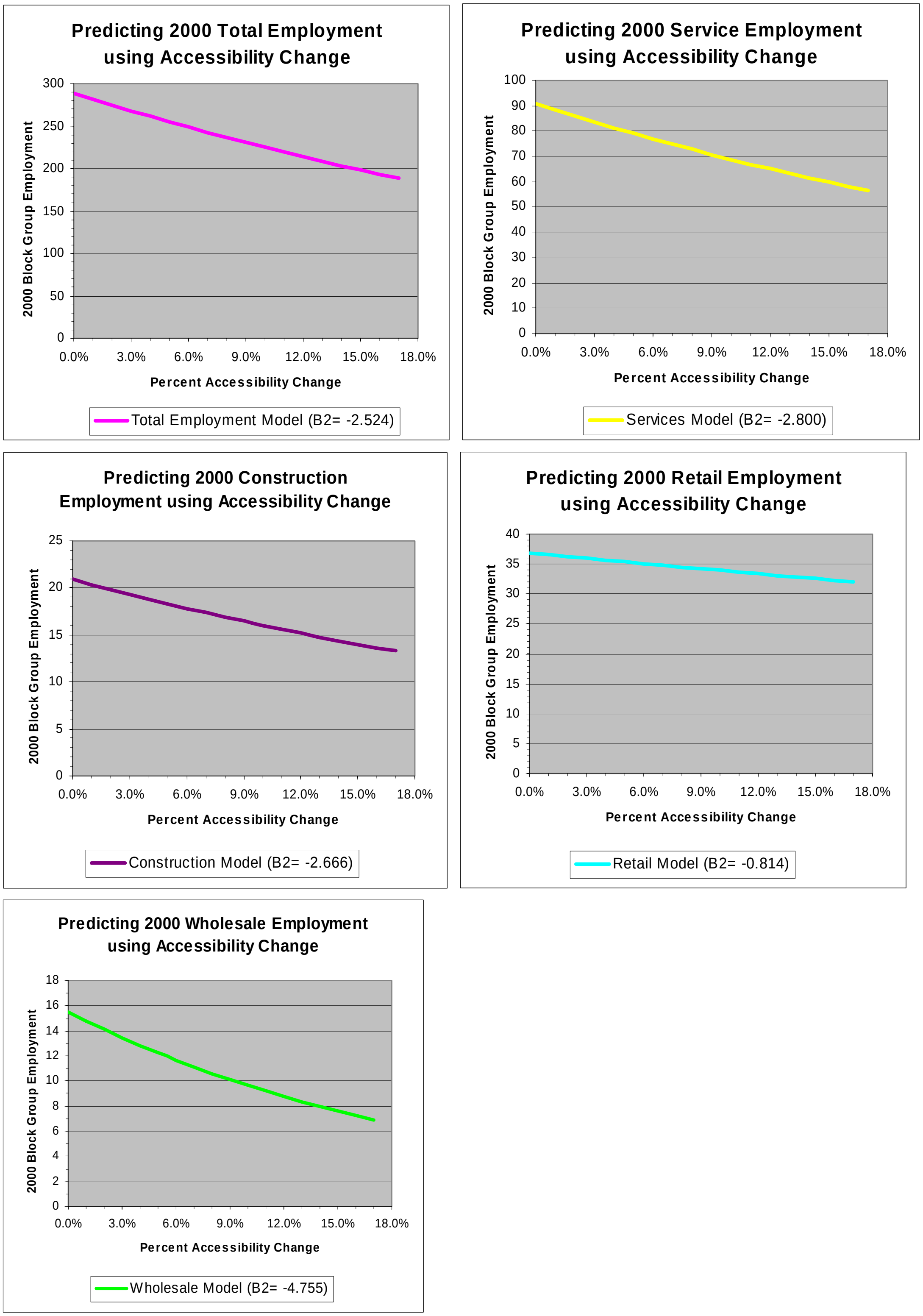

Figure 5.4: The impact of percent accessibility change on employment predictions (y-axes back transformed into a rational metric)

While the y-intercept for the services model is not as high as for total employment, it is much higher than the y-intercepts in the other models, causing it to also predict a large absolute decrease in employment growth due to accessibility change. With an increase in accessibility from 0.0% to 17.0%, predicted service-sector employment would fall from 91.0 to 56.5 employees.

The construction model has an accessibility change coefficient of -2.666 –very similar to the parameter estimates of the total and service-sector models. However, because the construction model has a very low y-intercept, the absolute decrease in employment is not as pronounced: predicted employment would only decrease from 20.9 to 13.3 with a 17.0% increase in accessibility. Figure 5.4 shows that both the slope and parameter estimate for the construction model are comparable to the service and total employment models, indicating that accessibility change has similar relative impacts on these three sectors.

In comparison, the retail model of accessibility change has the smallest coefficient, -0.814, resulting in the lowest relative impact on employment change due to accessibility change. Even though the retail model has a higher y-intercept than the remaining models, the extremely low parameter estimate causes the impact of accessibility change to be relatively minimal -shown in Figure 5.4 as a flatter slope. Predicted retail employment would only drop from 36.8 to 32.1 with an increase in accessibility from 0.0% to 17.0%.

Finally, the wholesale model, in which the accessibility coefficient is -4.755, is highly influenced by accessibility change. Predicted wholesale employment would drop from 15.5 to 6.9 jobs per block group (a 55.4% decrease) with an increase in percent accessibility change from 0.0% to 17.0%. Figure 5.4 demonstrates this by showing that the wholesale model has the steepest slope. The high accessibility change parameter estimate in the wholesale model indicates the highest relative impact of accessibility change on employment growth despite a low absolute predicted employment decrease. In comparison to the 55.4% decrease in wholesale employment with a 17.0% increase in accessibility, the total employment (B_2= -2.52) decreases 34.9%, service sector employment (B_2= -2.800) decreases 37.9%, construction employment (B_2= -2.666) decreases 36.4%, and retail employment (B_2= -0.814) decreases 12.9%.

Results Summary

Looking at the results for each economic sector presented in the previous sections, one can clearly see that the relationship between economic development and accessibility change through highway investment is complex and multifaceted. The models of agriculture, manufacturing, retail, FIRE, public administration, and transportation, communication, electric, and utilities indicate no significant relationship between highway-induced accessibility change and employment growth. In addition, the models for total employment, construction, wholesale, and services indicate that there is a statistically significant negative relationship between improved accessibility due to GA-316 and employment growth. In no economic sector did I find that improved levels of accessibility to Atlanta were positively associated with subsequent increases in economic activity.

While one cannot determine whether an economic impact may be pending in the future, these current findings suggest that one needs to reconsider the complex relationship between highway investment and economic development. These results contradict previous findings of Botham (1980) and Dodgson (1974), but share some similarities with the research of Linneker and Spence (1996). Linneker and Spence (1996) find that areas in London that benefit from increased accessibility due to building roads actually are associated with a reduced likelihood for economic activity to occur in those areas. However, they find that those areas in London that benefit from increased accessibility due only to M25 do benefit from increased economic activity. In this study, I have found that areas that are associated with increased levels of accessibility to Atlanta due to GA-316 are not associated with or are negatively associated with increased levels of future economic activity.

Both my study on GA-316 and the Linneker and Spence (1996) study on M25 take place in developed nations with already well designed transportation networks. As a result, it is not a surprise that slightly altered accessibility patterns would not have the same impact on economic activity as the initial building of an entire highway system (as in post-WWII Britain, the object of the Botham, 1980 study). The Atlanta area is well known for being a transportation hub that has focused on enabling high levels of mobility through cycles of road and other infrastructure investments. GA-316 enables improved travel times and increases road capacities, but has not yet reshaped study area accessibility patterns in a significant enough way that redirects the spatial distribution of employment growth.

My findings that improved accessibility patterns due to GA-316 did not have the traditionally documented positive effects on economic activity indicate that we may need to reconsider how transport investment impacts economic activity in developed nations. Some researchers have already outlined new ways to think about this complex relationship in developed nations with highly advanced economies. Banister and Berechman (2000) have suggested that transport investment may not change the spatial distribution of economic activity within the immediate region, but may serve to give that region a competitive advantage over competing economic areas. This theory is beyond the scope of this research. Advocating another approach, Banister and Berechman (2000) suggest that adding transportation links to already well connected networks does bring about travel time savings, but that these savings are relatively small compared to the cost savings threshold needed for actual business relocation to take place. The authors go on and say that changing accessibility patterns through transport investment tends to propagate existing patterns of economic development instead of creating new patterns (Banister and Berechman, 2000). This assertion is supported by the findings of this research. Instead of increased accessibility positively relating with increased employment, 2000 employment levels seem to more closely reflect 1992 employment levels. New and expanded businesses for the most part appear to have located in areas that were already centers of employment, particularly in Gwinnett County.

This study focuses on a specific case study in order to explore the complex links between highway investment and economic development. By using a methodology that compares with similar studies in other areas, I described how the influence of transport investment on economic development has changed over time in developing countries. While I do not claim that these results would be the same in all corridor case studies, I believe that this study shows the need to rethink the transport investment-economic development relationship in developed nations with complex economies.

CHAPTER 6

CONCLUSIONS

While highways provide important functions by increasing regional mobility, they also indirectly impact individuals and regions in a host of other ways. In this study I explore the impacts of building GA-316 on local economic development within the Atlanta regional area. My research focused on two primary questions: 1. What role do changed accessibility patterns play in explaining how highway investment shapes the economic landscape? 2. How do different types of economic activity react differently to highway investment and changed accessibility patterns? Through this research, I find that the areas that most benefit from increased accessibility by building GA-316 either do not correspond or correspond negatively with areas of employment growth. Total study area employment is negatively impacted by accessibility improvements while each of the nine specific economic sectors that I evaluate are impacted in varying ways; but in no case was improved accessibility associated with increased economic activity.

Given the goal of increased mobility through highway investment, changed accessibility patterns provide an effective way to explain how GA-316 changes the economic landscape. Approaching the issue of how highway investment changes economic activity in this way allows excellent comparability with previous research. My results are contrary to earlier research, such as Botham (1980) and Dodgson (1974). However, similar to my research findings, more recent studies (e.g. Banister and Berechman, 2000; Linneker and Spence, 1996) have indicated that the relationship between transportation investment and economic development has been changing in developed nations.

By further focusing on the impacts of highway investment on nine different economic sectors, I acknowledge that not all types of economic activity react in the same way to accessibility changes. Based on the results of this study, I conclude that accessibility improvements due to building GA-316 did not enhance employment growth in any sector. The multivariate regression models of agriculture, manufacturing, retail, FIRE, public administration, and transportation, communication, electric, and utilities indicate no significant relationship between highway-induced accessibility improvements and job growth from 1992 to 2000. In contrast, the regression models for total employment, construction, wholesale, and services indicate that there is a statistically significant negative relationship between accessibility improvements and employment growth. These results are contrary to traditional notions of highway construction stimulating economic development.

Given these findings, it is important to reexamine the traditional notions of transportation investment causing economic development. This traditional understanding has assumed that building highways would enable better accessibility for the surrounding region and would thereby stimulate economic growth. However, transportation costs now make up a reduced proportion of total business costs because the economies of developed nations have become more advanced (Chapman, 1990). Any additional road network link does not always provide accessibility improvements and cost savings that warrant a spatial relocation of economic activity. This is particularly true in developed nations that already have high mobility through existing transportation networks.

Even among urban areas in developed nations, Atlanta is well known for being a transportation hub that has relied heavily on improving accessibility by promiting high levels of mobility through road and highway investment (Jaret, 2002). These transportation policies have been very effective at fostering an environment for rapid suburban development and economic growth; but this trend has not remained free from criticism. Because Atlanta, similarly to other cities in developed nations, already has relatively ubiquitous road networks, the construction of a single additional link does not necessarily generate enough travel time savings to warrant a complete relocation by businesses. GA-316 is designed for congestion relief and improved travel times and is thus an example of an additional link that does not structurally alter the already highly interconnected regional road network. As a result, areas that benefit the most from increased accessibility do not profit from the increased economic activity that is predicted by traditional understandings of the impacts of highway investment on economic development. While each economic sector reacts in slightly different ways to the changed accessibility patterns due to GA-316, the magnitude of the accessibility benefits does not exceed the threshold for firms to relocate into more accessible areas. Instead, one sees a phenomenon noted by Banister and Berechman (2000) in which changed accessibility patterns enhance existing economic trends instead of creating new spatial patterns. As a result, the most development occurs in the already quickly growing Atlanta suburban area of Gwinnett County instead of formerly rural areas whose accessibility was most improved due to GA-316.

Limitations

Inherent in this study are the limitations of using empirical quantitative data for research purposes. Both job growth and changes in accessibility patterns are complex phenomena that are difficult to quantify without losing some information. The difficulty of generating detailed data that adequately control for other important control variables also poses difficulties. Because using a quantitative methodology allows excellent comparability with other studies, future research may need to supplement quantitative methods with qualitative analysis.

Additional studies are needed to consider the timing of economic impacts due to highway investment. There is still much discussion over how different economic sectors may react to highway investment over different time periods (EDRG, 2001). Many studies have found increases in economic activity as little as three years after highway completion (e.g. Southern Tier *et al.*, 2003). Much research indicates that highway-dependent sectors often quickly locate near a highway after it has initially been built, but planners need to understand what longer-term impacts these highways have on the surrounding economic landscape. Based on the suggestions of previous research (Banister and Berechman, 2000), this project assesses the short to medium-term economic impacts of GA-316 using an eight year lapse time (1992 to 2000). Further research should consider examining whether it takes a longer period of time for GA-316 to have a stronger impact on employment in the corridor.

Conclusions and Future Considerations

Understanding how additional highway investment impacts the economic landscape is important because of the vital role that highways play in enabling accessibility and standards of living for individuals. While enabling high mobility and reducing travel times is important, one must consider how creating this mobility through highway investment impacts other facets of the population's daily life. Even if a new highway link reduces travel times in a well-connected road system, these reduced travel times may not reach a cost-savings threshold for businesses to significantly redistribute the spatial patterns of economic activity. Some highway projects, such as Appalachian Regional Commission (1998), still focus on enabling 'underdeveloped' regions to achieve higher levels of economic development. If the "if you build it, they will come" paradigm may no longer hold true, as this and other research has indicated, these expensive development projects need to better understand the cost and time-savings threshold at which firms are willing to relocate to these areas. These issues particularly need to be considered in the face of the already high mobility and reduced proportion of production costs that transport makes up.

While this study focuses on the effects of *highway* investment on economic development, the determination of the effect of transportation infrastructure –in general- on localized economic activity continues to be an important topic. Highway investment may have less drastic effects on accessibility and economic development due to the ubiquity of the U.S. road network. In contrast, improving less tightly developed transport networks may more significantly impact accessibility patterns and subsequent levels of economic development. Some researchers such as Aschauer (1991) even indicate that there are significant differences between the impacts of highway and public transportation investment on long-term economic development. Highway investment has historically enabled inaccessible regions to experience economic development and higher qualities of life. This research indicates that this relationship is in the process of changing. Planners in industrialized nations with high mobility and advanced economies will have to carefully outline the goals of transport investment and must reevaluate traditional understandings of the impact of highway investment on economic development.

NOTES

1. When the accessibility measurements were constructed using the changed travel times from each block group in the study area to every other block group in the study area, that the change measurement did not significantly change. This seemed to primarily be due to the fact that Gwinnett county and western portions of the study area already benefit from proximity to other opportunity locations (hence the high density of block groups), whereas eastern portions of the study area are more distant from many of these population and employment concentrations, and thereby rely more on high mobility and benefit more from reduced travel times.

REFERENCES

Anderson, Connie and Otto, David, 1991. "The Economic Impact of Rural Highway Bypasses: Iowa and Minnesota Case Studies," Office of Advanced Planning, Iowa Department of Transportation, Ames Iowa.

Anderstig, Christer, 1999. "The Regional Development Impacts of the Öresund Bridge," Department of Infrastructure and Planning, Royal Institute of Technology, Stockholm, Sweden; Draft.

Appalachian Regional Commission (ARC), 1998. "Economic Impact of the Appalachian Development Highway System." Prepared by Wilbur Smith Associates.

Aschauer, David Alan, 1991. "Transportation Spending and Economic Growth: The Effects of Transit and Highway Expenditures." Prepared for American Public Transit Association.

Banister, David and Joseph Berechman. 2000. *Transport Investment and Economic Development,* UCL Press, London.

Bhat, Chandra, Susan Handy, Kara Kockelman, Hani Mahmassani, Anand Gopal, Issam Srour, and Lisa Weston, 2002. "Development of an Urban Accessibility Index: Formulations, Aggregation, and Application." Center for Transportation Research. FHWA Texas DOT 4938-4. FHWA, Austin, TX.

Botham, R., 1980. "Regional development effects of road investment," *Transport Planning and Technology*, Vol. 6, No. 1, pp. 97-108.

Broder, Josef M., Teresa D. Taylor, and Kevin T. McNamara, 1992. "Quasi-Experimental Designs for Measuring Impacts of Developmental Highways in Rural Areas," *Southern Journal of Agricultural Economics*, Vol. 24, No. 1, (199-207).

Brookings Institution Center on Urban and Metropolitan Policy, 2000. "Moving Beyond Sprawl: The Challenge for Metropolitan Atlanta," Available at www.brookings.edu/es/urban/atlanta/preface.htm at 3 pm on 3/21/00.

Bullard, Robert D. Glenn S. Johnson, and Angel O. Torres (Editors), 2000. *Sprawl city: race, politics and planning in Atlanta*, Island Press, Washington, DC.

Burress, David, 1996. *Impacts of Highway Bypasses on Kansas Towns*, University of Kansas. Prepared for the Kansas Deptartment of Transportation.

Chapman, Keith. and David F. Walker, 1990. *Industrial Location 2nd Edition*, Basil Blackwell Ltd, Oxford U.K.

Dalvi, M., 1978. 'Behavioural modeling, accessibility, mobility and need: concepts and measurement,' In Hensher, D.A. and P.R. Stopher, 1978. *Behavioural Travel Modelling*, Croom Helm, London pp. 639-653.

Dodgson, J, 1974. "Motorway investment, industrial transport costs, and sub-regional growth: a case study of the M62," *Regional Studies* Vol. 8, No. 1, pp. 75-91.

Economic Development Research Group, Inc. (EDRG) and Cambridge Systematics, Inc., 2001. "Using Empirical Information to Measure the Economic Impact of Highway Investments." Prepared for the FHWA through contract #DTFH61-98-D-00107.

Eyerly, Raymond W., Richard Twark, and Roger H. Downing, 1987. "Interstate Highway System: Reshaping the Non-Urban Areas of Pennsylvania," *Transportation Research Record*, No. 1125, pp. 1-14.

Feser, Ed. Associate Professor, Department of City and Regional Planning, University of North Carolina, Chapel Hill, 2003. Personal communication on September 4, 2003.

Geertman, Stan, and Jan R. Ritsema van Eck, 1995. "GIS and models of accessibility potential: an application in planning," *International Journal of Geographical Information Systems*, Vol. 9, No. 1, pp. 67-80.

Gould, G., 1987. "The Impact of the M25 on innovative forms of retailing –myth or reality?", unpublish MPhil thesis, Bartlett School of Planning, University College, London.

Grizzard, Lewis, 1991. "A new highway will goto Dogs," *Atlanta Journal Constitution,* June 19, 1991.

Grizzard, Lewis, 1993. "Opening a stretch of memory lane," *Atlanta Journal Constitution*, July 4, 1993.

Hanson, S. and M. Schwab, 1987. "Accessibility and intraurban travel," *Environment and Planning A*, Vol. 19, pp. 735-748).

Jaret, Charles, 2002. "Suburban Expansion in Atlanta 'The City without Limits' Faces Some," In Squires, Gregory D. 2002. *Urban Sprawl: Causes, Consequences & Policy Responses,* The Urban Institute Press, Washington DC.

Kanaroglou, Pavlos, William Anderson, and Aleksandr Kazakov. 1998. "Economic impacts of highway infrastructure improvements Part 1. Conceptual framework," *Journal of Transport Geography*, Vol. 6, No. 3, pp. 203-210.

Koenig, J. G., 1980. "Indicators of urban accessibility: theory and application," *Transportation*, Vol. 9, pp. 145-172.

Kwan, Mei-Po, 1998. "Space-Time and Integral Measures of Individual Accessibility: A Comparative Analysis Using a Point-based Framework," *Geographical Analysis*, Vol. 30, No. 3, pp. 191-216.

Linneker, B.J. and Spence, N.A., 1996. "Road transport infrastructure and regional economic development: the regional development effects of the m25 London orbital motorway," *Journal of Transport Geography*, Vol. 4, No. 2, pp. 77-92.

McCarthy, Rebecca, 1995. "Straight shot to stadium: Completion of Athens highway is a break for Bulldog fans," *Atlanta Journal Constitution*, August 31, 1995.

McMurry, Russell, Pre-Construction Engineer, Georgia Department of Transportation, 2003. Personal communication. 24 Oct. 2003.

Miller, James P., 1979. "Interstate Highways and Job Growth in Nonmetropolitan Areas: A Reassessment," *Transportation Journal*, Vol. 19, No. 1, pp. 78-81.

Moon, Henry E., Jr., 1988. "Interstate Highway Interchanges as Instigators of Nonmetropolitan Development," *Transportation Research Record*, No. 1125, pp. 8-14.

Orus, Jean-Pierre, 1996. "The Economic Impacts Of Major Motorways Infrastructures: Main Lessons Of Ex Post Studies." S.E.T.R.A – Ministère de l'Equipement, du Logement, des Transports et du Tourisme, Bagneux, France.

O'Sullivan, David, Alastair Morrison, and John Shearer, 2000. "Using desktop GIS for the investigation of accessibility by public transport: an isochrone approach," *International Journal of Geographical Information Science*, Vol. 14, No. 1, pp. 85-104.

Parantainen, Juha, 1999. "Effects of Transport Infrastructure on Regional and Peripheral Development," Ministry of Transport and Communications, Finland.

Rephann, Terance J., and Andrew M. Isserman, 1994. "New Highways as Economic Development Tools: An Evaluation Using Quasi-Experimental Matching Methods," *Regional Science and Urban Economics*, Vol. 24, No. 6, pp. 723-51.

Standing Advisory Committee on Trunk Road Assessment (SACTRA), 1977. "Report of the Advisory Committee on Trunk Road Appraisal, Chairman Sir George Leitch", Standing Advisory Committee on Trunk Road Assessment, HMSO, London.

Saporta, Maria, 2003. "GRTA edges away from transit," *The Atlanta Journal-Constitution*, December 15, 2003.

Song, Shunfeng, 1996. "Some Tests of Alternative Accessibility Measures: A Population Density Approach," *Land Economics*, Vol. 72, No. 4, pp. 474-483.

Southern Tier West Regional Planning and Development Board (Southern Tier), Don Rychnowski, Paul Miller, Economic Development Research Group, Inc., Glen Weisbrod, Manisha Gupta, and Cambridge Systematics , Inc., Brian Ten Siethof, Chris Porter, and John Suhrbier, 2003. "Preliminary Economic Impact of the Southern Tier Expressway: Western Portion," Federal Highway Administration.

Turner, Renee, 1986. "700 attend forum on Ga. 316 extension," *The Atlanta Journal and The Atlanta Constitution*, May 28, 1986.

Wheeler, James O. Clifton W. Pannell, Z. Andrew Farkas, 1977. "The impact of an expanding transportation network on potential economic development locations in the North Georgia area." GA-Department of Transportation, State of Georgia, Appalachian Regional Commission. Published by UGA Department of Geography and GA-DOT.

Wisconsin Department of Transportation, 1998. "The Economic Impacts of Highway Bypasses on Communities," Technical Report.

APPENDIX

Appendix A: Unmodified Variable Descriptives

VARIABLE		MIN	MAX	MEAN	Standard Deviation
Economic Development Variables					
total block group employment	1992	0	9737	560.8	1168.9
	2000	0	16566	1026.4	1967.3
Agriculture employment	1992	0	116	5.3	13.5
	2000	0	261	12.8	32.9
Construction employment	1992	0	421	27.1	50.9
	2000	0	773	69.7	123.5
Manufacturing employment	1992	0	2704	85.7	303.6
	2000	0	3156	123.7	396.5
Transportation, Communication, Electricity employment	1992	0	225	15.7	38.2
	2000	0	947	37.0	94.4
Wholesale employment	1992	0	2506	64.8	222.2
	2000	0	2138	118.3	318.5
Retail employment	1992	0	4978	134.1	368.9
	2000	0	6528	232.4	556.6
Finance, Insurance, or Real Estate employment	1992	0	1474	28.2	115.8
	2000	0	2657	47.8	176.1
Services employment	1992	0	9574	188.4	719.9
	2000	0	15917	369.2	1205.7
Public Administration employment	1992	0	1302	11.3	82.5
	2000	0	1590	15.0	103.70
Accessibility Variables					
2000 travel time		6.01	95.37	37.04	26.08
Simulated travel time without GA-316		6.01	103.53	38.97	29.30
Percent change in accessibility		0.0%	17.0%	2.2%	4.3%
Control Variables					
Labor talent (education rate)		0	.6857	.1791	.1202
Labor availability (population)		0	12267	1520.61	1510.598