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ROAD CONSTRUCTION AND REGIONAL DEVELOPMENT

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EXECUTIVE SUMMARY

The state of Georgia has undertaken major road construction in the last three decades. After the completion of the interstate highways in the late 1970s, many regions throughout the state found themselves not easily connected to the interstate network. To address this problem, the Economic Development Highway System was developed. This plan, initiated by the legislature and the Governor (hence sometimes also referred to as Governor's Road Improvement Plan), called for major construction of two- and four-lane highways that would interconnect many regions and extend to the interstates. When completed, the network would place 98 percent of the state's population within 20 miles of a four-lane highway. Under this plan, construction started in the mid-1980s and continues in the 1990s. In a few counties up to 700 miles of new roads were built between 1984 and 1994, including about 16 "corridors of economic development." Projects such as Corridor Z, the Appalachian Highway, and the Georgia 400 extension were completed.

As the plan's name indicates, the purpose of building new roads was to foster economic development. This report evaluates whether roads and road construction are associated with economic development. Economic development, in this report, is measured by the creation of employment and business establishments. Statistical tests to uncover and quantify the importance of roads for development are conducted using data from all 159 counties within the state of Georgia. Three different specifications for roads are used in the estimation process. The first specification estimates the effects of the number of paved miles of state routes and county roads built in a county in the preceding four years. This specification attempts to measure the development consequences of networks of roads built in the immediate past. Results show that

such road construction has had a significant, positive effect on development. In fact, between 1992 and 1994, every 2 miles of road built in a county are associated with an average of 20 new jobs and 1 new business establishment per year. This result is magnified considering that on average over 70 miles of roads per county were built in a ten-year period.

However, when the estimation is carried out excluding the ten counties of the Atlanta Regional Commission (ARC), these effects are only about one-half to two-thirds as large. This is because much of the road construction and employment creation has taken place in the Atlanta area. While roads are still a significant determinant of development in non-ARC counties, the estimates of their contribution are not as large. In addition, there are other variables that also affect development positively in both samples (the full sample and the non-ARC sub-sample). These include population density, the level of urbanization of the county, past employment creation, and past population growth.

The second specification used for roads is the overall stock of county roads and state routes (excluding interstate highways) in each county. The third specification includes only the stock of state routes. Estimates using these two specifications indicate that counties with larger existing stock of roads are associated with higher growth of employment and establishments. Estimates are consistently significant across the years for which estimates were developed. Once again, the effects on development are larger when the ARC counties are included.

This report's conclusion is that roads are one of the important determinants of development within counties. Road building alone, however, does not guarantee increased employment and establishments of business for a region. It may be more accurate to think of roads as the foundation of regional development. The statistical estimation tries to carefully separate the effects of roads on development from the effects that development has on the future

construction of roads. However, it is possible that roads were built in anticipation of development. That would suggest that Georgia's DOT is a good predictor of future growth in employment and business establishments in a region. Even if roads are built in regions already projected to grow, the statistical analysis finds that road construction contributes positively, increasing economic development. It is also possible that the same aggregate level of development would have occurred without the roads, but that the roads influenced the location pattern of this development. It should be noted that in evaluating new road construction proposals the benefits should be carefully weighted against both the direct and indirect costs (e.g., environmental costs).

ROAD CONSTRUCTION AND REGIONAL DEVELOPMENT

I. Introduction

Most economists and policy makers believe that roads play a role in regional economic development. Good road networks are essential to transport products to and from markets and employees to their workplace. The state of Georgia has undertaken a large amount of road construction during the last three decades. After the completion of the interstate highways, there were many regions throughout the state which still had no easy access to the interstates. Thus, the focus of construction planning shifted towards building two- and four-lane highways that would interconnect these regions and extend to the interstate highways. A plan was devised for the construction of 2,600 miles of road so that all communities of at least 2,500 inhabitants could be within 20 miles of a four-lane highway. The purpose of this plan was state-wide economic development, which can be measured by creation of employment and business establishments.

This report examines whether road construction following this initiative has been successful in luring new establishments and creating employment. This is done by statistically estimating the effects of roads using various economic data. The basic questions are:

- Has road construction had a significant effect on economic development?
- How many jobs, on average, has each paved mile of road created?
- How many business establishments, on average, has each paved mile of road created?

Given that there are presently new projects calling for further construction, these are important questions for which policy makers seek answers.

In the academic literature, a number of researchers have studied the importance of public infrastructure as a whole (roads, water systems, sewer systems, buildings, etc.) for development.

Most of these studies have concentrated on estimating the effects of public infrastructure on output either at the local, state, country or international levels. Helling (1997) summarizes the methodology and results of several studies of transportation and economic development. Aschauer's (1989) seminal paper finds that public infrastructure has high, significant effects on U.S. gross domestic product (GDP) at the macroeconomic level. At the local level, Eberts (1986) studies changes in the metropolitan capital stock and firm openings. He finds positive effects for small firms. Munell (1990) estimates the public capital stock at the state level and finds positive effects of infrastructure on employment. One common trend among most of these studies is the estimation of a public capital (infrastructure) stock based on monetary data, but this measurement has been problematic. Recently, Sanchez-Robles (1997) has suggested that using physical measures of infrastructure may characterize this stock more accurately. This report follows Sanchez-Robles's suggestion by using data on linear road miles in the various counties in Georgia.

II. Historical Background

In 1972, the State Highway Department became the Georgia Department of Transportation (DOT). During the 1970s, the DOT concentrated on completing the interstate highways. By 1978, interstates 16, 20, 75, and 85 were all operational in their entirety. Much of the state, however, did not have easy access to these interstates. While Georgia had one of the largest road systems in the southeast, it had the smallest percentage of rural four-lane primary mileage highways. During the 1980s and early 1990s, DOT's focus shifted to road construction geared to connecting many of these regions among themselves and to the interstate system. This paper concentrates on the effects of construction that took place starting in the mid-1980s.

The importance of expanding the state's road infrastructure is clear from the 1985 DOT Annual report. It states, "transportation access is no panacea for development, but an efficient transportation system is a good ingredient for industrial development providing jobs for economically sluggish areas." This initiative, known as the Economic Development Highway System (or sometimes as Governor's Road Improvement Program), called for building 2,600 miles of two- and four-lane highways. Upon completion of such construction, most communities of at least 2,500 individuals would be within 20 miles of a four-lane highway. The program had a number of specific projects, including 16 corridors of economic development. For example,

- Corridor Z, linking Columbus and Brunswick via Albany and Tifton. The corridor is 256 miles long, and it goes through 14 counties. It is the only continuous four-lane highway crossing the whole southern part of the state.
- Appalachian Highway, linking the northern-Georgia Appalachian communities with the interstate system. It runs from the end point of I-575 to Blairsville.
- Georgia 400 Extension, six-lane toll road designed to alleviate congestion and connect interstate 285 to 85.
- Golden Isles Parkway, providing a more direct link between Atlanta and the Brunswick coast. It begins at Perry on I-75 and goes to Brunswick via Hazelhurst and Jesup.
- Fall Line Freeway, connecting Columbus to Augusta via Macon. Essentially it goes through the center of the state, running east to west.
- Outer Perimeter, an ambitious project that would build 200 miles of road 20 miles outside the existing perimeter with the purpose of alleviating the high degree of congestion in the Atlanta area.

Map 1, describes the location and trajectory of some of the above projects. Some of these projects were completed by the early 1990s. For example, Corridor Z was completed during 1989. The Appalachian Development Highway was completed in the 1990s, and the Georgia 400 extension was completed in 1994. There are some projects, however, that are still under construction or in pre-planning, as in the case of the Outer Perimeter.[1]

Road construction did not only concentrate on the above mentioned projects. Many smaller scale projects were completed, adding a significant number of miles to the state's infrastructure. Some descriptive statistics of this are given in Table 1.

Table 1. Paved State Route and County Road Construction in Georgia
(in miles of new roads)

	1984-1989	1989-1994
County Average	30	43
Largest	347 (Gwinnett)	580 (Cobb)
	127 (Carroll)	394 (Gwinnett)
	103 (Chatham)	292 (Fulton)
	99 (Walton)	283 (DeKalb)
Smallest	-36.7 (Marion)	-4.58 (Charlton)
	-35.6 (Troup)	-2.46 (Stewart)
	-6.91 (Houston)	-1.64 (Taliaferro)
	-6.86 (Floyd)	0.18 (Clay)

Source: The Georgia County Guide

Table 1 presents data on the miles of road built during two five-year periods. In the first period (1984-1989), the average was 30 miles per county.[2] In the second, more recent period (1989-1994), the per-county average increased to 43 miles built. This second period coincides with the completion of several projects of the Economic Development Highway System. Individually, Gwinnett County stands out with an average of nearly 400 miles of road built in each period. Also, Cobb, DeKalb, and Fulton (all part of the Atlanta Regional Commission (ARC) region) are among the top in terms of miles of road built for both periods. Conversely, Table 1 also lists those counties where very little, if any, construction was undertaken. In fact, in some counties like Marion, Troup, Houston, and Charlton, there was a small reduction in road miles.

This could be due to deterioration or occasional re-classification of some roads, but further details on these were not available for this report.

While Table 1 describes the construction efforts over a decade, it is also informative to examine data on counties' total stock of roads. Descriptive statistics on stock (in miles) of State Routes and County Roads are given in Table 2.

Table 2. Paved State Route and County Road Stock in Georgia in 1994 (in miles)

	State Routes and County Roads	State Routes
County Average	404	113
Largest	2,164 (Cobb)	353 (Fulton)
	2,066 (DeKalb)	267 (Laurens)
	1,831 (Gwinnett)	234 (Hall)
	1,476 (Fulton)	223 (Decatur)
Smallest	77 (Chattahoochee)	33 (Chattahoochee)
	100 (Quitman)	39 (Quitman)
	121 (Long)	40 (Glascock)
	132 (Tattnall)	50 (Webster)

Source: The Georgia County Guide

On average, counties had 113 miles of state routes and about 291 (404-113 = 291) miles of paved county roads in 1994. Table 2 indicates that the ARC counties of Cobb, Gwinnett, DeKalb, and Fulton had the largest stock of state and county miles. There is also a wide variation between these ARC counties and those with the smallest stock, like Chattahoochee and Quitman counties. Map 2 depicts the state with all the counties' names and borders. Map 3 presents the percentage increase in the stock of each county's state routes and county roads over the period 1984 to 1994.

III. Data

The data used to study the effects of road construction on regional economic development are described in this section. First, every relevant variable to this study is described. Second, descriptive statistics of the two dependent variables, employment and establishments, are presented and discussed. The data are annual numbers for the period 1984 to 1994 for all 159 counties of the state of Georgia. The data come mainly from The Georgia County Guide, a yearly publication that assembles information from various original sources.

A. Description of Variables

The first three variables are those of greatest relevance to this study.

1. Change in employment: This is the change from the previous year in the count of employees in a county during the pay period that includes the date March 12. The focus of this study is on the number of jobs created in the private sector as result of better road networks. Hence, this measure of employment excludes most government employees and railroad employees. One limitation of the data is that it does not include self-employed persons.

2. Change in number of establishments: This is the change from the previous year in the number of business establishments in a county. Each establishment is defined as a single location where business is conducted or services or industrial operations are performed. It is not necessarily the same as a company or an enterprise, which can be composed of several establishments. This measure excludes governmental establishments except for depository institutions, federal and federally sponsored credit agencies, and hospitals.

3. Paved mileage: This variable counts the number of paved miles in a county. Three different specifications of this variable are used. Specification 1 is the number of newly

paved miles of state routes and county roads in the 4-year period prior to the year of interest. Specification 2 is a county's total existing stock of paved miles of state routes and county roads. Finally, Specification 3 is the county's total existing stock of state routes only.

The following variables are included to control for factors other than highways that could affect the level of development within a county.

4. Taxes: This variable is the property tax millage rate for each county. Taxes must be controlled for since, a priori, one would expect taxes to affect business location decisions.

5. Density: This variable is defined as the ratio of a county's population to its area in square miles. Counties with higher density should be expected to create higher employment levels, so this must be controlled for. In 1994, the counties with highest density in Georgia were DeKalb (2120 inhabitants per square mile), Cobb (1456 inhabitants per square mile) and Clayton (1340 inhabitants per square mile).

6. Percent of population living in urban areas: Higher urbanization is usually associated with higher numbers of establishments and employment and must be controlled in the estimation. Twelve counties in Georgia have urbanization rates of higher than 80 percent. The most highly urbanized counties are DeKalb (97.5 percent), Muscogee (96.8 percent), Clayton (95.6 percent), and Fulton (95.4 percent).

7. Change in employment (lagged): This variable is the one-year lagged change in employment. This variable is included to account for the possibility that growth in one year is related to the growth in the previous year. Consider, for example, a county where employment has grown significantly two years in a row for some unspecified reason. This

pattern may affect employment growth the following year. Hence, this effect should be controlled for using lagged employment as an explanatory variable.

8. Atlanta dummy: This variable equals 1 if the county is part of the Atlanta's MSA (20 counties) and 0 otherwise.[3] This Atlanta dummy variable should measure some of the amenities of being near the city of Atlanta. These amenities include things as closeness to professional sports events (e.g., Braves, Hawks, and Falcon games), major museums and attractions (e.g., the High Museum, the Cyclorama, Stone Mountain), the wide variety of restaurants and bars (e.g., Buckhead and Midtown), and Hartsfield airport.

9. Interstate dummy: This variable equals 1 if there is an interstate going through the county and 0 otherwise. Inclusion of this variable also attempts to control for a fixed effect from amenities arising due to the convenience of having an interstate going through the county.

10. Change in Population (lagged): This variable measures the annual growth in population in a county for the prior year. Thus, if we are considering employment growth from March 1990 to March 1991, we include population growth from April 1989 to April 1990. Intuitively, a county where population is increasing rapidly may also see a rapid increase in employment.

B. Descriptive Statistics

The variables described in the previous subsection are presumably important in determining economic development in each county. Before proceeding to the statistical analysis that estimates just how important each variable has been in determining economic growth, this subsection presents descriptive statistics of the growth in employment and establishments between

1990 and 1994. Table 3 shows the number of new jobs in Georgia created every year within this period.

On average, about 600 jobs per county were created each year between 1992 and 1994. In 1991, however, jobs were lost on average mostly due to the U.S. recession of 1990-1991. There are large differences in the numbers of jobs created across counties. As expected, four counties of the Atlanta metropolitan area (Gwinnett, Fulton, Cobb, and DeKalb) led in employment creation. Gwinnett County stands out with over 15,000 new jobs created every year between 1992 and 1994. Notice that these counties are also the ones with the largest road construction described in Section II. In order to uncover potential differences in estimates due to the large disparity between ARC counties and the rest of the counties, the statistical analysis in the next section uses two samples: a full sample of 159 counties and a sub-sample that excludes the 10 ARC counties (Non-ARC sub-sample).

Another interesting fact from Table 3 is that several counties experienced some loss of jobs.[4] There may be different reasons for this. Some counties that lost jobs also had little road construction, but clearly lack of roads is not the only reason for reduced employment. For details on the remaining counties, Map 4 shows the percentage increase in employment in each county between 1984 and 1994.

Descriptive statistics of the number of new business establishments between 1990 and 1994 in the counties of Georgia are presented in Table 4. In the period between 1992 and 1994, about 30 establishments per county were created per year. However, the numbers vary widely among individual counties. Once again, Gwinnett, Fulton, Cobb, and DeKalb led the state in new establishments, with 700 to 800 created each year.

Table 3. Number of New Jobs in Georgia

	1990	1991	1992	1993	1994
County Average	192	-182	443	697	660
Largest	15,394 (Fulton)	3,171 (Cobb)	15,701 (Gwinnett)	15,420 (Gwinnett)	15,387 (Gwinnett)
	9,312 (Gwinnett)	1,657 (Chatham)	13,833 (Clayton)	13,837 (Fulton)	15,239 (Fulton)
	3,543 (Cobb)	1,520 (Columbia)	11,104 (Cobb)	13,092 (Cobb)	11,239 (Cobb)
	2,703 (Bibb)	1,377 (Gwinnett)	6,793 (Richmond)	8,095 (DeKalb)	10,447 (DeKalb)
Smallest					
	-3,110 (DeKalb)	-11,299 (DeKalb)	-10,643 (DeKalb)	-3174 (Richmond)	-785 (Troup)
	-1,167 (Thomas)	-2,630 (Troup)	-2,994 (Gordon)	-475 (Floyd)	-747 (Haralson)
	-1,011 (Troup)	-2,527 (Clayton)	-1,660 (Hart)	-431 (Terrell)	-436 (Emanuel)
	-655 (Lowndes)	-2,276 (Dougherty)	-1,109 (McDuffie)	-256 (Polk)	-303 (Meriwether)

Source: The Georgia County Guide

Table 4. Number of New Establishments of Business in Georgia.

	1990	1991	1992	1993	1994
County Average	48	6	30	30	33
Largest	487 (Gwinnett)	506 (Fulton)	867 (Gwinnett)	762 (Gwinnett)	899 (Fulton)
	437 (Fulton)	400 (Gwinnett)	786 (Cobb)	701 (Fulton)	827 (Gwinnett)
	243 (Cobb)	142 (Cobb)	511 (DeKalb)	506 (Cobb)	708 (Cobb)
	76 (Fayette)	57 (Henry)	236 (Murray)	182 (DeKalb)	260 (DeKalb)
Smallest					
	-33 (Dougherty)	-86 (Muscogee)	-429 (DeKalb)	-13 (Pierce)	-18 (Worth)
	-25 (Mitchell)	-55 (Glynn)	-168 (Gordon)	-10 (Meriwether)	-14 (Spalding)
	-21 (Chattooga)	-49 (Clayton)	-52 (Toobs)	-9 (Richmond)	-12 (Tattnall)
	-19 (Ware)	-39 (DeKalb)	-40 (Oconee)	-9 (Mitchell)	-12 (Banks)

Source: The Georgia County Guide

IV. Estimation and Results

A. Estimation

Regression analysis is employed to determine if roads have contributed to county-level creation of new employment and new business establishments, and in what amounts. The statistical analysis must be done carefully in order to address the causality question: did roads create employment or did higher employment cause more roads to get built?[5] This study tries to avoid the causality problem by only examining the effect of completed networks of roads on subsequent employment.

A number of regressions are estimated where growth in employment and establishments are the dependent variables. The independent variables used are listed and described in Section IIIA. The technical details of the estimating procedure are more fully described in the Appendix. The results are presented on Tables 5 through 10. The next subsection discusses and interprets these results.

B. Discussion of Results

1. Employment

The regression results for the determinants of employment growth for each year between 1994 and 1992 are reported in Tables 5, 6, and 7. Regressions are estimated for two samples in each year. The first sample is the full sample of all counties for which data were available. The second is a sub-sample excluding the ten ARC counties (Cherokee, Clayton, Cobb, DeKalb, Douglass, Fayette, Fulton, Gwinnett, Henry, and Rockdale). Since growth in employment and

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Table 5. Employment Growth Determinants
(Specification 1: Road Construction is change in miles in state and county paved roads in preceding four-year period)

	Coefficient 1994				Coefficient 1993				Coefficient 1992			
	Full Sample		Non-ARC		Full Sample		Non-ARC		Full Sample		Non-ARC	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Int.	-260 (-1.39)	-171 (-0.95)	-87.2 (-0.51)	-20.8 (-0.12)	-1098 (-1.92)	-1001 (-1.81)	-6.79 (-0.03)	55.5 (0.31)	-90.8 (-0.22)	-251 (-0.90)	32.5 (0.08)	-36.6 (-0.12)
Road Const.	7.48** (2.99)	4.69 (1.78)	5.76* (2.20)	3.61 (1.20)	19.9*** (3.65)	16.1* (2.53)	6.17 (1.97)	6.42* (2.53)	12.0** (3.11)	4.44 (0.96)	3.12 (0.81)	0.55 (-0.13)
Taxes (lag)	2.27 (0.29)	-0.60 (-0.08)	1.59 (0.22)	-0.96 (0.13)	37.7 (1.64)	35.0 (1.59)	0.78 (0.10)	-3.14 (-0.46)	-6.50 (-0.38)	3.92 (0.36)	-2.55 (-0.16)	1.20 (0.10)
I-hwy. Dummy	-20.4 (-0.17)	-8.35 (-0.08)	82.3 (0.90)	73.7 (0.81)	-123 (-0.85)	-169 (-1.15)	30.5 (0.34)	152 (1.53)	-30.7 (-0.20)	-223 (-1.55)	45.5 (0.28)	-142 (-0.93)
Density (lag)	2.85*** (3.84)	3.24*** (4.09)	0.90 (1.09)	1.20 (1.42)	2.18 (1.45)	1.92 (1.58)	2.50* (2.06)	4.54** (3.30)	0.92 (0.56)	0.22 (0.16)	-0.38 (-0.21)	-1.55 (-1.13)
Urban Pop.	-10.1 (-1.91)	-10.38* (-2.04)	-3.02 (-0.54)	-3.15 (-0.57)	-7.92 (-1.06)	-9.48 (-1.41)	0.74 (0.13)	-2.65 (-0.72)	16.9** (2.64)	11.1 (1.50)	21.6*** (3.40)	20.9** (3.00)
ΔEmp (lag)	0.26** (2.67)	0.15 (1.22)	0.19** (2.62)	0.11 (1.20)	0.14 (1.21)	0.08 (0.97)	-0.30 (-1.71)	-0.14 (-1.23)	0.05 (0.33)	-0.22 (-1.05)	-0.22 (-1.06)	-0.33 (-1.47)
Atlanta dummy	-10.4 (-0.04)	-109 (-0.36)			-660* (-2.13)	-749* (-2.28)			0.93 (0.01)	-867* (-2.03)		
ΔPop (lag)		0.15 (1.66)		0.14 (1.79)		0.25 (1.27)		-0.40* (-2.59)		0.52* (2.28)		0.44 (1.98)
Adj. R^2	0.84	0.85	0.25	0.28	0.76	0.78	0.31	0.46	0.61	0.68	0.23	0.34
No. obs	154	154	146	146	158	158	148	148	155	155	148	148

Note: T-statistics are in parenthesis. T-statistics were computed using White heteroskedasticity-consistent standard errors and covariance.
* significant at the 5% level; ** significant at the 1% level; *** significant at the 0.1% level

Table 6. Employment Growth Determinants
(Specification 2: Roads is lag (-2) stock of paved state and county road)

	Coefficient 1994				Coefficient 1993				Coefficient 1992			
	Full Sample		Non-ARC		Full Sample		Non-ARC		Full Sample		Non-ARC	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Int.	-697**	-649**	-509*	-459*	-1855*	-1492*	-108	-37.3	-306	-164.9	-188	24.5
	(-3.25)	(-3.07)	(-2.46)	(-2.14)	(-2.40)	(-2.35)	(-0.54)	(-0.21)	(-0.77)	(-0.46)	(-0.56)	(0.07)
Road	1.69***	1.49**	1.49***	1.34**	3.23**	2.30**	0.66	0.66*	1.39*	0.00	0.69	0.18
Const.	(4.08)	(3.78)	(3.75)	(3.22)	(2.96)	(3.16)	(1.90)	(2.20)	(2.00)	(0.00)	(1.33)	(-0.31)
Taxes	5.26	4.89	5.45	4.04	39.2	34.7	0.76	-3.28	-9.35	1.61	1.11	0.23
(lag)	(0.72)	(0.69)	(0.86)	(0.65)	(1.63)	(1.62)	(0.09)	(0.49)	(-0.58)	(0.14)	(0.08)	(0.01)
I-hwy.	-44.0	-47.8	61.9	35.7	-98.2	-168.9	86.2	210.3	-70.2	-256.6	25.7	-140.8
Dummy	(-0.41)	(-0.48)	(0.73)	(0.43)	(-0.08)	(-1.17)	(1.03)	(1.94)	(-0.41)	(-1.77)	(0.17)	(-0.93)
Density	2.47***	2.88***	0.62	0.80	3.56*	2.83*	2.56*	4.58**	3.37	0.93	-0.55	-1.52
(lag)	(4.48)	(4.97)	(0.87)	(1.19)	(2.29)	(2.55)	(2.02)	(3.09)	(2.08)	(0.64)	(-0.34)	(-1.11)
Urban	-9.43*	-9.96*	-2.89	-2.77	-15.2	-15.5	0.90	-2.49	7.65	7.53	21.4**	20.9**
Pop.	(-2.16)	(-2.47)	(-0.59)	(-0.59)	(-1.49)	(-1.67)	(0.16)	(-0.59)	(0.93)	(0.91)	(3.28)	(3.00)
ΔEmp	0.33***	0.12	0.18*	0.10	0.25	0.11	-0.31	-0.15	0.28	-0.21	-0.22	-0.33
(lag)	(3.60)	(1.10)	(2.50)	(1.33)	(1.77)	(1.39)	(-1.59)	(-1.15)	(1.12)	(-1.01)	(-1.15)	(-1.62)
Atlanta	3.83	-226			-373	-574			47.0	-996**		
dummy	(0.01)	(0.82)			(-0.99)	(-1.32)			(0.16)	(-2.72)		
ΔPop		0.19**		0.13*		0.36*		-0.40*		0.62***		0.44
(lag)		(2.63)		(2.09)		(2.11)		(-2.41)		(3.58)		(1.97)
Adj. R^2	0.86	0.87	0.36	0.39	0.71	0.75	0.28	0.43	0.54	0.67	0.24	0.34
No. obs	154	154	146	146	158	158	148	148	155	155	148	148

Note: T-statistics are in parenthesis. T-statistics were computed using White heteroskedasticity-consistent standard errors and covariance.
* significant at the 5% level; ** significant at the 1% level; *** significant at the 0.1% level

Table 7. Employment Growth Determinants
(Specification 3: Roads is lagged (-2) stock of paved state routes)

	Coefficient 1994				Coefficient 1993				Coefficient 1992			
	Full Sample		Non-ARC		Full Sample		Non-ARC		Full Sample		Non-ARC	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Int.	-186 (-0.74)	-218 (-0.89)	-156 (-0.66)	-138 (-0.60)	-282 (-1.18)	-1401 (-1.94)	-275 (-1.11)	-256 (-1.27)	-66.3 (-0.14)	-286 (-0.87)	-184 (-0.44)	-158 (-0.41)
Road Const.	1.93 (1.55)	1.79 (1.55)	2.21 (1.74)	1.93 (1.66)	3.98** (3.05)	7.71* (2.33)	3.48** (3.31)	3.89*** (3.82)	3.38 (1.87)	0.97 (0.73)	2.20 (1.80)	0.79 (0.55)
Taxes (lag)	-5.57 (-0.69)	-4.30 (-0.52)	-1.40 (-0.19)	-2.40 (-0.34)	-7.01 (-0.74)	23.1 (1.27)	0.46 (0.06)	-3.33 (-0.48)	-18.6 (-1.00)	2.77 (0.25)	-0.83 (-0.05)	2.66 (0.21)
I-hwy. Dummy	-1.26 (-0.01)	-15.3 (-0.13)	111 (1.14)	67.5 (0.68)	-20.9 (-0.17)	-253 (-1.48)	43.0 (0.50)	161 (1.62)	-79.0 (-0.49)	-271.1 (-1.92)	10.0 (0.07)	-156.8 (-1.09)
Density (lag)	3.18*** (4.61)	3.59*** (5.14)	1.51 (1.68)	1.64 (1.95)	4.98*** (3.67)	4.01*** (3.76)	42.9 (0.50)	5.11*** (3.69)	3.99* (2.24)	0.88 (0.60)	-0.11 (-0.07)	-1.54 (-1.13)
Urban Pop.	-9.80 (-1.80)	-10.4* (-2.11)	-4.48 (-0.76)	-4.10 (-0.75)	-12.4 (-1.35)	-17.3 (-1.84)	3.00* (2.51)	-3.60 (-0.89)	7.87 (0.94)	7.80 (0.94)	20.4** (3.20)	20.9** (2.99)
ΔEmp (lag)	0.44*** (3.85)	0.15 (1.16)	0.20* (2.45)	0.08 (0.89)	0.07 (0.43)	0.10 (1.09)	-0.32 (-1.65)	-0.16 (-1.22)	0.32 (1.21)	-0.19 (-0.91)	-0.21 (-1.10)	-0.31 (-1.51)
Atlanta dummy	302 (1.13)	-24.0 (-0.08)			195 (0.61)	-214 (-0.43)			298 (0.95)	-943* (-2.53)		
ΔPop (lag)		0.23** (2.79)		0.18** (2.84)		0.42* (2.30)		-0.41* (-2.60)		0.61*** (3.73)		0.42* (2.02)
Adj. R^2	0.82	0.85	0.22	0.28	0.61	0.74	0.30	0.46	0.53	0.67	0.22	0.34
No. obs	154	154	146	146	158	158	148	148	155	155	148	148

Note: T-statistics are in parenthesis. T-statistics were computed using White heteroskedasticity-consistent standard errors and covariance.
* significant at the 5% level; ** significant at the 1% level; *** significant at the 0.1% level

Table 8. Establishment Growth Determinants
(Specification 1: Road Construction is change in miles in state and county paved roads in preceding four-year period)

	Coefficient 1994				Coefficient 1993				Coefficient 1992			
	Full Sample		Non-ARC		Full Sample		Non-ARC		Full Sample		Non-ARC	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Int.	-23.0*	-15.7	-3.37	-0.79	-0.72	-1.03	2.08	1.79	6.31	6.97	3.72	5.59
	(-2.27)	(-1.73)	(-0.54)	(-0.13)	(-0.11)	(-0.17)	(0.38)	(0.33)	(0.55)	(0.66)	(0.31)	(0.50)
Road Const.	0.54***	0.37*	0.22*	0.16	0.51***	0.48***	0.35***	0.35***	0.48***	0.34*	0.42**	0.30*
	(3.58)	(2.44)	(2.51)	(1.88)	(5.21)	(5.07)	(3.76)	(3.75)	(3.48)	(2.60)	(3.23)	(2.46)
Taxes (lag)	0.45	0.23	-0.02	-0.12	-0.02	0.01	-0.03	-0.01	-0.32	-0.33	-0.13	-0.15
	(1.20)	(0.69)	(-0.09)	(-0.53)	(-0.09)	(0.06)	(-0.12)	(-0.05)	(-0.69)	(-0.77)	(-0.26)	(-0.34)
I-hwy. Dummy	1.51	1.59	7.20	6.35	-5.08	-6.80	-0.97	-1.51	1.94	-6.09	2.97	-4.21
	(0.34)	(0.40)	(1.85)	(1.67)	(-1.34)	(-1.82)	(-0.31)	(-0.49)	(0.30)	(-0.90)	(0.44)	(-0.61)
Density (lag)	0.002	0.01	0.03	0.04	0.03	0.01	0.06*	0.05	0.01	0.00	0.03	-0.01
	(0.09)	(0.35)	(0.89)	(1.12)	(0.92)	(0.34)	(2.00)	(1.77)	(0.39)	(0.22)	(0.86)	(-0.55)
Urban Pop.	-0.007	0.07	-0.01	0.00	0.04	0.01	0.01	0.02	0.44*	0.29	0.27	0.32*
	(-0.05)	(0.42)	(-0.09)	(0.05)	(0.25)	(0.06)	(0.10)	(0.10)	(1.99)	(1.90)	(1.30)	(2.03)
ΔEst (lag)	0.61**	0.39	0.33*	0.17	0.16***	0.12**	0.007	0.00	0.57***	0.51***	0.36	0.24
	(2.91)	(1.86)	(2.22)	(1.17)	(3.50)	(2.62)	(0.10)	(0.00)	(11.1)	(8.44)	(1.59)	(1.27)
Atlanta dummy	9.71	7.59			1.95	-1.10			33.4*	4.68		
	(0.65)	(0.56)			(0.23)	(-0.13)			(2.21)	(0.32)		
ΔPop (lag)		0.01*		0.01*		0.00		0.00		0.02***		0.01***
		(2.05)		(2.04)		(1.81)		(0.52)		(3.61)		(4.05)
Adj. R^2	0.86	0.88	0.42	0.47	0.83	0.84	0.39	0.39	0.65	0.70	0.16	0.26
No. obs	154	154	146	146	158	158	148	148	155	155	148	148

Note: T-statistics are in parenthesis. T-statistics were computed using White heteroskedasticity-consistent standard errors and covariance.
* significant at the 5% level; ** significant at the 1% level; *** significant at the 0.1% level

Table 9. Establishment Growth Determinants
(Specification 2: Roads is lag (-2) stock of paved state and county road)

	Coefficient 1994				Coefficient 1993				Coefficient 1992			
	Full Sample		Non-ARC		Full Sample		Non-ARC		Full Sample		Non-ARC	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Int.	-9.43	-6.68	-3.62	-3.32	-19.5*	-18.47*	-9.10	-9.32	5.03	-0.03	0.87	14.3
	(-0.77)	(-0.69)	(-0.48)	(-0.49)	(-2.18)	(-2.58)	(-1.48)	(-1.51)	(0.30)	(-0.00)	(0.05)	(0.86)
Road Const.	0.003	0.01	0.01	0.02	0.07***	0.07***	0.05***	0.05***	0.03	0.02	0.03	-0.00
	(0.21)	(0.38)	(1.91)	(1.87)	(4.27)	(5.48)	(4.13)	(4.16)	(1.31)	(1.17)	(1.69)	(-0.02)
Taxes (lag)	0.009	-0.08	-0.11	-0.16	0.04	0.08	0.03	0.05	-0.37	-0.25	-0.13	-0.33
	(0.02)	(0.23)	(-0.43)	(-0.65)	(0.15)	(0.34)	(0.14)	(0.22)	(-0.72)	(-0.56)	(-0.24)	(-0.63)
I-hwy. Dummy	6.59	4.44	8.79*	5.84	-4.85	-6.84*	1.04	0.61	1.72	-9.75	3.28	-3.66
	(1.32)	(1.12)	(2.27)	(1.84)	(-1.35)	(-1.98)	(0.34)	(0.18)	(0.27)	(-1.56)	(0.52)	(-0.55)
Density (lag)	0.04*	0.03	0.03	0.04	0.07*	0.05	0.05	0.04	0.06	0.08	0.04	-0.00
	(2.21)	(1.35)	(0.99)	(1.16)	(2.41)	(1.45)	(1.87)	(1.61)	(1.71)	(1.69)	(1.05)	(-0.03)
Urban Pop.	-0.15	0.01	-0.03	0.01	-0.12	-0.15	0.05	0.05	0.29	-0.37	0.21	0.24
	(-1.14)	(0.08)	(-0.18)	(0.06)	(-0.62)	(-0.76)	(0.31)	(0.30)	(1.32)	(-1.36)	(1.06)	(1.63)
ΔEst (lag)	1.05***	0.58**	0.40**	0.17	0.25***	0.20***	0.02	0.02	0.65***	0.45***	0.39	0.27
	(13.7)	(2.72)	(2.88)	(1.13)	(3.91)	(2.85)	(0.36)	(0.25)	(10.2)	(5.97)	(1.66)	(1.36)
Atlanta dummy	16.0	10.4			6.25	2.46			40.0*	-32.1		
	(1.82)	(0.71)			(0.65)	(0.24)			(2.37)	(-1.74)		
ΔPop (lag)		0.01*		0.01*		0.01		0.00		0.04***		0.02**
		(2.52)		(2.43)		(1.39)		(0.29)		(5.48)		(3.60)
Adj. R^2	0.83	0.87	0.40	0.47	0.80	0.81	0.38	0.38	0.62	0.85	0.11	0.22
No. obs	154	154	146	146	158	158	148	148	155	155	148	148

Note: T-statistics are in parenthesis. T-statistics were computed using White heteroskedasticity-consistent standard errors and covariance.
* significant at the 5% level; ** significant at the 1% level; *** significant at the 0.1% level

Table 10. Establishment Growth Determinants
(Specification 3: Roads is lagged (-2) stock of paved state routes)

	Coefficient 1994				Coefficient 1993				Coefficient 1992			
	Full Sample		Non-ARC		Full Sample		Non-ARC		Full Sample		Non-ARC	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Int.	-1.54 (-0.15)	1.62 (0.19)	-0.13 (-0.02)	0.82 (0.11)	-7.31 (-0.77)	-6.15 (-.72)	-1.76 (-0.24)	-1.77 (-0.24)	4.73 (0.32)	2.72 (0.19)	5.09 (0.31)	12.18 (0.77)
Road Const.	-0.05 (-1.04)	-0.05 (-1.24)	0.03 (0.97)	0.02 (0.93)	0.14** (2.96)	0.12** (2.74)	0.10** (2.69)	0.10** (2.61)	0.11 (1.94)	0.05 (0.89)	0.08 (1.61)	0.01 (0.29)
Taxes (lag)	-0.05 (-0.15)	-0.16 (-0.48)	-0.18 (-0.73)	-0.24 (-0.97)	-0.28 (-0.93)	-0.21 (-0.78)	-0.13 (-0.54)	-0.12 (-0.53)	-0.46 (-0.95)	-0.35 (-0.72)	-0.26 (-0.49)	-0.31 (-0.61)
I-hwy. Dummy	8.13 (1.75)	6.04 (1.42)	9.15* (2.43)	7.34 (1.99)*	-4.50 (-1.17)	-6.65 (-1.75)	1.75 (0.50)	1.46 (0.41)	0.92 (0.14)	10.38 (-1.70)	3.27 (0.52)	-3.93 (-0.61)
Density (lag)	0.04* (2.05)	0.03 (1.54)	0.04 (1.21)	0.05 (1.33)	0.13*** (3.88)	0.09** (2.61)	0.08** (2.84)	0.07** (2.83)	0.06 (1.96)	0.08 (1.73)	0.07 (1.65)	-0.00 (-0.03)
Urban Pop.	-0.17 (-0.98)	-0.00 (-0.04)	-0.06 (-0.31)	-0.01 (-0.08)	-0.25 (-1.17)	-0.28 (-1.25)	-0.02 (-0.14)	-0.03 (-0.15)	0.31 (1.42)	-0.37 (-1.35)	0.16 (0.80)	0.24 (1.56)
ΔEst (lag)	1.07*** (4.96)	0.61** (2.80)	0.46** (3.14)	0.24 (1.60)	0.29*** (3.49)	0.23** (2.69)	0.06 (0.84)	0.05 (0.77)	0.63*** (9.78)	-0.4*** (5.84)	0.43 (1.79)	0.27 (1.40)
Atlanta dummy	15.4 (0.09)	10.1 (0.70)			16.0 (1.54)	10.7 (0.92)			45.8* (2.77)	-30.1 (-1.62)		
ΔPop (lag)		0.01* (2.46)		0.01* (2.23)		0.01 (1.39)		0.00 (0.24)		0.04*** (5.67)		0.02*** (4.02)
Adj. R^2	0.84	0.87	0.39	0.46	0.75	0.77	0.28	0.28	0.62	0.85	0.09	0.22
No. obs	154	154	146	146	158	158	148	148	155	155	148	148

Note: T-statistics are in parenthesis. T-statistics were computed using White heteroskedasticity-consistent standard errors and covariance.
*significant at the 5% level; ** significant at the 1% level; *** significant at the 0.1% level

roads in the ARC counties is so much larger than in the average county, estimating this sub-sample may display fairly different coefficients. Additionally, for each of the two samples, two separate regressions are estimated. The only difference between these two regressions is that one includes population growth as an explanatory variable while the other does not. For ease of exposition every regression is numbered from (1) to (12) in each table.

The three different specifications for the road variable described in Section IIIA are used alternatively to derive the results reported on Tables 5, 6, and 7. Recall Specification 1 uses the number of paved miles of state routes and county roads built in a county in the preceding four years. This means, for example, that the number of miles of state routes and county roads built between 1989 and 1993 is an explanatory variable for employment growth in 1994. The results using Specification 1 are described in Table 5. Road construction is a significant determinant of employment growth in six out of twelve regressions at the 5 percent level (and in eight out of twelve regressions at the 10 percent level). The estimated coefficients are easily interpretable. Estimates using all the counties in Georgia are discussed first (i.e., the full sample estimates). For example, in regression (1) the estimated coefficient for road construction, 7.48, indicates that an additional mile of road construction (built between 1993 and 1989) is associated with 7.48 additional jobs in 1994, holding everything else constant. The estimates of this coefficient for the years 1993 and 1992 are 19.9 (regression (5)) and 12.0 (regression (9)), respectively. Both of these are also highly significant and larger than the 1994 estimate. The average of all significant estimates for the full sample is 12.0. Hence, on average, an extra mile of road built in a four-year period is associated with 12 new jobs the following year.

How does the size of these coefficients change when the ARC counties are excluded? The results for this sub-sample are reported under the "Non-ARC" columns on Table 5. Using this

sub-sample, the road construction coefficient is statistically significant in regressions (3) and (8). In each of these regressions, the estimate is of smaller magnitude than its full-sample counterpart. The average is 6.0, which is only half as large as the average under the full sample. This implies that every mile of road construction outside the Atlanta area is not associated with as many jobs as construction in the Atlanta area. Put differently, the contribution of an extra mile of road is greater in the ARC counties. Consequently, there must be other relevant variables, more abundant in the Atlanta region, contributing to employment creation.[6]

Two other variables are statistically significant in explaining employment in at least four regressions: population density (in regressions (1), (2), (7), and (8)); the percentage of population living in urbanized areas (in regressions (2), (9), (11), (12)).[7] Counties that are more densely populated and that have experienced population growth in the preceding year seem to create more new jobs, as may be expected.

Results using Specification 2, i.e., the stock of paved state routes and county roads, are presented in Table 6. Under this specification, the second lag of this road variable is used in the estimation. That means, for example, that a county's existing 1992 stock of paved state routes and county roads is used when estimating how much roads contributed to employment growth in 1994. Presumably, road additions bring in employment a year or two after being built. All twelve regressions are re-estimated using this new specification. As in Specification 1, results from Specification 2 show roads are a significant explanatory variable of employment creation in eight out of twelve regressions.

The results for the full sample regressions are discussed first. The estimated road stock coefficient for 1994 is 1.69 (regression (1). The interpretation of this coefficient is that every existing mile of county and state road is associated with 1.69 new jobs per county. The average

road stock coefficient (when significant) is about 2 in the full sample regressions. Next the results for the "Non-ARC" sub-sample are discussed. Once again, this sample displays smaller coefficients for the contribution of the road variable, averaging 1.16. The intuition for why this coefficient is smaller than its full sample counterpart is the same as described in the discussion of Table 5.

Finally, Table 7 reports results using Specification 3: the existing stock of state routes in a county. The road variable is significant at the 1 percent level in all the 1993 regressions. Most of the estimates for the road stock coefficient in the remaining eight regressions are only significant at the 10 percent level. The intuition for the results in Table 7 closely follows those for Table 6 and hence are not repeated. Summarizing results from Tables 5, 6, and 7, road variables are found consistently important in explaining employment creation.

2. Establishments

The regression results for the determinants of business establishments are reported in Tables 8, 9, and 10. The estimation uses alternative specifications and samples exactly as described above. Table 8 presents results using Specification 1. Road construction appears to be a highly significant across the board. In addition, the estimated coefficients of road construction for the full sample are very uniform in size at about 0.50 for all three years estimated. The interpretation is that every two miles of road built in a county in the previous four-year period is associated with the opening of about one new business. In comparison, the non-ARC sub-sample displays smaller coefficients, averaging 0.30. This coefficient can be interpreted as follows: outside of the Atlanta region, every three miles of road built is associated with the establishment of one new business. Once again, this indicates that there are some variables more abundant in the

Atlanta region so that every mile of road construction is associated with the opening of more new business establishments.

Besides roads, there are other variables that are significant for explaining new business openings. For example, the lagged growth in establishments is also significant in six out of twelve regressions as described on Table 8. This means that once a number of establishments were opened in a county during a certain year, the trend continued, with more establishments opening the following year. This effect is strongest in the ARC counties. Economists have developed theories of locational clustering to explain this phenomena. Finally, population growth is significant in four out of twelve regressions; businesses open new establishments in those counties where population has been growing. Results from Specifications 2 and 3, reported on Table 9 and Table 10, tell basically the same story and are not discussed in detail for brevity.

V. Conclusion

Road construction in the state of Georgia appears to have been successful in facilitating the state's development goal. This report finds that on average about 20 new jobs and 1 new place of business per year are associated with every 2 miles of road built in the preceding four years. Also on average, more jobs were created in counties with larger existing stock of road infrastructure. In particular, counties in the Atlanta area have benefited from large amounts of road construction that has been followed by larger numbers of jobs created. For all counties, the payoffs from construction should continue as existing roads and businesses should attract more establishments and hence more employment to the various regions. Additionally, the analysis finds that there are several other determinants of county economic development, including population density, the level urbanization, and population growth.

Some caveats apply to these findings. First, the statistical estimation attempted to separate the effects of roads on growth from the effects of growth on roads. However, it is possible that roads were built in anticipation of growth so results may simply suggest that the DOT is a good predictor of growth patterns. Second, while we have shown that economic growth in a county is positively associated with roads and road construction in a county, we have not necessarily shown that roads cause growth. It is possible that roads influence where growth occurs in the state, and not the level of growth. Third, it remains to be determined if the estimated contribution of roads to development outweighs the costs of construction, both direct and indirect (e.g., environmental costs).

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Endnotes

[1] Major portions of the Outer Perimeter have not been approved for funding. Environmental concerns outlined in the Clean Air Act will have to be addressed before federal funding is approved.

[2] These figures refer to linear miles of road, not lane miles. Data on the latter were not available.

[3] Atlanta's MSA is composed of the following counties: Barrow, Bartow, Carroll, Cherokee, Clayton, Cobb, Coweta, DeKalb, Douglass, Fayette, Forsyth, Fulton, Gwinett, Henry, Newton, Paulding, Pickens, Rockdale, Spalding, and Walton.

[4] DeKalb County experienced a dramatic loss of jobs in 1991 and 1992 as Table 3 reports. The General Motors assembly plant in Doraville was closed down in that period, releasing thousands of employees. Also, many businesses moved out of the southern part of the county during that period.

[5] A number of Granger causality tests were conducted which are not reported in full here due to space constraints. These tests consist of two parts. In the first part employment growth is regressed on all the available lags of itself and of road mileage growth. Then this same regression is estimated without the road mileage growth lags. Finally an F-test is used to test the hypothesis, "roads do not cause employment." This hypothesis was rejected for all regressions, implying that roads may create subsequent employment.
The second part of the test proceeds similarly except road construction growth becomes the dependent variable. The hypothesis is "employment does not cause roads." Once again, this hypothesis was rejected for all regressions meaning that employment growth may indeed cause increased road construction in the future. In other words, there is causality going in both directions. This two-way causality is not a problem for the regressions reported in the paper since only lagged values of road construction or road stock are used to determine their effects on subsequent employment.

[6] It should also be noted that the explanatory power (R-square) of the variables in the sub-sample regression is lower than that of the full sample. This indicates that the explanatory variables used have been more important for employment growth in the Atlanta region.

[7] There are other variables that are significant in some regressions, e.g., lagged employment growth (in regressions (1) and (3)); and lagged population growth (in regressions (8) and (9)). These two variables are likely to be correlated. However, there are intuitively good reasons to include both of these as explanatory variables. Both can affect employment growth while not necessarily incorporating the same information. Their potential collinearity should not affect, however, the estimates or standard errors of the road variable's coefficients. The Atlanta dummy variable is also significant in three of twelve regressions. However, the coefficients are negative. This is counterintuitive since one would expect that county's in Atlanta's MSA would create more employment than those outside.

Appendix

Estimating Procedure

The following equation was estimated using OLS:

$$\Delta EMP_t = a_1 + a_2 * ROAD + a_3 * TAX_{t-1} + a_4 * INTST + a_5 * DENSE_{t-1} + a_6 * URB + a_7 * \Delta EMP_{t-1} + a_8 * ATL + a_9 * \Delta POP_{t-1} + e_t$$

ΔEMP: Change in employment

ROAD: Specification 1: change in state and county road miles in previous 4 years

Specification 2: stock of total paved miles of state routes and county roads

Specification 3: stock of total paved miles of state routes

TAX: County millage rates

INTST: Interstate highway dummy

DENSE: Population per square mile

URB: Percent of county population living in urban area

ATL: Atlanta MSA dummy

ΔPOP: Change in population

ε: Random error term

For a complete definition and description of these variables refer to Section IIIA in this report. Lags of independent variables are used to avoid the causality problem described in Section IV. Specification 1 is effectively the number of miles of state and county roads built in the previous four years (i.e., $ROAD_{t-1}$ - $ROAD_{t-5}$). This specification has two advantages. First, it avoids simultaneity problems. Second, it provides a better measure of networks of roads. Networks take time to get built, so using the stock built over a four- year period may be more indicative of a network. Specification 2 uses $ROAD_{t-2}$ instead, where this variable is the total stock of paved

state routes and county roads existing two years before. Specification 3 is similar except it only includes the stock of state routes. As Section IIIB describes, there are wide variations across counties in employment, establishments and road construction. Hence, White heteroskedasticity-consistent standard errors and covariance are used to test hypothesis.

The determinants of new business establishments are also estimated using a similar equation. The change is establishments, ΔEST, is simply replaced for the change in employment, ΔEMP, in the equation above.

About the Author

Felix Rioja an Assistant Professor in the Department of Economics at Georgia State University, has studied the effects of public infrastructure on economic growth in developing countries. He has also researched the welfare costs of inflation across countries under different exchange rate regimes. Professor Rioja, who teaches macroeconomics and international finance, holds a Ph.D. from Arizona State University.