The Relationship between Transportation Accessibility and Economic Development

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Abstract:

This paper investigates the possible relationship between transportation infrastructure accessibility and economic development in a given region. The study will incorporate data from counties in the state of Massachusetts to compare development from previous studies in the New York area. The independent variable will be transportation infrastructure accessibility, and the dependent variable will be measures of economic development. The results show that there are generally not correlations between better accessibility and economic development in a given region.

JEL Classification: O10, O11, O18

Keywords: Infrastructure, Economic Development

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1.0 INTRODUCTION

One of the main factors that plays an important role in any region's economic well-being is reliable and efficient transportation infrastructure system. A properly developed transportation system gives adequate access to the region which is a necessary condition for the efficient operation of retail, manufacturing, housing markets, and labor. The relationship between accessibility through transportation infrastructure and economic development has long been an important topic. Establishing this relationship can enable policy decisions on how to enhance economic growth in regions that may be struggling.

This study aims to enhance understanding of the relationship between accessibility and economic development in Massachusetts. From a policy perspective, this analysis is important because understanding the degree to which transportation infrastructure impacts economic development can inform policymakers as to how to improve economically under-developed areas potentially with higher investment in the infrastructure in those areas. The relevance of this study is that the highways in the United States are in worse shape than in other developed countries, so examining the relationship between transportation infrastructure in highways and other roads can give insight into how to better develop these regions.

This paper was guided by three research objectives that differ from other studies: First it investigates relationship between economic development and transportation infrastructure in the entire state of Massachusetts; Second, it incorporates monthly data from the five-year period from 2014-2019, giving a recent look at this trend; Last, it analyzes the differences in the relationship when looking at major highways as opposed to smaller roads. There is very little empirical work in the literature concentrating on an entire state in the Northeast using dynamic panel data model. This paper successfully fills this void.

The rest of the paper is organized as follows: Section 2 gives a brief literature review. Section 3 outlines the empirical model. Data and estimation methodology are discussed in section 4. Finally, section 5 presents and discusses the empirical results. This is followed by a conclusion in section 6.

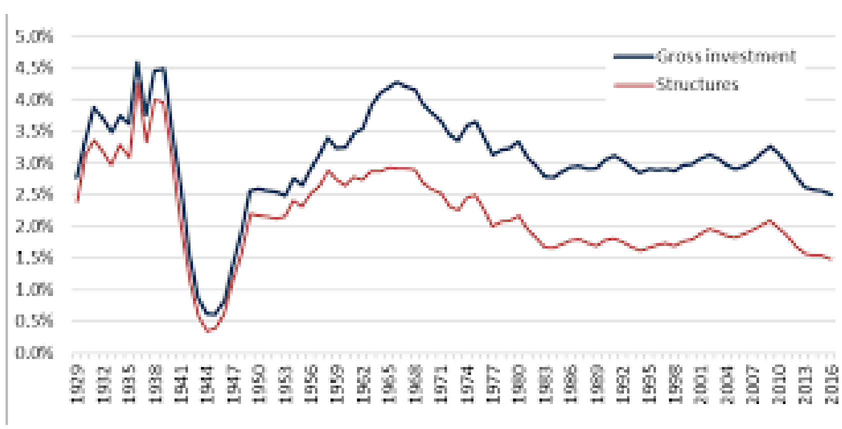
2.0 TREND OF EMPLOYMENT AND TRAFFIC

Figure 1 shows the framework that represents the relationship between accessibility and economic growth, taken from research of Banister and Berechman. The two trendlines show gross investment and structures, which shows that investing in infrastructure leads to the development of said infrastructure and establishes that these two variables move together.

Figure 2 shows the monthly data for Boston used in this study. The first graph is showing employment and the second shows the traffic data for urban interstates in Boston from January 2014 to December 2019. The trendlines do not match up well, with employment steadily rising over the course of the time period and traffic seeing rises and falls over the course of the time period. This could indicate that there is not a strong relationship between these variables, which will be further explored later in the analysis.

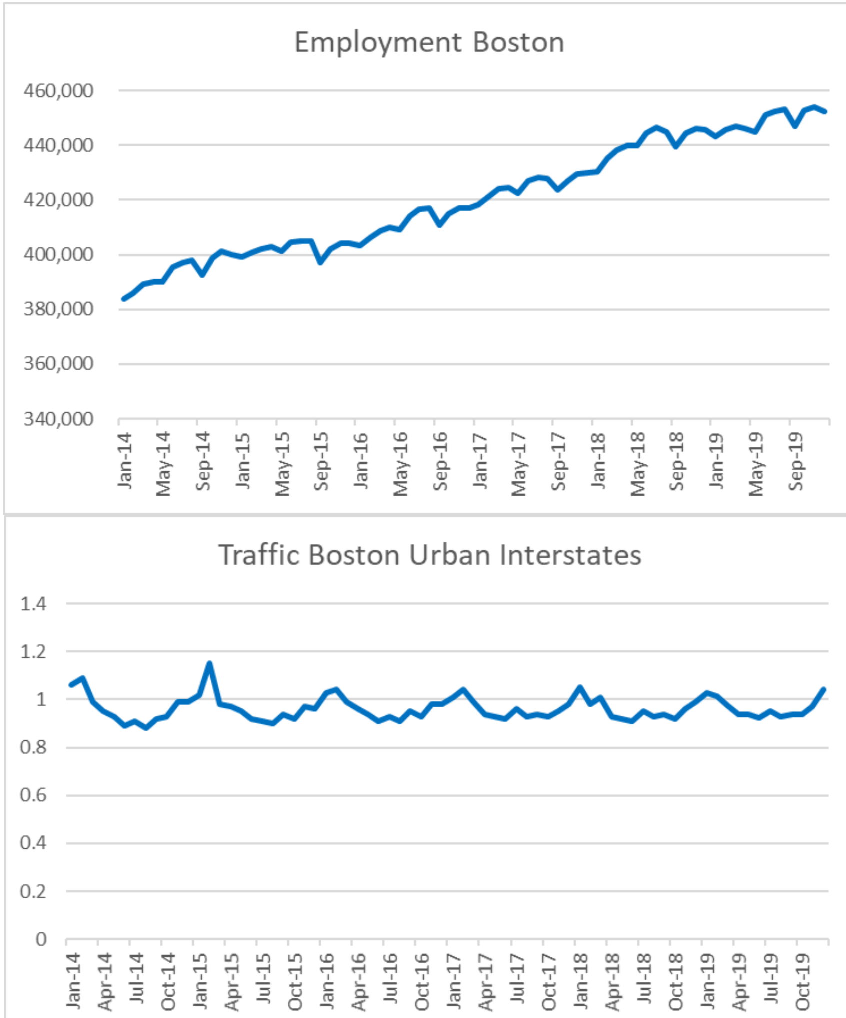
Figure 3 shows annual data for Boston, with the first graph showing employment and the second graph showing traffic data from 2014 to 2019. As with the monthly figures, the trendlines for each of these graphs do not align very well, with employment steadily rising and traffic experiencing increases and decreases. This again indicates that there may not be a strong relationship between these two variables with the yearly data as well as the monthly data.

Figure 1: Framework representing relationship between accessibility and economic growth



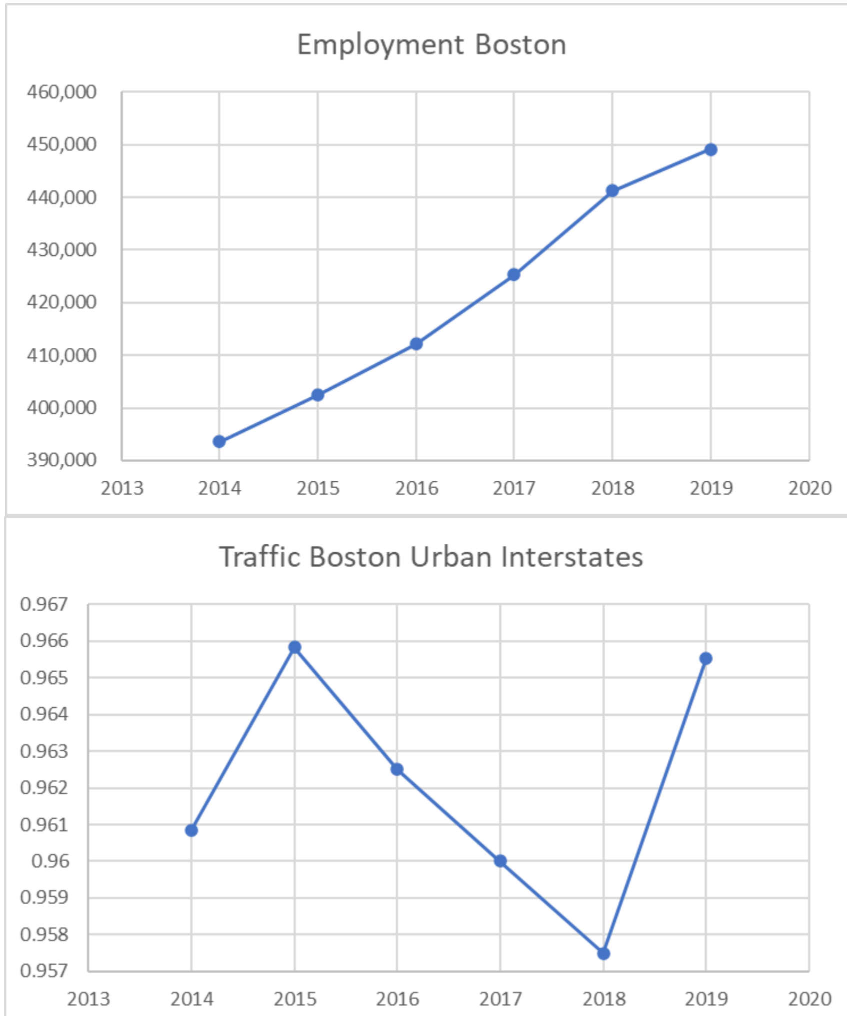
Source: Banister and Berechman, 2000

Figure 2: Monthly Employment and Traffic Trends in Boston



Source: MassDOT & ALFRED

Figure 3: Annual Employment and Traffic Trends in Boston



Source: MassDOT & ALFRED

3.0 LITERATURE REVIEW

The relationship between accessibility through transportation investment and economic development in a given region has been widely investigated by several researchers over the past several decades.

Boarnet (1996) has examined the way highway investments redistribute economic activity by dividing the economic impacts of the transportation infrastructure into a direct and an indirect effect. The direct effect is considered to be the impact on locations near streets or highways, and the indirect effect is any impact that occurs at locations more distant from the highway corridor. A loglinear Cobb-Douglas specification was applied to the California data such as county employment, using capital stock in the county and other counties as independent variables and the county's output as the dependent variable. It was concluded that the direct and indirect effects of investing in transportation infrastructure were of equal and opposing magnitude.

Cidell (2014) conducts a study performs two analyses, both that concern the connection between airports and economic development at the sub-regional level. The first analysis builds on existing work that identifies significant concentrations of jobs in the airport vicinity by carrying out a similar calculation for other major pieces of infrastructure in the metropolitan area to see if the airport is unique as a secondary job center. The second analysis takes the professional services jobs thought to be drawn to a metropolitan area by a major airport and determines where they locate within the region: evenly distributed, clustered near the airport, or clustered elsewhere? The results of this study found that within the US context, more often than not, the economic development an airport brings to its region is occurring somewhere other than the vicinity of the airport. This research does not deny the existence of a connection between airports and economic development, but it does demonstrate that the connection between airports and economic development is uneven both across regions and within them.

Isserman et al. (1989) used a quasi-experimental approach to investigate the effect of highways on smaller communities and rural areas. The authors examined income growth rates for 231 small cities during the period of 1969–1984, some with highway access, some without. It was found that the cities located near highways had faster economic growth.

Ozbay et al (2003) have a main goal to study the existence of the relationship between economic growth and transportation system performance in 18 counties in the New York and New Jersey region between the years 1990 and 2000. The paper establishes that one of the key factors that plays a pivotal role in a region's economic well-being is the presence of a reliable and efficient transportation infrastructure. Well-developed transportation systems provide adequate access to the region. Longitudinal change in total earnings or income and employment growth are used to measure economic development. The transportation system performance can be measured using a suitable accessibility index, which can be defined as a combination of interzone travel time and zonal activity levels. Data used to perform a multiple linear regression analysis to investigate the hypothesized relationship between economic development measures and accessibility.

Travel times between the counties were obtained from the North Jersey Transportation Authority. The results of this study show that accessibility is found to have considerable impact on the employment growth value and the total earnings growth value, and that economic growth is a function of accessibility and is related to the transportation system performance measured in terms of travel times.

Rephann (1993) reviews criteria used in US development highway corridor selection and variables identified by various regional development theories. A synthesis of highway empirical research suggests that geographic region, urbanization, development, and public infrastructure may be important triggering forces in the United States. The research done here suggests that highways are most stimulating for urban areas near metropolitan areas that are located in less industrialized and developed regions, but severely under-developed regions are not good candidates for investment.

Stephanedes and Eagle (1986) used a time-series approach to investigate the relationship between state highway expenditures and changes in employment levels in 30 nonmetropolitan Minnesota counties between 1964 and 1982. Grouping all 87 Minnesota counties, they found no overall relationship between highway expenditures and changes in employment levels. For a subgroup of regional centers, however, highway expenditures did appear to engender job growth.

4.0 DATA AND EMPIRICAL METHODOLOGY

4.1 Data

The study uses monthly and annual data for time series and panel data analysis from 2014 to 2019. Data for traffic were obtained from the Massachusetts Department of Transportation (MassDOT) website. Economic data were obtained from the St. Louis Federal Reserve's Economic Data Research Division (ALFRED). Summary statistics for the data are provided in Table 1 and Table 2.

Table 1: Summary Statistics Panel Data Analysis

Variable	Observation	Mean	Std. Dev.	Min	Max
Emp	30	530729.7	248179.6	380813	1067274
Traffic	30	. 9712667	.0184875	.9308333	1.021667
Pop	30	1011191	492939.7	639594	2006184
Crime	30	911.2	382.761	358	2011
Edu	30	.8938167	.024058	.84	.92375
GDP	30	69500000	38500000	35400000	138000000

Table 2: Summary Statistics Time Series Analysis

Variable	Observation	Mean	Std. Dev.	Min	Max
EMPBos	72	420629.5	20570.2	383737	453962
TrafficBos	72	.9620333	.0492212	.88	1.15
EMPEssex	72	399025.4	13620.29	370669	420405
TrafficEssex	72	.9713583	.0721638	.86	1.17
EMPSou	72	1016756	38010.52	938091	1089146
TrafficSou	72	.9759833	.0841281	.84	1.25
EMPWest	72	399141.6	10129.49	376375	417457
TrafficWest	72	.9612417	.0657479	.8644	1.191
EMPWor	72	418095.6	13680.89	391655	442619
TrafficWor	72	.9857167	.0837459	.88	1.39

4.2 Empirical Model

Following Ozbay et al (2003) this study adapted and modified the independent and dependent variables to include different measures of economic development and accessibility. Previous literature used an accessibility index to measure accessibility, while I used traffic to measure accessibility. Previous literature used multiple measures of economic development, while I used only employment to measure economic development. I also added four additional independent variables to the panel data model, some following previous literature and some that are altered, these variables are population, crime, educational attainment, and gross domestic product. The time series models have employment as the dependent variable and traffic as the independent variable.

The models could be written as follows:

(1) $EMP_{it} = \beta_0 + \beta_1 TRAFFIC_{it} + \beta_2 POP_{it} + \beta_3 CRIME_{it} + \beta_4 EDU_{it} + \beta_5 GDP_{it} + u_{it}$

(2) $EMP_t = \beta_0 + \beta_1 U1Boston_t + \varepsilon_t$

$EMP_t = \beta_0 + \beta_1 U1Essex_t + \varepsilon_t$

$EMP_t = \beta_0 + \beta_1 U1Southeast_t + \varepsilon_t$

$EMP_t = \beta_0 + \beta_1 U1West_t + \varepsilon_t$

$EMP_t = \beta_0 + \beta_1 U1Worcester_t + \varepsilon_t$

EMP_{it} is the total employed persons in each of the counties examined in Massachusetts in county *i* at year *t*. EMP_{it} is used as an endogenous variable and can be seen in Model 1 above. Various studies in this area of economics use employment as a measure of economic growth. EMP_t in each of the time series analyses is the measure of employment in each of these five regions in time *t*, which is measured in months for these models, which can be seen in Model 2 above.

Independent variables consist of five variables obtained from various sources. Appendix A and B provide data source, acronyms, descriptions, expected signs, and justifications for using the variables. First, $TRAFFIC_{it}$ (traffic in county *i* at year *t*) represents the traffic rates in each county. Second, POP_{it} is the total population of county *i* at year *t*. Third, $CRIME_{it}$ is a measure of crime in each of the counties, measured as persons out of 100,000 in county *i* at year *t*. Fourth, EDU_{it} is a measure of educational attainment and measures the percentage of the population who have completed a high school diploma or higher in county *i* at year *t*. Fifth, GDP_{it} is a measure of gross domestic product in the counties studied in county *i* at year *t*.

In the time series models, seen in Model 2, $U1Boston_t$ is the measure of traffic on urban interstates in Boston at month *t.* Shown second, $U1Essex_t$ is the measure of traffic on urban interstates in Essex county at month *t.* Shown third, $U1Southeast_t$ is the measure of traffic on urban interstates in the Southeast region, representing Norfolk, Plymouth, Bristol, and Barnstable counties at month *t.* Shown fourth, $U1West_t$ is the measure of traffic on urban interstates in the West region, representing Franklin, Berkshire, Hampshire, and Hampden counties at month *t*. Shown last, $U1Worcester_t$ is the measure of traffic on urban interstates in Worcester county at month *t*.

5.0 EMPIRICAL RESULTS

The empirical estimation results are presented in Table 3 and Table 4. The empirical estimation shows the negative relationship between employment and traffic in the time series analysis where the relationship is significant.

Table 3: Regression results for the Panel Data Analysis

Variable	Fixed 1
Dependent variable: employment (annual)	
Traffic	87598.01
	(81797.82)
Pop	1.369223***
	(0.1985908)
Crime	-20.44668***
	(6.058753)
Edu	200902
	(415477)
GDP	-0.0006033
	(0.0004448)
Constant	-1057874**
	(383052.2)
# of Observations	30
# of Groups	5
F-Statistic	49.25
Prob>F	0.0001
R2	0.9249
Adjusted R2	0.9661
rho	0.99978979
*** = 1%, ** = 5%, * = 10%, () = Standard Error	

Table 4: Regression Results for the Time Series Analyses

Variable	Fixed 1	2	3	4	5
Dependent variable: employment (monthly)					
Traffic	-42188	-44120.8**	-164555***	6170.183	-5728.5
	(50912.8)	(21933.86)	(50293.43)	(18399.6)	(19513.49)
Constant	461179***	441882.5***	1177359***	393210.6***	423742.3***
	(48908.37)	(21363.54)	(49265.05)	(17727.21)	(19303.11)
# of Observations	72	72	72	72	72
F-Statistic	0.79	4.05	10.71	0.11	0.09
Prob>F	0.3773	0.0481	0.0017	0.7384	0.77
R2	0.0112	0.0546	0.1326	0.0016	0.0012
Adjusted R2	-0.003	0.0411	0.1203	-0.0127	-0.013
Root MSE	20601	13337	35652	10193	13770

Note: *** , **, and * denotes significance at the 1%, 5%, and 10% respectively. Standard errors in parentheses

In the panel data analysis, the results can be seen in Table 3, and population and crime are the only significant variables in this regression. Traffic, which is the main variable being measured compared to the dependent variable of employment, is not significant in this regression. Population is significant at the 1% level and has a positive coefficient. This indicates that a higher level of population is correlated with a higher level of employment. Crime is significant at the 1% level and has a negative coefficient, which indicates that a lower level of crime is correlated with a higher level of employment. The R^2 value for this analysis is 0.9249, and the adjusted R^2 is .9661 and both of these values are very high. The high values indicate that the model is a good fit.

Table 4 shows the results for all of the time series regressions. The first column is for Boston, the second for Essex county, the third for the Southeast region, the fourth for the West region, and the fifth for Worcester County. The R^2 values for all of these regressions are very low, with the Southeast region having the highest one with a value of 0.1326. The low R^2 values for all of these regressions indicates that the models are not very accurate, and since the Southeast region has the highest value, this indicates that it is the most accurate out of all the time series analyses. Traffic is significant for two out of the five regressions, for Essex county and the Southeast region. For the regression for Essex county, traffic is significant at the 5% level and it has a negative coefficient. This indicates that a lower level of traffic is correlated with a higher level of employment. For the regression for the Southeast region, traffic is significant at the 1% level and it also has a negative coefficient, indicating that a lower level of traffic is correlated with a higher level of employment. All of the time series regressions have negative coefficients for traffic with the exception of the fourth one, which represents the West region, and this has a positive coefficient for traffic. This indicates that a higher level of traffic is correlated with a higher level of employment. One reason for why the West region may have a different coefficient sign from the rest of the time series regressions is because western Massachusetts is significantly less populated than the rest of the state, so more traffic in this region could mean that the region is developing more.

The results of these regressions show that traffic is not usually significantly correlated with employment, indicating that there is not always a strong relationship between transportation accessibility and economic growth, and this is consistent with previous literature (Cidell, 2014) (Stephanedes and Eagle, 1986). Traffic was not significant in the panel data analysis, and it was only significant in the Essex and Southeast time series analyses. In the panel data analysis, population and crime are correlated with employment but traffic is not. This could be due to the measure of accessibility that was used, as previous literature used an accessibility index while this study only used traffic times as a measure of accessibility. It could also simply mean that employment and traffic are not significantly correlated with each other, suggesting that there is not a relationship between transportation accessibility and economic development. The regressions in which traffic is significant had traffic with a negative coefficient, showing that lower levels of traffic is associated with higher levels of employment. This result was expected because lower levels of traffic make a region more accessible to drivers. Overall, these results show that there is not a strong relationship between employment and accessibility through traffic data when examined with other economic variables. There is a relationship between accessibility and economic growth in certain regions in Massachusetts but not all of them.

5.0 CONCLUSION

The results of this study can inform policy decisions, as they show that in some regions of Massachusetts transportation infrastructure investment to reduce traffic and travel times could be effective in improving economic growth, while not in others. Targeted investment in improving traffic in these counties (Essex, Norfolk, Plymouth, Bristol, and Barnstable) could have a marked effect on economic growth, but a general investment at the state level in Massachusetts would likely not have a strong impact on economic growth. One potential strategy for improving traffic is to invest in overall infrastructure and improve interstates, thereby cutting down on the potential for car accidents due to poorly maintained roads. A better strategy for improving economic growth in all counties in Massachusetts would be to focus on crime reduction, since crime was significantly correlated with economic growth across the entire state.

This study had several limitations. One of the major limitations was data availability. Monthly data was not available for the other economic variables used in the panel data analysis, so there were only 30 observations for that analysis which is too few for the analysis to be very significant. In order to make the entire analysis more significant I added the five time series analyses with monthly data for employment and traffic, and these analyses all had 72 observations which significantly improves the scope of this study. I had originally hoped to analyze the relationship between transportation infrastructure and economic development, however data for transportation infrastructure is difficult to accumulate. There are several press releases and announcements for investment packages in transportation infrastructure, but there is not enough information to form a cohesive dataset.

This study is an empirical analysis of the relationship between transportation accessibility and economic growth, and panel data and time series analyses were used to examine the data for this relationship. The results confirm that there is not a significant relationship between these two variables in most of the analyses. The relationship was not significant in the panel data analysis with yearly data from all the counties in Massachusetts, even with the addition of other economic variables and an indication that the model is a good fit judging by the R^2 value. Since this model is a good fit with these variables, traffic not being significant gives even more evidence to there not being a relationship between transportation accessibility and economic growth. The time series analyses show a relationship between these two variables in two out of the five analyses. However, the models for the time series analyses are not shown to be very accurate based on their R^2 values, so the results of these regressions are not as significant as the panel data analysis where traffic was not significant at all. Due to all these results, I can conclude that there is not a consistent relationship between transportation accessibility and economic development in Massachusetts counties.

Appendix A: Variable Description and Data Source

Variable	Description	Source
U1Boston	Urban Interstates Boston	MassDOT
U1Essex	Urban Interstates Essex County	MassDOT
U1Southeast	Urban interstates Southeast MA (Norfolk, Plymouth, Bristol, and Barnstable counties)	MassDOT
U1West	Urban Interstates West MA (Berkshire, Franklin, Hampshire, and Hampden counties)	MassDOT
U1Worcester	Urban interstates Worcester County	MassDOT
Emp	Employed persons	ALFRED
Traffic	Traffic on MA urban interstates	ALFRED
Pop	Total population	ALFRED
Crime	Crime rate, persons out of 100,000	ALFRED
Edu	Educational attainment, high school graduate or higher (%)	ALFRED

Appendix B- Variables and Expected Signs

Acronym	Variable Description	What it captures	Expected sign
U1Boston	Traffic in urban interstates in Boston	The rate of traffic on primary urban interstates in the Boston area	-
U1Essex	Traffic in urban interstates in Essex county	The rate of traffic on primary urban interstates in Essex county	-
U1Southeast	Traffic in urban interstates in the Southeast (Norfolk, Plymouth, Bristol, and Barnstable counties)	The rate of traffic on primary urban interstates in the Southeast region of MA	-
U1West	Traffic in urban interstates in the West (Franklin, Berkshire, Hampshire, and Hampden counties)	The rate of traffic on primary urban interstates in the West region of MA	-
U1Worcester	Traffic in urban interstates in Worcester county	The rate of traffic on primary urban interstates in Worcester county	-
Emp	Employed persons	Total employed persons in all counties in MA	+
Traffic	Traffic in MA urban interstates	Traffic rate for all urban interstates in MA	-
Pop	Total population	Total population for all of MA	+
Crime	Crime rate, persons out of 100,000	Crime rate for persons out of 100,000 for all of MA	-
Edu	Educational attainment, high school graduate or higher (%)	Educational attainment of at least high school graduation as a percentage for all of MA	+

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