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Transportation Networks and the Geographic Concentration of Industry

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Abstract

This paper examines the effect of expanding transportation networks on changes in industry location within the United States. I use the construction of the Interstate Highway System, from 1962 to 1996, to measure how improvements in transportation infrastructure and market access alter industry concentration. To address the endogenous placement of highways, the paper instruments for eventual highway location using a military map of high priority routes designed after the First World War. To address the endogeneity surrounding the timing of highway construction, I use a network theory algorithm to predict when each segment of the highway network should have been constructed. The algorithm ranks predicted highway segments based on their importance for network connectivity and uses a simple social planners problem to determine the order of predicted segment construction. Results indicate that counties that received interstate highways experience more overall employment growth than non-highway counties and the magnitude of this growth varies by industry. Employment in highway counties is also much more concentrated and this concentration is being captured in both more establishments and larger establishment sizes.

KEYWORDS: agglomeration, specialization, interstate highways, public infrastructure

JEL CLASSIFICATION: L25, N92, R12, R30

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1 Introduction

Transportation costs are an integral component of the spatial arrangement of economic activity. Expanding transportation infrastructure impacts trade flows and alters the organization of cities by changing the cost of moving goods and commuting. New transportation infrastructure motivates firms and individuals to alter their location choices. The construction of the Interstate Highway System (IHS) in the United States introduced over 40,000 miles of new highways, which lowered the costs of moving goods and people. For example, from 1975 to 1985 shipping rates by truck fell by nearly 20 percent (Rose 1988). The IHS also led to changes in driving behavior. From 1966 to 1995 the percentage of total vehicles miles traveled along interstate highways increased from 10 percent to nearly 25 percent (FHWA 1997). These changes in costs and usage suggest that interstate highways could have altered the location choices of both firms and individuals. This paper uses the construction of the Interstate Highway System to understand the relationship between transportation infrastructure and industry concentration.

I measure the causal effect of having an interstate highway on industry growth and concentration using a reduced form analysis, where I instrument for the presence of a highway to address two types of endogeneity. The first endogeneity concern I address is the non-random placement of highways Interstate highways. Highways were often directed to struggling communities (Duranton and Turner 2012). The paper instruments for eventual highway location using two proposed government maps of high priority routes. The second endogeneity concern I address is the endogenous allocation of funding by state politicians, which determined when particular segments of the IHS were constructed. To address the endogeneity surrounding the timing of highway construction, I use an algorithm from network theory to predict the timing of highway construction. The algorithm ranks predicted highway segments based on their importance for network connectivity and uses a simple social planners problem to determine the order of predicted segment construction. With this method I construct an instrumental variable that predicts both where an interstate highway will locate and when it will be built by combining the location prediction and the predicted construction schedule.

I use a county-level panel dataset spanning from 1962 to 1996 to examine industry growth and concentration using several different measures. First, I compare differences in employment growth between highway and non-highway counties and find there were significant positive differences starting in the early-1980s. This growth was more pronounced in agriculture, retail sales, and the transportation and public utilities sector. I find very little evidence of growth in manufacturing employment. Next, I use two measures of industry concentration to determine whether the employment growth was concentrated in a fewer sectors. Results indicate there was substantial increases in employment concentration in highway counties relative to non-highway counties. To measure changes in the scale of firms by industry, I compare changes in the share of large firms in highway counties compared to non-highway counties as larger firm size is typically associated with increased concentration (Holmes and Stevens 2004). These results indicate that highways led to moderately larger manufacturing firms in highway counties relative to non-highway counties. Finally, I measure the full dynamic response of receiving an interstate highway, these results indicate that it takes between 15 and 20 years before highways significantly differ from non-highway counties. These results taken together suggest that the Interstate Highway System significantly contributed to industry concentration in highway counties.

My analysis is most directly related to the growing literature on relationship between transportation infrastructure and the organization of economic activity.[1] The majority of papers in this literature study the effect of highways in cities. Several papers document population and industry decentralization, and the growth of the suburbs (Baum Snow 2007, 2014; Baum-Snow *et al.* 2014; Rothenberg 2013). Duranton and Turner (2012) find employment increases in cities for several years after expansions in highway mileage. Duranton, Morrow, and Turner (2013) examine trade relationships between several major cities and find that cities with more highway mileage specialize in the production of heavier goods, but there was no difference in product value.

[1]For a comprehensive survey of this literature see Redding and Turner (2014).

Michaels (2008) finds that interstate highways increase earnings in retail sales and trucking, both trade related activities, in rural counties within the US. He also finds an increase in the demand for skilled labor, however he cannot identify an effect of highways on the industrial composition of employment. Chandra and Thompson (2000) examine the effect of interstate highways on earnings by industry using a distributed lag model for a subset of rural counties. They find that earnings increased for several industries and that counties adjacent to highways experience a decline in earnings, a result they attribute to reorganization of economics activity and not growth.

My paper contributes to the literature in several ways. This is the first paper in this literature to directly instrument for the timing endogeneity, which allows me to measure the effects of receiving a highway over a longer period of time and provides valuable insight into the political motives surrounding early highway construction. My outcomes of interest build on the employment findings from Baum-Snow (2014) and Duranton, Morrow, and Turner (2013). Both of these papers restrict their analysis to urban areas and are more interested in growth in the urban highway network than the broader national system. My paper is also the first to include both rural and urban counties in the analysis.

This paper relates to the literature identifying the consequences of shocks to the spatial equilibria of economic activity (Davis and Weinstein 2002; Redding and Sturm 2008; Redding, Sturm, and Wolf 2011). The construction of the IHS changed the distance between locations and altered the spatial equilibrium of employment and firm locations. It is important to understand the effect of changing the relative geography between locations because Allen and Arkolakis (2014) find that geographic location accounts for at least 20 percent of the spatial variation in income. The magnitude of their result indicates that changes in the relative distance between locations has important consequences for development.

The paper proceeds as follows. Section 2 gives a brief history of the Interstate Highway System and emphasizing the potentially confounding role that politicians and industrial leaders played in the design and construction of the IHS. Section 3 describes the data used in the empirical analysis and documents the pattern of industry growth and concentration that occurred between 1962 and 1996. Section 4 discusses the empirical strategy and the endogeneity issues associated with estimating the causal effects of transportation infrastructure on industry growth and concentration. Section 5 examines the role that highways played in employment and establishment growth in highway and non-highway counties. Section 6 discusses patterns of employment and establishment concentration induced by the IHS. Section 7 measures the dynamic effects of interstate highways. Section 8 provides two falsification exercises for robustness and Section 9 concludes.

2 History of the Interstate Highway System

2.1 Federal Aid Highway Act of 1956

In the early 1950s several Congressional Committees developed plans for funding and designing a new system of limited access interstate highways. President Eisenhower was influential in helping support some of these committees and invited Governors and heads of interest groups to participate in the planning process (Rose 1990). Industry representatives from oil, trucking, and manufacturing were particularly influential in these discussions (Kaszynski 2000).

In 1956, after several different plans, construction guidelines, and financing methods were introduced, the House and Senate ultimately agreed on an interstate highway plan. The plan was approximately 90 percent Federally funded and was paid for with taxes revenue from a variety of sources (Kaszynski 2000). Eisenhower signed the Federal-Aid Highway Act of 1956 into law on June 29th. The final design, as presented in Figure 1, was "a culmination of decades of input and research from auto clubs, civil engineers, and state and federal highway officials" (Kaszynski, 167, 2000). The Highway Act of 1956 placed states in charge of construction. Each state's funding was determined based on a formula of population, area, and highway mileage. This allowed states to build their segments of interstate highway when they wanted and at the pace they wanted. The solicitation of opinions from heads of industry and government officials for both the eventual location of interstate highways and the pace of construction have important consequences for empirically estimating the effects of interstate highways.

2.2 The Pershing Map and the National Interregional Highway Committee

My empirical design requires that the interstate highway system was exogenously assigned to counties. Early proposals of interstate highway locations date back to the early 1920s, which may provide predictions of eventual IHS locations for my empirical strategy. Following the First World War the U.S. government began discussing the merits of a national highway system, similar to what it saw in Europe. This led Congress and the Bureau of Public Roads, to seek input from the War Department regarding a national system of interstate highways (Karnes 2009). The War Department commissioned General John J. Pershing to provide a network map of high priority military routes. The army did not value a "transcontinental road which merely crosses the continent", but rather they wanted "roads connecting all our important depots, mobilization and industrial centers" (Swift, 76, 2011). The resulting map contained nearly 78,000 miles of highway that the War Department deemed as strategically important. The map emphasized "coastal and border defense and links to major munitions plants" (Swift, 76, 2011). These routes were never built as superhighways but this map influenced future highway location decisions.

National interstate highway programs were reintroduced during the Great Depression as part of New Deal legislation. President Roosevelt formed the National Interregional Highway Committee "to investigate the need for a limited system of national highways to improve the facilities now available for interregional transportation" (US DOT, 273, 1977). Committee members included engineers, government officials, and highway planners. With the help of state highway departments, the committee produced a new 39,000 mile national highway plan. The committees objectives were to "provide highway transportation to serve the economic and social needs of the nation" (US DOT, 274, 1977). The highway network was intended to "serve the Nation's agricultural production, its mineral production, its forest production, its manufacturing centers and ... its population centers and defense establishments" (US DOT, 274, 1977). Interest groups on behalf of the farming and trucking industry "lobbied for their own plans to foster particular and local needs" (Rose, 16, 1990). The final plan, published in 1947, was the most comprehensive national network map that had been produced and served as the major guide of highway location decisions for the next decade.

Highway construction plans were halted during the war and funding was restricted to high priority maintenance of current roads. Without adequate funding for repairs the quality of highway infrastructure deteriorated rapidly. Prior to World War II total road spending was about 1.4 percent of GNP and after the war this amount fell to about 0.2 percent (Karnes 2009). As the quality of roads decreased the demand for high quality roads increased rapidly. From 1945 to 1950 vehicle registrations increased nearly 60 percent (Swift 2011). The Bureau of Public Roads determined that between the mid-1920s and early 1950s traffic had increased by 250 percent and highway demand had increased by a factor of eight (Rose 1990). This put tremendous strain on the existing infrastructure that was ill equipped to deal with new faster cars and heavier trucks. Travel times increased dramatically due to elevated levels of congestion and the increased probability of an accident (Kaszynski 2000).

3 Data and Preliminary Evidence

My empirical analysis uses a county-level panel dataset that spans from 1962 to 1996 for the contiguous United States. The primary outcomes of interest rely on annual employment and establishment data collected by the Census Bureau and published in the County Business Patterns. This data is combined with contemporary and historical transportation network information, which allows me to examine the relationship between transportation networks and the several measures of industry growth and concentration.

3.1 County Business Patterns

In 1962 the United States Census Bureau began publishing information regarding employment and the number of establishments for counties in the United States.[2] This paper uses the employment and establishment data for the primary Standard Industrial Classification (SIC) economic divisions: Agriculture, Construction, Finance, Manufacturing, Mining, Retail Sales, Services, transportation and public utilities, Wholesale Trade, and Unclassified Occupations.[3]

For each broad industry division, I observe the total number of establishments and the total number of establishments in eight employment size groups.[4] One limitation of the County Business Patterns data is that it does not include establishments with zero employees.[5] For confidentiality purposes the Census Bureau censored the county-level employment data for some smaller industries. Similar to Duranton, Morrow, and Turner (2013), I impute employment values using the establishment count data.[6] The result is a county-level panel dataset spanning from 1962-1996 with employment quantities, establishment counts, and establishments counts by eight employment size groups for each of the ten SIC economic divisions. I also aggregate the ten SIC economic divisions to make a total category containing the employment, number of establishments, and establishment group counts for all sectors in the county.

3.2 Calculating Concentration Measures

To understand the relationship between highways and employment and establishment concentration I construct two measures of concentration. I use the following Herfindahl Index for employment

[2]Prior to 1962, published establishment and employment information was combined for some counties in eight states. I exclude these counties, so the sample in 1962 consists of 2661 of the 3079 counties in the full sample.

[3]After 1996 the Census Bureau no longer used the SIC system, moving to NAICS. For classification consistency this paper concentrates on the period using the SIC system. The SIC experienced several modifications over this 30-year period, however the broad categories I am interested in were largely unaffected by these changes.

[4]Employment size groups include: 1-4, 5-9, 10-19, 20-49, 50-99, 100-249, 250-499, and above 500 employees.

[5]In the robustness section I will discuss what affect this omission has on the empirical results.

[6]For each industry I regress the county sectoral employment on the full set of eight establishment count groups and I use the resulting regression coefficients to impute the number of employees. The R^2 for each regression is between 0.945 and 0.999.

concentration.

$$H_{ct} = \sum_i {s_{cit}}^2 \tag{1}$$

For each county c in year t, equation 1 sums the squared share of each division's employment in industry i. If employment is fully concentrated in a sector, then $H_{ct} = 10000$, and the index decreases as employment becomes more diverse. I construct the same measure using the number of establishments.

The Gini Specialization Index is an alternative concentration measure, used by Duranton and Puga (2004). This measure corrects for differences in local sectoral employment by comparing it to the national share of employment in the sector. Formally, the GSI is given by

$$GSI_{ct} = \frac{1}{2} \sum_i |s_{cit} - s_{it}| \tag{2}$$

The value s_{cit} is the share of employment in county c in year t in industry i. The value s_{it} is the national employment share for industry i in year t. This index is closer to one if employment in a county is fully specialized in an economic division that has a very small employment share at the national level. The index is near zero if employment in the county and national employment are similarly distributed. I also construct the GSI using the number of establishments.

I supplement these two broad measures of concentration with two measures of industry level concentration. These measures allows me to test for differences in the scale of firms across industries.[7] I use data on establishment counts within the eight employment size groups to construct two measures of firm size. I compare the fraction of firms with more than 20 employees and the fraction of firms with between one and four employees by industry. Combining these industry measures of concentration with the industry level patterns in employment growth provide insight into whether growth in concentrated in several large firms or is dispersed across several smaller firms. Distinguishing between these two results is important for understanding whether public infrastructure

[7] The results for firms in the smallest size bin may shed some insight onto the behavior of firms with zero employees, which were not included in the data.

alters market power within an industry and whether it promotes entrepreneurship.

3.3 Interstate Highway System Maps

I use two data sources to construct an annual county-level panel dataset with Interstate Highway System information spanning from 1962 to 1996. The first is current highway location information from NationalAtlas.gov (2014). I combine this file with highway construction information from the PR-511 collection at the National Archives. This series contains maps produced quarterly that show the progress of interstate highway construction. I digitized these maps and traced the annual construction progress of interstate highways in GIS.[8] I intersected this progress with a map of county locations in 1980, which allows me to know the year a county was connected to the Interstate Highway System.[9] Figure 1 shows the current interstate highway locations overlaid on a map of county locations.

For each county, I determine whether an interstate highway intersects that county and the year that segment of highway was completed. I can use this data to determine two key measures for my empirical strategy, in each year I know whether a county had received an interstate highway and how many years ago that particular segment of highway was constructed.

3.4 Supplemental Data

In order to account for factors that are correlated with the economic growth, concentration, and location and funding of interstate highways, I supplement the economic and highway information with data covering population, historical economic data, and alternative methods of transportation.[10] I use county-level population data from the U.S. Census for every decade from 1910-1950. I

[8] I denoted a segment of interstate highway completed once construction of that segment was finished and it was completely open to traffic. I used the fall quarter of each year when available. While I tried to be careful to accurately track annual construction progress it is possible that I classified counties as receiving interstate highways either before or after they actually did. This variation is likely to be random and corrected within the next year, which leads to short-term noise in the date of arrival.

[9] I adjust all of the county locations and data to be consistent with the 1980 county borders.

[10] Population and historical economic data is from the National Historical Geographic Information Systems (NHGIS) (2014).

combined this with information on the percent of population living in cities larger than 25,000 people, the number of manufacturing establishments, and the number of farmers from the 1910-1940 censuses. I also collected information on the number of establishments and employees in manufacturing, wholesale trade, retail trade, and farming from the 1930 and 1940 census. This historical population and industry information is useful for supporting the exogeneity requirements of my instrumental variables. Lastly, I collected high school attainment information to help approximate the skill endowment of each county in 1950 (ICPSR 2005). This measure will allow me to look for evidence of heterogeneous effects of the interstate highway system based on the skill endowment of counties prior to highway construction.

I collected additional geographic information for alternative methods of transportation from NationalAtlas.gov (2014). I use GIS to construct an indicator that is equal to one if a county has a railroad.[11] For each county I calculate the Euclidian distance to the nearest coastal port and the nearest airport.

3.5 Summary Statistics

My completed county-level panel dataset contains employment and establishment information, highway location and construction information, historical population and economic data, and geographic measures of alternative methods of transportation infrastructure. Table 1 presents summary statistics for two groups: counties that eventually received an interstate highway and counties that never received an interstate highway. The table presents the number of observations, the mean, and the standard deviation for both groups for the full sample of years from 1962 to 1996. The last two columns calculate the difference between highway and non-highway counties. The most striking feature of the table is how different highway and non-highway counties are. Highway counties generally have more employment and establishments, and also are less concentrated. Highway counties are more likely to be near a MSA, have a railroad, and are generally closer to airports and

[11] Due to data availability constraints I ignore railroad lines that were decommissioned following deregulation.

ports. They were also have much larger populations in 1950 and their population grew much faster from 1940 to 1950.

To preview the empirical strategy, table 2 compares the differences between highway and non-highway counties in 1965 and 1996. The outcomes reported in the table are for the County Business Patterns employment and establishment count data, along with the concentration measures and the firm size measures. The differences between highway and non-highway counties are reported in the last two columns. Highway counties are significantly different from non-highway counties in both periods. Highway counties in 1965 have more employment and establishments, and are less concentrated. In 1996 the difference between highway and non-highway counties has grown for both employment and the number of establishments. The Herfindahl Index values for both employment and the number of establishments changes sign and now indicates that highway counties are more concentrated than non-highway counties. Comparing the difference in the means across the two time periods indicates that both employment and the number of establishments grew over the period. This growth was accompanied by increases in employment concentration, which suggests that a large portion of the job growth was concentrated in a few industries.

4 Empirical Strategy

4.1 Static Identification

To investigate the effect of the Interstate Highway System on employment growth and industry concentration, I exploit variation in the location of interstate highways at different points in time. I use a county-level panel dataset to estimate the following specification:

$$Y_{cit} = \sum_{d} \beta_d (hwy_{ct} \times YearBin_d) + \delta_{rt} + \gamma_c + X' \rho_{ct} + \epsilon_{cit} \tag{3}$$

where Y_{cit} is the outcome of interest in county c, in industry i at time t. The variable hwy_{ct} is an indicator variable that is equal to one if an interstate highway intersects county c at time t.

The coefficients of interest are the set of β_d's, which measures the effect of the interstate highway system during the d different periods.[12] I include census region $\times$ year fixed-effects, δ_{rt}, county-fixed effects, γ_c, additional controls, $X'\rho_{ct}$, and ϵ_{cit} is the error term. The controls include alternative methods of transportation infrastructure, 1950 population, 1940 to 1950 population growth, and distance to closest Metropolitan Statistical Area (MSA). I also two-way cluster the standard error by county and state/year to account for serial correlation and spatial correlation in the error term. I estimate equation (3) using Two-Stage Least Squares (TSLS).[13]

This specification identifies the effect of being a highway county compared to non-highway at different points in time, β_d. This model does not allow me to separately identify the effect of highways on growth and relocation, but rather the effect of both. The county fixed-effects account for any county characteristics that are not varying between 1962 and 1996 that may be correlated with economic growth and the location and construction of interstate highways. By including the census region $\times$ year fixed-effects, the treatment effect of an interstate highway is only identified from variation within a census region in a year. Including this set of fixed-effects allows me to account for any region wide changes that affect employment, the opening or closing of businesses, or promote growth in specific industries that change over time and are correlated with the construction of interstate highways.[14]

I include transportation infrastructure, population, and geographic controls to account for differences between highway and non-highway counties prior to highway construction. In order to use these time-invariant controls I interact them with an indicator variable in each year to create a "trend" for each control. I include alternative transportation infrastructure controls to account

[12] I estimate each β_d from a separate regression where I partial out all the fixed-effects and reduce the comparison to a bivariate regression within each period d. The periods of interest are from 1962-1966, 1967-1971, 1972-1976, 1977-1981, 1982-1986, 1987-1991, and 1992-1996.

[13] The results are nearly identical when I estimate the regression using Limited Information Maximum Likelihood (LIML).

[14] I have also considered replaced the region $\times$ year fixed-effects with state $\times$ year fixed-effects. One limitation of this specification is that it excludes non-highway counties in states without any highways until at least one county receives an interstate highway. In that sense I am losing potentially valuable counterfactual information, so I elected to use the census region $\times$ year fixed-effects. The results with state $\times$ year fixed-effects are slightly smaller in magnitude, but tell a similar story to the results presented below.

for evolving trends in substitutability or complementarity between the alternative methods and interstate highways. For example, both airlines and railroads faced deregulation over this period, which likely altered the dynamics between highways and the deregulated industries. The population controls account for different trends both in the level of population as of 1950 and the growth in population between 1940 and 1950. The level of population or changes in population is likely correlated with whether a county receives an interstate highway and any future growth in employment. I control for the Euclidian distance from each county centroid to the nearest MSA to account for changes in the relative distance between locations due to technology improvements. These distance time trends account for automobile safety or speed improvements that may affect rural, suburban, and metropolitan areas differently.

4.2 Dynamic Identification

The static model allows me to estimate the causal difference between highway and non-highway counties at different points in time. However, it does not allow me to separate the effects of recently constructed highways from newly constructed highways. To understand the dynamic effects of having a highway a certain number of years after construction I need to use a more dynamic approach. I adjust the prior specification to identify the effects of the Interstate Highway System by measuring the evolution of the effects over time.

$$Y_{cit} = \phi_c + \rho_{rt} + \sum_a \beta_a HwyAgeDum^a_{ct} + X'_{ct}\mu + \epsilon_{cit} \tag{4}$$

Similar to equation 3, Y_{cit} is the outcome of interest in county c, in industry i at time t. The variable $HwyAgeDum_{ct}$ refers to a series of dummy variables set equal to one if a county received an interstate highway a years ago. The coefficients of interest are the set of β_a's, which measures the effect of the interstate highway system the stated number of years ago. These coefficients map out the full dynamic response of the outcomes of interest to receiving an interstate highway. I continue to include region × year fixed-effects, δ_{rt}, county-fixed effects, γ_c, additional controls, $X'\rho_{ct}$, and ϵ_{cit}

is the error term. I include controls for alternative methods of transportation infrastructure, 1950 population, and 1940 to 1950 population growth, and distance to closest Metropolitan Statistical Area (MSA) because these are likely correlated with whether a county receives a highway and when they start building that highway. I two-way cluster the standard error by county and state/year to account for serial correlation and spatial correlation in the error term. I estimate equation (4) using Two-Stage Least Squares (TSLS).[15]

4.3 Addressing Highway Endogeneity

Measuring the differences between highway and non-highway counties will likely result in biased estimates because counties selected to receive a highway and when they receive the highway are likely to differ along unobservable dimensions that are correlated with economic growth. The history of highway construction indicates that the placement and funding of highways was an intensely political process. Politicians, lobbyists, and heads of industry all contributed to the current locations of interstate highways and state politicians were in charge of allocating resources for construction. If these outside contributors viewed highway construction and development as a place-based economic development policy, they may have been more likely to add segments of highway or reroute planned segments to reach less developed counties or start construction earlier to promote more growth. Therefore both location choice and timing of construction are potentially endogenous.

To address endogeneity concerns regarding highway location, I use two historical government proposals for a national highway system as separate instrumental variables to predict eventual highway location. The first is the military plan proposed by General Pershing in 1921 commonly referred to as the Pershing Map. Proposed highway location data is based on the digitized Pershing Map from the Bureau of Public Roads collection at the National Archives. I intersect the digitized highway locations with a county map from 1980 to determine the set of counties that received

[15] The results are nearly identical when I estimate the regression using Limited Information Maximum Likelihood (LIML).

the proposed military routes. Figure 2 depicts the highly prioritized routes drawn in the Pershing Map.[16] The Pershing Map is relatively new in the literature and has only been used by Michaels et al. (2013).

The second is the proposed map from the National Interregional Highway Committee published in a 1947 report. I similarly digitize the 1947 Plan and identify the set of counties that received proposed highways. Figure 3 shows the 1947 Interregional Highway Committee plan. This map is visually very similar to the map of eventual highway locations. Table 1 confirms this result, 81 percent of highway counties were designated to receive a highway by the 1947 Plan compared to only 32 percent for the Pershing Map. The 1947 Plan is the most commonly used location instrument in the literature (Baum-Snow 2007, 2010, 2014; Michaels 2008; Duranton and Turner 2012; Duranton, Morrow, and Turner 2013). I include this instrument in order to position my results in the context of the prior literature.

I address the endogenous timing of highway construction using an application from network theory to predict the optimal timing of highway construction. I borrow from the Newman-Girvan Algorithm (Girvan and Newman 2002, 2004; Newman 2001, 2004) to prioritize each segment of the proposed highway networks. This algorithm was originally used to identify important connections in biological and social networks. To my knowledge this is the first application of this algorithm in the economics literature. In order to apply the algorithm to the each of the historical highway network plans, I decompose each planned road system into a mathematical network of nodes and edges, where each node occurs at the intersection of two edges or at the end of an edge. I then weight each edge by it's length. The Newman-Girvan Algorithm calculates the edge-betweenness for each edge by determining the shortest path from each node to every other node in the system and then counting the number of shortest paths that move along that edge. Edges with the largest betweenness value are more important for connecting nodes in the network, therefore these edges

[16]The full Pershing Map contains three priority levels, the depicted map shows routes in the two highest priority levels. Priority three routes are shorter in length and appear to be designed to reach specialized locations, like military installations.

of the networks should have been built earlier.

My algorithm sequentially builds the network edges with the highest betweenness value subject to an annual construction budget. I derive this constraint from the construction costs of the entire network. I calculate total construction costs by aggregating the construction cost of each edge. Construction costs are based on weighted average costs of the urban and rural mileage. I use construction cost estimates for urban and rural cost per mile from a 1955 Congressional highway proposal. Urban mileage had an estimated cost of $2,431,818 per mile, while rural costs are significantly lower at $378,787 per mile.[17] Contemporary cost estimates of adding new rural and urban highway mileage are consistent with this urban to rural cost ratio.[18] I use historical cost estimates instead of current cost estimates because it better approximates the decision a social planner would have made at the time of construction.

I calculate the total cost of construction for each entire network using the computed cost of each segment of the proposed network. I then calculate the annual construction constraint by dividing the total network construction cost over a twenty five year construction period, which roughly approximates the timeframe of actual highway construction. Once I have an annual construction constraint I rank the proposed networks edges with the highest betweenness scores first and build them in that order until the total amount spent on construction equals the annual construction constraint. Unbuilt edges are carried over to the next year and the process repeats. The algorithm allows me to assign a construction year for each edge, which results in a highway instrument that predicts both the location of an interstate highway and the year of construction.

4.4 Instrument Validity

4.4.1 Static Model Inclusion Restriction

To test whether each proposed network with predicted construction timing sufficiently predicts whether a county will have an interstate highway at time t I estimate the following first-stage

[17] These construction cost estimates include the actual cost of construction as well as the cost of acquiring land.
[18] The ratio of construction costs is more important to the model than the actual costs.

regression using a Linear Probability Model.

$$hwy_{ct} = \theta Plan_{ct} + \psi_{rt} + \lambda_c + V'\pi_{ct} + \upsilon_{cit} \quad (5)$$

The variable $Plan_{ct}$ is an indicator for whether a county c is predicted to have a highway from the proposed network in year t. I also include the covariates from the second-stage, ψ_{rt} are the census region × year fixed-effects, λ are the county fixed-effects, $V'\pi_{ct}$ are the infrastructure, population, and geographic controls, and υ_{cit} is the error term.

Figures 3 and 4 present the first-stage regression results by year along with the corresponding F-statistics. The F-statistics in these figures only approximate the true F-Statistics used in the paper because the regressions estimate the treatment effects for the 5 year bins. Clustering the error terms by county and state/year alters the i.i.d. assumption associated with the standard first-stage F-statistic calculation. To test the inclusion restriction I use Kleibergen-Paap F-statistics that adjusts for clustering the error term (Stock and Yogo 2005). The Kleibergen-Paap F-statstic in the static model ranges between 20 and 170 using the Pershing Map and 140 and 1700 using the 1947 Plan, which indicates that using either proposed system of roads with predicted construction timing is a sufficient instrument for both the location and timing of interstate highway construction.

4.4.2 Dynamic Model Inclusion Restriction

To test whether each proposed network with predicted construction timing sufficiently predicts the age of each segment of interstate highway I estimate the following first-stage regression using a Linear Probability Model.

$$HwyAgeDum^a_{ct} = \alpha_c + \rho_{rt} + \gamma PlannedHwyAgeDum^a_{ct} + X'_{ct}\delta + \upsilon_{ct} \quad (6)$$

The variable $PlannedHwyAgeDum_{ct}$ is an indicator for whether county c is predicted to have a highway from the proposed network in year t that is age a years old. I also include the covariates from the second-stage, ρ_{rt} are the census region × year fixed-effects, α are the county fixed-effects, $V'\pi_{ct}$ are the infrastructure, population, and geographic controls, and υ_{cit} is the error term. The first-stage regression results are available in table 7. The instrument predicts sufficiently well for both the Pershing Map and the 1947 Plan with the exception of 0-4 year highways using the Pershing Map.

4.4.3 Exclusion Restriction

Using planned transportation networks to instrument for eventual highway location is consistent with several recent empirical papers examining the effects of transportation networks. The 1947 Plan is the most commonly used location instrument in the literature (Baum-Snow 2007, 2010, 2014; Michaels 2008; Duranton and Turner 2012; Duranton, Morrow, and Turner 2013). The primary objective of the 1947 was to *"connect by routes as direct as practicable the principal metropolitan areas, cities, and industrial centers, to serve the national defense and to connect suitable border points with routes of continental importance in the Dominion of Canada and the Republic of Mexico"* (United States Federal Works Agency 1947). The results in section 8, confirm that the plan was not drawn as a result of growth in population or employment in agriculture and manufacturing. I control for both the level of 1950 population and population growth from 1940 to 1950 because planners were connecting population centers.

The validity of the Pershing system as a suitable instrument hinges on the degree to which military motives in 1921 are orthogonal to employment growth and industry concentration in the later part of the 20th century. In other words, the Pershing predictions should only influence industry growth and concentration through their ability to predict actual highway construction. One concern is that routes proposed in 1921 may have directly influenced industry growth, employment growth, or population growth. One advantage of using the Pershing system is the strong military influence and the lack of input from outside political and economic agents. These military motivations are evident in the lack of roads in Florida and the emphasis in roads along the coasts and the borders. Another advantage is that the Pershing system was connected with straight lines. These straight line connects remove the possibility of manipulating the route in order to pass through a specific county.

If the military designed the network around the potential growth of industrial centers, this might result in biased estimates. To test for this, I regress the Pershing system on changes in population and employment in both agriculture and manufacturing between 1910 and 1940, with the same set of fixed-effects and controls as equation (3) and I do not find any evidence that the military was choosing areas with high growth rates in either industry or in population. Section 8 elaborates further on these results.

5 Employment and Establishment Growth

5.1 Total Employment and Establishment Growth

To measure whether the Interstate Highway System changed industry concentration, I start by determining if there is a difference in the size of employment and the number of establishments for highway counties compared to non-highway counties and whether or not the difference is changing over time. Table 3 shows growth patterns for both employment and establishments using the OLS and TSLS specifications. The coefficient estimates, β_d, compare highway to non-highway counties measured in five year intervals. The coefficients can be interpreted as the difference in highway and non-highway counties in period d.

By the early 1990s employment was 7.04 percent higher in highway counties compared to non-highway counties. TSLS results for both instruments indicate positive employment growth occurred at a similar time but was substantially larger than the OLS results suggest. After the mid-1980s, the TSLS highway interaction terms are all substantially larger than the OLS. Considering the same period in the early 1990s, employment was 10-18 percent higher in highway counties relative to non-highway counties. Duranton and Turner (2012) find that within US cities, a 10 percent increase in highway mileage leads to a 1.5 percent increase in total employment over 20 years. The results presented in Table 3 are consistent with their result, I find that highway counties gain between 10 and 25 percent more employment every 20 years compared to non-highway counties.

Columns 4 through 6 present the OLS and TSLS regression results for establishment growth. The OLS and TSLS results indicate that growth in establishments was roughly monotonic. The patterns are similar to the employment results but are typically smaller in magnitude. Taking the employment and establishment results together, it suggests that employment growth in highway counties was not driven by growth in the number of firms, but rather firms hiring additional workers.

The general pattern of growth is consistent with Michaels (2008), where the benefits of highway infrastructure occurs after the mid-1970s. The first three columns show the results for employment. The OLS results indicate that highways counties have lower employment in the early periods and larger employment differences in the later periods. The early employment differences suggest that highways led non-highway counties to have more employment. One explanation for this difference is that non-highway counties that are currently constructing their segments of interstate highway may have an influx of employment. I test this theory by comparing the employment of places that just received their highways to counties that are about to receive their highways.[19] The results suggest that between 20 and 40 percent of the difference between highway and non-highway counties can be explained by these soon to be highway counties.

The difference between the OLS and both TSLS estimates highlights two potential forms of bias consistent with politicians and lobbyists using interstate highways as place-based economic development policies for growth and directing interstate highways to negatively selected counties. Recall that the OLS estimates could be biased for two different reasons, the endogenous placement of highways and the endogenous funding of highways. The OLS estimates in the early periods suffer from both forms of endogeneity, whereas the estimates after 1990 primarily suffer from location endogeneity. The difference between the OLS and both TSLS estimates suggests the

[19]These results are available in the online appendix.

location endogeneity induces a negative bias on the estimates, which is consistent with planners and government officials assigning interstate highways to lower quality locations. This result is consistent with the interstate highway literature and the literature on other place based development interventions (Duranton and Turner 2012).

The difference between the OLS and both TSLS estimates in the early years indicates that the estimates are positively biased. The difference in the direction of the bias comes from differences in the predicted timing of highway construction. Figures 6 presents a map for actual interstate highway construction progress in 1965. Figures 7 and 8 present the maps for predicted construction progress using the Pershing Map and 1947 Plan respectively. The biggest differences between the maps is the disjoint nature of the IHS construction compared to the predicted construction plans. The predicted construction plans build the highway networks progressively. The number of small segments in the map of actual highway construction suggests that areas were targeted. This targeting was done specifically based on the quality of location. A comparison of the raw data supports this hypothesis, areas targeted earlier for highway construction had higher levels of employment and more establishments than areas targeted later. This bias is not present in the IV.

Putting the two forms of endogeneity together, interstate highways were assigned to lower performing locations but within this group of locations they were constructed in the highest performing places first. The combination of these two forms of bias results in a positive bias in the early OLS estimates and an negative bias in the later estimates. The early results also indicate the importance of the positive timing bias, which is substantially larger than the negative location bias.

5.2 Employment Growth by Industry

Next I determine if the employment growth observed in the previous section varies across sectors. Table 4 shows employment growth results for 4 of the 10 industry classifications.[20] These four industries generally follow the patterns found in total employment growth the the previous section.

[20]Regression results for all 10 industry classifications are available in the online appendix. Employment growth across the ten industries is mostly consistent with earnings growth found by Chandra and Thompson (2000).

The results indicate employment grew the most in the agricultural sector and the transportation and public utilities sector. By the mid-1990s, employment in both sectors was between 17 and 27 percent higher in highway counties compared to non-highway counties. The large gains in employment in agriculture are consistent with the results found in Frye (2014).

Growth in manufacturing employment follows a similar monotonically increasing pattern but the results are not significantly distinguishable from zero. These muted gains in highway counties are consistent with the findings for manufacturing earnings in Chandra and Thompson (2000). Baum-Snow (2014) finds that increasing interstate highways in SMSAs led manufacturing jobs to move to rural areas or abroad. Combining my results with the results in Baum-Snow (2014) suggests that manufacturing jobs move from urban areas to rural counties with interstate highways, because we do not see a net change in manufacturing employment in highway counties relative to non-highway counties.

Employment growth in retails sales follows a similar monotonically increasing pattern to overall employment growth for both the OLS and using the 1947 Plan as an IV. The TSLS results using the Pershing Map are slightly smaller in magnitude and are estimated with less less precision. As a result we cannot rule out that there is no difference between retail sales employment in highway and non-highway counties. It is also worth noting that the estimated effects for employment are similar in magnitude to the growth in retail sales per capita found by Michaels (2008).

The degree of difference between the OLS and both TSLS estimates varies considerably across industries. The bias is most pronounced in agriculture and in transportation and public utilities, which consistent with the historical accounts of industrial involvement in the planning of interstate highways. The bias is much smaller in retail sales and is similar results found by Michaels (2008), which showed little difference between OLS and IV estimates when measuring the effect of highways on retail sales per capita.

6 Employment and Establishment Concentration

6.1 Concentration Across-Industries

Results from the previous section established that highways led to significant employment and establishment growth differences between highway and non-highway counties. The findings also indicate this growth was not equally distributed across industries. Unequal growth both across space and across industries suggests that highways may induce changes in regional specialization. In this section I measure the degree to which interstate highways led to differential specialization in employment and the number of establishments. To empirically measure specialization I will use the Herfindahl Index and the Gini Specialization Index described in equation (1) and (2). Larger values for both of these measures indicate a higher degree of concentration where a larger share of employment is in fewer sectors. Table 5 presents OLS and TSLS results for the different concentration measures. The dependent variable in Panel A is the Herfindahl Index and the dependent variable in Panel B is the Gini Specialization Index.

The concentration results using the Herfindahl Index indicate employment was more concentrated in highway counties in the early years of highway construction, then became more diverse, before finally becoming more concentrated again. The explanation for this pattern may be similar to the explanation for employment. If employment shifts in non-highway counties grow, particularly in very few sectors, then the herfindahl index would likely rise initially. The results from the TSLS specification with the Pershing Map indicates this shift is only temporary and by the early 1970s employment in highway counties is less concentrated than in non-highway counties. By the 1990s, highway counties are substantially more concentrated. The TSLS estimates using the Pershing Map indicate employment in highway counties was 18 percent more concentrated at the mean than non-highway counties.[21] The concentration results using the Herfindahl Index for the number of establishments shows fewer statistically significant results. The results using the 1947 Plan as an IV suggest there may have been limited establishment concentration by the mid-1990s. The results

[21] This value is the coefficient estimate divided by the average Herfindahl Index for employment across all years.

using the Gini Specialization Index tell a similar story for employment. Highway counties appear to diversify their employment relative to non-highway counties in the mid-1970s. Employment then becomes more concentrated in the late 1980s, although the large standard errors makes inference difficult.

6.2 Skill-Endowments and Concentration

I exploit the introduction of the Interstate Highway System to quantify the role of skill endowments in changes in industry concentration. In a simple two-factor Heckscher-Ohlin trade model with two economies, lowering trade costs and removing trade barriers through the expansion of transportation networks should lead skill-abundant areas to shift production to skill-intensive industries and low skill areas to shift to production to low-skill industries. This suggests that areas in the tails of the skill distribution should be more likely to specialize in particular industries. I test this theory by determining whether or not employment in extreme skill places is more likely to be concentrated following the introduction of the Interstate Highway System. Empirically, I interact the highway indicator variables in equation 3 with a binary indicator for extreme skill. I define extreme skill as places in the top 25th and bottom 25th percentiles of 1950 skill distribution, where I approximate the skill distribution with the percent of people over the age of 25 with at least a high school diploma.

Table 6 presents the regression results measuring the effect of extreme skill on employment concentration. The coefficients of interest are the interaction term between highway counties in each year and the extreme skill dummy variable. Based on the Heckscher-Ohlin model, I expect these interaction terms to have a positive coefficient, indicating that places in the tails of the skill distribution are more likely to specialize following the introduction of interstate highways. The results seem to support this theory although the coefficient estimates in many cases are not statistically different from zero.

6.3 Establishment Scale

This section considers the role of interstate highways in promoting changes in the size of firms. I measure scale changes using two similar metrics, the share of firms with more than 20 employees and the share of firms with between one and four employees. Understanding the affect of highways on the size of firms is informative for several reasons. It connects to a literature on the relationship between employment growth and firm size. It also has implications for market power within industries and the role of infrastructure in promoting entrepreneurship. My empirical analysis follows from equation (3) and I estimate the effects of interstate highways on the scale of firms for each industry. All of the results are available in the online appendix.

The results indicate the effect of interstate highways on the share of larger firms varies considerably by industry. When the dependent variable is the share of firms with more than 20 employees, the results indicate there was considerable variation across industries. The results indicate the percentage of firms in agriculture, construction, wholesale trade, and the unclassified industries show no difference in the percentage of firms with over 20 employees between highway and non-highway counties. Only firms in finance had a smaller proportion of medium and large sized firms in highway counties relative to non-highway counties. Combined with the employment growth results from section 5.2, this suggests most of the employment growth in finance occurred among smaller firms. The proportion of medium and larger firms grew for several industries, including mining, retail sales, services, and transportation and public utilities, in highway counties relative to non-highway counties. When these results are considered with the employment growth results by industry, it appears that most of the employment growth occurred in medium and large firms for these industries.

Next I consider the effect on the smallest firm size category, firms with between one and four employees. Changes to these firms may give some insight into the impact of interstate highways on firms with no employees, which are not observed in the data. The results indicate the proportion of tiny firms changed for only a couple industries over this period as a result of interstate highways.

The percentage of tiny firms in retail sales, services, and transportation and public utilities all fell considerably after the expansion of interstate highways. Considering highways only affect three of the ten industries, these results indicate that small businesses with no employees are not likely to substantially change the results. These results also suggest interstate highways are not useful for decreasing market power or promoting entrepreneurship in small businesses.

7 Dynamic Effects of Interstate Highways

The prior two sections measure the differences between highway and non-highway counties at different points in time. Now I focus on a more dynamic model for measuring the effects of the Interstate Highway System using equations 4 and 6, which map out the full dynamic response of the outcomes of interest to receiving an interstate highway.

7.1 Employment and Establishment Growth

Table 7 presents the regression results for the full dynamic response of employment and the number of establishments to receiving an interstate highway. These results are consistent with the prior findings of the effects of interstate highways on employment. Both TSLS results indicate substantial employment and establishment growth takes between 15 and 20 years to be realized. This explains why many of the positive benefits of interstate highways are not evident in the static model until the late 1970s. In 1996, the average highway was about 30 years old, which indicates the average highway community experienced between 15 and 18 percent more employment than non-highway counties.

7.2 Employment and Establishment Concentration

The dynamic response of industry concentration as measured by the Herfindahl Index and the Gini Specialization Index are presented in table 8. The two measures of concentration give slightly competing results. The Herfindahl Index results for employment suggest that the longer highways are in a county the more likely that county is to diversify. This is contrasted with the results from the Gini Specialization Index, which shows that the longer a highway is in an area the more like it is to specialize. Both concentration measures for the number of establishments appear to support that the longer an area has an highway the more likely it is to specialize although these estimates are imprecisely estimated, which makes inference difficult.

8 Robustness

8.1 Effects Prior to Construction

One threat to the empirical strategy is that the military or the Interregional Highway Committee may have targeted areas to receive highways that were growing already, were expected to grow, or had time varying characteristics that made them more likely to grow. Table 9 empirically tests for this possibility by measuring the effect of the Pershing Map and the 1947 Plan on several economic outcomes prior to the construction of the Interstate Highway System. I construct a panel dataset from the U.S. Census that includes information on population, urbanization, and the two dominant industries, agriculture and manufacturing, that covers from 1900 to 1940. Using this dataset I estimate the following regression, which is similar to equation 3, to determine the likelihood that the government targeted specific areas for growth potential:

$$Y_{ct} = \sum_{d} \beta_d (Plan_c \times YearBin_d) + \delta_{rt} + \gamma_c + X'\rho_{ct} + \epsilon_{ct} \tag{7}$$

where Y_{ct} is the percent growth in the outcome of interest in county c between time t and time $t-1$. The variable $Plan_c$ is an indicator variable that is equal to one if a county c was supposed to receive a planned highway. The coefficients of interest are the set of β_d's, which measures the effect of the planned highway during the d different periods. The interaction term in 1910 is the excluded year. I include the same set of controls and fixed-effects as the prior regressions. I also two-way cluster the standard error by county and state/year.

The outcomes of interest from the regression are two general measures, population and urbanization, and two measures of industry similar to the metrics used in the paper, establishments and employment. Panel A presents the results for the 1947 Plan. There is some evidence that the 1947 plan may have been influenced by the growth potential in 1930, however these effects appear to diminish by 1940. Panel B presents the results for the Military Plan. These results look better in the years immediately around the proposed plan. The only statistically significant difference is that Pershing Map is negatively associated with population and urbanization in 1940. This may be by design, the original Pershing Map was intentionally designed to run near but not through urban areas. Mechanically this could create a negative relationship between Pershing Map counties and growth if the routes were drawn to intentionally avoid growing areas. This does not appear to be affecting the measures of industry growth. Overall, these results seem to indicate neither plan targeted locations that were poised to grow.

8.2 Planned but Unbuilt Highway Segments

To verify that counties assigned to receive highways in the Pershing Map did not grow because they were assigned routes, which would violate the exclusion restriction, I examine whether planned but unbuilt routes in the Pershing Map affected growth. The full Pershing Map, contained three priority levels of routes, many of which were never constructed. I exploit these unbuilt routes to verify that it is actually receiving a route that benefits a location, not receiving a planned route. I estimate the following regression to determine whether these unbuilt routes predict growth in employment and the number of establishments:

$$Y_{ct} = \sum_{d} \beta_d(Unbuilt_c \times YearBin_d) + \delta_{rt} + \gamma_c + X'\rho_{ct} + \epsilon_{ct} \quad (8)$$

where Y_{ct} is either the log of employment or the number of establishments in county c at time t. The variable$Unbuilt_c$ is an indicator variable that is equal to one if a county c was supposed to receive a segment of the Pershing Map and never received any highway. The coefficients of interest are the set of β_d's, which measures the effect of the unbuilt segment during the d different periods. The interaction term in 1962-1966 is the excluded year. I include the same set of controls and fixed-effects as in the prior models. I also two-way cluster my standard errors by county and state/year. I restrict the sample to counties that never received an interstate highway, so the comparison is between non-highway counties and non-highway counties that contain any unbuilt portions of the Pershing Plan. The results are presented in table 10 and suggest that the unbuilt segments of the Pershing Map have no impact on employment and the number of establishments. This result supports the exogeneity requirements for the Pershing Map.

9 Conclusions

This paper examines the causal effect of interstate highways on the geographic concentration of industry. The paper addresses two major forms of endogeneity regarding the placement and timing of highway construction by using historic government proposed national highway network plans and network theory. The bias induced by timing endogeneity is salient to the literature on other government infrastructure projects that are rolled out over time and show the need to account for the temporal variation in the allocation of fundings.

Results indicate the expansion of transportation infrastructure led to substantial employment growth in highway counties relative to non-highway counties. This employment growth was concentrated in a few industries, which led highway counties to specialize more after the expansion of interstate highways. I also find evidence that highways caused a difference in the scale of firms away from very small firms towards large firms. This paper demonstrates that expanding transportation networks are important for reshaping the spatial arrangement of economic activity.

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10 Figures

Figure 1: National System of Interstate and Defense Highways

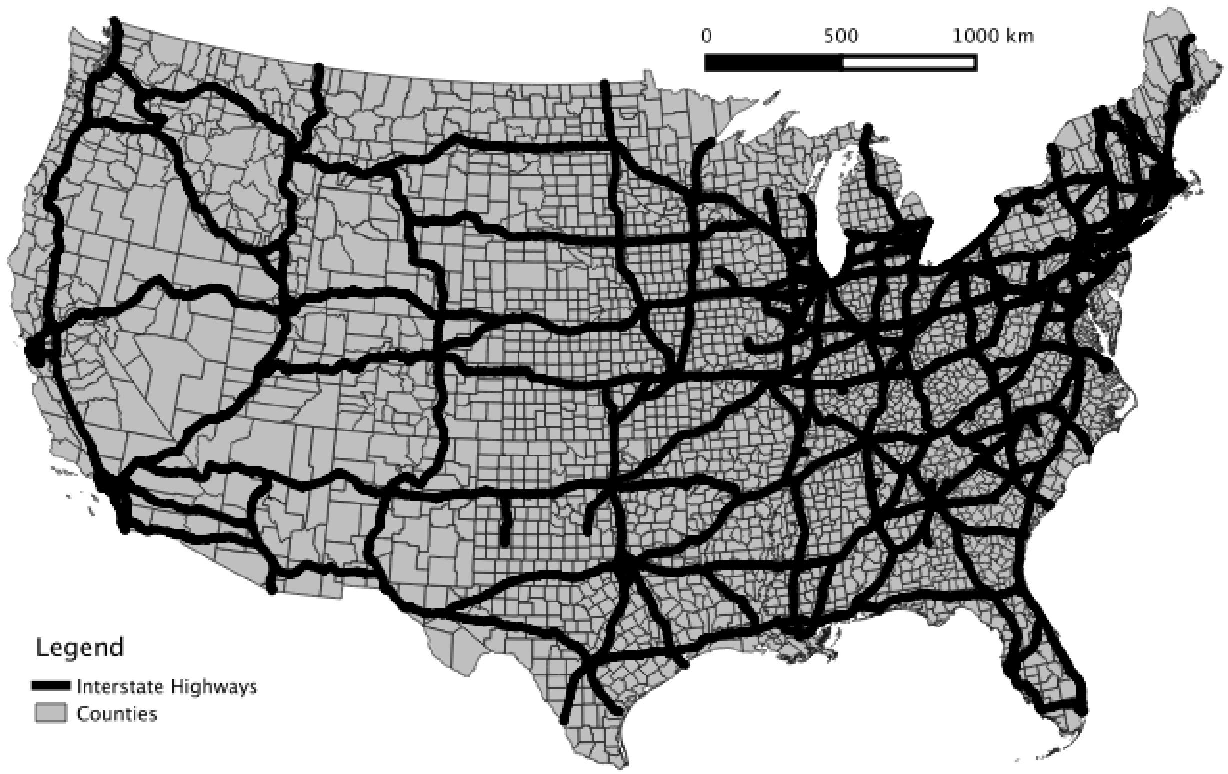


Figure 2: Pershing Military Plan

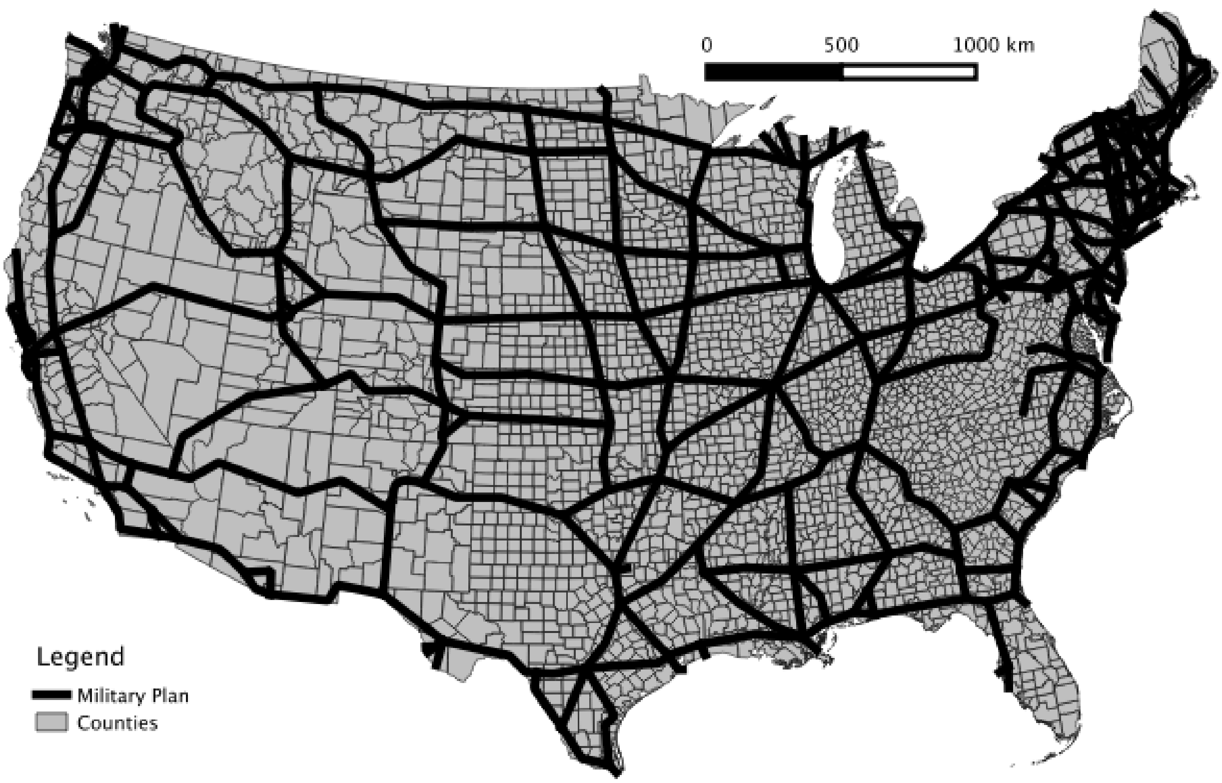


Figure 3: 1947 Plan from the Interregional Highway Committee

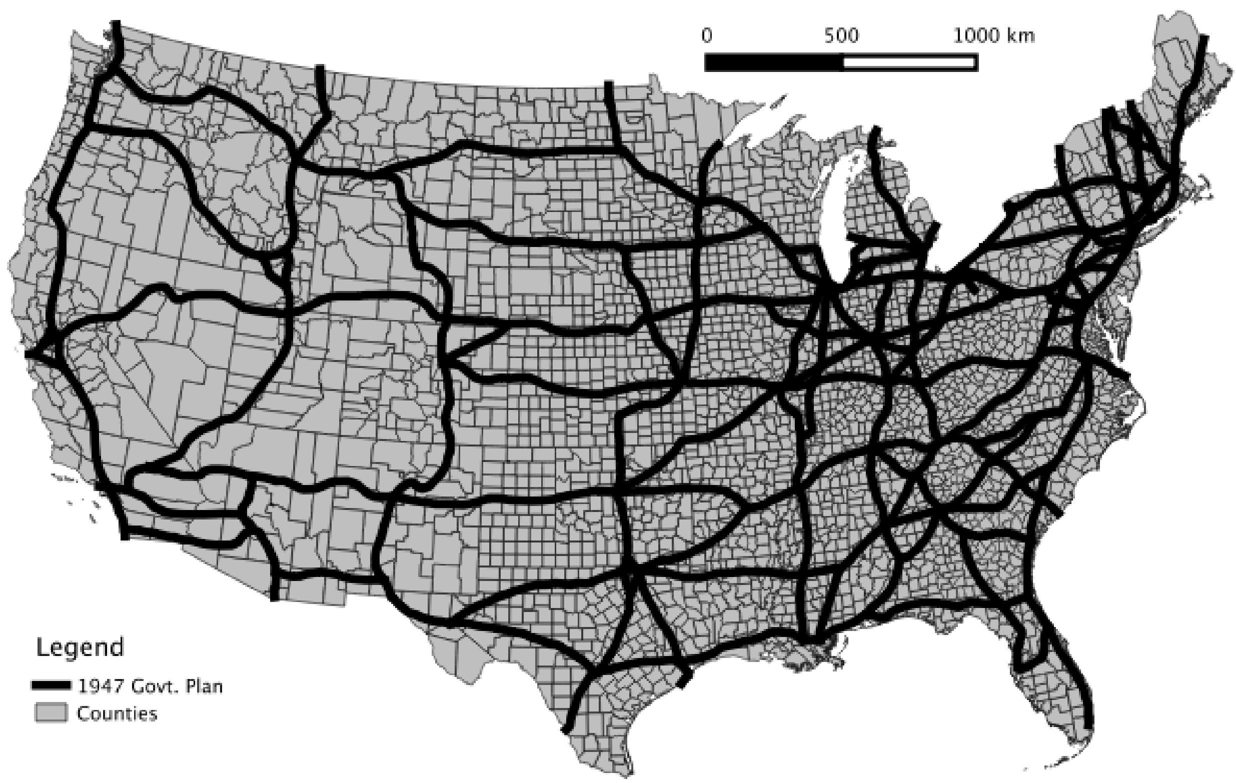


Figure 4: First-Stage Coefficients and F-Statistics by Year for the 1947 Plan

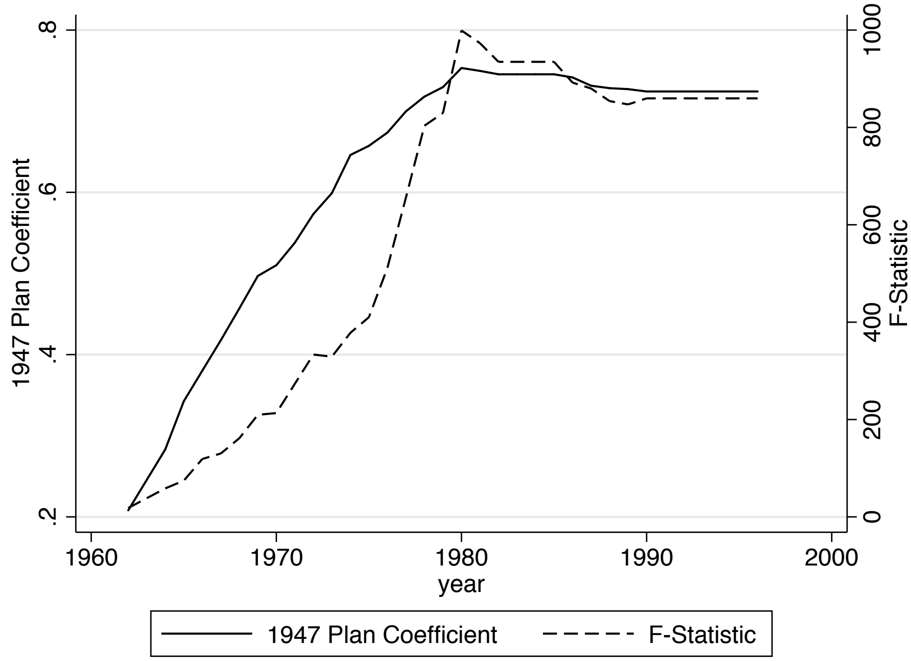


Figure 5: First-Stage Coefficients and F-Statistics by Year for the Military Plan

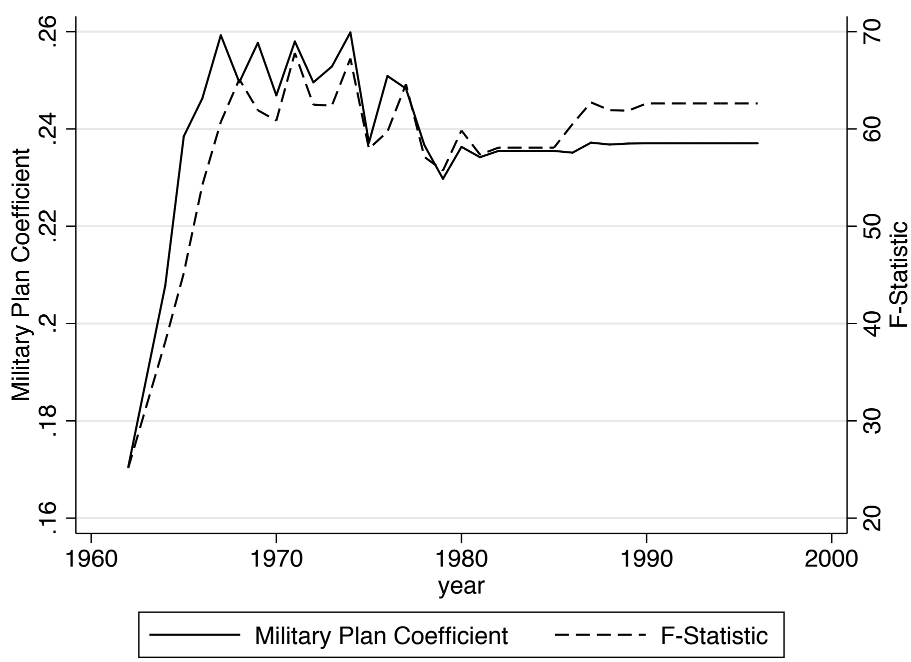


Figure 6: Interstate Highways Constructed in 1965

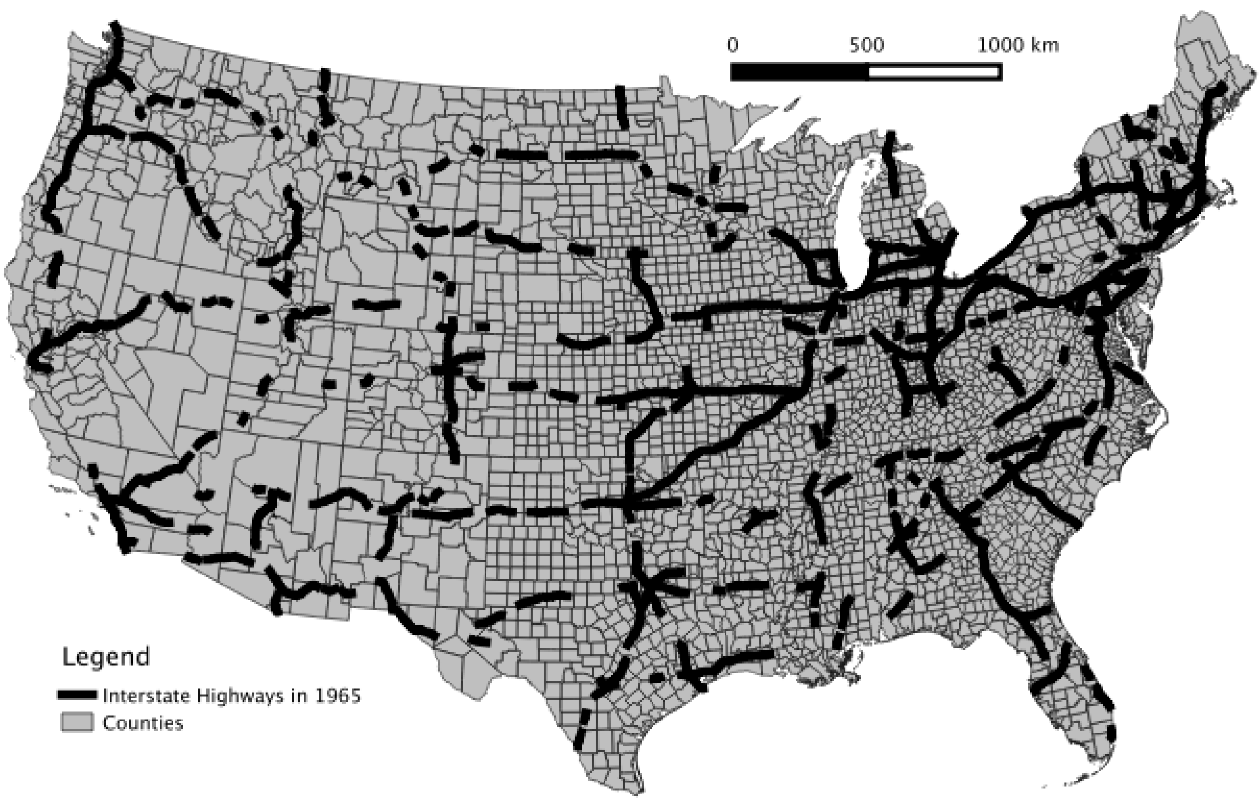


Figure 7: Proposed Military Plan Construction in 1965

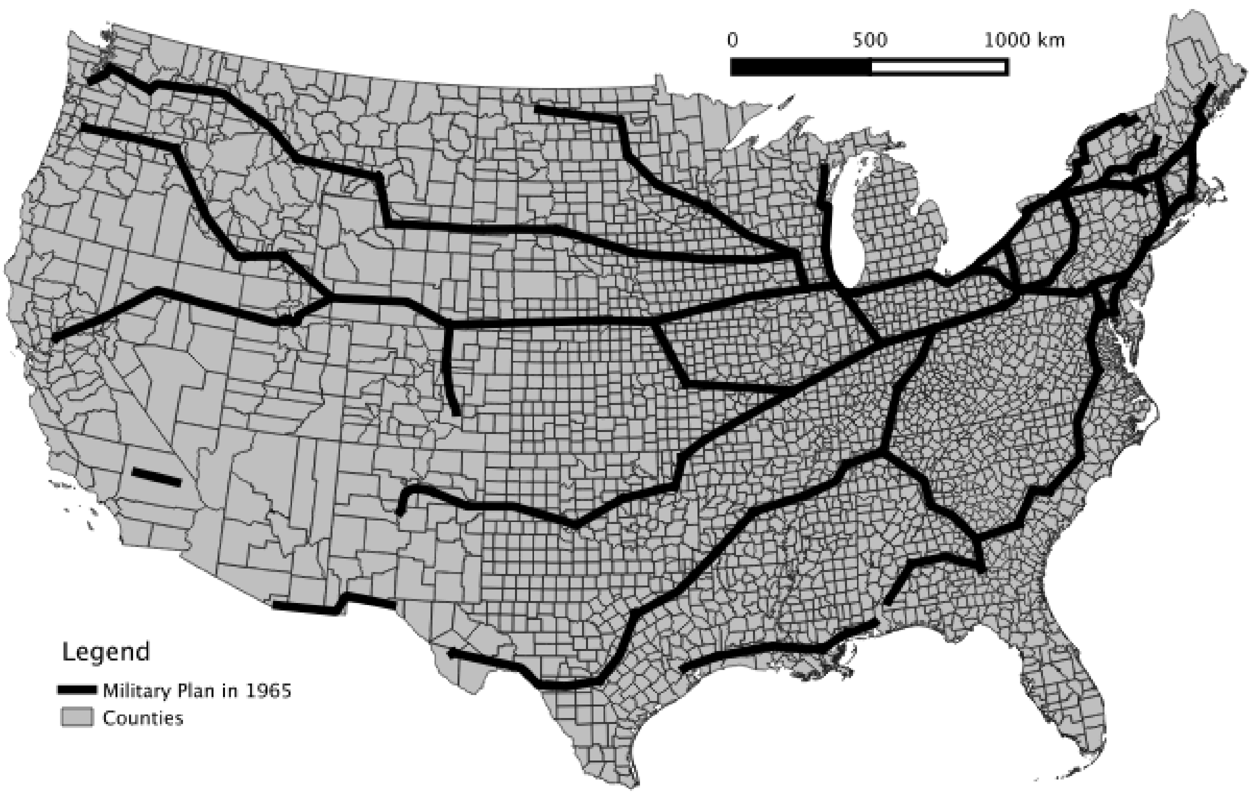
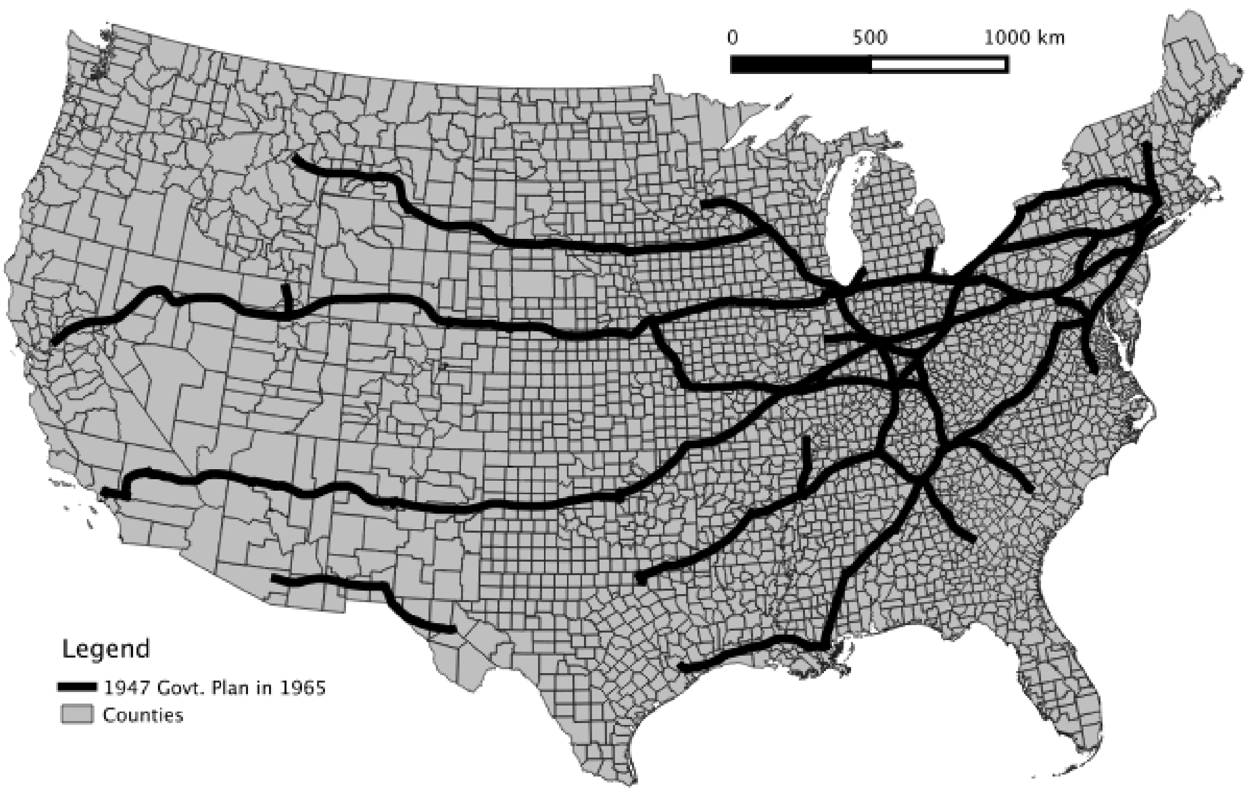


Figure 8: Proposed 1947 Plan Construction in 1965



11 Tables

Table 1: Full Sample Summary Statistics By Highway Status

	Non-Highway Counties			Highway Counties				
	Mean	SD	N	Mean	SD	N	Difference in Means	SE
Employment (in 1,000s)	5.03	8.65	56,991	44.36	138.90	44,616	39.330***	0.583
Establishments (in 100s)	4.50	6.78	56,991	27.99	77.94	44,616	23.488***	0.328
Employment Herfindahl Index	2,729.48	1,007.64	56,991	2,521.14	776.25	44,616	-208.344***	5.773
Establishments Herfindahl Index	2,137.88	400.94	56,991	2,127.30	283.74	44,616	-10.581***	2.240
Gini Spec. Index for Employment	0.26	0.13	56,991	0.20	0.10	44,616	-0.059***	0.001
Gini Spec. Index for Establishments	0.15	0.07	56,991	0.11	0.05	44,616	-0.043***	0.000
Military Plan	0.18	0.38	56,991	0.32	0.47	44,616	0.147***	0.003
1947 Govt. Plan	0.06	0.23	56,991	0.81	0.39	44,616	0.749***	0.002
Distance to MSA (in km)	142.06	116.43	56,991	96.38	105.27	44,616	-45.673***	0.706
Railroad	0.43	0.50	56,991	0.77	0.42	44,616	0.339***	0.003
Airport Distance (in km)	60.21	29.92	56,991	42.29	27.59	44,616	-17.914***	0.183
Port Distance (in km)	363.98	291.64	56,991	291.93	275.50	44,616	-72.051***	1.799
1950 Population (in 1,000s)	18.38	16.87	56,991	82.89	237.52	44,616	64.513***	0.998
Percent Pop. Growth From 1940 to 1950	-0.01	0.21	56,991	0.12	0.27	44,616	0.131***	0.001

Notes: Data comes from the 1962 - 1996 County Business Patterns annual reports. Highway counties are those that ever received a highway. All distances are calculated from the county centroid to the centroid of the nearest Metropolitan Statistical Area, Port, and Airport. *** p<0.01, ** p<0.05, * p<0.1

Table 2: Full Sample Summary Statistics of Growth and Concentration Measures
By Highway Status in 1965 and 1996

	Non-Highway Counties			Highway Counties				
							Difference in	
	Mean	SD	N	Mean	SD	N	Means	SE
Panel A: 1965 Outcomes for Counties that Ever Receive a Highway								
Employment (in 1,000s)	3.10	4.65	1,727	28.46	100.91	1,352	30.627***	2.708
Establishments (in 100s)	3.41	3.96	1,727	19.46	58.41	1,352	18.758***	1.572
Employment Herfindahl Index	2,966.38	1,206.49	1,727	2,770.42	1,022.74	1,352	-180.261***	45.875
Establishments Herfindahl Index	2,520.48	527.53	1,727	2,360.18	321.83	1,352	-148.795***	18.302
Gini Spec. Index for Employment	0.29	0.14	1,727	0.23	0.12	1,352	-0.061***	0.005
Gini Spec. Index for Establishments	0.18	0.09	1,727	0.13	0.06	1,352	-0.051***	0.003
Panel B: 1996 Outcomes for Counties that Ever Receive a Highway								
Employment (in 1,000s)	7.31	12.72	1,727	62.63	169.96	1,352	55.319***	4.104
Establishments (in 100s)	6.12	9.72	1,727	39.66	99.75	1,352	33.546***	2.415
Employment Herfindahl Index	2,589.01	728.07	1,727	2,445.76	486.13	1,352	-143.253***	22.998
Establishments Herfindahl Index	2,042.79	258.31	1,727	2,149.44	228.71	1,352	106.654***	8.924
Gini Spec. Index for Employment	0.23	0.11	1,727	0.18	0.09	1,352	-0.050***	0.004
Gini Spec. Index for Establishments	0.14	0.06	1,727	0.10	0.05	1,352	-0.037***	0.002

Notes: Data comes from the 1962 - 1996 County Business Patterns annual reports. All distances are calculated from the county centroid to the centroid of the nearest Metropolitan Statistical Area, Port, and Airport. *** p<0.01, ** p<0.05, * p<0.1

Table 3: The Effect of Highways on Total Employment and Total Establishments

	Ln(Employment)			Ln(Establishments)		
	OLS	TSLS 1947 Plan	TSLS Military Map	OLS	TSLS 1947 Plan	TSLS Military Map
Hwy X 1962-1966	-0.0506***	-0.0920	-0.00844	-0.0686***	-0.112**	-0.0545
	(0.0149)	(0.0594)	(0.0766)	(0.0116)	(0.0448)	(0.0540)
Hwy X 1967-1971	-0.0523***	-0.0289	-0.104**	-0.0515***	-0.0274	-0.0421
	(0.0115)	(0.0268)	(0.0455)	(0.00950)	(0.0214)	(0.0351)
Hwy X 1972-1976	-0.0390***	-0.0423***	-0.0735**	-0.0273***	-0.0257***	-0.0122
	(0.00756)	(0.0125)	(0.0307)	(0.00538)	(0.00905)	(0.0190)
Hwy X 1977-1981	-0.0133*	-0.0160*	-0.0220	-0.00591	-0.0118**	-0.00906
	(0.00694)	(0.00915)	(0.0281)	(0.00360)	(0.00533)	(0.0142)
Hwy X 1982-1986	0.0264***	0.0263**	0.0411	0.0223***	0.0228***	0.0276
	(0.00812)	(0.0104)	(0.0329)	(0.00553)	(0.00755)	(0.0208)
Hwy X 1987-1991	0.0586***	0.0795***	0.137***	0.0453***	0.0595***	0.0331
	(0.0106)	(0.0144)	(0.0423)	(0.00829)	(0.0116)	(0.0305)
Hwy X 1992-1996	0.0704***	0.101***	0.181***	0.0625***	0.0828***	0.0789*
	(0.0137)	(0.0193)	(0.0525)	(0.0109)	(0.0155)	(0.0412)

Notes: All estimates are from a panel of counties from 1962 - 1996 that include county fixed-effects, region X year fixed-effects, and the full set of covariates. Each entry in the table comes from a separate regression. Robust standard errors are two-way clustered by both county and state/year. All distances are calculated from the county centroid to the centroid of the nearest Metropolitan Statistical Area, Port, Airport. *** p<0.01, ** p<0.05, * p<0.1

Table 4: The Effect of Highways on Employment Growth by Industry

	Agriculture			Manufacturing		
	OLS	TSLS 1947 Plan	TSLS Military Map	OLS	TSLS 1947 Plan	TSLS Military Map
Hwy X 1962-1966	-0.145***	-0.333**	-0.403**	-0.00842	0.0930	0.199
	(0.0328)	(0.131)	(0.165)	(0.0323)	(0.108)	(0.156)
Hwy X 1967-1971	-0.124***	-0.183**	-0.299**	0.00508	0.0815	-0.0186
	(0.0307)	(0.0721)	(0.127)	(0.0265)	(0.0582)	(0.109)
Hwy X 1972-1976	-0.0841***	-0.0883**	-0.0782	-0.00687	-0.0216	-0.0436
	(0.0239)	(0.0364)	(0.0939)	(0.0211)	(0.0314)	(0.0905)
Hwy X 1977-1981	-0.0356	-0.0309	-0.0145	-0.0153	0.00426	0.0685
	(0.0253)	(0.0336)	(0.0975)	(0.0206)	(0.0298)	(0.0989)
Hwy X 1982-1986	0.0396*	0.0531*	0.102	0.00872	0.0273	-0.0218
	(0.0230)	(0.0309)	(0.0964)	(0.0236)	(0.0307)	(0.102)
Hwy X 1987-1991	0.106***	0.148***	0.186*	0.00804	0.0265	0.0128
	(0.0247)	(0.0340)	(0.104)	(0.0257)	(0.0336)	(0.114)
Hwy X 1992-1996	0.151***	0.186***	0.247**	0.0254	0.0217	0.0440
	(0.0281)	(0.0375)	(0.120)	(0.0268)	(0.0362)	(0.118)

	Retail Sales			Transp/Utilities		
	OLS	TSLS 1947 Plan	TSLS Military Map	OLS	TSLS 1947 Plan	TSLS Military Map
Hwy X 1962-1966	-0.0879***	-0.171***	-0.0636	-0.121***	-0.306***	-0.328**
	(0.0150)	(0.0567)	(0.0699)	(0.0249)	(0.0983)	(0.134)
Hwy X 1967-1971	-0.0751***	-0.0728***	-0.0568	-0.0937***	-0.117**	-0.241**
	(0.0118)	(0.0263)	(0.0461)	(0.0221)	(0.0520)	(0.0985)
Hwy X 1972-1976	-0.0375***	-0.0536***	-0.0273	-0.0150	-0.0404	-0.0578
	(0.00707)	(0.0111)	(0.0265)	(0.0175)	(0.0312)	(0.0732)
Hwy X 1977-1981	0.00604	-0.00109	0.00911	-0.0262	-0.0271	-0.0222
	(0.00572)	(0.00803)	(0.0240)	(0.0193)	(0.0273)	(0.0824)
Hwy X 1982-1986	0.0321***	0.0256**	0.0395	0.0418**	0.0456*	0.0696
	(0.00763)	(0.0105)	(0.0326)	(0.0188)	(0.0257)	(0.0878)
Hwy X 1987-1991	0.0650***	0.0905***	0.0166	0.101***	0.132***	0.257**
	(0.0113)	(0.0155)	(0.0423)	(0.0238)	(0.0327)	(0.102)
Hwy X 1992-1996	0.0867***	0.116***	0.0513	0.0951***	0.175***	0.279**
	(0.0141)	(0.0195)	(0.0524)	(0.0266)	(0.0382)	(0.116)

Notes: Dependent variable is the log of employment for each industry. All estimates are from a1962 - 1996 panel of counties that include county fixed-effects, region X year fixed-effects, and the full set of covariates. Each each entry in the table comes from a separate regression. Robust standard errors are two-way clustered by both county and state/year. All distances are calculated from the county centroid to the centroid of the nearest Metropolitan Statistical Area, Port, Airport. *** p<0.01, ** p<0.05, * p<0.1

Table 5: The Effect of Highways on Industry Concentration

Panel A: Herfindahl Index	Employment			Establishments		
	OLS	TSLS 1947 Plan	TSLS Military Map	OLS	TSLS 1947 Plan	TSLS Military Map
Hwy X 1962-1966	60.52**	55.45	273.8*	-29.07***	-24.23	1.525
	(25.45)	(92.06)	(141.8)	(9.382)	(38.97)	(51.92)
Hwy X 1967-1971	32.67	47.13	-129.9	-17.82**	-3.830	-27.89
	(21.31)	(45.80)	(83.92)	(8.454)	(19.75)	(36.98)
Hwy X 1972-1976	-25.45*	21.01	-235.6***	-6.570	-6.361	-19.29
	(15.32)	(27.97)	(62.67)	(4.806)	(8.242)	(22.21)
Hwy X 1977-1981	-28.51*	-23.72	-159.8**	5.364	3.961	44.67**
	(15.17)	(20.42)	(64.32)	(5.155)	(6.905)	(22.13)
Hwy X 1982-1986	-22.31	-43.18**	62.33	2.458	-3.863	51.65**
	(15.05)	(20.04)	(66.09)	(5.791)	(7.794)	(24.95)
Hwy X 1987-1991	6.047	-11.71	312.6***	13.49**	4.056	17.90
	(19.68)	(25.35)	(93.33)	(6.166)	(8.348)	(28.20)
Hwy X 1992-1996	29.22	12.51	382.6***	30.52***	24.29**	-28.72
	(24.63)	(31.89)	(101.6)	(7.620)	(10.60)	(34.43)

Panel B: Gini Specialization Index	Employment			Establishments		
	OLS	TSLS 1947 Plan	TSLS Military Map	OLS	TSLS 1947 Plan	TSLS Military Map
Hwy X 1962-1966	0.00194	-0.0196*	-0.00349	-0.00447***	-0.00435	-0.0125**
	(0.00291)	(0.0102)	(0.0153)	(0.00119)	(0.00435)	(0.00626)
Hwy X 1967-1971	-0.000893	-0.00919*	-0.00589	-0.00170	0.00264	-0.00251
	(0.00239)	(0.00534)	(0.00954)	(0.00111)	(0.00235)	(0.00459)
Hwy X 1972-1976	-0.00355**	-0.00180	-0.0201***	0.00110	0.00178	0.000502
	(0.00174)	(0.00296)	(0.00702)	(0.000772)	(0.00135)	(0.00314)
Hwy X 1977-1981	-0.00221	-0.00262	-0.00833	0.00271***	0.00222**	0.00199
	(0.00174)	(0.00227)	(0.00730)	(0.000843)	(0.00108)	(0.00361)
Hwy X 1982-1986	-0.000901	-0.00134	0.00234	0.000603	0.000659	0.00696*
	(0.00173)	(0.00228)	(0.00763)	(0.000906)	(0.00126)	(0.00400)
Hwy X 1987-1991	-0.000319	0.00384	0.0153	-0.000169	-1.27e-05	0.00529
	(0.00229)	(0.00315)	(0.0101)	(0.00102)	(0.00142)	(0.00418)
Hwy X 1992-1996	0.00106	0.00834**	0.00920	0.000248	-0.000306	0.00277
	(0.00265)	(0.00354)	(0.0112)	(0.00111)	(0.00156)	(0.00472)

Notes: All estimates are from a 1962 - 1996 panel of counties that include county fixed-effects, region X year fixed-effects, and the full set of covariates. Each entry in the table comes from a separate regression. Robust standard errors are two-way clustered by both county and state/year. All distances are calculated from the county centroid to the centroid of the nearest Metropolitan Statistical Area, Port, Airport. *** p<0.01, ** p<0.05, * p<0.1

Table 6: The Effect of Highways on Employment Concentration by Highway Age

	Herfindahl Index			**Gini Specialization Index**			F-Stat	
	OLS	TSLS	TSLS	OLS	TSLS	TSLS		
		1947 Plan	Military Map		1947 Plan	Military Map	1947 Plan	Military Map
Hwy X 1962 - 1973	34.665	40.285	83.649	-0.001	-0.005	-0.010*		
	(24.647)	(87.114)	(51.480)	(0.003)	(0.010)	(0.006)		
Hwy X 1962 - 1973 X Extreme Skill Dum	-4.840	-73.911*	-32.190	0.000	0.002	0.002	230.4	78.67
	(23.582)	(43.908)	(34.802)	(0.002)	(0.005)	(0.004)		
Hwy X 1974 - 1983	-40.653**	-205.708***	-30.113	-0.003	-0.015**	-0.003		
	(17.267)	(66.106)	(24.520)	(0.002)	(0.007)	(0.003)		
Hwy X 1974 - 1983 X Extreme Skill Dum	15.003	40.053*	29.551*	0.001	0.001	0.002	790.6	65.36
	(12.851)	(22.422)	(16.060)	(0.002)	(0.003)	(0.002)		
Hwy X 1984 - 1996	15.006	377.075***	-19.090	-0.000	0.011	0.007*		
	(27.595)	(106.915)	(37.485)	(0.003)	(0.012)	(0.004)		
Hwy X 1984 - 1996 X Extreme Skill Dum	-7.194	22.485	3.078	0.000	0.005	-0.001	1108	62.28
	(19.551)	(34.078)	(22.820)	(0.002)	(0.004)	(0.002)		

Notes: Kleibergen-Paap F-Statistics are reported. All estimates are from a 1962 - 1996 panel of counties that include county fixed-effects, region X year fixed-effects, and the full set of covariates. Each entry in the table comes from a separate regression. Robust standard errors are two-way clustered by both county and state/year. All distances are calculated from the county centroid to the centroid of the nearest Metropolitan Statistical Area, Port, Airport. *** p<0.01, ** p<0.05, * p<0.1

Table 7: The Effect of Highways on Total Employment and Total Establishments by Highway Age

	Ln(Employment)			**Ln(Establishments)**			F-Stat	
	OLS	TSLS 1947 Plan	TSLS Military Map	OLS	TSLS 1947 Plan	TSLS Military Map	1947 Plan	Military Map
0 - 4 Years	-0.0306***	-0.137	-1.309	-0.0315***	-0.128	-0.623	9.928	0.706
	(0.00833)	(0.201)	(1.825)	(0.00658)	(0.148)	(0.925)		
5 - 9 Years	-0.0293***	-0.147	-0.235	-0.0330***	-0.190*	-0.121	11.88	12.01
	(0.00824)	(0.127)	(0.176)	(0.00660)	(0.0994)	(0.112)		
10 - 14 Years	-0.0164**	0.0194	0.0529	-0.0187***	-0.0599	0.0440	19.67	21.42
	(0.00729)	(0.0866)	(0.105)	(0.00567)	(0.0577)	(0.0743)		
15 - 19 Years	0.00409	0.0941	0.222*	-0.00325	0.0309	0.114	22.79	20
	(0.00708)	(0.0722)	(0.117)	(0.00549)	(0.0531)	(0.0779)		
20 - 24 Years	0.0220***	0.153**	0.265**	0.0160***	0.107**	0.0537	40.55	18.95
	(0.00830)	(0.0660)	(0.129)	(0.00616)	(0.0491)	(0.0790)		
25 - 29 Years	0.0460***	0.143**	0.200*	0.0404***	0.131***	0.0512	53.12	25.96
	(0.00936)	(0.0676)	(0.102)	(0.00756)	(0.0492)	(0.0717)		
30 - 34 Years	0.0690***	0.181***	0.150*	0.0653***	0.165***	0.0412	60.87	48.10
	(0.0121)	(0.0632)	(0.0798)	(0.00940)	(0.0488)	(0.0563)		
35 - 39 Years	0.0691***	0.0284	0.00997	0.0855***	0.125***	0.0499	65.03	52.26
	(0.0182)	(0.0607)	(0.0810)	(0.0153)	(0.0474)	(0.0610)		

Notes: Kleibergen-Paap F-Statistics are reported. All estimates are from a 1962 - 1996 panel of counties that include county fixed-effects, region X year fixed-effects, and the full set of covariates. Each entry in the table comes from a separate regression. Robust standard errors are two-way clustered by both county and state/year. All distances are calculated from the county centroid to the centroid of the nearest Metropolitan Statistical Area, Port, Airport. *** p<0.01, ** p<0.05, * p<0.1

Table 8: The Effect of Highways on Industry Concentration by Highway Age

Panel A: Herfindahl Index

	Employment			Establishments		
	OLS	TSLS 1947 Plan	TSLS Military Map	OLS	TSLS 1947 Plan	TSLS Military Map
0 - 4 Years	16.37	162.8	-4278	-14.94***	-27.7	-941.4
	(16.1)	(311.8)	(5459)	(5.787)	(130.3)	(1334)
5 - 9 Years	24.35*	198.2	-92.11	-10.91**	-167.1*	28.07
	(14.63)	(239.7)	(329)	(5.407)	(91.57)	(136.3)
10 - 14 Years	2.006	192.7	125.7	0.791	-141.3**	76.62
	(13.67)	(173.4)	(212.3)	(4.824)	(62.21)	(90.01)
15 - 19 Years	6.573	-32.29	314.9	8.153*	-75.1	88.17
	(12.53)	(135.8)	(228.4)	(4.566)	(53.33)	(86.95)
20 - 24 Years	7.58	-18.22	928.2***	10.29**	35.14	126.4
	(13.81)	(110.3)	(317)	(5.222)	(43.44)	(93.93)
25 - 29 Years	-7.265	-124.5	293.5	13.27**	53.24	20.75
	(16.21)	(112.2)	(178.6)	(5.746)	(37.46)	(65.79)
30 - 34 Years	11.68	-217.7**	22.44	16.36**	63.07*	-36.01
	(20.64)	(104.3)	(143.9)	(6.469)	(37.63)	(52.04)
35 - 39 Years	-24.19	-336.8***	-128.8	10.24	39.29	-23.98
	(27.21)	(108.1)	(108.6)	(9.349)	(37.46)	(37.08)

Panel B: Gini Specialization Index

	Employment			Establishments		
	OLS	TSLS 1947 Plan	TSLS Military Map	OLS	TSLS 1947 Plan	TSLS Military Map
0 - 4 Years	0.000189	0.00623	0.0587	-0.00119	-0.00522	-0.152
	(0.00183)	(0.0357)	(0.233)	(0.000819)	(0.0170)	(0.206)
5 - 9 Years	-0.00198	-0.0426	-0.0818*	-0.000206	-0.00260	-0.0257
	(0.00166)	(0.0300)	(0.0425)	(0.000731)	(0.0108)	(0.0193)
10 - 14 Years	-0.00311**	-0.0353**	-0.0377	0.000850	0.000264	-0.00772
	(0.00152)	(0.0179)	(0.0254)	(0.000680)	(0.00747)	(0.0131)
15 - 19 Years	-0.00152	-0.00847	0.00669	0.000214	0.000730	0.0198
	(0.00147)	(0.0146)	(0.0260)	(0.000664)	(0.00774)	(0.0137)
20 - 24 Years	0.000165	0.00436	0.0328	-2.75e-05	0.00694	0.0400***
	(0.00159)	(0.0133)	(0.0283)	(0.000778)	(0.00656)	(0.0151)
25 - 29 Years	0.000994	-0.00194	0.00560	0.000147	-0.00543	0.0108
	(0.00177)	(0.0128)	(0.0207)	(0.000829)	(0.00531)	(0.00993)
30 - 34 Years	0.000705	0.0248*	0.00441	0.000981	0.00255	0.00116
	(0.00222)	(0.0137)	(0.0171)	(0.000942)	(0.00485)	(0.00677)
35 - 39 Years	-0.00136	0.0225*	0.00147	0.00122	0.00163	0.000727
	(0.00311)	(0.0119)	(0.0127)	(0.00136)	(0.00490)	(0.00530)

Notes: All estimates are from a 1962 - 1996 panel of counties that include county fixed-effects, region X year fixed-effects, and the full set of covariates. Each entry in the table comes from a separate regression. Robust standard errors are two-way clustered by both county and state/year. All distances are calculated from the county centroid to the centroid of the nearest Metropolitan Statistical Area, Port, Airport. *** p<0.01, ** p<0.05, * p<0.1

Table 9: The Effect of a Planned Highway on Historical Census Outcomes Prior to Construction

	(1) Population	(2) Urbanization	(3) Manuf. Estab	(4) Manuf. Employ	(5) Number of Farms	(6) Farmers
Panel A: Planned 1947 Map						
1947 Plan X 1920	0.00631	-0.0523	-0.0162	0.145	-0.00363	-0.00363
	(0.0218)	(0.0971)	(0.0801)	(0.100)	(0.0228)	(0.0227)
1947 Plan X 1930	0.0384*	0.0221	-0.00541	0.141**	0.00206	0.00308
	(0.0220)	(0.0822)	(0.0456)	(0.0690)	(0.0183)	(0.0184)
1947 Plan X 1940	0.0290	-0.108	0.0357	0.102	0.00118	0.00311
	(0.0251)	(0.0732)	(0.0439)	(0.0727)	(0.0240)	(0.0241)
Panel B: Planned Military Map						
Military Plan X 1920	-0.0127	-0.00202	0.0660	0.140	0.00931	0.00931
	(0.0139)	(0.0866)	(0.0594)	(0.0880)	(0.0187)	(0.0187)
Military Plan X 1930	-0.0173	0.0344	0.000243	0.0362	-0.0157	-0.0151
	(0.0119)	(0.105)	(0.0313)	(0.0628)	(0.0140)	(0.0139)
Military Plan X 1940	-0.0266**	-0.143*	-0.000865	-0.0193	-0.0141	-0.0128
	(0.0125)	(0.0775)	(0.0281)	(0.0642)	(0.0155)	(0.0156)
Observations	11,244	11,244	10,460	10,160	11,244	11,225
Number of fips	2,811	2,811	2,641	2,623	2,811	2,811

Notes: All estimates are from a panel of counties that include county fixed-effects, region X year fixed-effects, and the full set of covariates. Robust standard errors are two-way clustered by both county and state/year. All distances are calculated from the county centroid to the centroid of the nearest Metropolitan Statistical Area, Port, Airport. *** p<0.01, ** p<0.05, * p<0.1

Table 10: The Effect of Unbuilt Military Routes on Total Employment and Total Establishments

	Ln(Employment) OLS	Ln(Establishments) OLS
Hwy X 1967-1971	-0.00373	0.00785
	(0.0124)	(0.00967)
Hwy X 1972-1976	-0.0103	0.00439
	(0.00849)	(0.00519)
Hwy X 1977-1981	-0.00905	-0.00421
	(0.00782)	(0.00386)
Hwy X 1982-1986	0.00290	-0.00195
	(0.00859)	(0.00554)
Hwy X 1987-1991	0.00871	-0.00785
	(0.0113)	(0.00774)
Hwy X 1992-1996	3.57e-05	-0.0148
	(0.0133)	(0.0107)

Notes: All estimates are from a 1962-1996 panel of counties that include county fixed-effects, region X year fixed-effects, and the full set of covariates. Each each entry in the table comes from a separate regression. Robust standard errors are two-way clustered by both county and state/year. All distances are calculated from the county centroid to the centroid of the nearest Metropolitan Statistical Area, Port, Airport. *** p<0.01, ** p<0.05, * p<0.1