The Road to Reelection: Political Returns to Highway Construction

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Daniel Leff Yaffe* Alejandro Nakab† Wayne Aaron Sandholtz‡

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Abstract

Do voters reward public good provision? We measure the electoral effect of construction of the US Interstate Highway System (IHS). We construct a shift-share instrument for highway construction at the county×year level, interacting state×year congressional apportionments with the share of a state's total planned IHS mileage accounted for by each county. We find that completing one extra highway mile in an election year increases incumbent party vote share for governors and representatives by 2.7 and 1.5 percentage points respectively. We find no effect on senate or presidential incumbent vote share.

*Wayfair

†Universidad Torcuato di Tella

‡Nova School of Business and Economics

§Leff Yaffe: dleffyaf@ucsd.edu. Nakab: anakab@utdt.edu. Sandholtz: wayne.sandholtz@novasbe.pt. We are grateful to Guido Damonte for excellent research assistance. All errors are our own.

1 Introduction

This paper identifies the electoral effects of the construction of USA's Interstate Highway System (IHS). Specifically, we measure the effect of new IHS construction on contemporaneous county-level vote share for incumbent governors, congresspeople, and presidents from 1950-1972. Understanding the political economy of public goods such as transportation infrastructure is important. Governments spend massive amounts of money on them: transportation infrastructure projects account for almost 20% of World Bank lending, and highway spending constitutes 28% of gross US government investment (World Bank, 2007; Leff-Yaffe, 2020). These types of public goods can promote economic growth (Donaldson & Hornbeck, 2016; Donaldson, 2018; Fernald, 1999). Some scholars propose that democracies tend to grow faster precisely because voters demand investment in broad-based public goods (Acemoglu, Naidu, Restrepo, & Robinson, 2019; Acemoglu, 2008). Other theories predict that the costs of infrastructure projects may outweigh the benefits voters perceive, especially when electorates are well-informed (Glaeser & Ponzetto, 2018).

But credibly measuring the electoral returns to public goods is difficult, not least due to the rarity of exogenous variation in public good provision. Policymakers in democracies tend to target public investments to maximize political gain, creating a selection problem (Burgess, Jedwab, Miguel, Morjaria, & Padró I Miquel, 2015).[1] Political scientists debate when and why politicians target "core" vs. "swing" voters – making it difficult to even sign the bias (Dixit & Londregan, 1996; Stokes, 2005).

There are some reasons to believe voters reward infrastructure creation. Much of the research on returns to government spending focuses on direct cash transfers rather than public goods themselves, but public good provision can lay the foundations for growth in a way redistribution cannot (Manacorda, Miguel, & Vigorito, 2011; Golden & Min, 2013). Infrastructure tends to be highly visible, making it easier for politicians to claim credit (Mani & Mukand, 2007). A handful of studies have found evidence of positive political returns to public goods (Huet-Vaughn, 2019; Drazen & Eslava, 2010; Harding & Stasavage, 2014; Levitt & Snyder Jr., 1997).[2]

On the other hand, there are reasons to think electoral returns might be null or even negative. Cash transfers are easier to target clientelistically than public goods are (Linos, 2013). Some research has found no electoral impact even of large infrastructure programs (Goyal, 2019; Garfias, Lopez-Videla, & Sandholtz, 2021). Transportation infrastructure creates negative externalities (Nall, 2018). This might lead to voter backlash (Sandholtz, 2023).

[1] See Rogoff (1990); Rogoff and Sibert (1988); Nadeau and Blais (1992); Peltzman (1992); Katsimi and Sarantides (2012); Potrafke (2010) for evidence of political budget cycles in the US, and Jones, Meloni, and Tommasi (2012) for an example from Argentina. Not all these studies sign the correlation between the electoral cycle and government spending the same way.

[2] See Hartmann and Sandholtz (2023) for a review of the nascent literature on electoral returns to public goods and services.

We first present an empirical fact showing the extent of politics-based selection in IHS construction. We find evidence that construction follows the electoral cycle, even though apportioned funds do not. Controlling for state and year fixed effects, the average state constructed 8.4 more miles in election years than in non-election years.

To overcome the endogeneity of IHS construction, we create a Bartik-style shift-share instrumental variable (IV), based on the original 1947 road network plan and the schedule of state-level highway appropriations from Congress (Bartik, 1991). We multiply (a) the total federal IHS apportionments for a state in a given year by (b) the fraction of the state's total planned miles represented by a given county. The instrument predicts actual new IHS miles constructed in a county-year, but is free from politicians' discretion over where and when to spend apportioned funds. We also include county and year fixed effects to control for time-invariant county differences and broader electoral trends (Bartik, 1991; Goldsmith-Pinkham, Sorkin, & Swift, 2020).

Opening one additional highway mile in an election year increases the incumbent governor's party's vote share in that county by 2.7 percentage points, and the incumbent representative's party's vote share by 1.6 percentage points. Part of this effect seems to be driven by voter mobilization: we estimate large effects of IHS construction on the number of votes cast in a county, controlling for past participation. We do not find evidence of significant effects on senate or presidential vote share. This suggests that politicians exerted effort to claim credit for the policy. Responsibility for the IHS could plausibly be attributed to governors, congresspeople, and presidents, but electoral returns appeared for offices whose jurisdiction is closest to the construction, who may have had more incentive to campaign on it.

These electoral benefits do not seem to come at the cost of alienating voters in non-interstate counties. Electoral returns to IHS construction spill over into surrounding counties. Governors receive a 1.6-percentage point electoral bump from a new IHS mile in counties adjacent to the county where the IHS was built. Spillovers also help incumbent representatives, with a positive effect of 1.4-2.1 percentage points.

Our paper shows that politicians can reap electoral benefits from transportation infrastructure projects. This is consistent with the theory of retrospective voting, which posits that voters reward good government performance (Key, 1966; Ferejohn, 1986). This contradicts somewhat the assertion that average citizens have little to no influence over US policy (Gilens & Page, 2014). Prior work has shown that the IHS created economic benefits (Michaels, 2008). Our contribution is to show that ordinary citizens rewarded (at least some of) the politicians responsible.

We also contribute to the robust literature examining the political and economic effects of highway construction. While our paper is the first to examine the effects of the Interstate Highway System's con-

struction on electoral outcomes, Huet-Vaughn (2019) shows that road and bridge construction increased Democratic party vote share in the US in 2012, and Voigtländer and Voth (2018) shows that highway construction can drive political support in an autocracy. Similarly, Harding (2015) finds that improvements to road quality increase incumbents' reelection rates in Ghana. Other work examines other outcomes of highway construction. Baum-Snow (2007) demonstrates that the IHS caused suburbanization and urban depopulation. Clayton Nall builds on this finding to show that highway construction contributed to the political polarization and class stratification of American geography in the 20th century (Nall, 2015, 2018).

The rest of the paper is organized as follows. Section 2 provides background information on the IHS. Section 3 gives an overview of the data and outlines the empirical inferential problem, while Section 4 explains our methodology. Section 5 presents the main results on the effect of the IHS on political outcomes at the county level. Section 6 concludes.

2 Background

2.1 History of the IHS

The Federal-Aid Highway Act of 1944 gave birth to the IHS, originally called the National System of Interstate Highways. The Act called for the designation of a highway system of 40,000 miles to connect metropolitan areas, cities and industrial centers, as well as to connect the U.S. with Canada and Mexico at key border points. In 1947 the selection of the first 37,700 miles was announced. However, at the time there was no plan on how to fund the system, nor an estimate of how much it would cost, so its construction was uncertain. A map of the 1947 plan is presented in Figure A.1.

In 1952, legislation approved a small amount of funding for a pilot of the IHS: $25 million for the fiscal year 1954 and a similar amount for 1955. States were required to match the federal funds with a 50% Federal - 50% State rule. Funds were apportioned across states according to a weighting formula involving population, area, and rural priority routes, all relative to the country as a whole (see Section A for more detail). The Act of 1954 expanded the program, appropriating $175 million of federal funds for the fiscal year 1956 and a similar amount for 1957, and changing the weighting formula again, and increasing the federal government's cost-sharing burden to 60%.

Shortly thereafter, President Dwight D. Eisenhower made expanding the IHS a central part of his campaign. With the president urging approval and compromise, Congress's draft of the 1956 Federal-Aid Highway Act represented a huge extension of the IHS project, creating a highway trust fund – fed by a

gasoline tax – to fund the expansion. The Act of 1956 is sometimes referred to as the Interstate Highway System Act, as it set forth a plan for completing the IHS within 13 years. It provided more substantial federal-aid funds than its predecessors, totaling $25 billion to be spent over 13 years. It also changed the matching funds rule to 90% Federal - 10% State, increasing states' incentives to invest in the IHS. The state matching funds rule, together with the $25 billion appropriation, meant total funds equaled 6.2% of GDP. The Act passed with 388 votes in the House and 89 votes in the Senate.

2.2 Funding details

Apportionment of federal IHS funds to the states was governed by a formula. From 1954 to 1959, the formula to apportion federal IHS funds to the states gave a weight of $2/3$ to relative population, $1/6$ to relative area, and $1/6$ on relative rural delivery and star routes. For the subsequent years, the 1956 Act provided a different formula, based solely on the ratio of the estimated cost of completing the system in each state compared with the cost in all states (cost estimates were updated periodically).

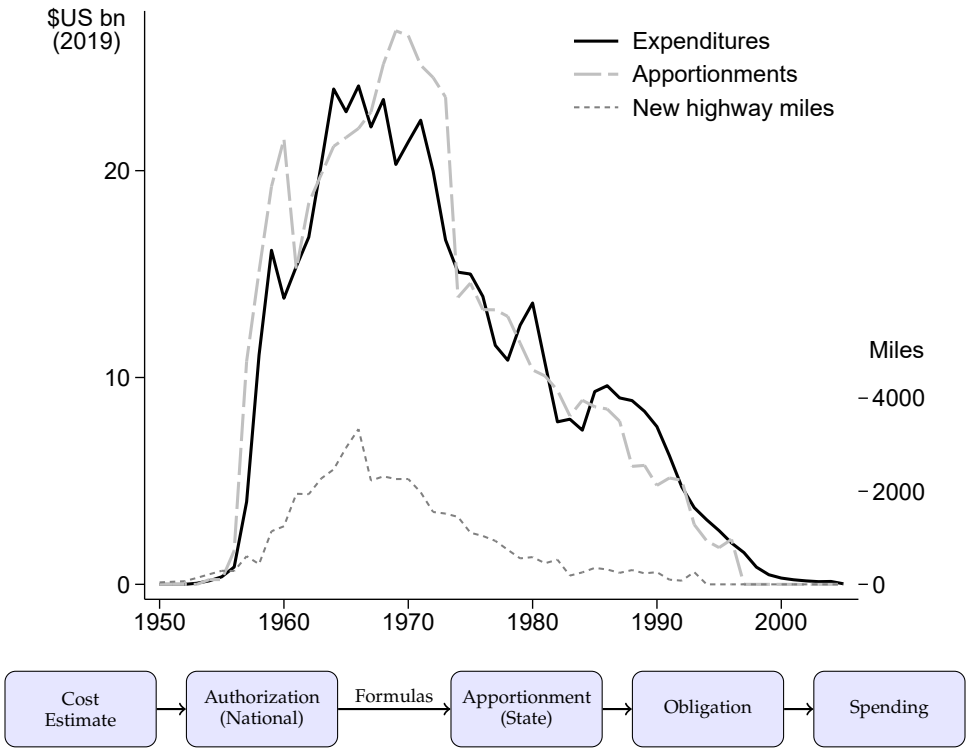
Figure 1 shows that apportionments, expenditures, and construction all track each other closely. It also illustrates the procedure by which spending took place. (1) First, an estimate of the cost of completing the interstate was released. (2) Then, an authorization took place in a Federal Highway Act, outlining the amount available at the national level for the next few fiscal years. (3) Funds were then apportioned across states using formulas provided by legislation. The share each state receives is called the apportionment factor (AF). For each fiscal year apportionment factors were usually announced between 1 and 2 years in advance; however, they could be predicted with accuracy many years in advance using the formulas set forth by legislation. (4) Once the fiscal year of the appropriation was reached, states obligated funds in interstate highway projects. (5) Finally, as highways were built, spending took place. Payments to contractors for work completed were initially made from state funds, sometimes transferred from cities or counties, and the federal share was paid as reimbursements.

As years progressed a few more routes were added into the system, and others deleted. Figure 2 presents a digitized version of the 1947 map together with the a digital map of the IHS as of May 2014.[3] Visual inspection of Figure 2 shows that the IHS followed the 1947 plan very closely. In fact, at the county-level, the correlation between the number of miles received by each county according to the 1947 plan, and the observed IHS (as of May 2014) is equal to .86.[4]

[3]Digitization of 1947 map by the authors (Leff). 2014 map from "Interstate highways according to the National Highway Planning Network, version 14.05."

[4]This calculation uses the county boundary definitions from the 2015 census, and the 48 contiguous U.S. states. Based on 3,107 observations.

Figure 1: Federal Government Funds to Construct the IHS
(Billions of 2019 USD)



States were required to spend apportioned funds within two years or forfeit them. This constrained somewhat governors' ability to manipulate the timing of construction for electoral gains. Still, it seems that they used what wiggle room they had to full effect. Figure 3 in the next section shows that although apportionments at the state level were unrelated to the gubernatorial electoral calendar, construction increased as election years approached.

We focus on the period until 1972. 89% of all counties that would ever receive any IHS miles had received them by this time; after 1972, the number of new miles constructed each year fell sharply. Also, as time progressed, changes to the apportionment formula made apportionments less predictable, potentially introducing more scope for endogeneity to political concerns. For more detail see Section A.6.

3 Data

Our primary explanatory variable is the number of miles of interstate highway built in a county $\times$ year (we index counties by i; years by t). We rely on the dataset created by Baum-Snow (2007), which combines

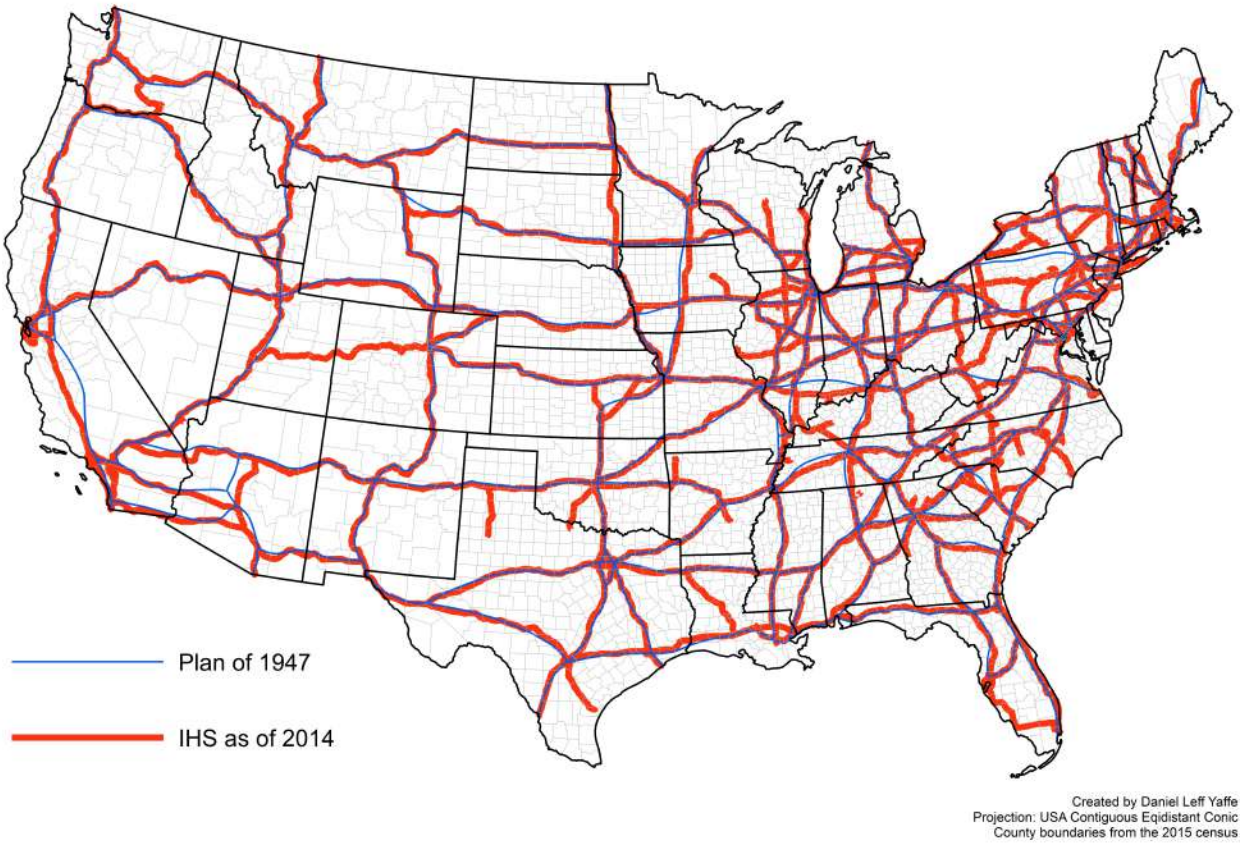


Figure 2: The 1947 Plan vs. the 2014 System

the PR-511 data set with a digital map of the interstate system.[5] Most county boundaries don't change over the period we study, but some do. To address this, we collapse all counties into 3058 time-consistent county boundaries – henceforth referred to as "counties."[6]

Our primary outcome variables of interest, obtained from the ICPSR, are the county-level vote share for candidates for governor, representative, senator, and president from their respective incumbent parties.[7] Table A.1 shows summary statistics for these variables at the level of the county, county $\times$ year, and county $\times$ gubernatorial election term. 38% of all counties had at least some open IHS miles by 1972 (this represents 89% of all counties that would ever have any IHS miles). The average county had 11 IHS miles by 1972. 5% of counties had any IHS construction in the average year, with an average of 0.46 new miles was built each year. 10% of counties had some IHS miles completed in the average gubernatorial term,

[5]The PR-511 data set was created by the government, by requiring each state to report the completion month of each interstate highway within its borders.

[6]The US Census Bureau's Cartographic Boundary Shapefile at the county level for the year 2000 contains a total of 3108 counties for the 48 contiguous states. Using Census information on *Substantial Changes to Counties and County Equivalent Entities*, we aggregated counties to obtain 3058 county-equivalent units with time-consistent boundaries from the year 1940 to the year 2000.

[7]General Election Data for the United States, and Candidate Name and Constituency Totals, Inter-university Consortium for Political and Social Research (ICPSR).

with an average of 1.3 miles built over the course of the term. Incumbent advantage is high in this period: the average county's vote share for the party of the incumbent governor was 59%.[8]

3.1 More IHS miles are built in election years

Here we show that interstate highway construction tends to happen in election years, even though apportioned funds from the federal government are more or less constant through the election cycle. Apportionments are governed by deterministic formulae which do not take the electoral cycle into account. But governors have some discretion over when to spend apportioned funds; they must spend them within two years or lose them.

Figure 3 plots the number of interstate highway miles built or under construction in each county $\times$ year, and the amount of federal apportionments for IHS construction (measured in real 2019 dollars), collapsed by the year in the 4-year gubernatorial election cycle in which they occurred.[9] Over the period we consider, construction (right axis) increased as election years approached, even as apportionments from the federal government (left axis) stayed more or less constant:

The same phenomenon is visible in Table A.2. While the average state built 31 IHS miles in the average year, gubernatorial election years saw 8 more miles completed than other years (controlling for state and year fixed effects). Apportionments, when controlling for state and year fixed effects, stayed constant across the electoral cycle.

This suggests temporal selection in IHS construction in a way that may be correlated with electoral outcomes, and highlights the importance of finding exogenous variation in IHS construction in order to identify its political effects.

4 Methodology

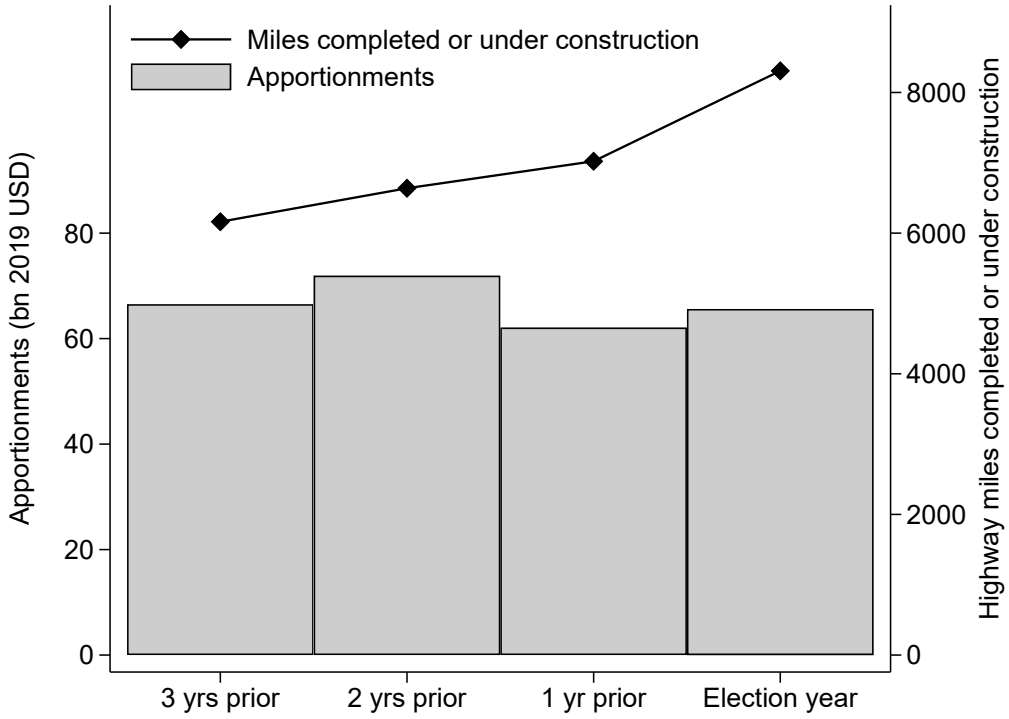
A naïve OLS regression of electoral outcomes on highway construction is likely to deliver a biased estimate due to selection of highway location on both the temporal and spatial dimension. Politicians may seek to build highways at electorally salient times, as shown by Figure 3 and Table A.2. Within a given year, they may also select which counties to build in to target either core or swing voters (Dixit & Londregan, 1996).

We measure the causal effect of IHS construction on electoral outcomes using a Bartik estimator which yields exogenous variation in IHS construction at the county $\times$ year-level (Bartik, 1991; Goldsmith-

[8]Many states impose term limits on governors, creating limits on the electoral rewards an individual politician can reap. For this reason we focus on rewards accruing to the party.

[9]This figure is limited to states and years with 4-year gubernatorial terms; some states in some years have 2-year gubernatorial terms. A similar pattern is evident in those states too.

Figure 3: Timing of apportionments and construction in the election cycle



1954-1972. Apportionments and miles completed or under construction both summed across years and counties. Sample includes only full election terms of 4-year length. States with at least one 4-year election term in the period 1950-1972: AL, AZ, CA, CO, CT, DE, FL, GA, ID, IL, IN, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NB, NV, NJ, NM, NY, NC, ND, OH, OK, OR, PA, SC, TN, UT, VA, WA, WV, WI, WY. Some of these states switched from 2-year to 4-year gubernatorial terms during the study period; this plot only includes 4-year terms from such states.

Pinkham et al., 2020). This estimator predicts the number of miles that would have been constructed in a given county $\times$ year if state governments had allocated federal interstate highway appropriation funds uniformly across the counties along the federally-designated interstate route. It interacts the share of a state's total planned miles represented by a given county with the amount of federally-appropriated IHS funds to the state in a given year.

To measure a county's share of overall planned IHS construction within the state, we use the federal 1947 plan for the entire IHS system. This plan closely predicts which counties ended up seeing IHS construction (see Figure 2). We denote as $Plan47_i$ the number of miles assigned to county i in the 1947 plan. This variable is estimated by digitizing the 1947 plan and measuring the number of miles inside each county using the USA Contiguous Equidistant Conic projection. Because this design was created in 1947 by the federal bureaucracy for the purpose of facilitating trade and national defense, it is plausibly exogenous to the electoral strategies of politicians in individual states in the following decades, most of whom were not in office in 1947 (see Figure A.3).

To measure the temporal shift in construction, we use state $\times$ year-level apportionments from Congress, denoted as $W_{S(i)t}$. Although these apportionments are strongly related to expenditures and construction (see Figure 1), they are determined according to a formula by the federal government rather than state governments, making them less subject to endogenous temporal allocation. Thus our measures of both the "share" and the "shift" in our estimator are plausibly unaffected by contemporaneous political manipulation.

The instrument, denoted by Z_{it}, can be calculated by:

$$Z_{it} = \left(\frac{Plan47_i}{\sum_{i \in S(i)} Plan47_i} \right) W_{S(i)t} \tag{1}$$

where $S(i)$ is a function that assigns each county to its respective state. For example, the 1947 plan assigned San Diego county 7.7% of all California's planned interstate miles. Then, San Diego county's instrument for year t multiplies 7.7% by the amount of federal funds apportioned to California in year t.[10]

Our empirical specification is

$$Y_{it} = \beta X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \tag{2}$$

where Y_{it} denote the share of votes received by the incumbent candidate's party in county i during the election of year t.[11] X_{it} denotes the number of interstate highway miles opened in county i during year election year t, and is instrumented by Z_{it} as specified in Equation 1. β is the parameter of interest. Because the number of miles assigned across counties is not randomly assigned, and counties on the interstate system may differ systematically from other counties, we include μ_i county fixed effects. Because federal appropriations at the state level tend to correlate with each other in large national trends, and because reelection patterns may change over time, we include γ_t year fixed effects.[12] ε_{it} is the error term.[13]

5 Results

In Table 1 we present the IV results for the effect of IHS construction on incumbent party vote share, and total votes cast, for four types of elected officials: state governors, members of the House of Representatives, senators, and presidents. Panel A presents estimates on incumbent vote share – a measure of the

[10] See Figure A.2 for an illustration of the intuition behind the shift-share instrument for one US state.

[11] Note that U.S. elections generally occur in November, while data on the number of opened miles covers the whole calendar year. In our data, 98.3% of elections happened in November, while the other 1.7% occurred in October or sooner. We leave these early-year elections in our data.

[12] See Figure 1 and Figure A.5.

[13] Since gubernatorial elections are scheduled to occur every 2 or 4 years (depending on the state and the year), the database to estimate equation (2) is by construction an unbalanced panel for gubernatorial elections.

electoral incentives politicians face to build public goods, or to claim credit for them. However, it is also important to know how public goods affect political participation more broadly. While we cannot compute voter turnout due to a lack of data on the number of registered voters, Panel B presents estimates on the total number of votes cast, controlling for the number of votes cast in the prior election, as a measure of political participation. As a measure of political selectivity in IHS allocation, we also present the descriptive naïve OLS regressions. All IV regressions show the first-stage "effective F-statistic" of Montiel Olea and Pflueger (2013), as recommended by Andrews, Stock, and Sun (2019). For every specification, standard errors are clustered at the state level.

The explanatory variable in these regressions – "New miles this year" – measures the difference between the number of IHS miles open this year and the number that were open last year. Because electoral outcomes are measured only in election years, we limit attention to miles opened in election years.[14]

Table 1: Effect of Interstate highway construction on electoral outcomes

	Governor		House		Senate		President	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Panel A: Vote share								
New miles	-0.237**	2.745**	-0.322***	1.567***	-0.306***	2.585	0.005	-3.247
	(0.104)	(1.228)	(0.086)	(0.579)	(0.098)	(1.582)	(0.052)	(2.805)
Year FE		✓		✓		✓		✓
County FE		✓		✓		✓		✓
N	24190	19806	33564	27876	24415	20541	18257	15199
DV Mean	59	58	69	68	61	60	48	49
F-stat		21		16		13		9
Panel B: Votes cast								
New miles	229***	4879***	37	3659***	278***	-1908	210***	3168**
	(76)	(1140)	(34)	(851)	(78)	(3398)	(53)	(1541)
Votes last election	1.009***	0.379**	1.000***	-0.014	1.023***	0.912***	1.019***	0.843***
	(0.015)	(0.156)	(0.011)	(0.091)	(0.026)	(0.063)	(0.014)	(0.050)
Year FE		✓		✓		✓		✓
County FE		✓		✓		✓		✓
N	21139	19808	30600	27749	27434	27434	15202	15202
DV Mean	17182	17310	11625	11545	13354	13354	22873	22873
F-stat		23		12		10		11

Observation is at the county × year level. OLS regressions include 1950-1972; IV regressions include 1954-1972 due to availability of apportionments data. SE clustered by state in parentheses. 'F-stat' reports the 1st-stage effective F-statistic of Montiel Olea and Pflueger (2013). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

IHS construction is negatively selected on incumbents' electoral strength. The descriptive, naïve OLS

[14]Table A.7 presents results on the effect of highway miles constructed during a gubernatorial election term, rather than considering only those constructed in an election year. The results are positive and significant, though of a lower magnitude. This suggests that IHS construction helps incumbents most when it is most salient in voters' minds.

regressions show negative and significant coefficients for governor, representative, and senator. Negative selection is strongest for members of Congress, consistent with vulnerable incumbents influencing apportionment legislation to favor their states. After controlling for county and year fixed effects, IHS construction is associated with higher vote share for incumbents in all offices, though again precision varies. Together with Figure 3, this suggests politicians target IHS construction to swing counties, and to moments of relative political vulnerability.

Instrumental variable estimates, by contrast, show large and significant effects of IHS construction on vote share for the party of incumbent governors and representatives. An additional IHS mile opened in an election year raised that county's vote share for the incumbent governor's party by 2.7 percentage points, from a base of 58%. It raised the vote share for the party of the incumbent representative of the county's congressional district by 1.6 percentage points, from a base of 68%. Effects for senators are also positive, though a bit noisier. (Point estimates for presidents are negative but very noisy, and the instrument is weaker.) These effects are large. Among counties ever connected to the IHS, the average county received 1.2 new IHS miles per year.

These effects illuminate the ways voters attribute credit for the IHS. Because the IHS legislation distributed the responsibility for funding across the federal and state governments, voters might plausibly have attributed credit for the IHS to any of the political actors we examine here. The federal government, under legislation passed by Congress, contributed 90% of the costs of construction. Completed interstate highways were then owned and operated by the states. The president who signed the Federal-Aid Highway Act of 1956, Dwight D. Eisenhower, made the IHS one of the central priorities of his presidency.

In the event, the largest electoral gains went to governors, who were responsible for executing the IHS plan. This is consistent with previous work that finds evidence that state officials behave as if they claim credit for federal transportation infrastructure (Nicholson-Crotty & Theobald, 2011). The effect on representatives' vote share, meanwhile, demonstrates that they are able claim credit for federal programs allocated to states, despite only representing (in most cases) a small part of the state (Lee, 2003). This is also in line with prior work showing that politicians are adept at claiming credit even for public goods they had little or no responsibility for (Cruz & Schneider, 2017; Guiteras & Mobarak, 2015).

We also find evidence of selectivity on participation margin: more miles are built in places and times where more people vote, even when controlling for participation in the last election. But these correlations understate the causal effect of IHS construction on people voting. In races for governor, house, and president, IHS caused very large increases in the number of people voting. This is consistent with public good provision mobilizing voters, as has been found previously in the case of health care (Baicker & Finkelstein, 2018). It could also be at least partly driven by increased migration to IHS counties.

We consider two potential mechanisms: retrospective voting and pocketbook voting. Retrospective voting means that voters decide whether to vote for the incumbent government by considering its performance; good performers are rewarded with reelection. Pocketbook voting means that voters make their choice based on economics conditions; they are more likely to vote for the incumbent when economic conditions are good.

Under "pocketbook voting," the IHS could raise incumbent vote share by improving economic growth. There is evidence that the IHS improved county-level economic outcomes (Leff-Yaffe, 2020). However, we argue that this is unlikely to explain the entire electoral effect for two reasons. First, Charles and Stephens (2013) has shown that better economic conditions - as measured by higher wages and employment - cause a reduction in county-level voter turnout. We show, by contrast, that IHS increased the number of votes cast at all levels of government, a result that would not be predicted by a pure pocketbook voting mechanism.

Second, Chandra and Thompson (2000) shows that IHS raises economic activity in the counties it passes through, while drawing it away from neighboring counties. Michaels (2008) shows a similar divergent effect, with the IHS raising demand for skilled manufacturing labor in skill-abundant counties and reducing it elsewhere. Purely pocketbook voting would imply that electoral returns would be positive for counties receiving IHS construction (and its attendant economic growth), and negative for adjacent counties which experience decreased economic activity. Instead, we find positive electoral spillovers: new IHS miles increase incumbent vote share significantly in neighboring counties, for both governors and representatives.

Table 2 shows the effect of IHS construction in *adjacent* counties on incumbent vote share and votes cast in counties not receiving IHS construction.[15] Odd columns use a sample of counties which had no IHS construction during the year in question. Even columns use a sample of counties which never received any IHS construction at all in the entire period we examine, up to 1972. All regressions here use instrumental variables.

The table shows robust evidence that incumbent governors get more votes in counties adjacent to new IHS construction, even when those counties get no new miles – and even when they don't even lie on the route of the interstate. House and Senate incumbents get spillover votes in counties which have lie on the route but which don't get any construction this year – estimates for counties no on the route are positive but noisier. We find no evidence of increased vote share for presidential incumbents.

[15] An observation is a county $\times$ year, as before. The measure of "New neighbor miles" for each observation is the sum of new miles constructed that year in all counties bordering that county (the county itself is not included). The instrument is constructed the same way as before: the sum of the shares of the state's total planned IHS miles represented by the neighboring counties, multiplied by the state-level appropriations for that year.

Table 2: Spillovers

	Governor		House		Senate		President	
Panel A: Vote share								
New neighbor miles	1.601**	1.628**	1.373**	2.072*	1.265	0.608	-1.866	-2.125
	(0.635)	(0.730)	(0.617)	(1.085)	(0.822)	(0.916)	(1.450)	(1.932)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓	✓
Sample: no IHS...	This yr	Ever	This yr	Ever	This yr	Ever	This yr	Ever
N	18578	11698	26396	16210	19308	11729	14261	8666
DV Mean	58	58	68	69	60	61	49	49
F-stat	17	8	15	10	11	6	9	9
Panel B: Votes cast								
New neighbor miles	1300***	188**	1051***	305***	237	-216	741**	100
	(480)	(77)	(216)	(92)	(512)	(177)	(293)	(90)
Votes last election	0.342**	0.402**	0.034	0.294	0.926***	0.979***	0.888***	0.988***
	(0.149)	(0.178)	(0.091)	(0.217)	(0.030)	(0.037)	(0.079)	(0.117)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓	✓
Sample: no IHS...	This yr	Ever	This yr	Ever	This yr	Ever	This yr	Ever
N	18580	11700	26289	16158	25616	15637	14264	8669
DV Mean	13340	5772	10464	5710	10137	4074	17230	7083
F-stat	16	6	12	6	8	2	10	5

Observation is at the county × year level. Years included: 1954-1972. SE clustered by state in parentheses. 'F-stat' reports the 1st-stage effective F-statistic of Montiel Olea and Pflueger (2013). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

We also find evidence of increased votes cast in governor and house elections in adjacent counties. These effects on participation are much smaller in counties off the IHS route than on the route, suggesting that they may be partly driven by migration. However, the effect on incumbent vote share is of almost equal size in both sets of counties, suggesting that at least some of the electoral effect is due to persuasion rather than mobilization.

5.0.1 Supplemental analyses

A number of ancillary analyses and robustness checks can be found in the Online Appendix.

Our main analyses study the effect of the IHS on vote share for the party of the incumbent. This allows us to include elections in which the incumbent herself is not running. Table **??** examines the effect of IHS on vote share for incumbent governors themselves, as well as for the incumbent governor's party when the incumbent herself is not running. Effects seem to be driven by incumbent governors themselves.

A large literature highlights the different ways in which the IHS affected urban and rural areas (Nall, 2015; Michaels, 2008). Table A.9 tests whether effects are different in urban counties. Even though only 39% of all counties are urban, they are over-represented among those in the IHS. F-stats are low for the

non-urban sample, so we interpret these results cautiously, but positive effects for governors appear in both urban and non-urban counties, while positive results for representatives are concentrated in urban counties.

Table A.5 looks at effects on vote share by the party affiliation of the incumbent. For each political office, we interact new miles with a dummy for whether incumbents were Republican (instrumenting for the interaction by interacting the instrument with the GOP incumbent dummy). It appears that the IHS brought bigger benefits to Republican governors, Democratic presidents, and Representatives of both parties.

Table A.6 examines the effect of IHS on vote share for each of the two major parties (independent of incumbency) for each of the four offices. We find little systematic evidence that one party benefited more than the other, although IHS construction did raise vote Democratic vote share in House elections.

6 Conclusion

While it is generally believed that incumbent parties can influence the behavior of voters with government spending, there are only a handful of papers that attempt to measure the magnitude of this causal effect with modern identification methods. For the most part, research on the subject has been limited due to the endogeneity between these two variables. As politicians have incentives to target spending where it will benefit them the most in the upcoming election, a simple OLS regression is likely to deliver a biased estimate of the causal effect of interest, and this bias may act in either direction depending on whether candidates target core or swing voters. Persson and Tabellini (2002) note that in this realm of inquiry "the bridge linking theory with data is way too fragile," an assessment which despite some progress remains broadly true two decades later.

In this paper, we construct a shift-share instrument to estimate the causal effect of the construction of the Interstate Highway System on electoral outcomes. We find that new highway miles increase the number of voters, and that many of these new voters vote for incumbent governors and representatives. We also find that new highway miles increase governors' vote share in neighboring counties.

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A Appendix: Extra tables and figures

A.1 Additional details on the IHS

The formula used in the 1952 Federal-Aid Highway Act was originally set forth by Section 21 of the Federal Highway Act of 1921. It assigned a weight of one-third to each of the following factors:

(1) Relative Population: the ratio which the population of each state bears to the total population of all the states (as shown by the latest available Federal census).

(2) Relative Area: The ratio which the area of each state bears to the total area of all the states.

(3) Relative Rural Delivery and Star Routes (RDSR) Mileage: the ratio which the mileage of rural delivery routes and star routes in each state bears to the total mileage of rural delivery and star routes in all the states at the close of the preceding fiscal year.

For the Act of 1954, the apportionment formulas for the states were modified to give more weight to the state's population: (1) a weight of 2/3 on relative population, (2) 1/6 on relative area, and (3) 1/6 on relative RDSR. Moreover, the matching funds rule changed to 60% Federal - 40% State.

Shortly after the Act of 1954 was passed, President Eisenhower started a campaign towards expanding the highway program with a speech given to the Governors' Conference.[16] After the speech, President Eisenhower asked General Clay to head a committee to propose a plan for constructing the interstate. At that time there was a consensus that there was a need for the IHS; however, there was no agreement on how to pay for it.[17] Using information on a report that was currently being developed by the Bureau of Public Roads, the Clay committee estimated the program would cost $27.2 billion (January 1955). They suggested for the Federal Government to cover $25 billion and to finance it with a 30-year bond. The financial plan set forth by the Clay committee had very little support and was rejected by Congress.

After legislation failed in 1955, it was predicted that in 1956 (a presidential election year) the Democratic Congress would not approve such an important plan sought by a Republican president. However, Eisenhower continued to urge approval and worked with Congress to reach compromises. New legislation in 1956 proposed to finance the interstate with the creation of a Highway Trust Fund (HTF), which would collect a tax of 3 cents per gallon on gasoline and diesel, along with other excise taxes on highway users.[18] The idea was for the HTF to be modeled after the Social Security Trust Fund; revenue would go

[16] Since the President's mother was seriously ill the speech was delivered by Vice President Nixon, who read from the President's notes.

[17] See https://www.fhwa.dot.gov/infrastructure/originalintent.cfm

[18] The HTF was also to be funded with taxes on tire rubber, tube rubber, new trucks, buses, and trailers. As of 2020 the HTF still exists, however it now collects a fuel tax of 18.4 cents per gallon on gasoline and 24.4 cents per gallon on diesel.

into the general treasury, but credited directly to the Fund. The HTF was a successful compromise which lead to the approval of the Federal-Aid Highway Act of 1956. The 1956 Act passed the Senate with 89 in favor and only 1 against, and was signed by President Eisenhower on June 29, 1956.

The Act of 1956 is sometimes referred to as the Interstate Highway System Act, as it set forth a plan for completing the IHS. First, it created the HTF to finance highway federal-aid; at the time this included the IHS and the ABC program.[19] Second, it envisioned that the IHS would be completed in the following 13 years. Third, it provided more substantial federal-aid funds than its predecessors, totaling $25 billion to be spent during the 13 year period considered. Fourth, it changed the matching funds rule to 90% Federal - 10% State, which provided more incentives for states to invest in the IHS.[20] This matching rule prevailed until the final federal-aid appropriations took place in 1996. The state matching funds rule, together with the $25 billion appropriation, meant total funds equaled 6.2% of GDP.

For 1957 to 1959 the apportionment formula was the same as the one provided by the Act of 1954. For the subsequent years, the 1956 Act provided a different formula, solely based on the relative costs of completing the IHS. That is, the formula was equal to the ratio of the estimated cost of completing the system in each state compared with the cost in all states.[21] To keep this formula up to date, the cost-estimate of completing the IHS was to be updated periodically by the Secretary of Commerce.[22] The logic behind this method was for all states to finish construction of the IHS around the same time.

Even though subsequent acts, amendments and resolutions shaped the future years of the IHS, its essence remained linked to the Act of 1956. The most important changes were triggered by the rising estimated cost of the system, which delayed the end of its construction until 1996 and required considerably more appropriations than what the original plan considered.

Figure 1 shows that apportionments, expenditures, and construction all track each other closely. While the final appropriation took place in fiscal year 1996, expenditure continued in the 2000s because funds had been obligated but not yet spent. The procedure by which spending took place is also illustrated in Figure 1: (1) First, an estimate of the cost of completing the interstate was released. (2) Then, an authorization took place in a Federal Highway Act. These authorizations outline the amounts that would be available at the national level for the following couple of fiscal years. (3) Funds were then apportioned across

[19]The ABC program is a Federal-aid program that provides funds for Primary and Secondary Highway Systems, as well as for extensions of these systems within urban areas.

[20]The federal government actually covered 90.4% of the funds as section 108(e) of the Act of 1956 specified that the federal government would cover a percentage of the remaining 10% in any state where the ratio between the area of Federal lands and nontaxable Indian lands to the total area of the state exceeded 5%. The additional percentage was equal to 10% times such ratio and was capped at 5%. This rule affected only 12 states.

[21]The Federal-Aid Highway Act of 1963 slightly changed the formula starting in fiscal year 1967. The new formula considered the ratio of the federal share of the estimated cost of completing the system in each state compared to the federal share of the estimated cost of completing the system in all states.

[22]This responsibility was later transferred to the Secretary of Transportation.

states using formulas provided by legislation. The share each state receives is called the apportionment factor (AF). For each fiscal year apportionment factors were usually announced between 1 and 2 years in advance; however, they could be predicted with accuracy many years in advance using the formulas set forth by legislation. (4) Once the fiscal year of the appropriation was reached, states obligated funds in interstate highway projects. (5) Finally, as highways were built, spending took place. Payments to contractors for work completed were initially made from state funds[23] and the federal share was paid as reimbursements.

[23]Sometimes from funds transferred to the state by cities, counties, or other local governments

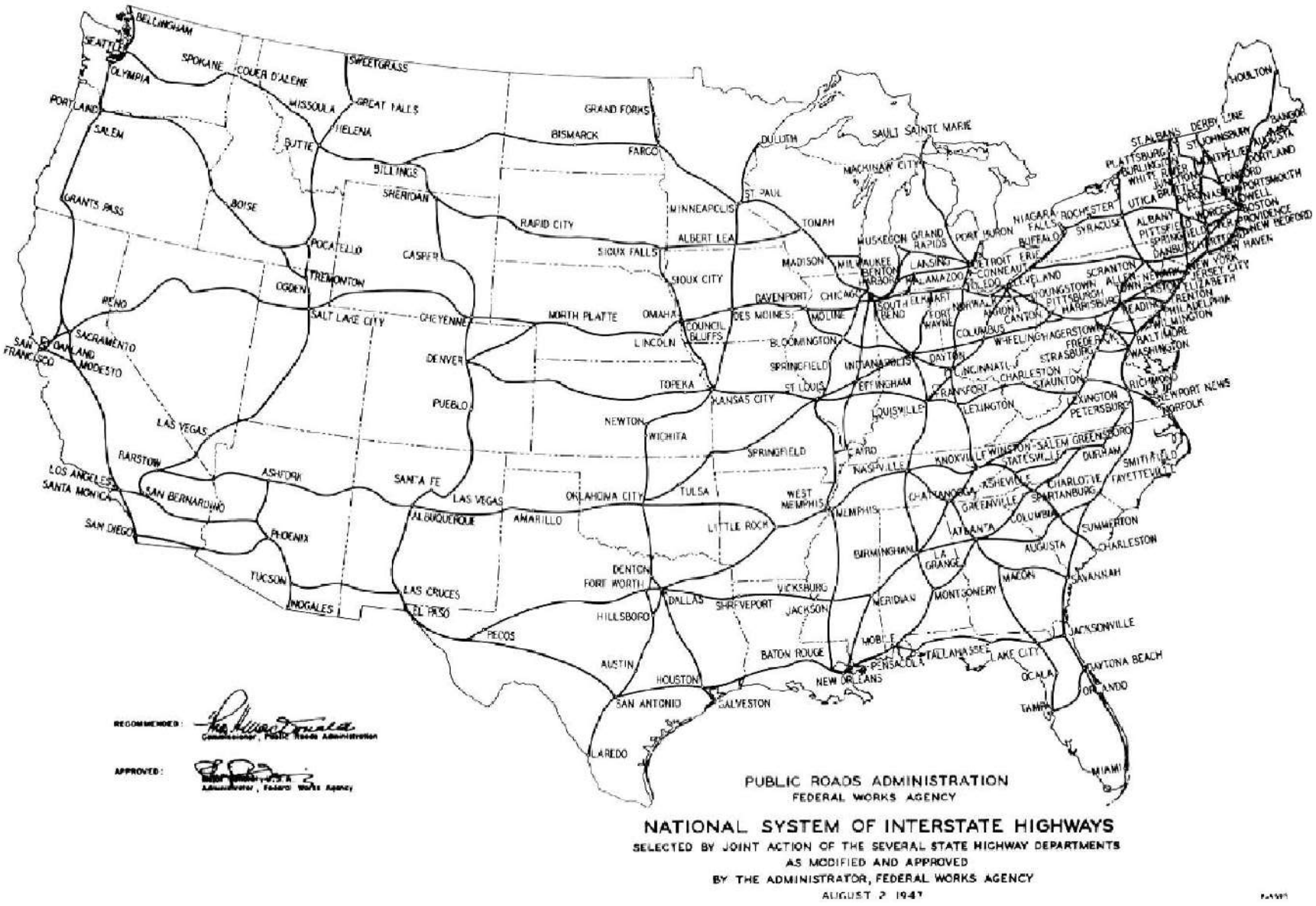


Figure A.1: The Projected System of Interstate Highways in 1947

Table A.1: Summary statistics

	Mean	Median	SD	N
County				
Dummy: any miles ever built in county i	0.38	0.00	0.49	3058
Total miles ever built in county i	10.60	0.00	19.93	3058
Total miles ever built in county i | ever IHS	27.76	24.00	23.75	1168
County $\times$ ***year***				
Num. new miles built in year t	0.46	0.00	2.63	70334
Num. new miles built in year t | ever IHS	1.21	0.00	4.15	26864
Dummy: any new miles built in year t	0.05	0.00	0.22	70334
Dummy: any new miles built in year t | ever IHS	0.14	0.00	0.35	26864
County $\times$ ***gubernatorial election term***				
New miles built in term ending in year t	1.26	0.00	5.12	24218
Dummy: any new miles built in term ending in year t	0.10	0.00	0.30	24218
Incumbent governor's party's vote share	59.30	56.05	19.86	24190

Table covers the years until 1972. (148 counties – 5% of the total – received their first IHS miles after 1972.)

A.2 Summary statistics

A.3 Illustration of shift-share instrument

Figure A.2 illustrates the intuition behind the shift-share instrument for one US state, Alabama. The panel on the left plots the level of real federal IHS apportionments to the state over the period 1954-1972. The panel on the right maps the state's counties, with shading varying by the fraction of the state's total planned IHS miles accounted for by that county.

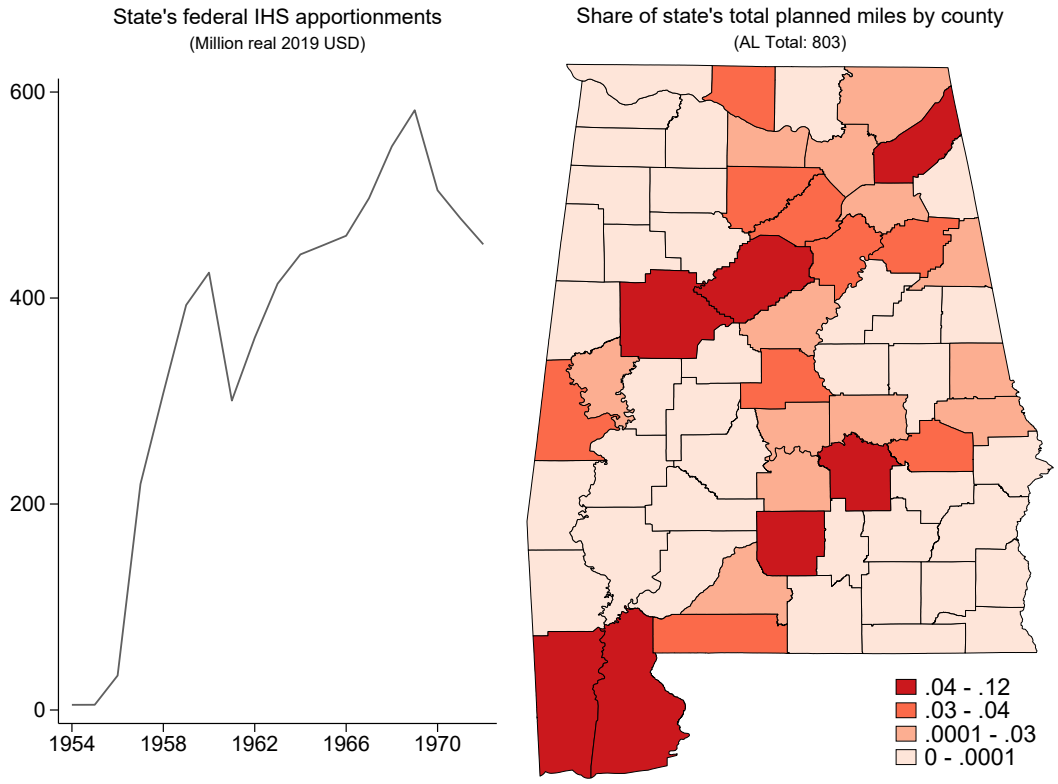
A.4 Tenure of 1947 incumbents

Here we examine the plausibility of whether politicians who were in office in 1947, at the time when the initial IHS plan was created, could have conceivably have influenced the design of this plan for their own political gain. Figure A.3 shows that this is unlikely. The fraction of 1947 incumbent representatives still in office by 1954, when our analysis begins, was below 40%; for governors it was under 20%. Both figures fell steadily throughout the period we study.

A.5 Highway construction over the electoral cycle

Table A.2 highlights how IHS construction correlates positively with the electoral cycle, even as state-level apportionments do not.

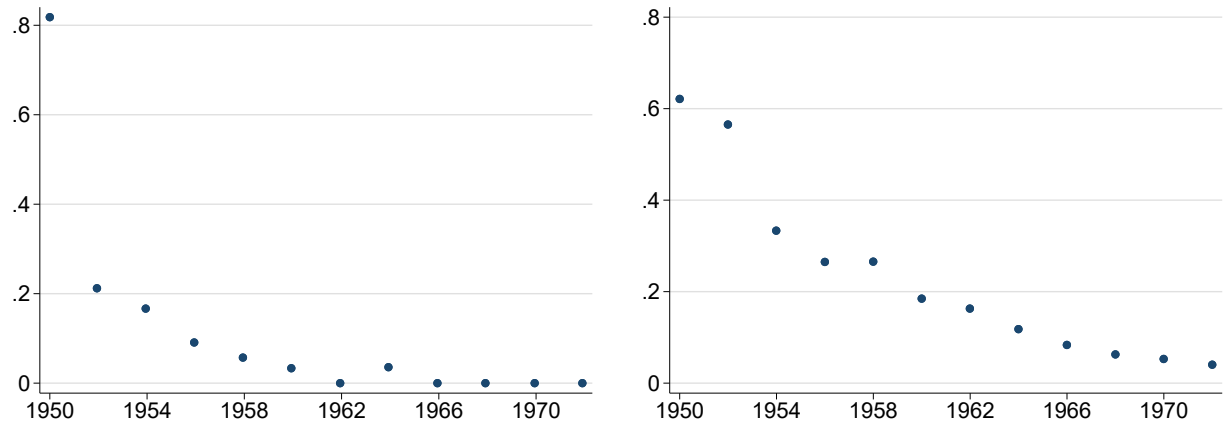
Figure A.2: Illustration of Bartik instrument



A.6 Apportionment factors over time

As described in Section 2, the apportionment that each state received each year depended on two elements: (i) total federal resources for county-level IHS spending, and (ii) the apportionment factor (AF) defining what share of those resources went to each state. Originally, that AF depended on States' area and 1947 population shares, but the definition changed over time. Figure A.4 displays the correlation between observed apportionment factors, and both area and 1947 population shares. From 1954 to 1959 this relationship is trivial, as these variables were directly used in the apportionment formula. Starting in 1960 we see that the correlation exists simply because states with more initial population and area required more highways. In the last 10 years of the program we find the weakest correlations; however, in these years appropriations were also very small as not that much money was needed to finish the interstate at the time. The average of these correlations weighted by appropriation amounts is given in Table A.3. For area it is 0.79 and for the 1947 population share 0.22. (The correlation between population and area is just 0.11). Thus, to ensure exogeneity on the apportionment we focus on the period between 1950 and 1972, for which we have electoral outcomes data and exogenous apportionment at the state level, that enable us to remove the endogeneity from the timing of expenditure from State officials.

Figure A.3: Fraction of incumbents from 1947 still in power



(a) Governors **(b)** House of Representatives

Panel A.3a shows the fraction of incumbent governors from 1947 who were incumbents in each subsequent election year. Since most states have 4-year gubernatorial terms, the vast majority of incumbent governors in 1947 were still the incumbent in the 1950 election. Panel A.3b shows the fraction of incumbent Representatives from 1947 who were incumbents in subsequent election years beginning in 1950 (limited to congressional districts that existed in 1947).

Table A.3: Average Cross Sectional Correlations

	App. Factor	**Area Share**	**Pop. Share 1947**
App. Factor	1.00		
Area Share	0.79	1.00	
Pop. Share 1947	0.22	0.11	1.00

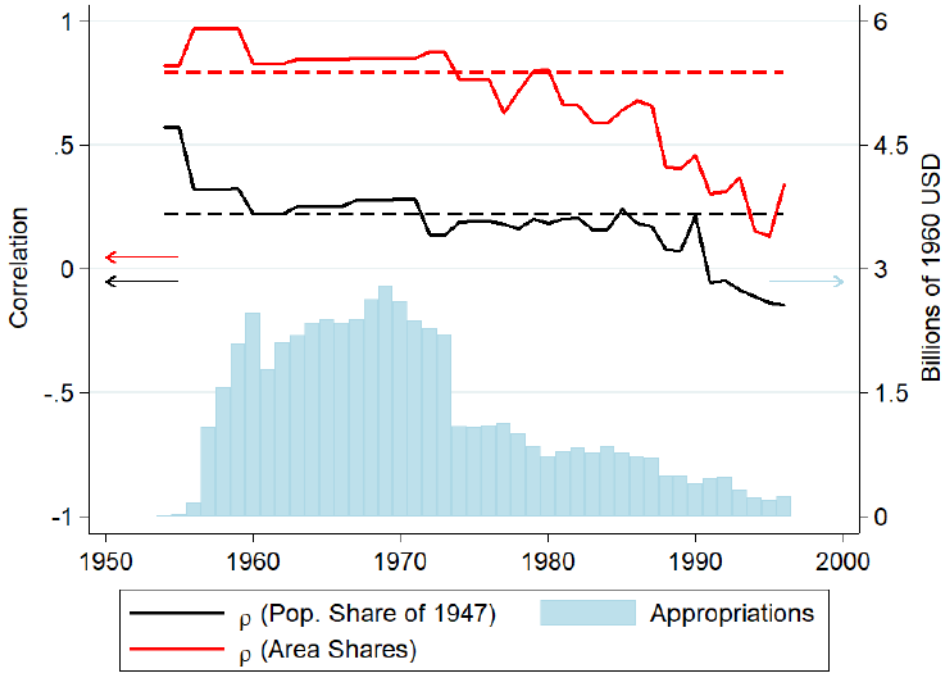
Notes: The correlations with the observed apportionment factors are a weighted average of cross sectional correlations between fiscal years 1954 and 1996, where real appropriations amounts are used as the weights.

Table A.2: More construction, but not more apportionments, in election years

	New miles constructed (State × year level)		Apportionments (State × year level)	
Gubernatorial election year	8.419***	5.623**	-2.520	1.782
	(2.547)	(2.683)	(11.196)	(10.449)
Year FE	✓	✓	✓	✓
FE	State	State	State	State
Term length	All	4yr	All	4yr
N	912	632	912	632
DV Mean	35.239	36.405	363.064	421.153

All regressions take state × year as the unit of observation. 1954-1972. Apportionments measures in millions of 2019 USD. All regressions cluster standard errors at the state level.

Figure A.4: Apportionment Factor Correlations & IHS Appropriations



Dashed lines represent average correlations weighted by real appropriation amounts.

A.7 Additional analyses

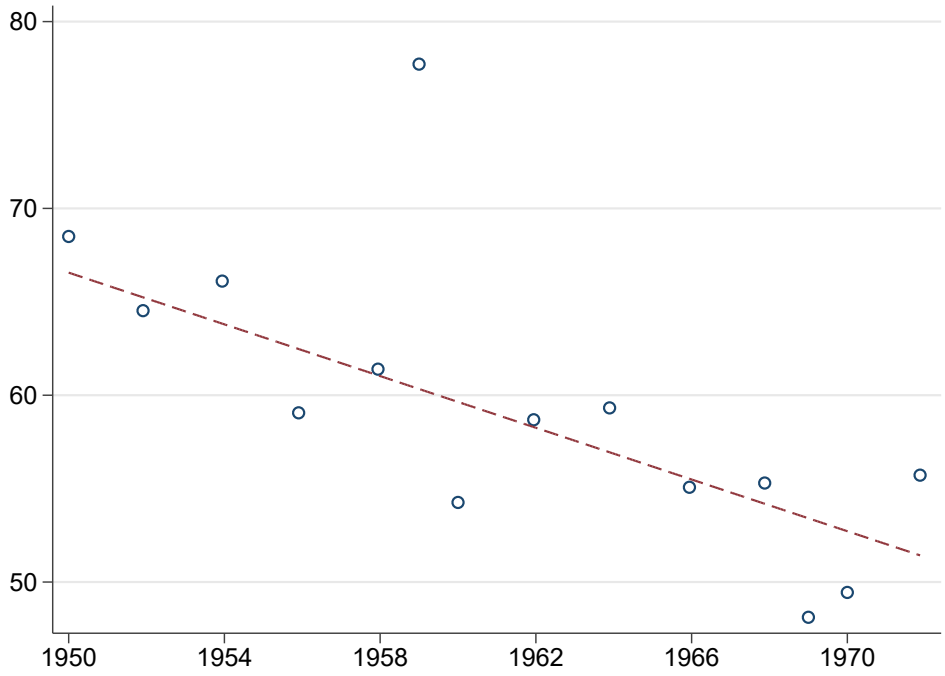
Table A.4: Incumbent governors

	Vote share for incumbent governor			Vote share for incumbent party when incumbent not running		
	OLS	OLS:FE	IV	OLS	OLS:FE	IV
New miles this year	-0.098	0.143*	4.042**	-0.363**	0.104	7.141
	(0.128)	(0.073)	(1.725)	(0.151)	(0.101)	(5.891)
Year FE		✓	✓		✓	✓
County FE		✓	✓		✓	✓
N	11106	10572	8532	13084	12938	10614
DV Mean	58	57	56	60	60	59
F-stat			12			4

Observation is at the county × year level. Years included: 1954-1972. 'F-stat' reports the 1st-stage effective F-statistic of Montiel Olea and Pflueger (2013). SE clustered by state in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

Table A.5 looks at effects on vote share by the party affiliation of the incumbent. For each political office, we interact new miles with a dummy for whether incumbents were Republican (instrumenting for the interaction by interacting the instrument with the GOP incumbent dummy). It appears that the

Figure A.5: Incumbent governor's party vote share over time



Binscatter: average county's vote share for incumbent governor's party, over time, 1950-1972

IHS brought bigger benefits to Republican governors, Democratic presidents, and Representatives of both parties.

Table A.5: Interacting with incumbent's party

	Governor		House		Senate		President	
	OLS	IV	OLS	IV	OLS	IV	OLS	IVS
New miles	0.036	0.970	-0.004	1.395***	-0.002	2.244	0.229***	-2.378
	(0.081)	(0.603)	(0.071)	(0.495)	(0.062)	(1.712)	(0.073)	(3.006)
Incumbent GOP		0.680		-1.362		1.888		0.000
		(3.903)		(2.382)		(3.790)		(.)
Incumbent GOP × New miles	0.193	3.418***	0.048	0.571	0.166	0.789	-0.207**	-3.508**
	(0.170)	(1.220)	(0.090)	(0.888)	(0.127)	(1.164)	(0.096)	(1.628)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓	✓
N	24190	19806	33559	27876	24415	20541	18257	15199
DV Mean	59	58	69	68	61	60	48	49
KP F-stat		24		12		6		2

Observation is at the county × year level. Interactions in IV regressions are also instrumented. OLS regressions include 1950-1972; IV regressions include 1954-1972. SE clustered by state in parentheses. 'F-stat' reports the 1st-stage effective F-statistic of . Because the method of Montiel Olea and Pflueger (2013) doesn't support multiple endogenous regressors, the interactive models report the first-stage F-stat of (Kleibergen & Paap, 2006) ('KP F-stat'). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A.6 examines the effect of IHS on vote share for each of the two major parties (independent of

incumbency) for each of the four offices.

Table A.6: Effect on GOP and Dem vote share

	Governor		House		Senate		President	
Panel A: Republican vote share								
New miles	-0.039	-0.863	-0.041	-1.755	0.011	-2.114	0.022	-3.714
	(0.049)	(0.800)	(0.040)	(1.200)	(0.035)	(1.391)	(0.056)	(2.957)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓	✓
N	24190	19806	33559	27876	24415	20541	18257	15199
DV Mean	41	41	39	39	42	42	51	51
F-stat		21		16		13		9
Panel B: Democrat vote share								
New miles	0.048	0.691	0.091*	2.675***	0.061	1.817	0.008	3.668
	(0.052)	(0.758)	(0.046)	(0.777)	(0.038)	(1.287)	(0.054)	(2.941)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓	✓
N	24190	19806	33559	27876	24415	20541	18257	15199
DV Mean	56	56	58	58	55	55	41	41
F-stat		21		16		13		9

Observation is at the county × year level. OLS regressions include 1950-1972; IV regressions include 1954-1972. SE clustered by state in parentheses. 'F-stat' reports the 1st-stage effective F-statistic of Montiel Olea and Pflueger (2013). * p < 0.10, ** p < 0.05, *** p < 0.01

Table A.7: County × gubernatorial electoral term

	OLS	OLS: FE	IV
New miles this term	-0.185**	0.055	0.693**
	(0.084)	(0.042)	(0.300)
Year FE		Yes	Yes
County FE		Yes	Yes
N	19806	19806	19806
DV Mean	58	58	58
F-stat			58

Standard errors clustered at state level in parentheses. 1954-1972. 'F-stat' reports the 1st-stage effective F-statistic of Montiel Olea and Pflueger (2013). * p<0.10, ** p<0.05, *** p<0.01

Table A.8 presents two small extensions of the baseline model. We add a lag of the new highway miles variable to control for the possibility that spending from the year prior to the election might also affect voters.

It is conceivable that the IHS brings benefits to adjacent counties even if it does not pass through them, and that voters in these counties might reward the governor. We also test whether controlling for highway miles opened in a county that shares a border with county i affects votes for the incumbent in county

i.[24] The results suggest that new highway miles in neighboring counties do not impact the share of votes received by the incumbent party.

Table A.8: Effect on incumbent governor's party vote share, controlling for lagged new miles and new miles in neighboring counties

	IV		
New miles this year	3.019**	3.226**	3.537**
	(1.357)	(1.441)	(1.589)
L.New miles this year	-0.250*		-0.243*
	(0.135)		(0.133)
New miles in nbor counties		-0.312*	-0.341*
		(0.162)	(0.178)
Year FE	✓	✓	✓
County FE	✓	✓	✓
N	19806	19806	19806
DV Mean	58	58	58
F-stat	24	15	17

Observation is at the county × year level. Years included: 1954-1972. SE clustered by state in parentheses. 'F-stat' reports the 1st-stage effective F-statistic of Montiel Olea and Pflueger (2013). * p < 0.10, ** p < 0.05, *** p < 0.01

Table A.9 looks at the effect in urban v. rural counties. Urban counties here are defined as those with more than 50% of their population living in urban areas as of 2010, as defined by the Census.

Table A.9: Effect of highway construction on vote share in urban v. non-urban counties

	Not urban				Urban			
	Gov.	Rep.	Sen.	Pres.	Gov.	Rep.	Sen.	Pres.
New miles this year	3.330*	0.609	1.415	-4.776*	2.694*	1.632**	3.084	-2.287
	(1.779)	(1.417)	(2.066)	(2.745)	(1.439)	(0.724)	(2.176)	(2.556)
Year FE	✓	✓	✓	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓	✓	✓	✓
N	12084	17477	12480	9211	7704	10752	8035	5968
DV Mean	58	69	61	49	57	67	59	50
F-stat	4	4	2	3	21	14	10	4

Observation is at the county × year level. 'Urban' means at least 50 percent of the county's population lived in an Urban area in 2010, as defined by the US census. 39% of counties are rural by this definition. All regressions include year and county fixed effects. All regressions include year and county fixed effects. 'F-stat' reports the 1st-stage effective F-statistic of Montiel Olea and Pflueger (2013). SE clustered by state in parentheses. * p < 0.10, ** p < 0.05, *** p < 0.01

[24] We calculate a matrix indicating if two counties are contiguous using the Polygon Neighbors tool in ArcGIS.