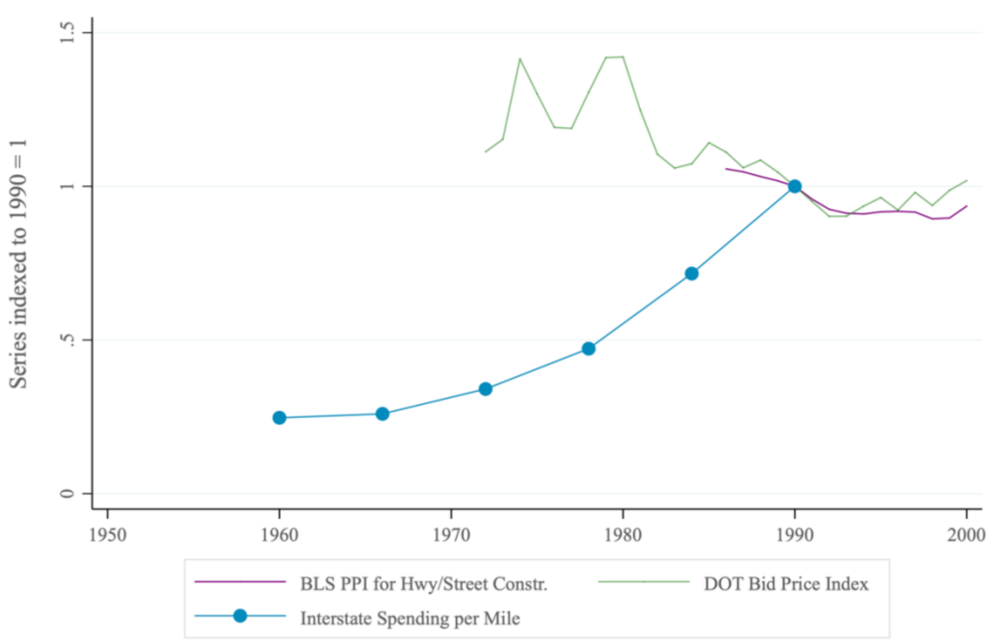
Online Appendix for "Infrastructure Costs," by Leah Brooks and Zachary Liscow

Online Appendix Figures and Tables

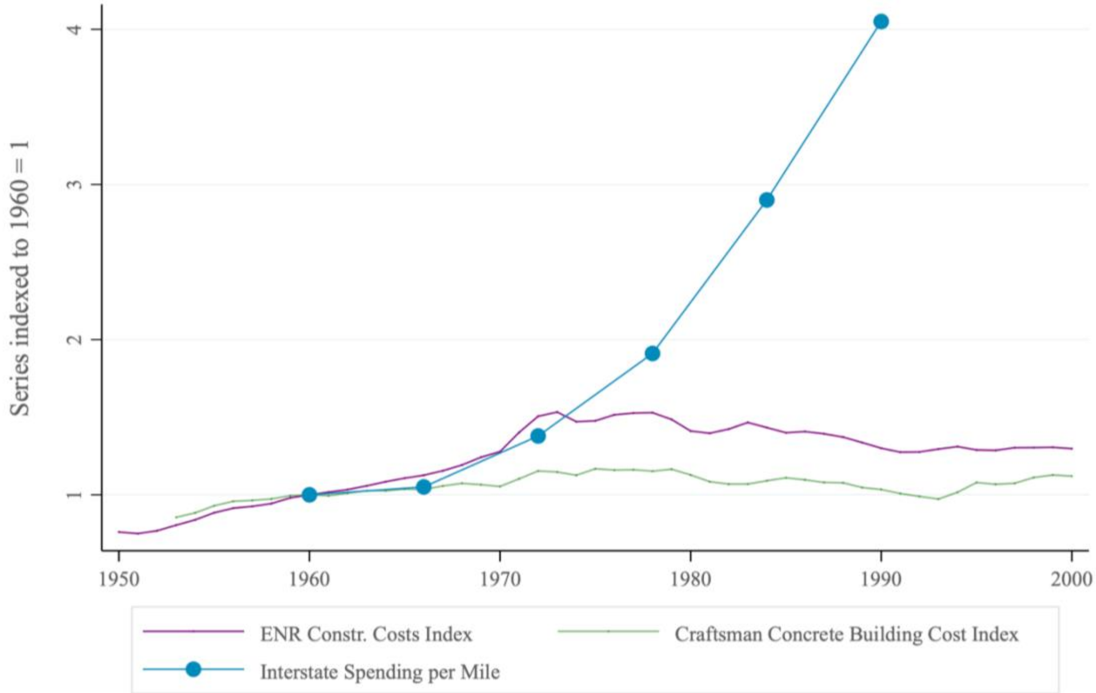
Figure A1. Government Transportation Construction Price Indices vs. Spending per Mile on Interstates



Notes: This figure presents average state spending per mile in each six-year period (see notes for Appendix Figure A6 for this measure), the US Department of Transportation Bid Price Index (FHWA 2019), and the Bureau of Labor Statistics Producer Price Index (US Bureau of Labor Statistics 2011) for Highway and Street Construction. We adjust all series to report in 2016 dollars and then index to 1990 to ease comparisons.

Sources: See Appendix B for calculation of spending per mile and Appendix A.6.c–d for cost indices sources.

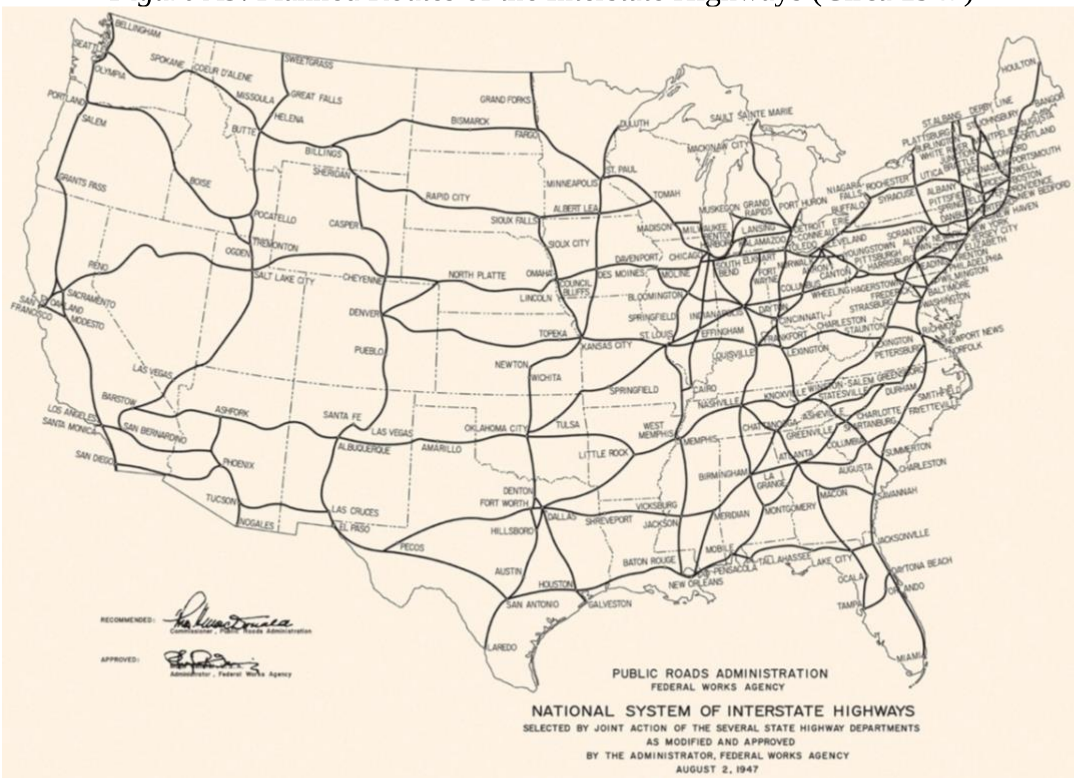
Figure A2. Overall Construction Price Indices vs. Spending per Mile on Interstates



Notes: This figure presents average state spending per mile in each six-year period (see notes for Appendix Figure A6 on this measure), the Engineering News-Record (ENR 2021) Construction Cost Index, and the Craftsman Concrete Building Cost Index (Moselle 2020). The ENR index is a price index for inputs into overall construction, and the Craftsman index is for the per-square-foot cost of a concrete building. We adjust all series to report in 2016 dollars and then index to 1960 to ease comparisons.

Sources: See Appendix B for calculation of spending per mile and Appendix A.6.a–b for cost indices sources.

Figure A3. Planned Routes of the Interstate Highways (Circa 1947)



Notes: This figure displays the federal plan Interstate routes as of the late 1940s.

Sources: Federal Highway Administration (2017c). This image, produced and published non-confidentially by federal agencies, is in the public domain.

Figure A4. Total Number of Interstate Miles Constructed by Opening Year

Notes: This figure reports the total number of Interstate miles completed in each year. The series begins in 1956 and ends in 1993.

Sources: Baum-Snow (2007).

Figure A5. Timing of Interstate Opening

Figure A5i. Interstates Opening 1950-1959

Figure A5ii. Interstates Opening 1960-1969

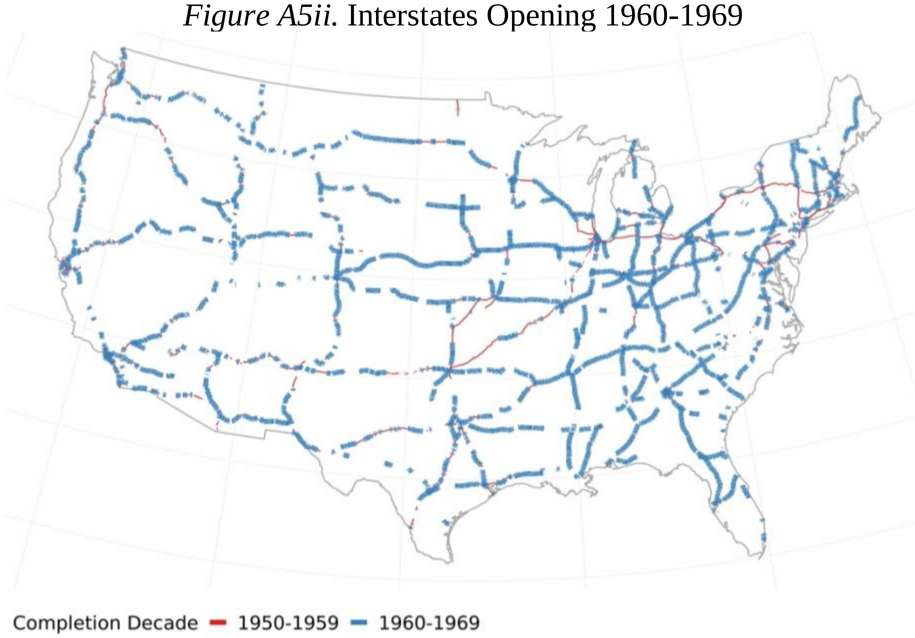


Figure A5iii. Interstates Opening 1970-1979

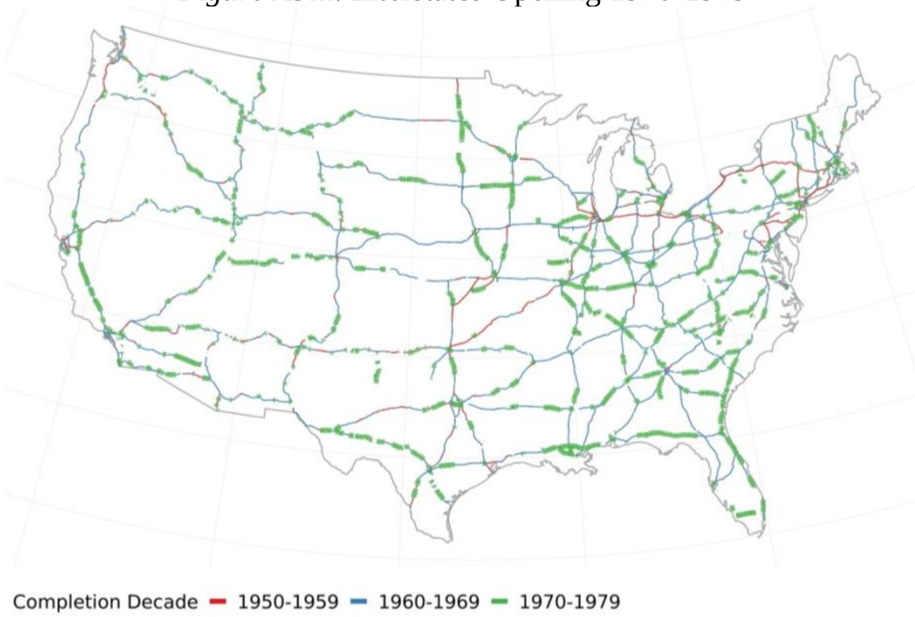


Figure A5iv. Interstates Opening 1980-1989

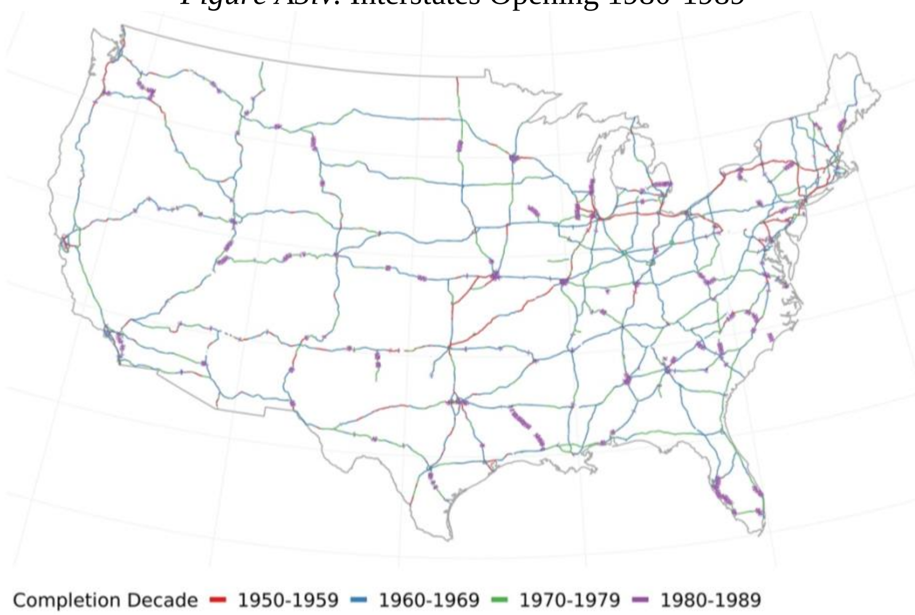


Figure A5v. Interstates Opening 1990-1993

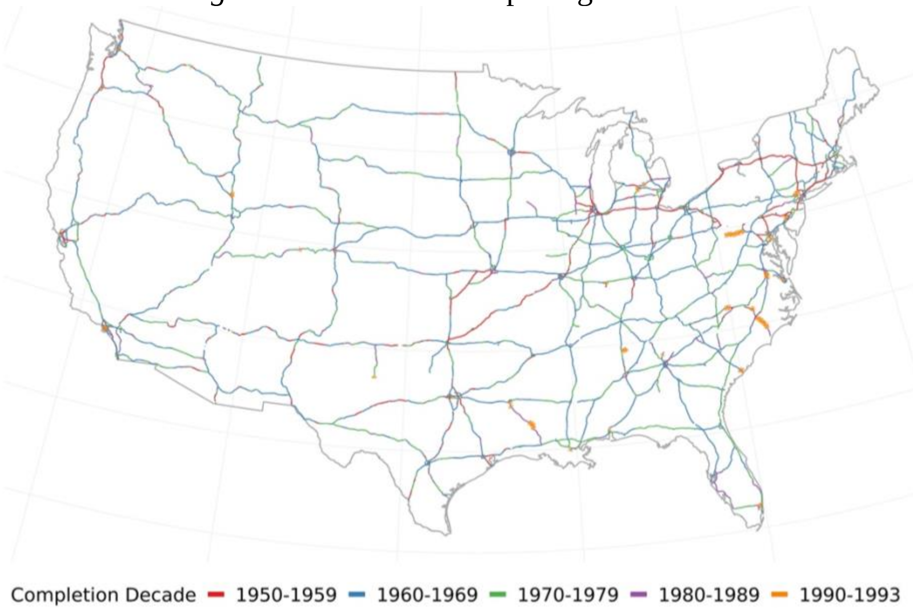
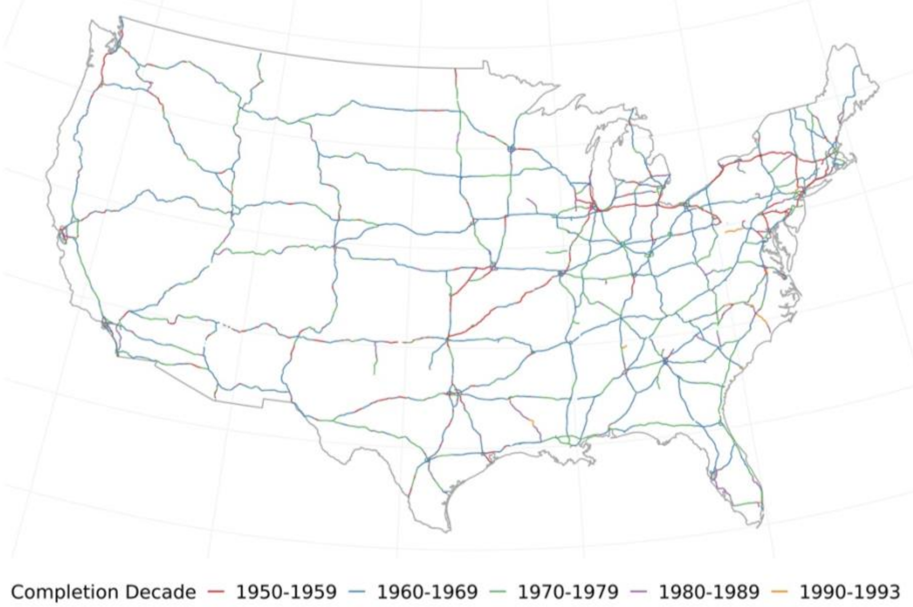


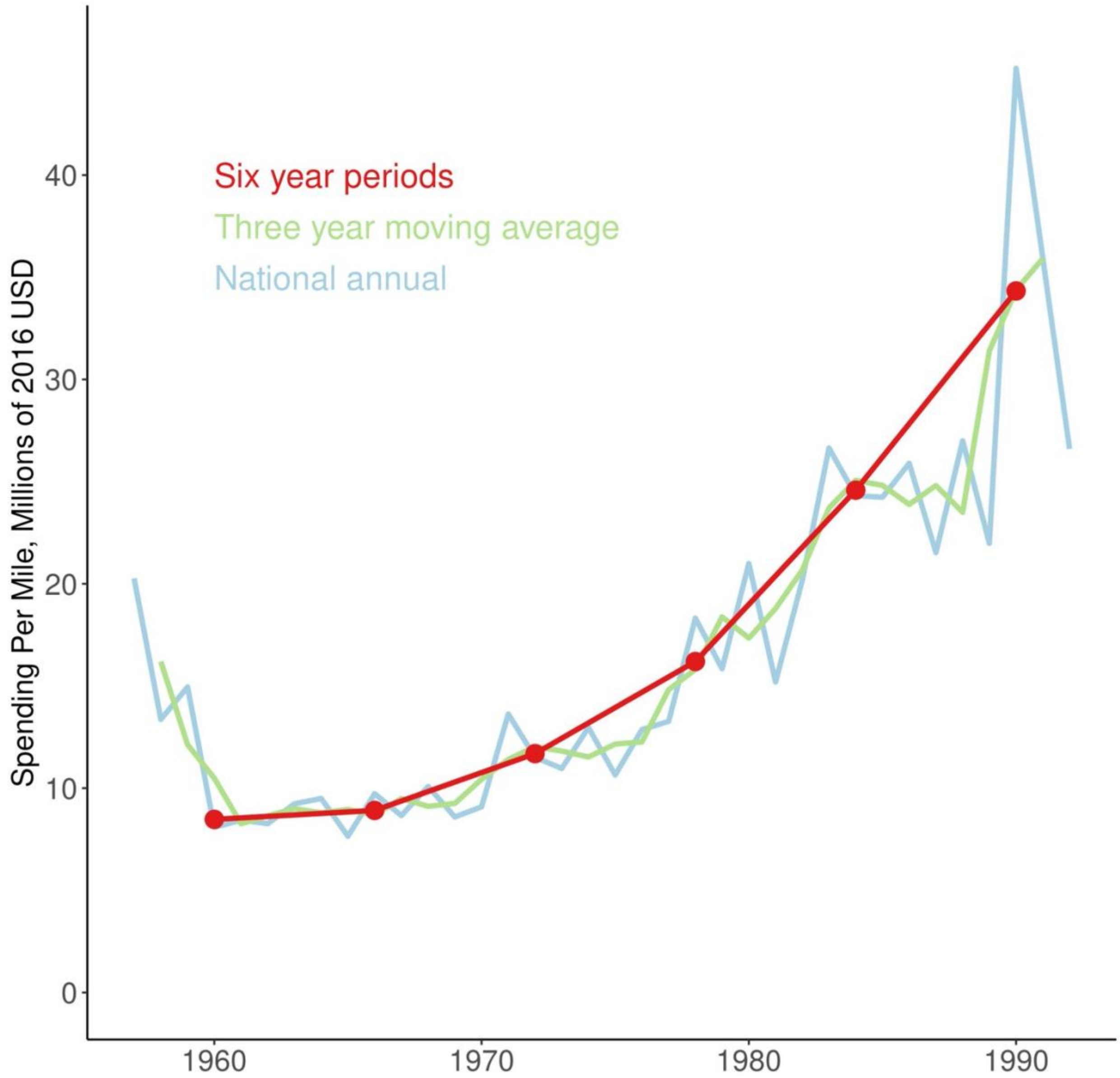
Figure A5vi. Full Interstate System



Notes: This figure reports which segments of Interstate opened in each decade.

Sources: Baum-Snow (2007).

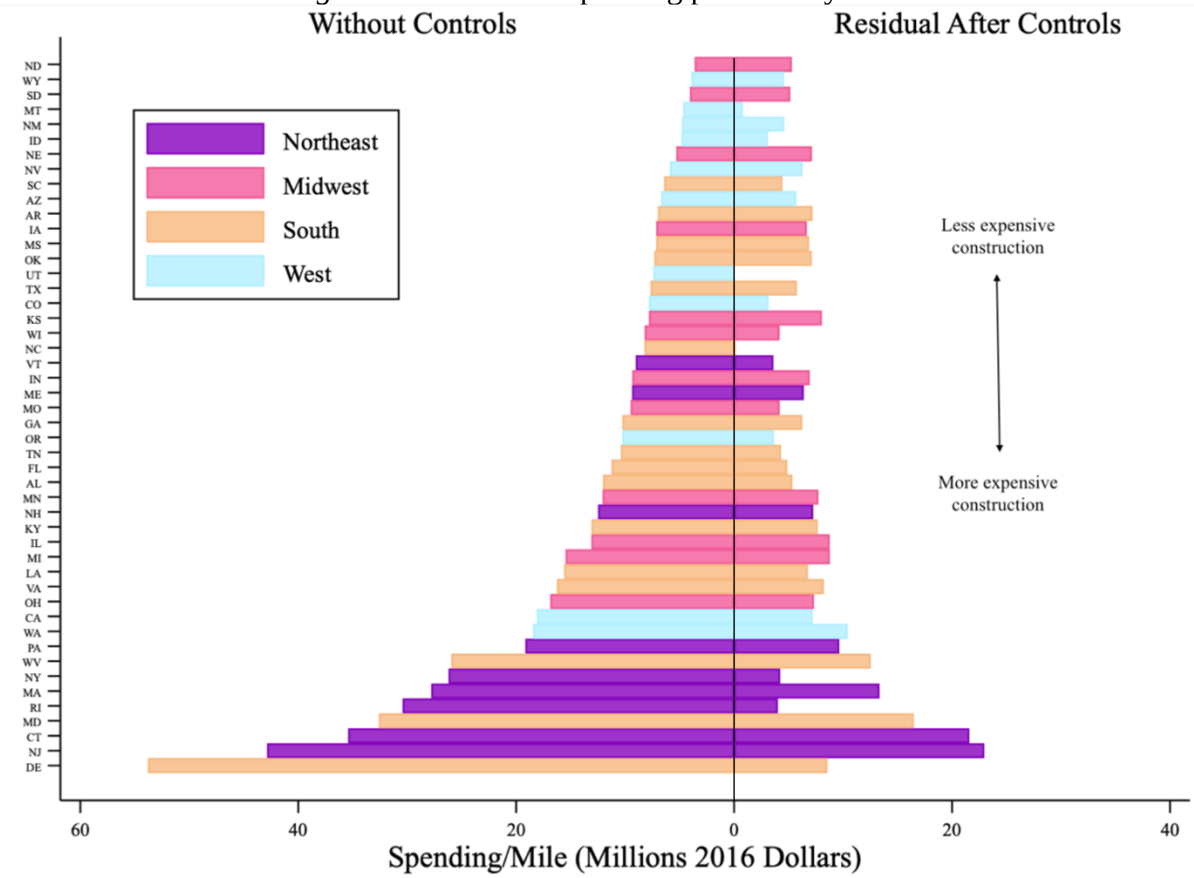
Figure A6. Interstate Construction Spending-per-Mile Increases over Time



Notes: This figure uses light blue to report national spending per mile, defined as the total spending in a given year divided by the miles completed in that year. The light green line presents the three-year moving average of this series. The red line with dots shows the miles-weighted average of state spending per mile by six-year periods as discussed in the text. For purposes of presentation, the national series omit 1993, which is a very high outlier and has very few newly completed miles.

Sources: See Appendix B for calculation of spending per mile and Appendix 2.a–c for sources and creation of geographic covariates.

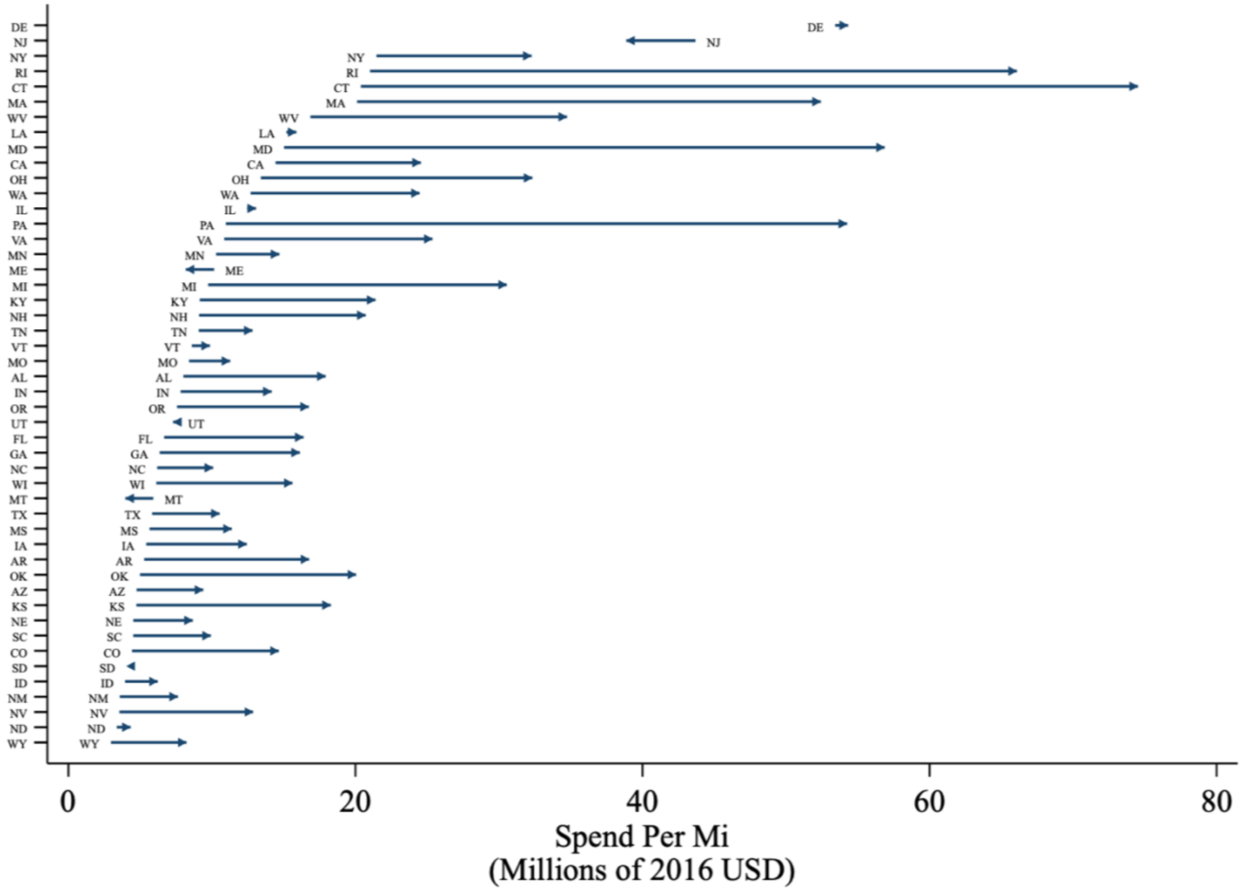
Figure A7. Interstate Spending per Mile by State



Notes: Values to the left of the vertical black line are total spending divided by total miles by state. Values in the right column are the miles-weighted averages of state-specific residual spending per mile (millions 2016 USD) after controlling for geography (from Table 1, column (3)).

Sources: See Appendix B for notes on the calculation of spending per mile and Appendix 2.a–c for sources and creation of geographic covariates.

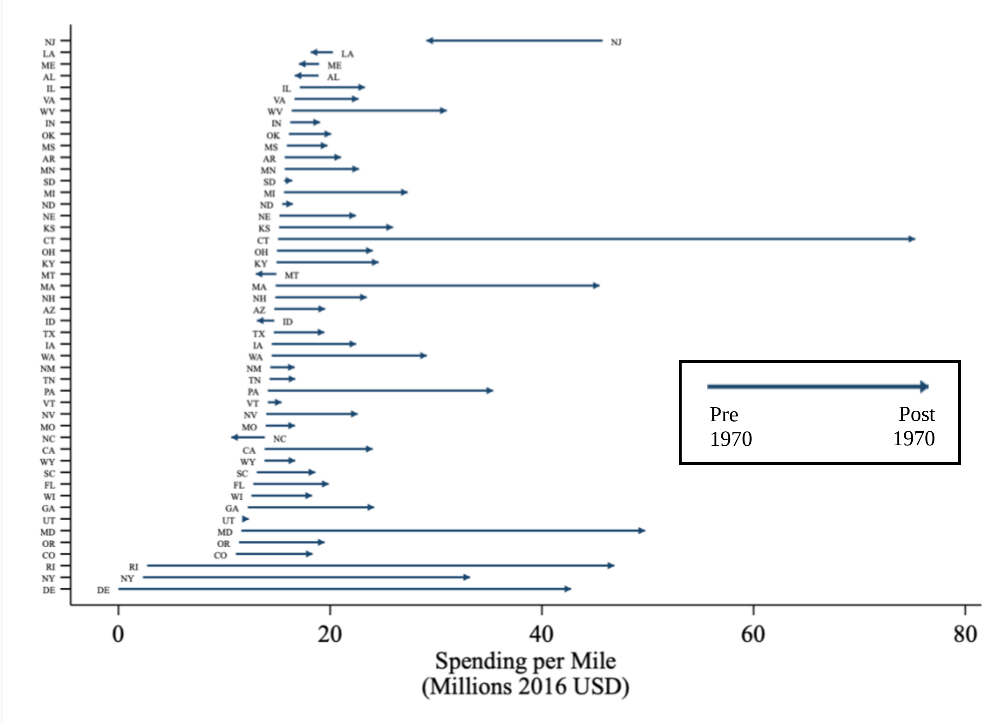
Figure A8. State Spending per Mile: Pre-1970 vs. Post-1970 Without Geographic Covariates



Notes: This figure reports average spending per mile in each state in the pre-1970 and 1970-onward periods, calculated as all spending divided by all miles in each state.

Sources: See Appendix B on the calculation of spending per mile.

Figure A9. State Spending per Mile: Before and After 1970, Controlling for Geography



Notes: This figure reports average spending per mile in each state in the pre-1970 and 1970-onward periods, conditional on geographic covariates. To calculate it, we weight the pre-1970 and post-1970 residuals of a regression of spending per mile on our main geographic covariates (as in Table 1, column (3)) by miles completed. To this value, we add the miles-weighted average of the period effects (pre-1970 and 1970-onward, also from column 3 of Table 1) to arrive at the numbers presented above. We scale the residuals so that the minimum pre-1970 residual value is 0.

Sources: See Appendix B on the calculation of spending per mile and Appendix 2.a–c for sources and creation of geographic covariates.

Figure A10i. Interstate Spending per Mile by State (Not Controlling for Geography)

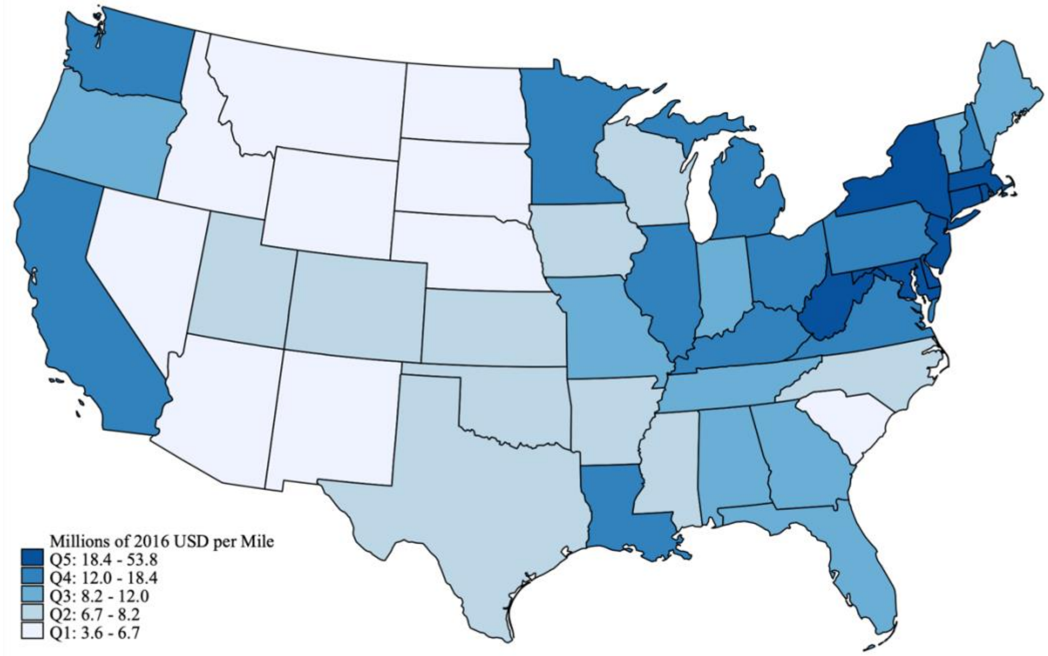
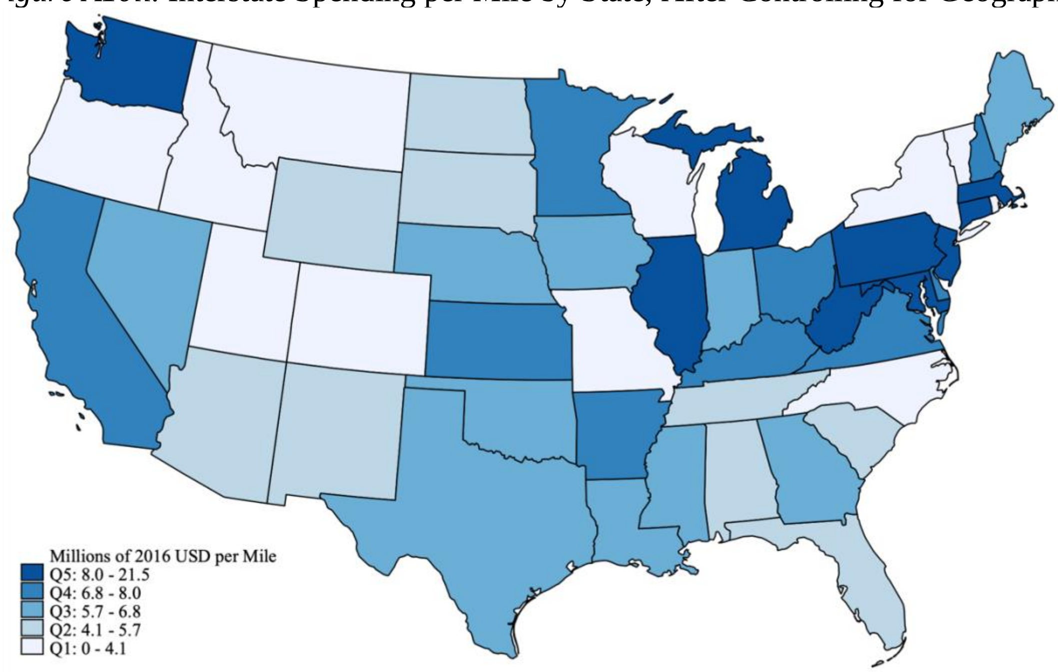


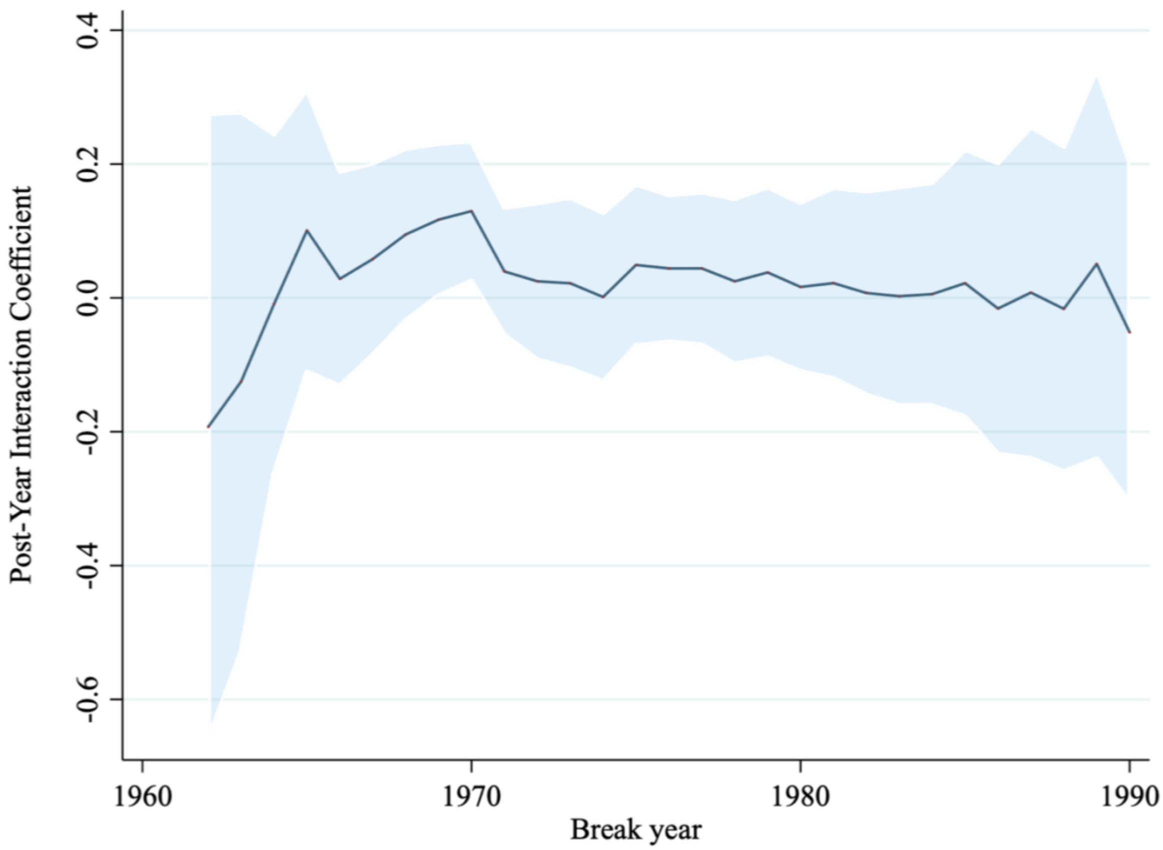
Figure A10ii. Interstate Spending per Mile by State, After Controlling for Geography



Notes: Panel (i) colors states by quintiles of spending per mile for all years in our sample, calculated as overall inflation-adjusted spending divided by overall miles by state. Panel (ii) colors states by the mileage-weighted residuals from column 3 of Table 1: a regression of spending per mile on the three geographic covariates as in Equation (2). We scale residuals so that the minimum is 0.

Sources: See Appendix B for calculation of spending per mile and Appendix 2.a–c for sources and creation of geographic covariates. State boundary map from U.S. Census Bureau (2017).

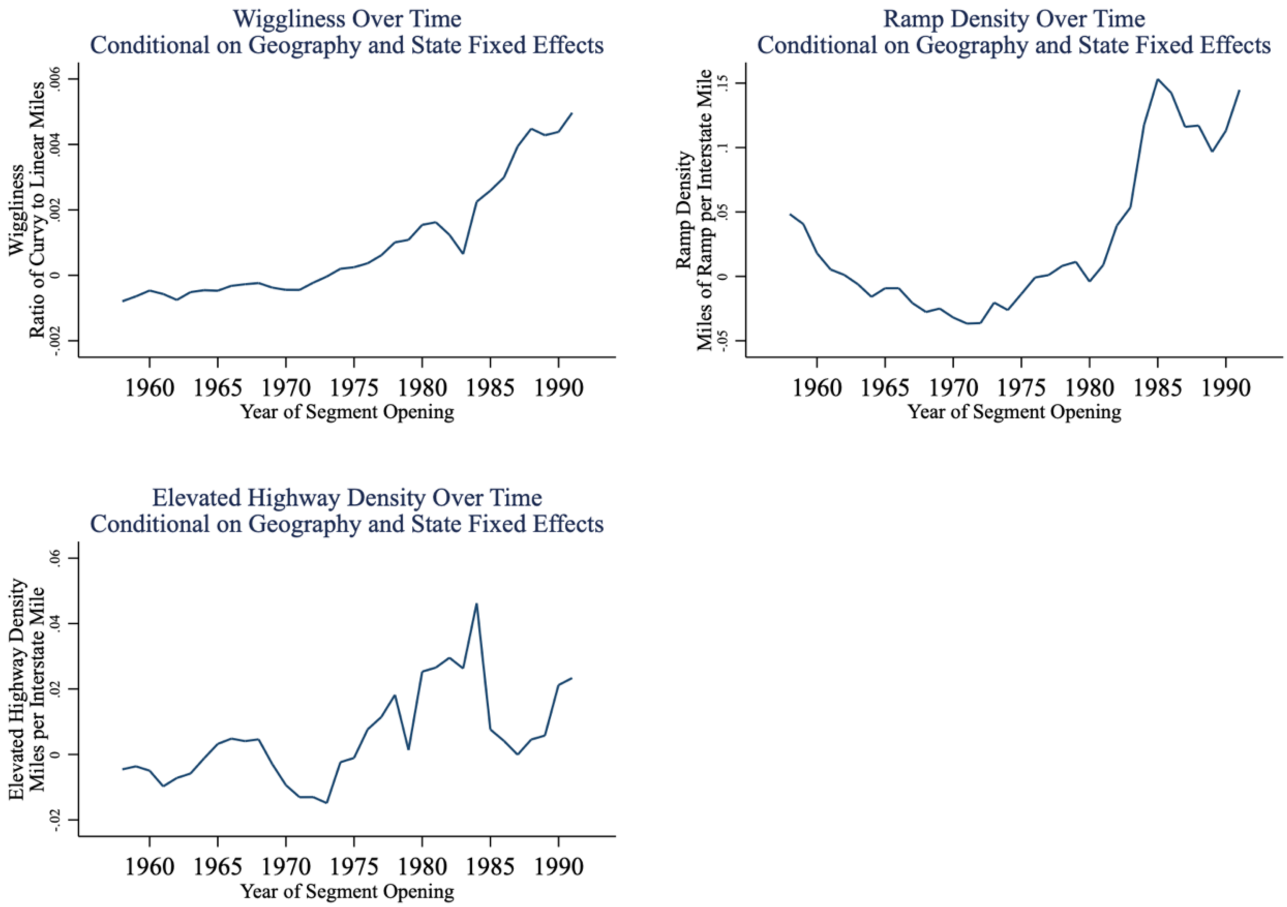
Figure A11. Regression Estimates of Time Trend After Trend Break, By Break Year



Notes: Each year *t* in this figure presents the coefficient (black line) and confidence interval (95 percent; light blue area) for the estimate of a trend break in year *t* following Equation (3). The unit of observation is state-year, rather than state-period as used in almost all other estimations. We omit the regression coefficients for the first three years for readability; those coefficients range from -3.14 to -0.35 and are all insignificantly different from zero at the 95-percent level.

Sources: See Appendix B for calculation of spending per mile.

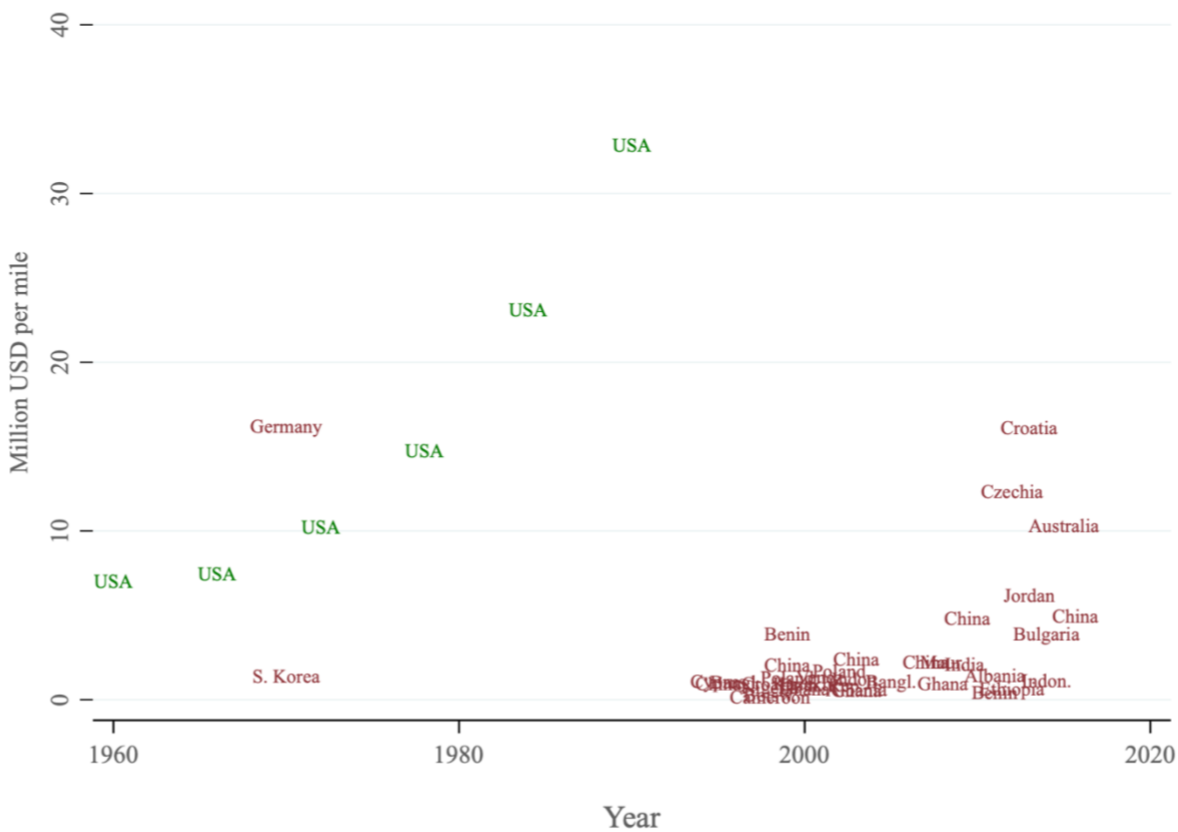
Figure A12. Time Trends in Interstate Attributes Controlling for Geography



Notes: This figure reports national annual averages for segment-level measures of highway attributes as in Figure 3. Here, however, we present residuals of these measures from a segment-level regression of each attribute on the three geographic variables that we use in Equation (2) (but here at the segment level) and state fixed effects. We weight the regression by segment length.

Sources: See Appendix A.2.a–b for structure and wiggliness variable sources.

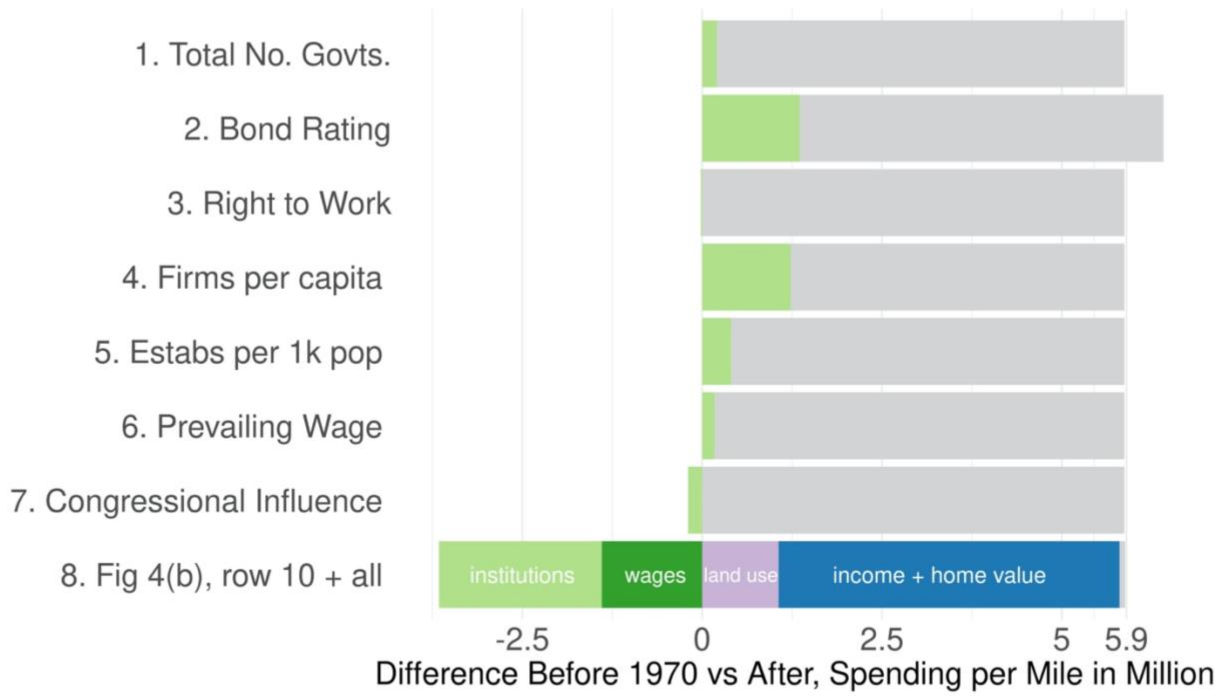
Figure A13. International Highway Spending Per Mile Over Time



Notes: This figure reports average state spending per mile by six-year period, as in Appendix Figure 1, with the points labeled “USA.” We report spending per mile on other highway projects, also in 2016 dollars, with the name of the country to which the spending pertains.

Sources: See Appendix B for calculation of US spending-per-mile; see Appendix C for international data calculation and sources.

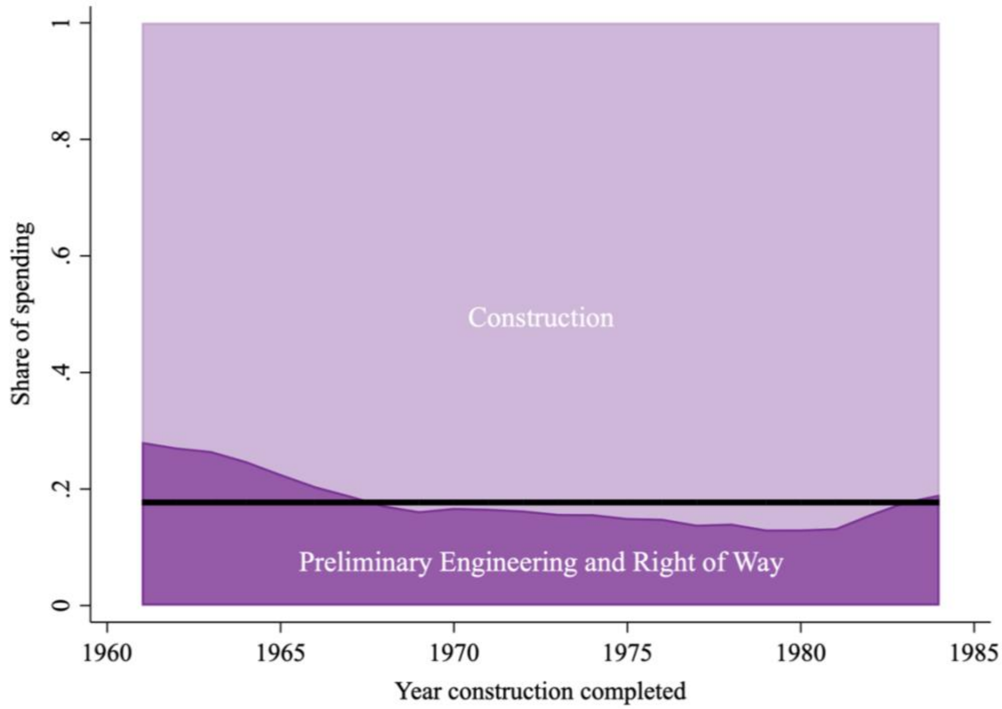
Figure A14: Other Institutional Measures and Spending per Mile Conditional on Geography



Notes: This analysis begins with the average difference across states in spending per mile conditional on geographic covariates (as listed in the notes for Figure 4) before 1970 versus 1970-onward. The colored portion on each successive bar shows the amount of the difference explained by a change in the covariate(s) listed to the left multiplied by the initial period relationship between the covariate(s) and spending per mile (as measured by the estimated coefficient in the pre-period). Each covariate in the figure is the residual from a regression of the standardized covariate on geographic variables and state fixed effects. All institutional variables are in light green; income and housing value variables are in blue, wage variables are in green, and the land use covariate is in light purple. The gray bar for bond rating is longer because of a slightly smaller sample. The final row reports results for all covariates included together (except for bond rating, to maintain the full sample). In all rows, we weight the decomposition by miles completed. Appendix Table A3ii shows the specific values for this figure, and Appendix Table A4iii shows the coefficients on the covariates for each analysis period (1958-1969, 1970-1993).

Sources: See sources note for Figure 4 for details of row 8. See Appendix A.3.k, l, n, j, o, m (in order of rows displayed) for information on sources.

Figure A15. Share of Spending on Preliminary Engineering and Right of Way



Notes: This figure reports data that divide national Interstate spending into either construction or "preliminary engineering and right of way" purchase. We show annual shares for all reported years. The dark black line at 17.8 percent is the average share of the latter spending category across all years.

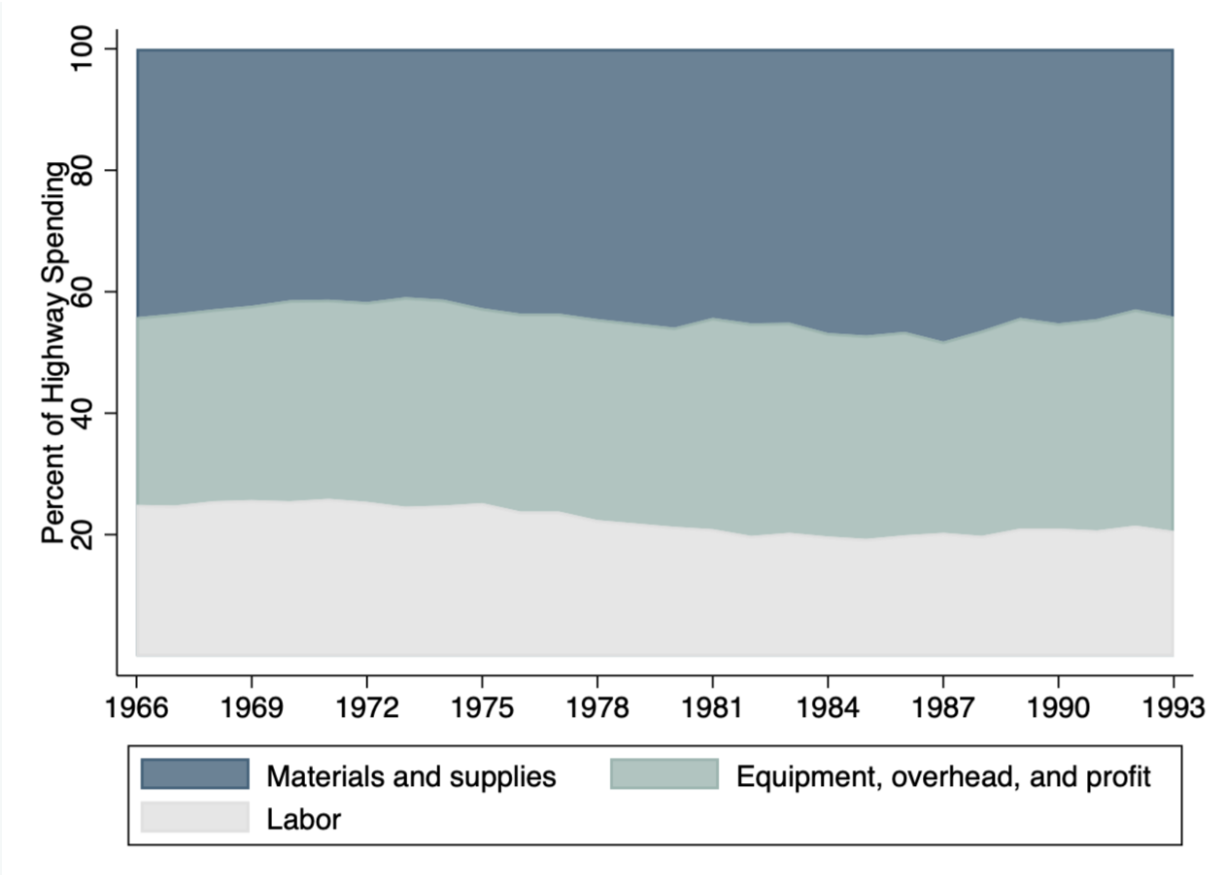
Sources: Data are from FHWA *Quarterly Reports* (FHWA [1963-1996]).

Figure A16. Pedestrian Plazas Across I-696 in Oak Park

Notes: This figure shows the final leg of I-696 outside of Detroit. This final leg of construction was much more expensive per mile than the previous two legs. The figure outlines a pedestrian plaza included to address community concerns.

Sources: Michigan Department of Transportation (2003). This image is in the public domain. We added the cyan outline onto this image.

Figure A17. Distribution of Highway Spending Over Time



Notes: This figure presents the percent of costs incurred by construction firms by spending type for all completed primary federal aid highway construction contracts. "Costs incurred by construction firms" does not include all costs due to planning, right-of-way access, or other state Department of Transportation costs.

Source: Data from *Highway Statistics* series (FHWA [1956-1995]). See Appendix A.5.b for further details.

Table A1. Mileage Openings Most Strongly Related to Spending in Two Years Prior

	(1)
Year *t* Expenditure	40.294**
	(15.17)
Year *t* -1 Expenditure	33.297***
	(10.91)
Year *t* -2 Expenditure	15.157**
	(5.72)
Year *t* -3 Expenditure	2.859
	(9.26)
Year *t* -4 Expenditure	4.159
	(9.31)
Year *t* -5 Expenditure	-8.169
	(6.31)
Year *t* -6 Expenditure	18.730*
	(10.66)
Year *t* -7 Expenditure	-14.785
	(10.69)
Year *t* -8 Expenditure	-8.972
	(11.22)
Year *t* -9 Expenditure	7.527
	(5.31)
Year *t* -10 Expenditure	-10.25
	(6.93)
Year *t* +1 Expenditure	-6.25
	(13.68)
Year *t* +2 Expenditure	-12.242
	(12.12)
Year *t* +3 Expenditure	8.267
	(12.84)
Year *t* +4 Expenditure	2.159
	(12.51)
Year *t* +5 Expenditure	19.094
	(11.70)
Constant	-2.807
	(3.98)
Observations	1100
R^2	0.582
Adjusted R^2	0.557

Notes: This table reports coefficients from a regression of the number of Interstate miles opened in year *t* in state *s* on state fixed effects and spending in year $t + n$, where n is in {-10, 5}. We use robust standard errors and cluster at the state level. * p<0.10; ** p<0.05; *** p<0.01.

Sources: See Appendix B for calculation of spending per mile. Segment opening dates from Baum-Snow (2007).

Table A2. Summary Statistics

	1958-1963	1964-1969	1970-1975	1976-1981	1982-1987	1988-1993	All years
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Spending per mile,	8.47	8.91	11.69	16.20	24.58	34.33	11.51
millions of 2016 dollars	(6.51)	(5.41)	(10.18)	(15.16)	(34.44)	(45.12)	(13.81)
New miles built	186.3	291.9	187.8	86.8	36.0	18.1	134.5
	(139.8)	(200.9)	(147.6)	(77.0)	(40.0)	(27.5)	(155.2)
State average for segments constructed in this period							
Pop. density, (1000s people/sq. mi)	0.69	0.55	0.52	0.57	0.82	0.96	0.60
	(0.99)	(0.54)	(0.52)	(0.74)	(0.59)	(0.68)	(0.69)
Share of segments in wetlands, rivers,	0.03	0.03	0.04	0.05	0.05	0.07	0.03
or other waters	(0.02)	(0.02)	(0.03)	(0.06)	(0.04)	(0.07)	(0.03)
Slope in degrees	2.68	3.04	2.94	3.31	3.23	4.03	2.99
	(1.30)	(1.53)	(1.77)	(1.80)	(1.82)	(3.50)	(1.66)
Local median family income	40,990	47,120	50,611	52,467	57,819	61,400	47,890
	(7,002)	(7,525)	(7,895)	(7,158)	(9,296)	(12,505)	(9,050)
Local median home value	79,383	81,437	81,896	119,660	133,943	131,146	88,637
	(16,047)	(17,363)	(19,074)	(33,408)	(42,191)	(57,921)	(28,351)
Observations	48	48	48	47	43	36	270

Notes: This figure presents summary statistics for the main dependent variables and covariates. We express all dollar figures in 2016 dollars. Later years have fewer observations because some states have completed their Interstate construction by those years.

Sources: See Appendix B for calculation of spending per mile. See Appendix A.2 and A.3.f–g for definitions and sources of the covariates.

Table A3i. Decomposing Spending per Mile with Geographic Covariates

			State Fixed Effects		Geographic Features	
	Overall Difference	Std. Error	Explained Amount	Std. Error	Explained Amount	Std. Error
State Fixed Effects	6.8	1.81	0.53	0.72		
Pre-determined Geog. Features	6.8	1.63			0.72	0.61
Both	6.8	1.80	0.70	0.68	-0.84	1.02

Notes: This table reports the exact numbers that underlie Figure 2. Each row is a decomposition. The figure reports the overall difference in spending per mile, expressed as the difference between the miles-weighted average across state-period data in the pre-1970 and 1970-onward eras, and the standard error of this difference. The following two columns report the contribution of state fixed effects to “explaining” the overall difference, as in Equation (4) in the main text (and the standard error of this explanation). The final pair of columns reports how much the geographic covariates (as listed in Equation (2)) “explain” of this difference. The final row reports results when we include all covariates in one estimation.

Sources: See sources note under Figure 2.

Table A3ii. Decomposing Spending per Mile with Wages, Income, Home Value and Land Use

	Wages		Income/Home Value		Land-Use Cases		Institutions			
	Explained Amount	Std. Error	Explained Amount	Std. Error	Explained Amount	Std. Error	Explained Amount	Std. Error	Overall Difference	Std. Error
Panel A: Wages, Income/Home Value and Land Use										
Wages										
2. Const. Wages by Occupation	0.02	0.10							5.88	1.36
3. Const. Wages by Industry	-0.02	0.66							5.88	1.36
4. Const. Payroll/Employee	0.18	0.42							5.87	1.36
5. 2 + 3 + 4	0.35	0.76							5.88	1.37
Income/Home Value										
6. Family Income			1.82	0.80					5.87	1.36
7. Home Value			2.99	0.79					5.87	1.36
8. 6 + 7			3.11	0.92					5.87	1.37
Land Use										
9. Land-Use Cases					2.25	0.76			5.87	1.36
Together										
10. 5 + 8 + 9	-0.83	1.35	3.31	1.35	1.35	0.79			5.88	1.38
Panel B: Institutions										
1. Number of Govts.							0.21	0.19	5.87	1.36
2. Bond Rating							1.36	0.59	6.41	1.53
3. Right to Work							-0.02	0.07	5.87	1.36
4. Firms per Capita							1.23	1.45	5.87	1.36
5. Estabs. per 1k Pop.							0.40	0.33	5.87	1.36
6. Prevailing Wage							0.17	0.17	5.87	1.36
7. Congressional Influence							-0.20	0.31	5.87	1.39
8. Fig 4(b), row 10 + all (w/o bonds)	-1.40	1.45	4.74	1.62	1.06	0.82	-2.26	1.64	5.88	1.42

Notes: This table reports the exact numbers that underlie Figure 4 and Appendix Figure 14. Each row is a decomposition. See notes for Figure 4.

Sources: See sources note for Figure 4 for Panel A, and sources note for Figure A14 for Panel B.

Table A4i. Coefficients and Means that Underlie Decomposition in Figure 2

		Before 1970			1970-Onward		
		Coefficient	Std. Error	Mean	Coefficient	Std. Error	Mean
Figure 2, Row in Figure							
3	Population Density	4.82	0.6	0.6	15.82	2.11	0.59
3	Wetlands	38.42	20.52	0.03	34.94	28.58	0.05
3	Slope	0.95	0.29	2.9	1.94	0.68	3.13
4	Population Density	2.77	0.99	0.6	15.96	3.9	0.59
4	Wetlands	-63.88	61.68	0.03	51.08	62.39	0.05
4	Slope	0.81	0.92	2.9	1.87	1.67	3.13

Notes: We estimate a decomposition as defined in Equation (4), where the dependent variable is spending per mile in a state-period. We standardize all covariates to mean zero, standard deviation one for ease of comparison (with the exception of state fixed effects). This table reports the coefficients β_{after} and β_{before} and their standard errors. We also report the mean of the covariate before and after 1970, as in Equation (4).

Sources: See sources note for Figure 2.

Table A4ii: Coefficients and Means that Underlie Decomposition in Figure 4

		Before 1970			1970-Onward		
		Coefficient	Std. Error	Mean	Coefficient	Std. Error	Mean
Figure 4, Row in Figure							
2	Const. Wages by Occupation	-1.65	1.2	0	-6.84	2	-0.01
3	Const. Wages by Industry	-0.03	1.13	-0.24	-5.65	2.78	0.35
4	Const. Payroll per Employee	0.49	1.11	-0.15	-2.46	2.78	0.22
5	Const. Wages by Occupation	-1.86	1.35	0	-6.3	2.41	-0.01
5	Const. Wages by Industry	-0.11	1.93	-0.24	-3.27	4.75	0.35
5	Const. Payroll per Employee	1.02	1.78	-0.15	2.98	4.22	0.22
6	Median Family Income	2.35	1.02	-0.31	8.54	2.11	0.46
7	Home Value	5.72	1.26	-0.21	6.44	1.31	0.31
8	Home Value	5.55	1.46	-0.21	4.99	1.59	0.31
8	Median Family Income	0.26	1.1	-0.31	3.98	2.52	0.46
9	Land-Use Cases	5.62	1.79	-0.16	10.8	2.38	0.24
10	Const. Wages by Occupation	-0.25	1.36	0	-2.65	2.49	-0.01
10	Const. Wages by Industry	-1.3	2.28	-0.24	2.52	5.1	0.35
10	Home Value	3.69	2.02	-0.21	2.86	2.22	0.31
10	Land-Use Cases	3.38	1.93	-0.16	7.33	2.76	0.24
10	Const. Payroll per Employee	-0.19	1.84	-0.15	0.29	4.05	0.22
10	Median Family Income	1.78	2.41	-0.31	3.71	2.95	0.46

Notes: We estimate a decomposition as defined in Equation (4), where the dependent variable is spending per mile in a state-period conditional on geographic covariates and state fixed effects. This table reports the coefficients β_{after} and β_{before} and their standard errors. We standardize all covariates to mean zero, standard deviation one for ease of comparison. We also report the mean of the covariate before and after 1970, as in Equation (4). All covariates are the residual of a regression of the covariate in the same geographic covariate and state fixed effects. Each covariate is the residual from a regression of the covariate on geographic variables and state fixed effects.

Sources: See sources note for Figure 4.

Table A4iii. Coefficients and Means that Underlie Decomposition in Appendix Figure A14

		Before 1970			1970-Onward		
		Coefficient	SE	Mean	Coefficient	SE	Mean
Appendix Figure A14, Row in Figure							
1	Total Governments	-2.95	2.52	0.03	1.87	7.39	-0.04
2	Bond Rating	4.46	1.46	-0.13	2.54	1.47	0.18
3	1{Right to Work State}	-0.66	2.41	-0.01	-1.67	5.7	0.02
4	Const. Firm per Cap	-1.97	2.32	0.25	-6.69	3.36	-0.37
5	Const. Estabs. per cap	2.02	1.46	-0.08	2.95	1.45	0.12
6	Prevailing Wage	1.86	1.52	-0.04	0.52	2.63	0.05
7	Senate: Share Reps. on Transp. Cmte.	0.17	7.48	0	2.25	15.52	0.01
7	Senate: Av. Representative Tenure	0.3	0.87	0.06	-0.6	1.69	-0.09
7	House: Av. Representative Tenure	0.49	1.16	0.01	-1.47	2.31	-0.01
7	House: Share Reps. in Majority	1.22	1.31	0.04	1.66	2.56	-0.06
7	Senate: Share Reps. in Majority	-0.5	0.98	0.08	-0.52	1.77	-0.12
7	House: Share Reps. on Transp. Cmte.	-1.26	0.84	-0.04	0.38	1.63	0.05
8	Const. Wages by Occupation	-0.2	1.42	0	-3.27	2.73	-0.01
8	Const. Payroll per Employee	-1.82	2.1	-0.15	-0.66	4.38	0.22
8	Median Family Income	1.92	2.59	-0.31	4.32	3.17	0.46
8	Home Value	6.23	2.25	-0.21	2.73	2.62	0.31
8	1{Right to Work State}	-3.37	2.54	-0.01	-2.81	5.84	0.02
8	Total Governments	-3.28	2.84	0.03	1.35	8.18	-0.04
8	Const. Firm per Cap	3.52	2.47	0.25	0.37	3.81	-0.37
8	Const. Estabs. per cap	-0.36	1.59	-0.08	-1.2	2.11	0.12
8	Prevailing Wage	2.87	1.82	-0.04	1.62	2.84	0.05
8	House: Av. Representative Tenure	1.01	1.15	0.01	-1.56	2.27	-0.01
8	House: Share Reps. in Majority	1.85	1.27	0.04	1.49	2.51	-0.06
8	Senate: Share Reps. on Transp. Cmte.	-3.7	7.3	0	-2.56	15.6	0.01
8	Senate: Av. Representative Tenure	0.95	0.85	0.06	-0.58	1.66	-0.09
8	Senate: Share Reps. in Majority	-0.21	0.97	0.08	-0.27	1.77	-0.12
8	House: Share Reps. on Transp. Cmte.	-0.35	0.83	-0.04	1.3	1.62	0.05
8	Const. Wages by Industry	-1.21	2.51	-0.24	2.15	5.62	0.35
8	Land-Use Cases	2.65	2.02	-0.16	7.49	3.04	0.24

Note: We estimate a decomposition as defined in Equation (4), where the dependent variable is spending per mile in a state-period conditional on geographic covariates and state fixed effects. This table reports the coefficients β_{after} and β_{before} and their standard errors. We standardize all covariates to mean zero, standard deviation one for ease of comparison. We also report the mean of the covariate before and after 1970, as in Equation (4). All covariates are the residual of a regression of the covariate in the same geographic covariate and state fixed effects. Each covariate is the residual from a regression of the covariate on geographic variables and state fixed effects.

Sources: See sources note to Figure A14.

Table A5. Temporal Cost Change Robust to Specification and Sample Changes

		Difference		Explained			Difference		
		Amount	S.E.	Amount	S.E.	Share of Diff	Amount	S.E.	Obs.
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Table 1 Specifications									
(1)	Col 4: geography + state FE	6.80	1.80	-0.09	1.03	-0.01	5.82	1.36	270
Remaining specifications described relative to Panel A									
Panel B. Alternative Geographic Specifications									
(1)	+ geographic cov. squared	6.80	1.81	-1.71	2.56	-0.25	5.71	1.34	270
(2)	+ geographic cov. squared and cubed	6.80	1.82	-26.37	16.68	-3.88	5.50	1.33	270
(3)	+ share in urban areas	6.80	1.80	0.33	1.09	0.05	4.14	1.30	270
(4)	+ ecoregions	6.80	1.84	-0.17	1.18	-0.02	5.33	1.33	270
(5)	+ average number of lanes	6.80	1.81	-0.28	1.02	-0.04	5.92	1.32	267
(6)	without weighting by miles constructed	31.55	7.46	-2.95	2.29	-0.09	30.79	6.21	270
Panel C. Robustness to Sample									
(1)	balanced panel	7.72	2.03	0.41	1.08	0.05	5.84	1.55	236
(2)	drop last period	5.71	1.76	-0.16	1.02	-0.03	5.16	1.25	234
(3)	balanced panel, no last period	6.50	2.01	0.34	1.10	0.05	5.13	1.44	201
(4)	dependent variable is spending without lag	6.80	1.80	-0.09	1.03	-0.01	5.82	1.36	270
(5)	omit Northeast region	5.21	1.75	-0.92	1.01	-0.18	4.62	1.31	239
(6)	omit Midwest region	7.14	2.18	-0.10	1.19	-0.01	5.22	1.66	230
(7)	omit South region	7.08	2.10	0.77	0.99	0.11	5.51	1.52	209
(8)	omit West region	8.27	2.21	0.28	1.32	0.03	5.81	1.68	228
(9)	3-year periods	6.43	1.39	0.61	0.73	0.09	5.82	1.14	504
(10)	5-year periods	8.18	2.17	0.77	0.85	0.09	6.41	1.68	313
(11)	7-year periods	7.69	1.77	-0.04	1.28	0.00	5.83	1.21	226

Notes: This table reports the difference in spending per mile (that is, the miles-weighted average of state-period figures) from pre-1970 to 1970-onward and that difference's estimated standard error in the first two columns. The third and fourth columns report the amount of this difference that is "explained" (in a decomposition sense, as in Equation (4) by our three main geographic covariates and state fixed effects (see Equation (2) for geography covariates). The sixth and seventh columns present the difference in residual spending for the same before and after periods. Residual spending is spending conditional on the three geographic covariates and state fixed effects, and it is the basis for the decomposition analysis in Figure 4. The final column notes the number of observations in each estimation. Panel A reports our baseline estimate. Panel B reports results using different specifications of the geographic covariates and different weighting. Panel C reports results for different sample choices. The five- and seven-year periods use 1973 and 1972, respectively, as breakpoints. Both exclude 1993. Panel B, row 5, is missing observations due to a small amount of missing lanes data. Sources: See Appendix A for complete details.

Table A6. Federal Legislation that Required Additional Consideration of Citizen Concerns

Legislation Title	Year of Passage	Citation	Relevance Regarding Citizen Concerns
National Historic Preservation Act of 1966	1966	16 U.S.C. 470 § 106	Requires the head of any federal agency with jurisdiction over the expenditure of federal funds to consider its impact on sites that are in the National Register.
Department of Transportation Act of 1966 §4(f)	1966	23 USC § 138, 49 USC § 303	For transportation projects that require land from parks, recreation areas, wildlife and waterfowl refuges, or historic sites, the project sponsor "must demonstrate that the need for these lands is unavoidable or that the project has only a minimal impact on the affected property."
Federal Highway Act of 1968	1968		Requires that highway construction projects hold two public hearings on site planning and design.
National Environmental Policy Act	1970	42 U.S.C. 55	Requires the submission of environmental impact statements and formal processes to collect public comments.
Clean Air Act of 1970	1970	42 U.S.C. §7401 et seq.	Allows for citizen suits, which enable citizens to (1) file suit to force a party to comply with national standards; (2) compel the administrator to perform a nondiscretionary duty; and (3) appeal final agency action to a Court of Appeals.
Federal-Aid Highway Act of 1970	1970	23 U.S.C. 109(i)	Requires the development of a noise-abatement policy
Uniform Relocation Assistance and Real Property Acquisition Act of 1971	1971	42 U.S.C ch. 61	Requires the create of standard relocation procedures for those displaced by federal eminent domain, expands the compensation available to those displaced, and requires the preparation of relocation plans.
Noise Control Act of 1972	1972	42 U.S.C. § 4901 et seq	Requires federal agencies to consider the impact of excessive noise in their work and empowers the EPA to regulate noise levels.
Clean Water Act	1972	33 U.S.C. ch. 23 § 1151	Allows for citizen suits to enforce the provisions of the Clean Water Act
Federal Highway Act of 1973	1973	23 U.S.C. 109(i)	Mandates that the Secretary of Transportation develop and promulgate standards for highway noise levels; permits the Secretary to approve plans for highways after 1972 only if they have adequate measures in place to control noise.
Endangered Species Act	1973	16 U.S.C. §1531 et seq.	Requires the FHWA, among other federal agencies, to use its authority to conserve listed species and ensure that transportation projects are not likely to jeopardize the continued existence of any listed species or result in the destruction or modification of critical habitat.

Notes: This table reports major federal legislation that requires citizen input, which create opportunities for citizen voice.

Table A7. Spending per Mile's Relationship to Income, Home Value and Implied Elasticities of Income and Home Value

	(1)	(2)		(3)	(4)
	Estimated Coefficients			Implied Elasticity	
	Covariate = Median Family Income	Covariate = Median Housing Value		Family Income	Housing Value
Demand Covariates			Period		
Covariate	-1.19	-1.87	1958-1963	-0.58	-1.75
	(2.26)	(2.94)			
Covariate * 1964-1969 period indicator	1.85	1.86	1964-1969	0.12	1.7
	(1.29)	(1.73)			
Covariate * 1970-1975 period indicator	4.17	4.71	1970-1975	1.18	3.3
	(2.50)	(3.96)			
Covariate * 1976-1981 period indicator	7.14**	4.87*	1976-1981	1.73	3.9
	(2.75)	(2.64)			
Covariate * 1982-1987 period indicator	4.24	3.90*	1982-1987	0.70	2.13
	(2.54)	(2.26)			
Covariate * 1988-1993 period indicator	15.02***	15.28***	1988-1993	2.40	5.84
	(4.15)	(2.47)			
Observations	270	270			
R^2	0.45	0.49			

Notes: The first two columns present results from regressions where the dependent variable is a state's real spending per mile in 2016 dollars in 6-year periods. We cluster standard errors by state. We standardize all covariates to mean zero, standard deviation one for ease of comparison. We weight both regressions by Interstate miles completed in that period. In addition to the reported coefficients, the regressions include our three main geographic controls, state fixed effects, and period fixed effects (as in Equation (2)). * $p<0.10$, ** $p<0.05$, ***$p<0.01$. The last two columns of results present the elasticities implied by these estimates, which we calculate as $\rho = \beta$ * mean(income or housing value) / mean(spending per mile).

Sources: See Appendix A.3.f–g for details on housing value and income covariates.

Table A8. Effect of Combinations of Highway Characteristics on Spending per Mile

	Alternative Specifications					
	(1)	(2)	(3)	(4)	(5)	(6)
Period Indicators, Years						
1964-1969	0.62	0.49	0.43	1.16	0.30	0.91
	(1.05)	(0.95)	(1.06)	(1.07)	(0.94)	(0.97)
1970-1975	4.70***	3.53**	4.07**	4.77***	4.64***	4.25**
	(1.45)	(1.52)	(1.66)	(1.60)	(1.29)	(1.69)
1976-1981	8.16***	7.60***	7.20***	7.92***	7.93***	7.86***
	(1.62)	(1.78)	(1.67)	(1.80)	(1.55)	(1.61)
1982-1987	12.37***	12.90***	10.65***	10.16***	11.26***	12.80***
	(3.01)	(3.00)	(3.04)	(3.05)	(2.94)	(2.68)
1988-1993	21.72***	19.08**	17.73**	17.75**	20.33**	17.30**
	(7.97)	(8.45)	(8.12)	(8.44)	(8.15)	(8.39)
Highway Characteristics						
Ramp & Elevated-Highway Density	6.37***		5.45***	4.32**	2.85**	
	(1.61)		(1.67)	(1.85)	(1.13)	
Wiggliness		6.31*	5.64	5.57		1.91
		(3.39)	(3.52)	(3.60)		(3.41)
Number of Lanes				2.85		
				(1.86)		
Ramp & Elevated Density * 1{year > 1970}					4.20**	
					(1.60)	
Wiggliness * 1{year > 1970}						5.10***
						(1.69)
Observations	270	270	270	267	270	270
R^2	0.43	0.44	0.47	0.48	0.45	0.46

Notes: This table reports regressions of spending per mile in state *s* in period *p* on listed covariates, as well as state fixed effects and geographic controls. We standardize all covariates to mean zero, standard deviation one for ease of comparison. We cluster standard errors by state. We weight regressions by mileage. Excluded time period category is for 1958-1963 and periods are six years long. Columns (2), (3), (4), and (6) have fewer observations due to missing wiggliness and lanes data. * p<0.10, ** p<0.05, *** p<0.01.
Sources: See Appendix A.3 for details on highway characteristics covariates.

Appendix A – Data Appendix: Data Summary and Variable Construction

We study the relationship of highway spending with covariates from many sources. This appendix reviews the sources and construction for each variable. For even more specificity in citations and how the data are obtained, see the online data directory.

Generally, we use data at the finest possible geographic and temporal granularity, and we match to our Interstate segment data.

1. *Initial notes*

Initially, we make four brief notes on the construction of our variables. First, we use many datasets from the Census, which we are able to spatially map to our segment datasets on ArcGIS using county- and tract-level shapefiles. Census data and shapefiles are provided by the Inter-university Consortium for Political and Social Research (ICPSR) or National Historical Geographic Information System (NHGIS) and can be found through the ID numbers.

These Census datasets and shapefiles are documented below:

- **State and county level**
    - Census data
        - 1950: ICPSR 2896, datasets 35 & 36 (Haines et al. 2010)
        - 1960: ICPSR 2896, datasets 38, 39, 74 (Haines et al. 2010)
        - 1970:
            - Housing: ICPSR 8107, all datasets (U.S. Census Bureau 2006a)
            - Population: ICPSR 8129, all datasets (U.S. Census Bureau 2006b)
        - 1980: ICPSR 8071, all datasets (U.S. Census Bureau 2008b)
        - 1990: ICPSR 9782, all datasets (U.S. Census Bureau 2006e)
        - And, all years except 1960: ICPSR 7736 (U.S. Census Bureau 2012)
    - Shapefiles (maps of county borders)
        - County borders from NHGIS (Manson et al. 2017)
- **Tract level**
    - Census data
        - 1940: NHGIS, dataset 76 (Manson et al. 2017)
        - 1950: NHGIS, dataset 82 (Manson et al. 2017)
        - 1960: NHGIS, dataset 92 (Manson et al. 2017)
        - 1970:
            - Housing: ICPSR 9014, all datasets (U.S. Census Bureau 2006c)
            - Population: ICPSR 8126, all datasets (U.S. Census Bureau 2006d)
        - 1980: ICPSR 8071, all datasets (U.S. Census Bureau 2008b)
        - 1990: ICPSR 9782 (U.S. Census Bureau 2006e)
    - Shapefiles (maps of tract borders)
        - 1940, 1950, 1960, 1970, 1980: NHGIS (Manson et al. 2017)
        - 1990: US Census Bureau website (U.S. Census Bureau 2017)

Second, the Interstate data from Baum-Snow (2007) partitions the Interstates into sections of varying lengths, for which we observe opening dates. Based on these sections, we divide the Interstates into roughly one-mile segments. These segments underlie many of our measures (e.g., the fraction of miles in a given state-year that pass through counties with characteristic X). We generally measure the segments by their true length (according to a high-fidelity map from Baum-Snow (2007)), but we also compute the end-to-end "as the crow flies" length of the segment to explore how segment "wiggliness" correlates with per mile construction spending.

Third, the variable descriptions below make reference to "periods," for example as in "state-period level data." In these contexts, a "period" is a unit of temporal aggregation. The variable descriptions are written to apply accurately to analysis of both annual data and aggregated periods.

Fourth, unless otherwise specified, we use the value of the nearest future year to backfill the values of our state-year aggregated time series measures for missing select state-years and those that are not available until after 1956 (when our data on spending and mileage begin). If a given variable is still missing after this backfilling, we then use the nearest past value to fill forward for any state-years from 1956 to 1993.

2. Segment Geography

a. Population Density

We construct a state-year level measure of the urban intensity of miles built using population density data from the Census. For most segments, we simply take the population of the segment's tract from the nearest Decennial Census and divide by the tract area (in square miles). For segments in areas not yet tracted at the segment's time of opening, we instead use the county population and area from the nearest Decennial Census. Our state-period level measure is then the segment-length-weighted average[1] of this measure across all segments opened in the given state and period. When we add as an additional control an indicator for being in a highly dense area (at the segment level) or the share of miles in a highly dense area (at the state level), we follow the Census definition of "dense" as being greater than 1,000 people per square mile.[2]

b. Wetlands, Water, and Rivers

To assess whether wetlands may have impacted per mile construction spending, we overlap a wetlands map from the US Fish and Wildlife Service with our segment data derived from Baum-Snow (2007) (US Fish and Wildlife Service 2018). This wetlands map is ecologically broad, covering documented waters that fall under the Cowardin classification system, which includes marine (roughly, oceanic), estuarine, riverine (roughly, flowing fresh water), lacustrine (roughly, lake waters), and palustrine (roughly, nonriver and nonlake fresh water) categories. Our segment-level measure is then the share of a segment's length passing through any part of this wetland map. At the state-period level, our measure is the segment-length-weighted average share of opened mileage constructed through wetland.

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[1] Here and in the descriptions that follow, the length we use for weighting is the length of the segment "as the crow flies." This length is very narrowly distributed around 1, so the weighted average approximates a standard arithmetic average.

[2] See https://www2.census.gov/geo/pdfs/reference/GARM/Ch12GARM.pdf.

c. Topography, as Measured by Slope
As a control for the impact of topography on per mile construction spending, we create a measure of the slope of the terrain in the area each Interstate highway segment is built. The granularity of our topographical data is one arcsecond (roughly a 30-meter-by-30-meter grid), and the data was collected by satellite in 2004. Data come from US Geological Survey Digital Elevation Model (US Geological Survey 2015).[3] To build our measure, first we average the slope values of each cell of data within 50 meters of each segment. The slope for a given cell is defined as the average difference between the cell's elevation and that of each of its eight neighbors. The state-period level measure is then the segment length-weighted average of these segment-level average slopes.

d. Construction Cost
Using the geography of each segment, we calculate a "construction cost" according to the formulation in Alder (2016) for one robustness test. We calculate

$$ConstructionCost = 1 + SlopePct + 25 \cdot 1[Builtup] + 25 \cdot 1[Wetland]$$

where $SlopePct$ is the segment's average slope in percent terms, $Builtup$ is a dummy variable for having a population density greater than 1000 people per square mile, and $Wetland$ is a dummy variable for segments that intersect with wetlands for more than 0.1 miles. The final variable is the miles-weighted average segment construction cost for each state over the period.

3. *Interstate Attributes*

a. Interstate Structures
To examine the presence of Interstate highway structures, we use a measure based on lengths of nearby Interstate bridges and ramps.[4] Data on these highway structures, themselves represented as segments, come from the 2016 Highway Performance Monitoring System (FHWA 2016a), which we matched to our dataset of Interstate segments derived from Nate Baum-Snow (FHWA 2016a; Baum-Snow 2007). Unfortunately, these data are measured as of 2016 (the earliest date to which we have access), and not at the time of construction; we have found no data on segment-level Interstate attributes at the time of construction. Because of this later date of measurement, these attributes are measured with error with respect to the initial opening date on which our analysis rests.

Assuming that these structures are constructed in the same year that nearby highway segments open, we can measure the length of structures associated with nearby Interstate mileage. To account for mild spatial mismatch, we assign each structure segment to its nearest highway segment, within 250 meters, and we exclude structure segments not within 250 meters of any highway segment. Our segment-level measure is then the sum of structure segment length divided by the highway segment length, and our state-period-level measure correspondingly represents the ratio of all structure mileage to all highway mileage opened in the state and period.

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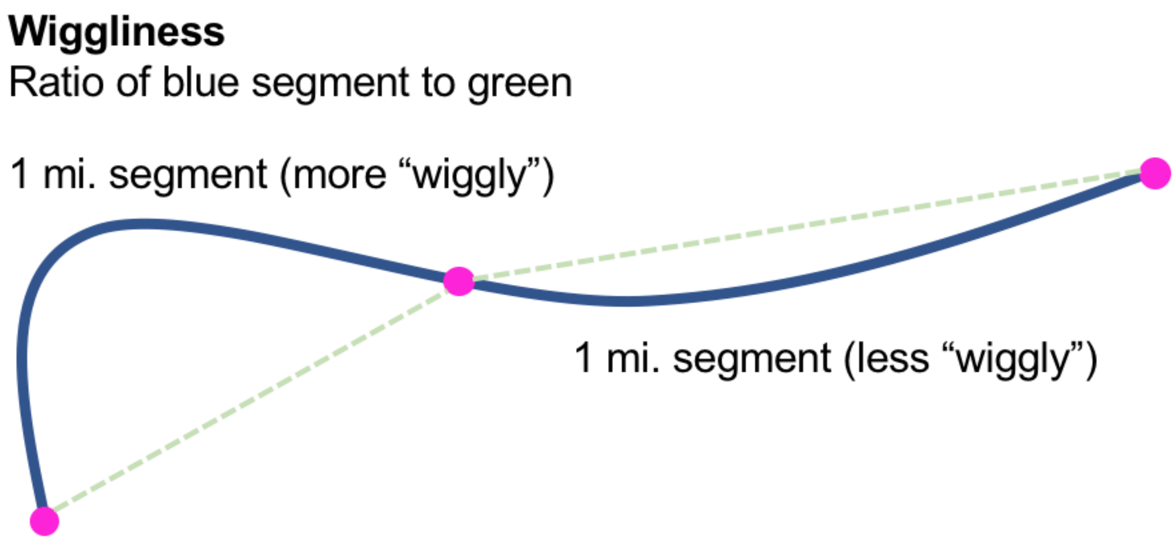
[3] Data is the 1 Arc-Second Seamless Standard DEM raster from the USGS 3D Elevation Program (3DEP).
[4] For definitions, see U.S.C. 23 CFR §650.305 and the HPMS 2016 Field Manual (FHWA 2016a).

b. Wiggliness

We measure the "wiggliness" (more formally, tortuosity) of a segment as the ratio of its true length to its length "as the crow flies" using our Baum-Snow segment data along with an auxiliary geographic shapefile of true lengths, also provided by Baum-Snow (2007). These segments partition a high-fidelity map of the Interstates into approximately one-mile pieces. We generate the ratio of "wiggly" to straight length of highways by dividing this one-mile length by the (smaller) geodesic length between the segment's endpoints. Our state-period level measure is then the total "wiggly" length of mileage open in the given state-period divided by the total linear mileage opened in that same state-period.



c. Number of Interstate Lanes

We also measure the total number of lanes (across both directions) of Interstate mileage using data from the Highway Performance Monitoring System (HPMS) (FHWA 2016a). HPMS data is provided in a geographic shapefile of Interstate segments, as is our mile segment data derived from Nate Baum-Snow (FHWA 2016a; Baum-Snow 2007). Importantly, the HPMS data only gives lane counts for Interstate mileage as of 2016. To account for mild spatial mismatch between the two, we take, for a given Baum-Snow segment, the length-weighted average number of lanes across all HPMS segments nearer to the given Baum-Snow segment than to any other. We exclude from this average any HPMS segments with fewer than two recorded lanes. Our state-period-level measure is then the average (weighted by Baum-Snow segment lengths) of these segment-level averages for all Baum-Snow segments built in the given state and period.

d. Noise Wall Area.

Data on the total area of noise walls on federal highways by year of construction come from the FHWA's Noise Barrier Inventory (FHWA 2017a).[5] For calculating the cost per mile, we multiply the average cost per square foot reported by the Noise Barrier Inventory from 1972-1993 by the number of feet in a mile by the average wall height reported by DOT.

4. *Explanatory Variables*

[5] Full dataset obtained via email with Aileen Varela-Margolles of the FHWA Highway Noise Program.

a. Construction Hourly Wage Index

We use an index of the hourly wage for construction workers using data that come from the Bureau of Labor Statistics (BLS) via Historical Statistics of the United States (Margo 2006).

b. Construction Compensation

We use the Bureau of Economic Analysis's (BEA) National Income and Product Accounts data on employee compensation (US BEA 2021e, 2021f), wages and salaries (US BEA 2021c, 2021d), and full time equivalent (US BEA 2021a, 2021b) in the construction industry.

c. Materials Index

We use indices from the BLS Producer Price Index of concrete (US BLS 2017e), construction machinery (US BLS 2017d), construction sand (US BLS 2017c), paving mixtures (US BLS 2017a), and steel mill products (US BLS 2017b) to create an index for construction materials prices.

d. Construction Wages

From the Current Population Survey (CPS) (1962 to 1993) hosted by IPUMS CPS (King et al. 2010), we use two measures of hourly construction wages, one using an occupation-based definition of construction, one using an industry-based definition. Early years of the CPS aggregated smaller states together, and we use this aggregation throughout for consistency. We adjust to 2016 dollars. Our final measure is the state-period average hourly construction wage.

e. Payroll per Employee

We use first quarter construction payroll data from County Business Patterns (CBP) available for 1953, 1959, 1962, 1964, 1965, 1967, 1969, and digitally for 1971-1993 (U.S. Census Bureau [1953-1993]). We use the detailed category of "highway and bridge construction" as well as the broader "heavy construction" and "construction" industries. We adjust first quarter payroll to 2016 dollars and interpolate for missing values. We multiply by four and divide by number of employees to approximate annual payroll per employee. The final metric is the state-period average annual payroll per employee.

f. Median Family Income

We use the Decennial Census's median family income, adjusted to tens of thousands of 2016 dollars, for a given segment's tract or, in the case of places and years not yet tracted, county (see Appendix A.1 for census citations). Our state-period measure, then, is the state-period average of segment median family income weighted by segment length.

g. Median Home Values

We use the Decennial Census's median value of an owner occupied home, adjusted to thousands of 2016 dollars, for a given segment's tract or, in the case of places and years not yet tracted, county (see Appendix A.1 for census citations). Our state-period measure, then, is the state-period average of segment home value weighted by segment length.

h. Congressional Record

We use the tm_map package for R to divide up the text of the *Congressional Record* (Gentzkow et al. 2018) (see https://data.stanford.edu/congress_text for details)—into strings of the 100 words before and after every appearance of the word "interstate" (excluding "interstate commerce"). We then measure the frequency with which words beginning with "environ" appear in those 201-word strings divided by total number of occurrences of "interstate" per Congress, from the 79th (1944-1945) to the 103rd (1993-1994).

i. Land Use Litigation
We base our study of local land use regulatory regimes on a historical tabulation of land use cases from Ganong and Shoag (2017). Available for each contiguous US state, and each year from roughly 1940 to 2010, this tabulation represents the number of cases in which the phrase "land use" appears in a state supreme or appellate court case. Our state-level measure for a given year is then simply this measure rescaled to the number of cases per ten thousand people, using state-level Decennial Census population data.

j. Construction Industry Concentration
We use two measures of market concentration.

First, we measure firms per capita from the Census of Construction Industries (U.S. Census Bureau [1971-1995]), from which we digitize state-level establishment counts from the "highway and street construction" category. The census series runs every 5 years from 1967, and we digitize it through 1992, linearly interpolating between census years. We divide this measure by the state population to yield a measure of concentration.

Second, we measure establishments per person using state-level counts of construction establishments from County Business Patterns (U.S. Census Bureau [1953-1993]) as an alternate measure of concentration. As we do for the Construction Census metric, we also divide this measure by state population.

k. Government Fragmentation
We construct a state-level measure consisting of counts of governments by state from the Census of Governments for 1957, 1962, and 1967 (U.S. Census Bureau 1963) and from the Willamette University Government Finance database (Pierson et al. 2015) for the remaining census years.[6] We linearly interpolate this measure between measured years to arrive at an annual measure of the number of governments by state.

l. Bond Ratings

To measure a state's level of fiscal responsibility, we use data on the state's general obligation debt ratings (or issuer credit rating where the general obligation debt rating is not available) from S&P Global Market (S&P Global Market Intelligence 2016). This dataset provides ratings for each state over time, since the year that S&P first issued each state's rating. (The date of initial rating varied from 1956 for Kansas and Colorado to 2014 for Idaho). We thank Kate Yang for sharing these data.

To quantify states' S&P bond rating, we assign a AAA-rated bond a value of one, and then we scale each of the remaining ratings based on the state's average percentage point increase in the interest rate on a ten-year bond relative to that of the average AAA bond. For example, we add sixteen for a year in which a state received a AA rating because its interest rate

[6] We use the two sources due to evidence of missing data in the Willamette database before 1967.

is sixteen basis points higher than that for a AAA ten-year bond (Violette 2018). Our state-year-level measure of a state's fiscal responsibility in a given year is thus the converted bond rating in that year; in analyses with periods of time longer than one year, the measure is a simple average of the yearly bond score across years within the period.

m. Congressional Variables
Using data from ICPSR (Swift et al. 2009), we calculate (for each state's representatives in the House and Senate) the average representative tenure at the beginning of each Congress, the percentage of state representatives in the majority party, and the percentage of state representatives on the transportation authorization committee, annually until 1992. Data for 1993 committee assignments come from Charles Stewart of MIT (Stewart 2017). For all six variables we use all members who ever served during the Congress, meaning that in the event of a resignation and replacement, for instance, both members who served in the seat over the course of the same Congress are part of the sample. Similarly, for percent majority and percent on transportation committee calculations, we count those who were ever part of the majority or on the transportation committee during the Congress, such that the few who switched parties mid-Congress or served fewer than two years on a transportation committee count as full members of the majority or committee. Representative tenure includes all congressional service, so if a member moved from the House to the Senate their tenure includes years spent in the House.

n. State Right to Work Laws
To measure the effect of state right to work laws on per mile Interstate spending, we use a value of one in a given state-year if the state had a right to work law (whether by statute or constitutional provision) in effect during any part of that year (National Right to Work Committee 2018). In any analysis with periods greater than one year, we use the share of years with a right to work law in place.

o. State Prevailing Wage Laws
To measure the effect of state prevailing wage laws on per mile Interstate spending, we use an indicator equal to one in a given state-year if the state had a prevailing wage law in effect during any part of that year (Philips et al. 1995, p. 4). In any analysis with periods greater than one year, we use the share of years with a prevailing wage law in place.

5. *Ancillary Construction Spending Data*

a. Preliminary Engineering and Right of Way Spending
We digitized annual state-level data from the FHWA's *Quarterly Report* series from 1961 to 1984 (FHWA [1963-1996]), on federal expenditures on Interstate preliminary engineering and right of way versus construction for completed projects.

b. Distribution of Highway Construction Spending
We digitized national data from the *Highway Statistics* series on the distribution of costs of construction of federal aid primary roads for completed contracts (FHWA [1956-1995]). Interstate specific numbers come from Table PT-2A, while overall numbers come from an unlabeled pie chart.

c. Interstate Cost Estimates
The *Interstate Cost Estimates* were produced periodically by the Department of Transportation between 1958 and 1991 and transmitted to Congress in official reports (DOT [1958-1991]; Weingroff 2017a). They estimated the amount of spending required to finish the Interstate system in each state.

6. *Cost Indices*

a. Engineering News Record (ENR) Construction Cost Index (CCI)
The ENR CCI (ENR 2021) measures the cost of construction. Components are common labor, structural steel price, Portland cement, and lumber. Data are available at the national-yearly level, and we adjust to 2016 dollars.

b. Craftsman Concrete Building Cost Index
The Craftsman Cost Index (Moselle 2020) measures the cost of construction. The index components are labor, material, equipment, plans, building permits, supervision, overhead, and profit. Data are available at the national-yearly level, and we adjust to 2016 dollars.

c. DOT Composite Bid Price Index (BPI)
The BPI (FHWA 2019) is composed of six indicator items: common excavation, to indicate the price trend for all roadway excavation; Portland cement concrete pavement and bituminous concrete pavement, to indicate the price trend for all surfacing types; and reinforcing steel, structural steel, and structural concrete, to indicate the price trend for structures. Data are available beginning 1972 at the national-yearly level, and we adjust to 2016 dollars.

d. BLS Producer Price Index (PPI)
The BLS PPI (US BLS 2011) is an index that measures road construction costs. It contains material input costs incurred by contractors, but it excludes capital investment and labor costs. Annual data are available nationally beginning 1986. We adjust to 2016 dollars.

Data Appendix References

Engineering News Record (ENR). 2021. "Construction Cost Index History - As of May 2021." https://www.enr.com/economics/historical_indices/ construction_cost_index_history.

Federal Highway Administration (FHWA). [1963-1996]. "Department of Transportation News: Federal Highway Administration. Quarterly Report [all reports from 1963-1996]."

Federal Highway Administration (FHWA). 1998b. "Part V – Interstate Withdrawal-Substitution Program." https://www.fhwa.dot.gov/highwayhistory/data/page05.cfm.

Federal Highway Administration (FHWA). 2017c. "Designing the Urban Interstates." https://www.fhwa.dot.gov/infrastructure/fairbank17.cfm.

Federal Highway Administration (FHWA). 2019. “Price Trends for Federal-Aid Highway Construction.” https://www.fhwa.dot.gov/programadmin/pt2006q4.cfm.

Gentzkow, Matthew, Jesse M. Shapiro, and Matt Taddy. 2018. “Congressional Record for the 43rd-114th Libraries [distributor]. Congresses: Parsed Speeches and Phrase Counts.” Palo Alto, CA: Stanford. https://data.stanford.edu/congress_text.

Haines, Michael R., and Inter-university Consortium for Political and Social Research. 2010. “Historical, Demographic, Economic, and Social Data: The United States, 1790-2002. Dataset 38: 1950 Census I (County and State), 1960 Census I (County and State).” Inter-university Consortium for Political and Social Research [distributor]. https://doi.org/10.3886/ICPSR02896.v3.

Manson, Steven, Jonathan Schroeder, David Van Riper, and Steven Ruggles. 2017. “IPUMS National Historical Geographic Information System: Version 12.0 [U.S. Census of Population and Housing].” Minneapolis: University of Minnesota. http://doi.org/10.18128/D050.V12.0.

Michigan Department of Transportation. 2003. “Pedestrian plazas over Interstate 696 in Oak Park, Michigan.” Retrieved May 16th, 2019, from https://commons.wikimedia.org/wiki/File:Interstate_696_pedestrian_plazas_Oak_Park.jpg.

Moselle, Ben. 2020 “National Building Cost Manual: 44th Edition. Craftsman Book Company.” https://www.craftsman-book.com/media/static/previews/ 2020_NBC_book_preview.pdf, page 9.

National Right to Work Committee. 2018. “Right to Work States Timeline.” https://nrtwc.org/facts/state-right-to-work-timeline-2016/.

Pierson, Kawika, Michael Hand, and Fred Thompson. 2015. “The Government Finance Database, United States: A Common Resource for Quantitative Research in Public Financial Analysis.” *PLoS ONE.* doi.org/10.1371/journal.pone.0130119.

S&P Global Market Intelligence. 2016. “State General Obligation Debt Ratings.” Unpublished raw data.

Stewart III, Charles and Jonathan Woon. 2017. “Congressional Committee Assignments, 103rd to 114th Congresses, 1993-2017: House and Senate.”

Swift, Elaine K., Brookshire, Robert G., Canon, David T., Fink, Evelyn C., Hibbing, John R., Humes, Brian D., … Martis, Kenneth C. 2009. “Database of [United States] Congressional Historical Statistics, 1789-1989.” Inter-university Consortium for Political and Social Research [distributor], 2009-02-03. https://doi.org/10.3886/ICPSR03371.v2.

U.S. Bureau of Labor Statistics (BLS). 2011. "PPI Industry Data - Discontinued Series (NAICS basis)." Retrieved from https://data.bls.gov/timeseries/NDUBHWY--BHWY--.

U.S. Census Bureau. 1971. "1967 Census of Construction Industries." Retrieved from https://babel.hathitrust.org/cgi/pt?id=umn.31951p010921839&view=1up&seq=52.

U.S. Census Bureau. 1976. "1972 Census of Construction Industries." Retrieved from https://archive.org/details/1972censusofcons01unit/page/n103/mode/2up?view=theater. pg. 105.

U.S. Census Bureau. 1981. "1977 Census of Construction Industries." Retrieved from https://ia902606.us.archive.org/34/items/1977censusofcons00unse/1977censusofcons00unse.pdf. pg. 6-4.

U.S. Census Bureau. 1984. "1982 Census of Construction Industries." Retrieved from https://ia800302.us.archive.org/30/items/1982censusofcons826uns/1982censusofcons826uns.pdf (last accessed June 3, 2021). pg. 4-5.

U.S. Census Bureau. 1990. "1987 Census of Construction Industries." Retrieved from https://ia800604.us.archive.org/35/items/1987censusofcon876unse/1987censusofcon876unse.pdf. pg. 6-5.

U.S. Census Bureau. 1995. "1992 Census of Construction Industries." Retrieved from https://www2.census.gov/library/publications/economic-census/1992/construction-industry/industry-series/cci06f.pdf. pg. 16-17.

U.S. Census Bureau. 2006a. "Census of Population and Housing, 1970 [United States]: Summary Statistic File 4C -- Population [Fourth Count]." Inter-university Consortium for Political and Social Research. https://doi.org/10.3886/ICPSR08107.v2

U.S. Census Bureau. 2006b. "Census of Population and Housing, 1970 [United States]: Summary Statistic File 4C -- Housing [Fourth Count]." *Inter-university Consortium for Political and Social Research*. https://doi.org/10.3886/ICPSR08129.v1

U.S. Census Bureau. 2006c. "Census of Population and Housing, 1970 [United States]: Summary Statistic File 4A -- Population [Fourth Count]." Inter-university Consortium for Political and Social Research. https://doi.org/10.3886/ICPSR09014.v2

U.S. Census Bureau. 2006d. "Census of Population and Housing, 1970 [United States]: Summary Statistic File 4A -- Housing [Fourth Count]." *Inter-university Consortium for Political and Social Research*. https://doi.org/10.3886/ICPSR08126.v1

U.S. Census Bureau. 2006e. "Census of Population and Housing, 1990 [United States]: Summary Tape File 3A." Inter-university Consortium for Political and Social Research. https://doi.org/10.3886/ICPSR09782.v1

U.S. Census Bureau. 2008b. “Census of Population and Housing, 1980 [United States]: Summary Tape File 3A.” Inter-university Consortium for Political and Social Research. https://doi.org/10.3886/ICPSR08071.v1

U.S. Census Bureau. 2017. “Cartographic Boundary Files – Shapefile. MAF-TIGER Geographic Database.” Retrieved from https://www2.census.gov/geo/tiger/GENZ2017/shp/cb_2017_us_nation_5m.zip.

Violette, David. 2018. “Relative Bond Value by Rating.” Muni Fortnightly.

Appendix B - Cleaning Interstate Expenditures Measure

The basis of our measure of spending on Interstates is the “Interstate” column in Table FA-3 of FHWA’s *Highway Statistics* series (FHWA [1956–1995]). To this basic data we make two small revisions because of two changes in the Interstate funding laws that led a small portion of expenditures from Table FA-3 to be used on non-Interstate projects. These two changes were first the introduction of the Interstate Withdrawal-Substitution Program and second the requirement, starting in 1982, that all states receive at least half a percent of each year’s apportionment (the “Minimum Apportionment”). In what follows, we outline these two programs and explain the changes we made to our Interstate expenditures measure to account for these two changes. We end by discussing a small third feature for which we do not account, which could lead to a small underestimate of spending in the final years.

I. Legislative History

a. Interstate Withdrawal-Substitution Program

The Interstate Withdrawal-Substitution Program came out of states’ desires to deviate from planned Interstate routes. The first such program was the Howard-Cramer Provision of 1968, which allowed states to withdraw planned Interstate routes and replace them with alternate Interstate routes of equal cost.[7] The Federal-Aid Highway Act of 1973 allowed the first substitution from Interstate highway projects to non-Interstate projects. States could withdraw planned highway segments within an urbanized area of the state and instead use the money for mass transit projects in the area.[8] The Federal-Aid Highway Act of 1976 expanded the program scope so that states could also withdraw Interstate segments connecting urbanized areas. The Act also allowed states to use the money from the withdrawn portion for non-Interstate highway projects.[9]

Save for a slight modification in the Federal-Aid Highway Act of 1978 that prohibited the withdrawal of Interstate segments after September 30, 1983,[10] the next major change in the Withdrawal-Substitution Program occurred with the Surface Transportation Assistance Act of 1982. Before the passage of that law, the money from withdrawn segments was available to be

[7] Pub. L. 90-238.
[8] Federal-Aid Highway Act of 1973, Pub. L. 93-87, § 137(b).
[9] Federal-Aid Highway Act of 1976, Pub. L. 94-280, § 110(a).
[10] Federal-Aid Highway Act of 1978, Pub. L. 95-599, § 107(b).

obligated at any time.[11] After the passage of the 1982 law, the government made available set amounts of money each year for substitution projects: 25 percent of each year's funds were to be allocated at the discretion of the Department of Transportation. The other 75 percent of the funds were allocated by formula: states were apportioned the fraction of the money that corresponded to the cost-to-complete estimates of their substitute projects as a fraction of the cost-to-complete estimates for all substitute projects in the country. States were apportioned this money using this formula for fiscal years 1984 through 1991. The money apportioned was available to be obligated for two years, after which that money would be withdrawn. Finally, the law allowed states to withdraw and substitute planned rural Interstate segments.[12]

The last change to the Withdrawal-Substitution Program came with the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). Section 1011 of the law apportioned money through fiscal year 1995 and also changed the apportionment rules so that all of the money would be allocated according to the formula based on the substitute project cost estimates of the states. The law made the money apportioned in 1995 available until obligated, meaning the previous two-year timer was not put in place for 1995. Fiscal year 1995 was the last year in which the US apportioned money to states for highway substitute programs.

The concern, then, is that Interstate expenditure tabulations over this period include funds used for substitute projects. Indeed, in the raw data, we see large expenditures when states are not building Interstates but withdrawals under the Withdrawal-Substitution Program are large. For example, by 1982, Rhode Island had withdrawn from building any more Interstate mileage in the face of popular opposition (FHWA 1998a), but it still had large "Interstate" outlays in Table FA-3. At the same time, data that we digitized on these withdrawals shows that Rhode Island, in fact, had withdrawals of $592 million.

The one exception in the data is that it appears that mass transit projects that were funded with withdrawn funds were, in fact, excluded from the FA-3 Interstate spending category. For example, according to Table FA-3, Massachusetts spent around $100 million a year from 1974 to 1987 while opening over 30 miles of Interstate—approximately $1.4 billion dollars in total. But our data show that Massachusetts withdrew Interstate projects in 1974 and obligated around $1.5 billion dollars from this withdrawal to transit projects (FHWA 1998a). As a result, if this funding were included in the Interstate funding, it would mean that Massachusetts spent virtually nothing on its Interstates, which is implausible. This distinction between transit and non-transit projects may be due to language in the Withdrawal-Substitution Program providing that "sums obligated for mass transit projects shall become part of, and administered through, the Urban Mass Transportation Fund,"[13] meaning that the money was no longer considered highway money.

b. Minimum Apportionment

The Minimum Apportionment rule in Interstate funding required that states receive at least 0.5% of the total money apportioned to all states every year. In general, if states had finished building their Interstates, they were allowed to spend the money on any other Federal-Aid highway. The rule was first put in place with the Federal-Aid Highway Act of 1970 for fiscal years 1972 and 1973, though the law did not specify what states could do with money that

[11] 1976 U.S.C. 23 § 103(e)(4).
[12] 1988 U.S.C. 23 § 103(e)(4).
[13] *Id.*

exceeded the cost to complete their Interstate systems.[14] Starting with the Federal-Aid Highway Act of 1973, highway legislation extended the Minimum Apportionment rule through fiscal year 1990 and specified that money apportioned under this rule that exceeded the cost to complete the Interstate highway system could be spent on other Federal-Aid highways.[15]

The law left the procedure for tracking the money apportioned under this rule ambiguous. The early laws establishing the Minimum Apportionment rule suggest that money that exceeded the cost to complete the Interstate system would be reapportioned to the other Federal-Aid highway categories. For example, Section 104(b) of the Federal-Aid Highway Act of 1973 states,

> Whenever such amounts made available for the Interstate System in any State exceed the cost of completing that State's portion of the Interstate System, the excess amount shall be transferred to and added to the amounts apportioned to such State under paragraphs (1), (2), (3), and (6) of subsection (b) of section 104 of title 23, United States Code, in the ratio which these respective amounts bear to each other in that State.

The law thus leaves open the possibility that money given to a state under the Minimum Apportionment rule that exceeded cost-to-complete would not be considered "Interstate" money, but rather that it would be tracked according to its reapportioned Federal-Aid category. However, the Federal-Aid Highway Act of 1978 removed the language about reapportionment to simply say "the excess amount shall be eligible for expenditure for those purposes for which funds apportioned [for other Federal-Aid highway categories] may be expended,"[16] which leaves open the possibility that Interstate apportioned funds spent on other Federal-Aid Highways were considered Interstate expenditures for Table FA-3 purposes.

Ideally, if states spent Interstate apportionment money for purposes other than Interstate construction, the expenditure would have been recorded in the appropriate category rather than the Interstate expenditure FA-3 category. This does not appear to be the case. For example, North Dakota did not open new Interstate mileage after 1977 and had a cost to complete their highway system of zero after at least 1982 (DOT 1983). Despite that, the state regularly recorded yearly Table FA-3 Interstate expenditures above $10 million throughout the 1980s. Something similar occurred in Delaware, which regularly recorded yearly Interstate expenditures above $10 million in the 1980s despite also having a cost to complete of zero since at least 1982 (DOT 1983).

II. Accounting for the Data Issues as a Result of the Two Programs

a. Interstate Withdrawal-Substitution Program

In order to strip the Table FA-3 Interstate highway expenditure data of money likely spent on non-Interstate substitute projects, we employ three data sources. First, we digitized data

[14] *Id.* § 105(b).
[15] The Federal-Aid Highway Act of 1973 Section 104(b) extended for fiscal years 1974-1976; the Federal-Aid Highway Act of 1976 Section 105(b)(1) extended for fiscal years 1978 and 1979; the Federal-Aid Highway Act of 1978 Section 104(b)(1) extended for fiscal years 1980-1983; the Surface Transportation Assistance Act of 1982 Section 103(a) extended for fiscal years 1984-1987; the ISTEA extended for fiscal years 1988-1990.
[16] 1988 U.S.C. 23 § 104(b)(1).

from the FHWA's Office of Engineering on how much money each state obligated to substitute highway projects and when they withdrew their Interstate sections.[17] Second, Table FA-3's Interstate Highway Substitute expenditure variable tracks how much substitute money was spent after 1991 (FHWA 1998b). And, third, Table FA-4's Interstate Highway Substitute apportionment data[18] is available from the years 1983 to 1994, meaning that it is the apportionments for fiscal years 1985-1996.

Between the three data sources, we can determine the total amount of substitute expenditures that must be recorded in the Table FA-3 Interstate highway expenditure variable prior to 1992 (when substitute expenditures began to be tallied separately) and roughly when those expenditures occurred. In the following algorithm Steps (1) – (5), we use the difference between apportionment and later expenditure to back out the amount spent on substitute projects from 1985-1991 that must be erroneously included in the Table FA-3 Interstate expenditure variable. In Steps (6) – (8), we find the amount that states obligated to substitute projects in excess of the amount apportioned (having already corrected for the apportioned amount) in the years from when they withdrew their segments through 1991. Both sums we subtract from the Table FA-3 Interstate expenditure variable so that our resulting variable reflects only Interstate spending and not money spent on substitute projects.

Withdrawal-Substitution Algorithm

1. Calculate total amount apportioned for the Interstate Highway Substitute.
2. Calculate total amount of Interstate Highway Substitute expenditure. This is a variable that runs from 1992 to 2014.
3. Calculate the amount that must have been spent in the years 1985 to 1991. This is Step (1) – Step (2). The idea is that, if states were apportioned the money and did not spend it in the years after 1991, the money must have been spent between 1985 and 1991. It is possible that the money could have been apportioned but never used, but we assume the amount of such money is negligible.
4. We impute the minimum amount spent on substitute projects each year from 1985 to 1991 using the following method:[19]
    a. Calculate the sum of apportionments for 1985 through 1991.
    b. Calculate the apportionment of each year from 1985 through 1991 as a percentage of Step (4a).
    c. Because apportionments in a few states drop off very quickly (much more quickly than expenditures), if the percentage in either 1990 or 1991 is less than five percent, then replace the amount calculated for that year in (4b) with five percent. The amount added to these years is removed from the other years in proportion to the amount in Step (4b).

[17] Apportionment is the act of dispensing funds to agencies; obligation is the designation of funds to particular goods and services; and expenditure occurs when agencies finally spend the money. See Appendix C for more details.

[18] FHWA's *Highway Statistics* series contains a federal Interstate Highway Substitute expenditure variable in Table FA-3 and a federal Interstate Highway Substitute apportionment variable in Table FA-4. The apportionment variable starts in the first year of apportionment (fiscal year 1984) and continues through 1995. However, the federal expenditure variable for highway substitute projects begins in 1992. We think it is very unlikely that states only started spending money 8 years after they were apportioned it. It is more likely that FHWA only started tracking these expenditures in 1992.

[19] An alternate method we explored was to set this to be the average yearly amount of Step (3). However, sometimes this would lead to more money being spent than had been apportioned.

    d. Calculate the minimum amount spent on substitute projects each year by multiplying Step (3) by Step (4c).
5. Remove the minimum substitution amount results from Step (4) from Table FA-3's expenditure variable in each corresponding year.
6. Subtract total highway substitute apportionment (Step (1)) from the total amount obligated to substitute highway projects (from FHWA 1998a). Because most states withdrew their segments before 1985, this amount—the substitute obligations in excess of known apportionments—represents money spent on substitute projects that we have not already accounted for but that could have been spent on substitute projects (and then recorded in the Table FA-3 Interstate expenditure variable) any year from the date of withdrawal to 1991.
7. Using this difference between highway substitute obligation and apportionment (Step (6)), we determine the maximum amount of Interstate expenditures from Table FA-3 (as modified in Step (5)) that was likely spent on Interstates specifically each year. In other words, we adjust the Interstate expenditure variable for the remaining amount of money that may have actually gone toward substitute projects. We do this in the following steps:
    a. Find the total amount of reported Interstate expenditure over this period by summing the Table FA-3 Interstate expenditure variable from the year of segment withdrawal to 1991.
    b. For each state, find the maximum amount recorded in the Table FA-3 Interstate expenditure variable over the time period when we know the amount found in Step (6) could have been spent, namely from the date of withdrawal to 1991.
    c. Find the average amount that a state could have spent on substitute projects but that is still contained in the Table FA-3 Interstate expenditure variable: Divide the amount found in Step (6) by the number of years in which it could have been spent, again from withdrawal to 1991.
    d. Find what we consider the maximum amount a state could have spent on Interstates alone each year by subtracting the amount found in Step (7c) from Step (7b).
    e. Use the value found in Step (7d) as a provisional ceiling for the portion of the Table FA-3 Interstate expenditure variable that we consider Interstate spending only.
    f. Record the difference between the initial overall Interstate expenditure variable (Step (7a)) and the new amount using the ceiling in (7e). For the first iteration, only the year of the maximum Interstate expenditure (as found in Step (7b)) will be affected and the total difference will equal the amount found in Step (7c).
    g. Subtract this amount purged from the overall expenditure tally, Step (7f), from the total amount spent on substitution programs but still contained in the FA-3 Interstate expenditure variable (Step (6)).
    h. Repeat Steps (7c) – (7g) until the amount of Interstate-only expenditure (from the Table FA-3 expenditure variable, see Step (7e)) has decreased overall by an amount roughly equal to the amount found in Step (6).
    i. Record the final ceiling value (Step (7d)).

8. Set the amount from Step (7i) as the ceiling for expenditures from the year of first withdrawal to 1991.[20]

b. Minimum Apportionment

To account for non-Interstate spending as a result of the Minimum Apportionment rule, we used the Interstate Cost Estimates (ICEs) produced by the FHWA, which we digitized (FHWA [1958–1991]). These were fifteen reports produced between 1958 and 1991 that were used to determine the distribution of each year's Interstate apportionment among the states. Crucially, states could spend money apportioned for Interstate construction on other kinds of highways only if the amount they were apportioned in a given year as a result of the Minimum Apportionment rule exceeded the cost to complete their Interstate system as reported in the most recent ICE. We use the cost-to-complete estimates from the ICEs to determine when states could have begun spending Interstate Minimum Apportionment money on non-Interstate projects and remove all spending that can plausibly be attributed as non-Interstate spending.

Minimum Apportionment Algorithm

1. Take the expenditures measure that has been cleaned of Withdrawal-Substitution spending as detailed above.
2. For the years in which the Minimum Apportionment Rule was in effect (1982 and on), impute the cost to complete (C2C) as reported in the ICE. The ICEs were only produced at the request of Congress, usually every two or three years. To determine the C2C of a state's system in a year in which an ICE was not produced, multiply the previous year's C2C by the miles not yet completed at the end of the current year divided by the number of miles not yet completed at the end of the previous year.
3. Identify the years in which the interpolated C2C was less than the amount apportioned for that year.
4. If a year *x* satisfies (3), then replace that year's Interstate expenditure with [year *x* C2C - year *x-1* C2C] (that is, the amount by which the estimated C2C decreased year over year), so long as the resulting value is less than the given state's spending in year *x*.
5. For the small number of cases in which miles are built after the C2C is zero, we assume negligible spending on those miles after the C2C went to zero, so we reassign the miles to the last year in which miles were opened before C2C went to zero.
6. Since Interstate Cost Estimates only go until 1990, we assume that the ICE for 1991, 1992, and 1993 is also zero if 1990 is zero. Otherwise, we make no guesses about the ICE. Therefore, we make no changes in expenditures for states for which the 1990 C2C is more than zero.

III. Results

Figure B1 below shows the evolution of the Interstate expenditure measure after we account for the Withdrawal-Substitution program and the Minimum Apportionment rule. The blue line represents the original Interstate expenditure measure from the *Highway Statistics*

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[20] There are two reasons why we consider expenditures from date of withdrawal to 1991 and not just until 1983. First, money can be spent many years after it is obligated. Second, states could have received money from the 25-percent discretionary fund of the FHWA, not just the apportionments by formula (see Section I(a) of this Appendix).

series. The red line shows the Interstate expenditure measure after adjusting for highway substitution, and the green line shows expenditures after adjusting for both highway substitution and the minimum. The lines begin to diverge in the mid-1970s, but the period of largest divergence occurs in the second half of the 1980s.

Figure B2 shows the share of the original total US Interstate real expenditures removed by accounting for the Withdrawal-Substitution Program and the Minimum Apportionment Rule. The share removed due to the Substitution program was less than ten percent each year from 1977 to 1984. After 1984 there was a surge in the removal, with the share removed as a result of the Substitution program never dipping below ten percent through 1991. Since the Interstate Highway Substitute variable in the *Highway Statistics* series starts in 1992, there was no more removal as a result of the Substitution program after 1991. The amount of real expenditures removed due to the Minimum Apportionment program was smaller than the amount removed by the Substitution program, but it grew over time. In total, the share of real expenditures removed by the Substitution program from 1977 to 1993 is 7.7 percent, while the share removed because of Minimum Apportionment rule is three percent.

We make a couple of notes about the final expenditure measure that we derived based on the methodology described above. First, it is much more reliable when considered over a period of years than when considered on a year-by-year basis. While we know how much a state that substituted spent on highway substitution, we do not know exactly how much was spent each year on substitution projects. Our method for dealing with this issue depends on the year of the money spent, but it requires either assuming that a year's substitute expenditure was correlated with that year's apportionment (see step 4 in the Substitution algorithm) or assuming that the years of highest expenditure between the year of withdrawal and 1991 were the years that contained the substitution expenses. Neither of these approaches guarantees that we will pin down the correct substitution expenditure in a given year.

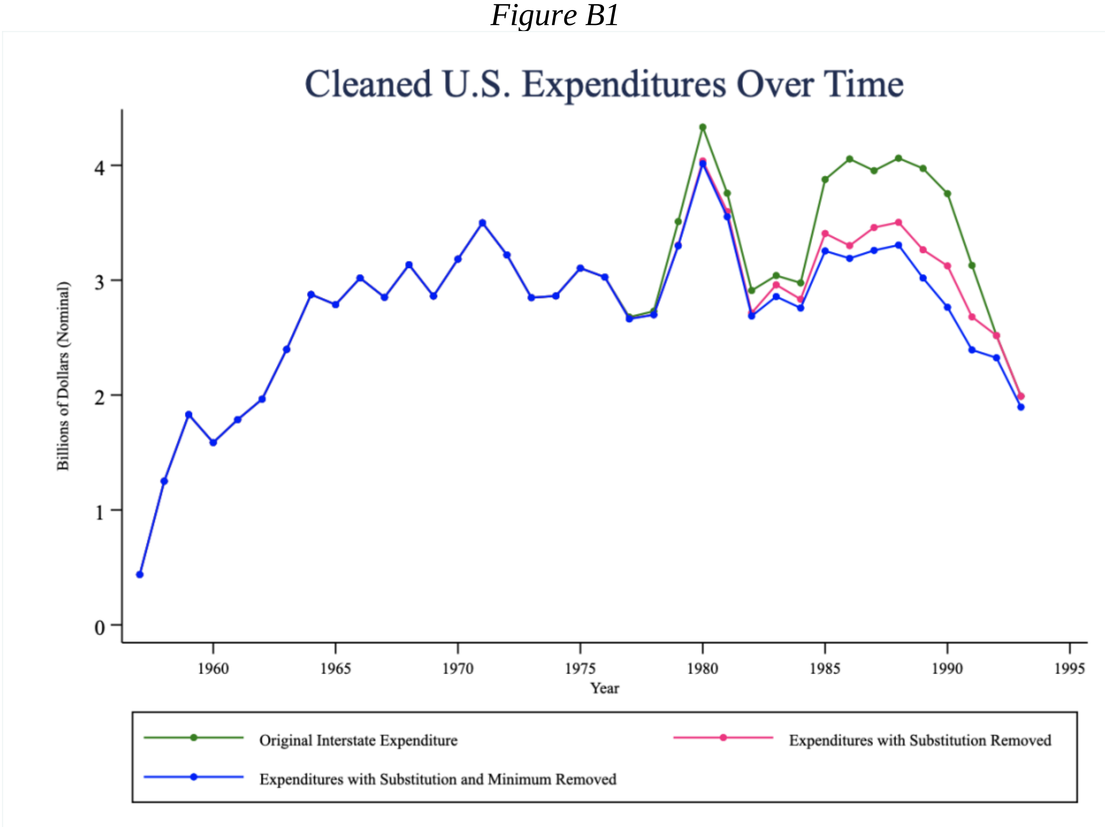
Second, we may be overestimating the amount to be removed as a result of the Minimum Apportionment program. Our method for dealing with the minimum issue is to use the Interstate Cost Estimates from the FHWA. When a state begins to receive more in apportionment than they need to complete their interstate system, we replace its expenditure with the (imputed, based on completed mileage) change in that state's estimated cost to complete as reported in the ICE. If there were cost overruns in a state for an Interstate project, then we would be underestimating the amount of actual Interstate expenditure in that state. The effect of this measurement error is likely to be very small, as the amount subtracted from expenditures due to this factor is small, as shown in Figure B1, so the effect of overestimating it somewhat is yet smaller in magnitude. Finally, one countervailing factor, as we explain in the next section, is that a separate rule may cause a small amount of underestimation of Interstate spending.

IV. Minimum Federal-Aid Percentage Allocation

Similar to the Minimum Apportionment rule, the Minimum Federal-Aid Percentage Allocation ("minimum percentage rule") required that the sum of all federal-aid funds provided to states in a given year comprise a minimum percentage of the amount of taxes the drivers in that state paid towards the Highway Trust Fund in the fiscal year with the latest available data. States in which the funding formulas for the different kinds of federal-aid funding produced apportionments that were lower than the minimum percentage of taxes paid to the Highway Trust Fund received an additional apportionment that would cover the difference. Money apportioned as a result of this rule could be spent on any road that was eligible for federal-aid funding. The rule was first put in place in fiscal year 1982, when the minimum percentage was set at 85 percent. That minimum percentage stayed until 1992, when it was increased to 90 percent.[21]

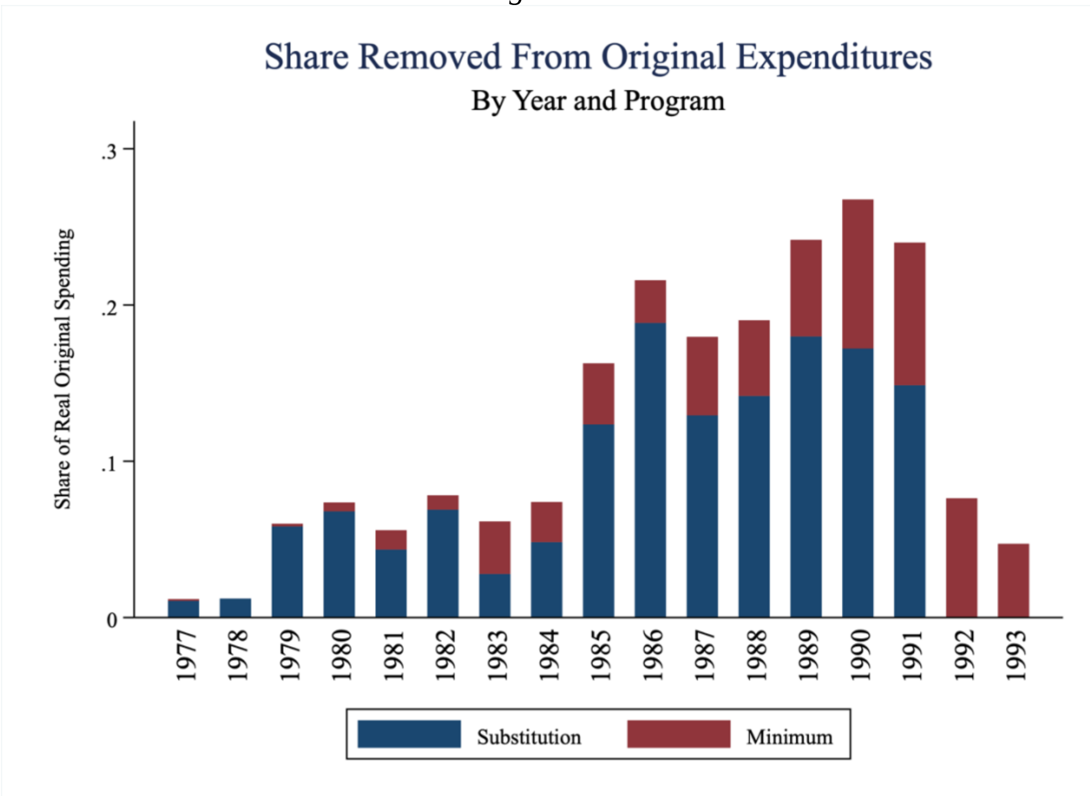
The *Highway Statistics* series tracks the amount of money apportioned due to the minimum percentage rule as a separate variable. It also tracks the expenditure of this money separately from the spending of the specific categories. We therefore cannot know what category of Federal-Aid highways the money was spent on. It could have been spent on Interstates, but it could have also been spent on Federal-Aid Primary, Secondary, or Urban roads, among others. As a result, we likely underestimate the amount of money spent on Interstates. In addition to not knowing how much of the money was spent on Interstates, it is difficult to remove the effects of this money since the time between obligation and expenditure is uncertain, and the states could have not obligated the money at all. Between 1982 and 1994, no more than 19 states received an apportionment under the minimum percentage rule in any given year, with at least seven states receiving the money every year. From 1982 to 1993, expenditures of money apportioned as part of the minimum percentage rule were 20.6% percent of the cleaned measure of Interstate highway expenditures. We think that this rule does not lead to a large amount of mismeasurement though because, by this point, states were overwhelmingly spending their Federal-Aid funds on projects other than Interstates.

Figure B1



[21] The exact wording and yearly requirements are in the Highway Improvement Act of 1982 Section 150(a) for fiscal years 1982-1986. For fiscal years 1987-onward, they are contained in the 1994 U.S. Code Section 157(a).

Figure B2



Appendix C – International Data

Our goal in this data collection was to gather available data on the per mile construction spending on completed, new, non-gravel highways outside of the United States. Importantly, we limited our search to projects that report completed, rather than projected or contracted, costs.

In all cases, we convert the original currency to US dollars using the Fxtop historical currency converter[22] and transform dollar figures to real 2016 dollars using the CPI-U as we do for the main dependent variable (Interstate spending per mile). We express all distances in miles, and we report spending per mile. (When raw data are in lane-miles, we adjust for the number of lanes.)

To make the data comparable with our US data, we report spending per mile in the same six-year periods as for our US data. In each six-year period, we report the weighted average cost for all projects in that country, where the weights are each project's mileage. The corresponding year value in the plot is the miles-weighted average of project completion years for that country.

We found data from many sources. Most of the data come from the Road Costs Knowledge System (ROCKS) database published by the World Bank, and the rest come from other sources. We review each in turn.

The ROCKS database systematically categorizes road works and provides unit cost data on road work costs per kilometer in low- and middle-income countries. "Version 2" contains

[22] Available at https://fxtop.com/en/historical-currency-converter.php.

projects from 1996 to 2006.[23] The database was updated in 2018, adding projects from to 1999-2016.[24] In ROCKS version 2, there are 74 relevant projects, yielding 17 datapoints after averaging to six-year periods.[25] In the ROCKS 2018 update, there are 33 relevant projects, yielding 12 datapoints in the six-year periods.

In addition to ROCKS, we collect eight cost datapoints that we report in the table below. We find most of these points in project completion reports, cost estimates audits commissioned by government transportation bureaus, and news articles.

[23] Available at https://www.doingbusiness.org/en/reports/thematic-reports/road-costs-knowledge-system.

[24] Available at https://collaboration.worldbank.org/content/sites/collaboration-for-development/en/groups/world-bank-road-software-tools.html.

[25] We keep only those whose worktype contains "new." We then drop those whose worktype contains "road," leaving only "new . . . expressway" and "new . . . highway." We then drop those with "gravel."

Table: Other International Cost Data

Country	Year	Raw spending figure	Clean: USD (2016) per mile	Source	Notes
Germany: Autobahn	1970	2,600,000 USD (1970) /mi	$16,049,344	Stueck, Hans J. 1970. "West Germany Modernizing 1,310 Miles of Old Autobahns." *New York Times,* Jan. 4, 1970. https://www.nytimes.com/1970/01/04/archives/west-germany-modernizing-1310-miles-of-old-autobahns.html.	These costs are high for many reasons. The article says: "Most run from west to east for rapid troop movements and have steep grades, up to 8 per cent. The Interstate Highway System in the United States has maximum grades of 3 per cent. . . . In mountainous central and southern Germany, some of the projects require up to 40 per cent of costs for bridges over rivers, railroads and low-lying built-up areas. . . . In the beautiful conutryside [sic] of mountainous southern Germany strict observance of ['embedding the highways into the scenery'] has cost millions of additional Deutsche marks."
South Korea: Gyeongbu Highway	1970	42.973 billion KRW (1970) / entire 430-km project	$1,234,556	Korea International Cooperation Agency. 2004. "Construction of the Gyeongbu National Expressway." *K-Developedia.* https://www.kdevelopedia.org/Development-Overview/official-aid/construction-gyeongbu-national-expressway--201412070000343.do?fldRoot=TP_ODA&subCate%E2%80%A6. Notes from Jeon, Chihyung. 2010. "A Road to Modernization and Unification: The Construction of the Gyeongbu Highway in South Korea." *Technology and Culture* 51(1), p. 66.	This was planned to be very cheap. "First, at least in principle, the route was designed to follow the shortest path between Seoul and Busan, keeping tunnels and bridges to a minimum for the sake of time and money. Second, due to budgetary constraints, engineers designed the Gyeongbu Highway with insufficient depth and width. The basic concept of the project was so-called stage construction, which aimed to build the highway with minimum initial investment and, when increased traffic flow began to cause problems, to perform repairs accordingly."
Cameroon: Connecting roads between Bafoussam and Foumbot	1998	220.890 million CFAF (1997) for 3.9-km stretch of new road.	$153,533	African Development Bank. 1998. "Republic of Cameroon Bafoussam-Foumban Road Project, Project Completion Report." https://www.afdb.org/fileadmin/uploads/afdb/Documents/Project-and-Operations/ADB-BD-IF-99-253-EN-CAMEROON-PCR-BAFOUSSAM-FOUMBAN-ROAD-PROJECT.PDF, p. 6, Table 4.6.1.	This estimate is specifically for the new road construction portion of the Bafoussam-Foumban Road Project.

Botswana: Trans-Kgalagadi Road Project	1998	94,605 USD (2006)/ lane km	$139,959	African Development Bank. 2014. "Study on Road Infrastructure Costs: Analysis of Unit Costs and Cost Overruns of Road Infrastructure Projects in Africa." *AfDB Market Study Series*, May 2014. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/Study_on_Road_Infrastructure_Costs-_Analysis_of_Unit_Costs_and_Cost_Overruns_of_Road_Infrastructure_Projects_in_Africa.pdf **(hereinafter "AfDB Study")**, p. 40.	The Kang to Ghanzi Junction (221 km) of the 589km road between Sekoma and Mamuno.
Mauritius: South-Eastern Highway Project	2008	1,419,591 USD (2006)/ lane km	$2,100,324	AfDB Study, p. 37. Descriptions given by https://projectsportal.afdb.org/dataportal/VProject/show/P-MU-DB0-007.	Part of the National Physical Development Plan (NPDP). Consists of the upgrading of the Ferney Community Centre-Ferney Sugar Estate (2.34 km) and Kewal Nagar-Bel Air (8.69 km) and the new construction of Mahebourg Ferney Community Centre (6.19 km) and Ferney Sugar Estate-Kewal Nagar (7.83 km) segments.
Ghana: Apedwa-Bunso Road	2008	553,799 USD (2006)/ lane km	$819,362	AfDB Study, p. 37.	Construction of the 21.8km Apedwa–Bunso Section of the Achimota–Anyinam Road.
Czech Republic: multiple-lane highways average	2012	14,570,000 EUR (2012) /km	$12,185,640	Heralova, Renata S., Eduard Hromada, and Hal Johnston. 2014. "Cost Structure of the Highway Projects in the Czech Republic." *Procedia Engineering* 85, p. 225, Table 1.	The year 2012 is estimated because it says "[r]ecently built" in 2014. Includes preliminary engineering, right of way and utilities, and construction costs.
Australia: average based on completed motorways	2015	5,400,000 AUD (2017) /lane km.	$10,154,233	Australian Government Bureau of Infrastructure, Transport and Regional Economics (BITRE). 2018. "Road Construction Cost and Infrastructure Procurement Benchmarking: 2017 Update." BITRE, Canberra ACT. https://www.bitre.gov.au/sites/default/files/rr148.pdf, p. v.	We estimate that the average motorway in Australia is a dual carriageway, i.e., 4 lanes.

Appendix D - Additional Background Detail on the Interstates

Funding Structure

Once apportioned, Interstate funding was available to the states for obligation on a per-Interstate-project basis. An obligation is a guarantee from the federal government to reimburse a state for the eligible portion of a project's cost. To obtain an obligation, states[26] submitted specific projects for FHWA approval (FHWA 1983). States generally had a two-year time limit to apply for funding and receive an obligation. If a state failed to obligate apportioned funds within that time period, then the apportioned funds would be revoked and apportioned to other states on the basis of the funding formula. Once a project was approved by the FHWA, the state was free to begin work on the Interstate project. Whether a state was reimbursed over the course of the project or upon the project's completion varied over time and by state, but states were generally reimbursed for expenditures upon the submission and certification of vouchers documenting their expenditures for the FHWA (FHWA 1983; Manes 1964).

This entire apportionment-obligation-expenditure process had a varying and uncertain time window. While states could wait no more than two years between apportionment and obligation before they would lose funding, the time period between obligation and expenditure was less certain. There was generally no limit between the date of obligation and date of expenditure, though states sometimes had to meet timelines for the start (but not completion) of construction.[27] If an approved project was delayed, for example, there could be a long gap between the date of expenditure and the date of actual reimbursement.

To better understand states' spending incentives, we provide more detail on this funding process. We begin with discussing the process of annual apportionment to and across states, and then we analyze the determinants of the timing of state spending. Crudely, the federal government financed Interstate construction via the revenue generated by the portion of the federal gas tax dedicated to highway funding. This revenue was credited to the Federal Highway Trust Fund and was apportioned among the states by formula (Weingroff 1996). The Byrd Amendment to the Federal-Aid Highway Act of 1956 prevented the program from running a deficit by requiring the Secretary of Commerce "to reduce the apportionments to each of the States on a pro rata basis" when a deficit existed (Congressional Quarterly Almanac 1956). This amendment, together with increased costs, required occasional increases in the gas tax, as well as the imposition of new taxes (FHWA 2017b). The last Interstate construction funds were apportioned in the 1996 fiscal year (FHWA 2017a).

In form, the Interstate construction program was reimbursable, meaning that the federal government paid states back for money spent on building the Interstates (FHWA 1983). The

[26] Later, after the passage of the Federal-Aid Highway Act of 1973, incorporated cities could also submit Interstate projects for Federal matching if 1) the relevant highway segments were designated as part of the Interstate system as of June 1, 1973, 2) the segments were entirely within the boundaries of the city, and 3) the city could pay the nonfederal share. 23 U.S.C. § 103(h) (1976) (as amended in 1973 by Federal-Aid Highway Act of 1973 § 110, Pub. L. No. 93-87, 87 Stat. 250, 256 (1973)).

[27] For example, projects that made use of the federal government's so-called "right-of-way revolving fund," which provided advance funding for land acquisition, were required for a time to commence construction on the purchased land not less than two years and not more than seven years from the end of the fiscal year in which the funds were approved. Federal-Aid Highways Act of 1968 § 7(b), Pub. L. 90-495, 82 Stat. 815, 818-19 (1968) (codified at 23 U.S.C. § 108(c)(3), amended 1973, repealed 1998).

process generally worked in the following manner. First, Congress annually authorized an amount of money for Interstate construction based on the estimated System completion cost and the funds available in the Highway Trust Fund. Next, this money was apportioned to the states.[28]

For all years after the first three,[29] states were apportioned funds in proportion to the estimated cost to complete their remaining planned Interstate mileage. Congress relied on state submissions of "Interstate Cost Estimates," which were prepared with federal oversight and which contained detailed estimates of costs by input (e.g., right of way purchase, planning, and construction) for planned Interstate segments (e.g., a two-mile segment of I-10) (Weingroff 1996). Congress required these submissions roughly every two to three years from 1958 to 1991.

Changes in Interstate Standards over Time

The only substantive change to federal highway standards of which we are aware is increased capacity requirements over time. This standard was put in place by the Federal-Aid Highway Act of 1966 and codified in 23 USC § 109(b). Prior to the enactment of this legislation, certain Interstate segments (rural, lightly traveled ones) were allowed to be constructed to a two-lane standard (one lane in each direction) and still receive full federal funding. The 1966 Act required that these lanes be brought up to the four-lane standard. This may contaminate our spending data, though likely only to a small extent. On the basis of congressional hearings over the 1966 Act, spending to upgrade two-lane segments under construction at the time of the legislation's passage was likely included in subsequent years of our expenditure data (Hearings 1965, Hearings 1966). But the hearings, as well as the 1968 Interstate Cost Estimate, suggest that this would have amounted to $335 million (DOT 1968, p. 12). Since this money was provided in the 1968 apportionment, inflating from 1969 to 2016 dollars provides a lower bound of approximately $2.19 billion (2016 USD) of possible additional spending. Because this is so small relative to the $504 billion (2016 USD) spent over the course of Interstate construction, we think it is unlikely to bias our estimates of cost change over time. As well, our analysis on the number of lanes in Appendix Table A5 shows that the number of lanes explains almost none of the cost increase.

Other changes to Interstate highway design standards included (1) increased specificity about the paving and design of highway shoulders between 1967 and 1991; (2) the reduction in median width in rural areas from 16 feet wide to 10 feet wide; and (3) a minimum 20-year future lifespan for bridges to remain in service.[30]

Appendix E – Further Evidence on Citizen Voice

[28] A certain amount of this authorized money was deducted to pay for FHWA operations and research (FHWA 1983).

[29] In the first three years of the Interstate program, the annual distribution of apportionments among states was determined by the population, area, and mileage formula used for determining appropriations in a much less ambitious earlier system.

[30] Compare "Geometric Design Standards for the National System of Interstate and Defense Highways," AASHO, 1967 (codified via 39 Fed. Reg. 35145 (1974) at 23 U.S.C. § 625.3(a)(2) (1975)) [hereinafter, DS-2] to DS-4. Additionally, (4) AASHO introduced pavement design standards in 1961, following the AASHO road test. See "Interim Guide for the Design of Flexible Pavement Structures," AASHO, 1961. Notably, much of the interstate system's design standards have remained constant over time. Compare DS-2 to DS-4.

1. Illustrative Example: Interstate Construction in Suburban Detroit

To illustrate how citizen demands, moderated by more responsive institutions, could increase costs, we give the example of a 28-mile stretch of I-696 in Detroit's affluent northern suburbs. It was built in three legs of similar lengths, all of which share a similar geography (Bureau of Public Roads 1955, p. 41; Hundley 1989).[31] The earlier two legs faced little resistance and cost far less than the final leg, which faced significant community resistance. The first leg was completed in 1964 at a cost of $13 million per mile (2016 USD) (Brown 1990; Hundley 1989). The second leg was completed in 1979 at a cost of $48 million per mile (2016 USD) (Brown 1990).[32] The last leg began planning in 1964—the same time as the second leg—and was completed a quarter century later, in 1989. It cost $86 million per mile (2016 USD), roughly seven times the first leg and twice the second leg.

This final leg disrupted a Jewish community around Oak Park, leading to years of community opposition (Center for Urban Transportation Research 1998). Given the prohibition in Judaic law on driving on the weekly Sabbath, an 8-lane highway through the neighborhood would significantly disrupt community members' lives. The community organized and lobbied, and in response, local governments opposed the project on their behalf.

Homeowners exerted especial power through a peculiarity of Michigan state law, which stipulated that the Interstate routes running through cities were subject to city approval.[33] Between the eight cities whose approval was required for the middle leg, the situation grew so tense that Governor George Romney stepped in: "[he] locked squabbling officials in a local community center overnight, and told them he would not let them out until they came to agreement" (Schmidt 1989). Local residents also used the recently enacted National Environmental Policy Act as a tool for highway opposition. According to the *New York Times*, in the 1970s, "foes began using new Federal environmental rules to oppose the road, arguing that it would wreak untold damage" (Schmidt 1989).[34] In addition, in the late 1980s, the state was required to replace 6.5 acres of wetland with eleven new acres (Woodford 1972, p. 54; Associated Press 1987).

The main text describes the outcome. Multiple strands of the rise of citizen voice are present in this story. The rise of community organizations shows the important of the rise of social movements in producing citizen voice. Legislation (NEPA) then gave opponents a judicial toehold for opposition.

2. Highway Attributes

The regression evidence in Appendix Table A8 shows that highway attributes are related

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[31] Furthermore, all three legs were built through fairly dense areas, passing through tracts with population densities above 1,500 people per square mile. That said, the 1960 population density of the western leg (1,657 people per square mile) was less than that of the middle (5,294 people per square mile) and eastern (4,107 people per square mile) legs.

[32] Data are from Baum-Snow (2007). Construction began in 1969-1971.

[33] United States Senate Committee on Public Works Subcommittee on Roads. 1970. *Report on the Status of the Federal-Aid Highway Program Hearing, Ninety-First Congress, Second Session, April 15, 1970*. United States Government Printing Office. Washington, D.C. p. 93.

[34] Furthermore, along I-696 as a whole, a reported 40 percent of homeowners challenged the state-paid relocation packages in court (Hundley 1989).

to higher costs—and are especially so after 1970. We combine elevated highways and ramps into "structure density," but we emphasize that these are only a portion of possible structures. For example, we do not capture tunnels, noise walls (which we do not have geocoded), or highway trenches. Column (1) implies that a one-standard-deviation increase in ramp density is associated with a $6.37 million increase in cost. Column (2) implies that an increase in wiggliness of one standard deviation is associated with a cost increase of $6.31 million.

Additionally, structures and wiggliness are more closely related to higher costs after 1970. For both structure density and wiggliness, we allow the measure to have an additional relationship with spending per mile after 1970. For structure density (column (5)), the post-1970 impact (7.05 = 2.85 + 4.20) is about three times as large as the pre-1970 impact (2.85). For wiggliness (column (6)), the impact again approximately triples, but the standard errors are too large to draw any conclusions. These results are consistent with the hypothesis that citizens are able to demand more expensive types of structures and route modifications after 1970.

Appendix F – Further Description of Cost Drivers with Limited or No Affirmative Evidence

Government Fragmentation: Some researchers suggest that infrastructure in the United States is more expensive relative to Europe because of the more fragmented governance system in the US. Interstate construction requires the coordination of many different levels of government that may have difficulty efficiently cooperating (Gillette 2001). While we cannot make a US-Europe comparison, we can assess whether greater fragmentation within the US is associated with higher costs. If this hypothesis is true, the number of governments per capita should explain some of the increase in the OB decomposition. We find that the temporal change in costs is little explained by inclusion of the number of governments per capita (Appendix Figure A14; all exact numbers for Appendix Figure A14 are in Appendix Table A3ii. Coefficients are in Appendix Table A4iii). However, the Census of Governments data do not contain all jurisdictions (e.g., many types of special districts), so this result may not reflect the complete picture.

State government quality. Government quality—for example, the effectiveness of government bureaucrats in contracting for construction services—may be linked to Interstate spending per mile. To test this hypothesis, we examine how well the state bond rating explains the cost increase. It does not significantly explain the increase. We take from this analysis that this measure of government quality is not an important driver of infrastructure cost increases.[35] We leave open the possibility that other measures we have not used may be more able to explain the change.

Increased use of labor. Figure 5 above shows that the price of construction labor has been fairly flat over the period. Thus, labor prices do not explain increased costs. However, using more labor per Interstate mile could increase costs. Some claim that "featherbedding," or hiring more workers than necessary for a project, often because of union work rules, is an important

[35] Knight (2002) finds that states' political power over federal transportation funding in Congress predicts transportation spending. We replicate his variables (average representative tenure, percent of representatives in the majority party, and percent of representatives on the transportation-authorization committee). See Appendix Figure A14, which shows that these variables explain very little of the change over time. This is consistent with the largely formulaic allocation of funds.

cost driver (Belman et al. 2007). Unions can demand such work rules in part because of "project labor agreements" signed by states that require union labor.

Appendix Figure A17 presents the share of federal-aid highway construction spending by type from 1966-1993.[36] This spending is amounts incurred by construction contractors, so they exclude land acquisition and planning. The relative amounts spent on the three input factors—materials and supplies; wages; and equipment, overhead, and profits—vary little over time. If anything, the wage bill actually *decreases* as a percent of total highway costs: wages constitute a high of 26 percent in 1971 and fall to around 21 percent of construction expenditures in the 1990s. We thus view it as unlikely that increases in the quantity of construction labor drive the overall cost increase.

To test this theory further, we include in the OB decomposition a variable that measures the likelihood that states mandate or encourage higher quantities of labor usage. We use the presence of "right to work" laws that make unionization more difficult, to account for the strength of the labor movement. As Appendix Figure A14 shows, this variable does not appreciably explain the cost increase.

Construction Industry Market Concentration. Basic economics suggests that increased market concentration may cause an increase in Interstate spending per mile. Recent work has noted long-run increases in market concentration (e.g., De Loecker, Eeckhout, and Unger 2018). A literature specific to state construction procurement offers evidence that builders may be able to manipulate their contracts in ways that increase spending (Bajari and Ye 2003; Gil and Marion 2013; Mochtar and Arditi 2001; Miller 2014).[37] However, whether these procurement practices are associated with increasing Interstate costs over time remains an open question.

Using two data sources (Census of Construction and County Business Patterns), we measure the number of construction establishments by state as an indication of industry concentration over the period.[38] Including the number of construction establishments as explanatory variables in the OB decomposition does not substantially explain the cost increase (Appendix Figure A14).

Notably, however, there are important concerns about these measures of concentration. Though our measures are in per capita terms, the measures do not adjust for the geographic size of the states or the total amount of funds available. Greater spending could attract more entry, especially if the extra spending is on items such as sound walls that are likely to be fulfilled by smaller, more specialized firms.

Economies of scale. Over time, the US produced fewer Interstates, which may have reduced economies of scale and thereby yielded higher spending per mile. That said, the United States continued both building other highways and roads and refurbishing existing ones, likely blunting this effect. One obvious way to test this explanation—associating the number of Interstate miles a state builds in a given period with spending per mile—is, in our opinion, so

[36] Figure A17 applies to all federal-aid primary highways. However, data specific to Interstates, available only until 1978, paint a similar picture in the overlapping years.

[37] Typically, state Departments of Transportation (DOTs) put out a specification with the needed quantities of materials, such as asphalt or guardrails. Construction firms bid a price per item, and the DOT is usually constrained to choose the lowest bidder. This creates an incentive for bidders to underbid on items for which the DOT is overestimating usage and overbid on items for which DOT underestimates usage. Bolotnyy and Vasserman (2019) show that in fact firms do exactly this.

[38] While the number of firms may measure concentration more directly than establishments, the two figures closely track one another: in 2016, for instance, the number of state construction establishments exceeded the number of firms by one percent on average, the maximum difference being three percent (US Census Bureau 2016).

problematic as to be worthless because of the way highway miles were funded. Since the federal government gave states a fixed budget in any year, years with more expensive miles must have fewer miles built. Thus, our data do not allow a test of this plausible hypothesis.

Moral hazard/end of repeated game. It is possible that the design of the Interstate program incentivizes states to build more expensively than they would if covering the entire cost. However, since federal reimbursement was set at 90 percent over the entire course of the Interstate program, it is not clear why the extent of this moral hazard problem would change over the course of building the Interstates.

The economics literature also discusses repeated games as a means of establishing social norms. Using this framework, it is possible to hypothesize that in the infancy of the program, state transportation officials perceived a repeated game in which there were future incentives for current economizing behavior. However, as the end of the repeated game—specifically, the end of the Interstate program—neared, the future benefits from state cost containment may have waned. States may have believed that the federal government would complete the Interstate system regardless of state behavior. At the same time, though, the federal government was funding large shares of many non-Interstate projects—both new mileage and maintenance—that it could use as leverage. If proof of fiscal responsibility was important in this continued relationship, then it is difficult to understand how the end of Interstate construction should therefore yield spending increases over time.[39] In any case, we have not developed empirical tests to better understand this dynamic.

Procurement practices. A sizable economics literature finds that procurement practices matter for spending (e.g., Bajari et al. 2014; Bolotnyy and Vasserman 2019). Unfortunately, we were unable to find cross-state data on procurement practices. We think that this is fruitful area for future research.

References from Appendices D, E, and F

Associated Press. 1987. “Michigan Freeway Link Won’t Smell as Sweet.” *The Junction City Daily Union*. p. 10.

Bajari, Patrick and Lixin Ye. 2003. “Deciding Between Competition and Collusion.” *Review of Economics and Statistics*, 85(4): 971-989.

Belman, Dale, Matthew Bodah, and Peter Philips. 2007. “Project Labor Agreements.” Report for the National Electrical Contractors Association. ELECTRI International. Bethesda, Maryland.

Brown, Warren. 1990. “Home of the American Auto Finds Reuther Freeway a Mixed Blessing.” *The Washington Post*. p. H2.

Bureau of Public Roads. 1955. “Detroit and Environs” (Map). *General Location of National System of Interstate Highways Including All Additional Routes at Urban Areas Designated in September 1955.* Scale not given. Washington, DC: Government Printing Office. p. 41.

[39] Alternatively, norms of thriftiness could have broken down over time.

Center for Urban Transportation Research. 1998. "Community Cohesion: Oak Park, Michigan." *Community Impact Assessment*. University of South Florida.

Congressional Quarterly Almanac. 1956. Vol. XII, p. 403. Washington, D.C.: Congressional Quarterly Research Service.

De Loecker, Jan, Jan Eeckhout, and Gabriel Unger. 2019. "The Rise of Market Power and the Macroeconomic Implications." Working Paper, November 15. http://www.janeeckhout.com/wp-content/uploads/RMP.pdf.

Federal Highway Administration (FHWA). 1983. "Funding Federal-Aid Highways." https://www.fhwa.dot.gov/policy/olsp/fundingfederalaid/.

Federal Highway Administration (FHWA). 2017b. "Highway History." Retrieved September 28, 2018, from https://www.fhwa.dot.gov/infrastructure/gastax.cfm.

Gil, Ricard and Justin Marion. 2013. "Self-Enforcing Agreements and Relational Contracting: Evidence from California Highway Procurement." *The Journal of Law, Economics, and Organization*, 29(2): 239-277.

Gillette, Clayton P. 2001. "Regionalization and Interlocal Bargains." *New York University Law Review*, 76(1): 190-271.

Hearings. 1965. "Hearings Before the Subcommittee on Roads of the Committee on Public Works." United States House Eighty-Ninth Congress, March 23, 1965.

Hearings. 1966. "Hearings Before the Subcommittee on Roads of the Committee on Public Works on S. 3155." United States Senate Eighty-Ninth Congress. https://hdl.handle.net/2027/uc1.$b642562.

Hundley, Tom. 1989. "After 32 Years, Motor City Gets New Lifeline." *Chicago Tribune*, December 15, 1989. p. A6.

Knight, Brian. 2002. "Endogenous Federal Grants and Crowd-Out of State Government Spending: Theory and Evidence from the Federal Highway Aid Program." *American Economic Review* 92(1): 71-92.

Manes, Rene. 1964. "The Grant-In-Aid System for Interstate Highway Construction: An Accounting or Economic Problem?" *The Accounting Review*, 39(3): 631-638.

Miller, Daniel P. 2014. "Subcontracting and Competitive Bidding on Incomplete Procurement Contracts." *The RAND Journal of Economics*, 45(4): 705-746.

Mochtar, Krishna and David Arditi. 2001. "Pricing Strategy in the US Construction Industry." *Construction Management and Economics*, 19(4): 405-415.

United States Senate Committee on Public Works Subcommittee on Roads. 1970. *Report on the Status of the Federal-Aid Highway Program Hearing, Ninety-First Congress, Second Session, April 15, 1970*. United States Government Printing Office. Washington, D.C. p. 93.

Woodford, J. P. 1972. "Draft Environmental Impact Statement for I-696, Lahser Road Easterly to I-75." Michigan Department of State Highways.