The Political Consequences of Spatial Policies: How Interstate Highways Facilitated Geographic Polarization

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In the postwar era, Democratic voters have become increasingly more likely than Republican voters to live in urban counties. Public policies that shape geographic space have been a major contributor to this *geographic polarization*. This article examines the effect of the Interstate Highway System, the largest public works project in American history, on this phenomenon. Drawing on a database of US highway construction since the passage of 1956 highway legislation, it shows that suburban Interstate highways made suburban counties less Democratic, especially in the South and where highways were built earlier. Metropolitan areas with denser Interstate networks also became more polarized. Analysis of the Youth-Parent Socialization Panel Study (1965–97) reveals individual-level mechanisms underlying these changes: Interstates drew more white and affluent residents, who tended to be Republican, to the suburbs.

American partisans are increasingly sorted by population density. While both parties have been suburbanizing for decades, Republicans have become much more likely to live in low-density suburban and exurban areas than Democrats (Gainsborough 2001; Schneider 1992).[1] By multiple measures, metropolitan areas have become more polarized along an urban-to-rural continuum. *Geographic polarization* has grown along with Congressional polarization, income inequality, and residential income segregation (McCarty, Poole, and Rosenthal 2006; Reardon and Bischoff 2011).

Such geographic sorting has influenced the issues that reach the parties' national agendas, distribution of public goods in metropolitan areas (Gerber and Gibson 2009), and translation of votes into legislative seats (Chen and Rodden 2013). Politicians speak to partisan audiences that are sorted not just on policy issues (Levendusky 2009), but also by geography, linking population density to party agendas. In 1968, for example, white swing voters lived in urban counties, and both party platforms devoted hundreds of words to urban policy (Democratic Party 1968; Republican Party 1968a). By 2012, only the Democratic platform presented noted urban issues at any length, while the Republican platform merely accused Democrats of "pursuing an exclusively urban vision of dense housing and government transit" (Baker 2012; Democratic Party 2012; Republican Party 1968b). The urban-suburban divide appears in numerous disputes, including, among others, urban financial autonomy, transportation systems, and electoral reform.

Though the urban-suburban socioeconomic, racial, and partisan divide has been a persistent feature of American politics, its growth in the last half century has been exceptional. Urban-suburban partisan polarization has doubled since World War II and has grown monotonically since 1970. Figure 1 presents the difference in the Democratic vote between the county containing a central city and other counties in the same Census 2000 metropolitan statistical areas (MSAs) with a major city of at least 200,000 persons (Leip 2012), for the country as a whole and for metropolitan areas in and out of the South. Polarization has grown faster in the South but also increased in non-Southern metropolitan areas after 1970.

The urban-suburban political divide has not occurred by chance or through independent individual choice. Pub-

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1. Upon publication, replication data will be made available at http://dvn.iq.harvard.edu/dvn/dv/claynall. Supplementary material for this article is available at the "Supplements" link in the online edition.

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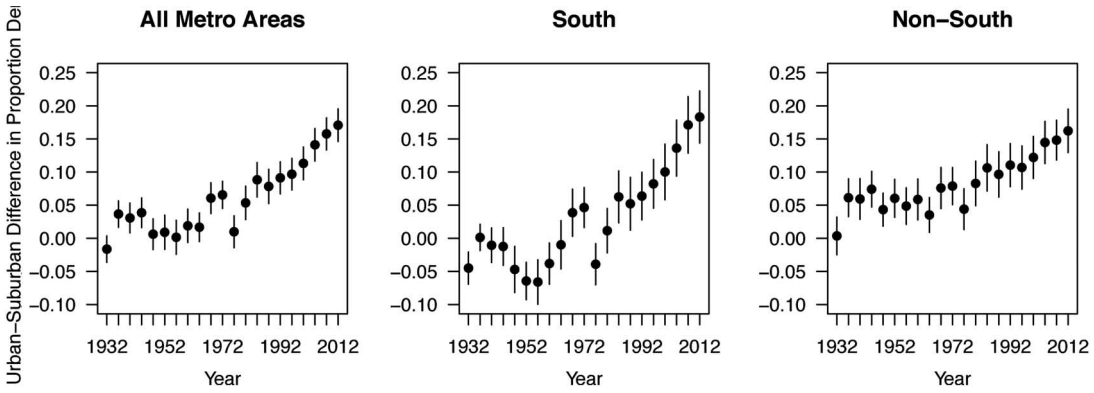

Figure 1. Mean metropolitan-level urban-suburban difference in the Democratic presidential vote, 1932–2012, for all metro areas (left), Southern metro areas (center), and non-Southern metro areas (right). Ninety-five-percent confidence intervals for the unweighted metro-level means accompany each estimate.

lic policy has played an important role. Prior research, mostly focused on racial and economic segregation, shows that sorting can be explained by the aggregation of ex ante individual-level preferences (Schelling 1971) or of local communities trying to lure residents who "vote with their feet" (Tiebout 1956). Other research argues that the aggregate consequences of residential choice are less important than discriminatory policies, such as zoning, redlining, and racially restrictive covenants, which have been a primary force behind racial and economic segregation (Hayden 2003; Levine 2006; Massey and Denton 1993). Yet regardless of their respective contributions to sorting, neither individual preferences nor de facto discrimination fully explain observed partisan sorting. Previous research has tended to neglect the role of transportation policy in residential mobility. Policies that appear universalistic and nondiscriminatory may selectively facilitate greater residential mobility among some groups than others, potentially leading to a different social, economic, and political geography, with all its concomitants. I call this process "spatial policy feedback."[2]

This article considers the political consequences of one of the most important of these "spatial policies": the Federal Aid Highway Act of 1956, colloquially known as the Interstate Highway Act. The largest public works project in American history, the carefully planned 41,000-mile system stimulated growth of a new class of suburb heavily reliant on federal housing and transportation policy, especially in the Sun Belt (Hayden 2003; Jackson 1985). Highways facilitated urban-suburban partisan sorting by enabling whites and middle-and upper-income citizens to move from declining cities into single-family residential neighborhoods along suburban freeways. A key result has been ongoing partisan residential sorting and associated geographic polarization, especially in the South. This article explicates highways' role in the development of this spatial, political hierarchy. Previous scholars have shown that highways stimulated urban and suburban growth (Baum-Snow 2007; Duranton and Turner 2008) and rural development (Chandra and Thompson 2000). However, previous studies have not rigorously examined highways' effect on what Rae (2001) calls the "viacratic hierarchy": separation of the rich, mobile, suburban, and Republican from the poor, immobile, urban, and Democratic.

This article presents two major aggregate-level implications of infrastructure-induced political change, demonstrating that highways changed political geography at county and metropolitan levels. It then examines observational data to ascertain the individual-level mechanisms underlying observed geographic change. First, matching comparable suburban counties with and without Interstates, I show that highways made suburbs in which they were built substantially more Republican, with much of the effect originating in the South and in counties where Interstates were built earliest. Next, using data on Interstates' overall density within metropolitan areas, and controlling for population and other confounders, I show that metropolitan areas with more Interstates became more polarized over time. Finally, I present individual-level findings from a restricted version of the Youth-Parent Socialization Panel Study (YPSPS), a panel survey of the high school Class of 1965. Results from this study show that Interstates were central to migration. Republicans were more likely than Democrats to move from urban areas after high school, and when they did, they were much more likely to settle in zip codes along nonurban Interstate highways. Republicans who began in nonurban areas were also more likely to eventually live in communities along Interstates than Democrats who also started adulthood outside cities, movements that coincided with racial and economic sorting. Together, these findings show that Interstate

2. See Pierson (1993).

highways added to urban-suburban polarization by growing Republican suburbs and speeding white flight from major metropolitan areas.

TRANSPORTATION INFRASTRUCTURE AND CAUSAL INFERENCE

Political scientists have rarely studied transportation infrastructure except as an instrument of "pork-barrel" distributive politics (Golden and Min 2013) and usually treat infrastructure as a dependent variable. Yet infrastructure often has consequences beyond its role in "greasing the wheels" of the legislative process (Evans 1994) or delivering "pork" to constituents (Ferejohn 1974). Scholars, mostly in other fields, have noted infrastructure's substantial consequences, from the spread of religious ferment in the Erie Canal's "burned over district" (Cross 1950), to turn-of-the-century transit lines' role in racial and ethnic segregation (Oliver 2010, 100), to infrastructure's use as a social control (Scott 1998). Others have noted neighborhood-level segregation that can arise from infrastructure's placements. Governments have rerouted highways to separate white and black neighborhoods (Connerly 2002; Kruse 2005, 86), and major streets and rail lines often demarcate neighborhoods (Ananat and Washington 2009; Grannis 2009).

While previous research on infrastructure's effects has been suggestive, the Interstate Highway System offers an ideal policy case to study infrastructure's effects on political geography. First, it was both large in scope (41,000 miles in length, as originally planned) and centrally organized, distinguishing it from earlier infrastructure programs in which small projects were easily controlled by members of Congress (Weingast and Wallis 2005). By contrast, the Federal-Aid Highway Act of 1956 established a single, nationwide highway construction network, with the dedicated Highway Trust Fund covering 90% of the cost. Continuing prior practice in the federal-aid highway program, the Interstate program gave state and federal highway engineers substantial discretion over highway placement, which they exercised freely through the 1960s, keeping Congress from key decisions (Seely 1987). The process by which highways were built strategically (or the "assignment mechanism") can therefore be reconstructed for Interstates more easily than for other policy interventions (Rubin 1991).[3]

Studies of infrastructure programs have made major claims using historical counterfactual reasoning. Major suburban histories note that the federal highway program was crucial to suburban growth and changing suburban politics, but they rarely state the strong assumptions necessary to conclude that the public policy was responsible for American suburbanization, and not vice versa (Fishman 1989, 190–91; Jackson 1985, 249–50). Classic economic histories have examined infrastructure's effects by constructing their own counterfactuals rooted in the authors' imagined alternative histories. Fogel (1964), for example, estimates railroads' effect on economic growth by drawing a map in which rivers and canals, rather than railroads, were built to connect the Great Plains region to markets.

Rather than reconstructing the implausible historical counterfactual of a country devoid of Interstate highways, this article exploits spatial and temporal variation in highways' placement to infer the highways' effect on political geography. It examines the politics of places where Interstates were built, compared to a counterfactual constructed from comparable units that had no (or fewer) highways. It is assumed throughout that Interstate highways were assigned as if randomly to places, conditional on inclusion of relevant observable confounders (Dunning 2012). In this respect, the article follows on previous work. The earliest work on Interstates' effects used interrupted time series in case studies of highways' effects on local economic development (e.g., Garrison et al. 1959). More recent work has noted that Interstates were built to connect cities, thus making their placement in rural counties effectively random (Chandra and Thompson 2000, 482). Both of these approaches assume that reverse causality is not a concern. Other work has addressed confounding and reverse-causality using instrumental-variables methods, using preexisting infrastructure, geography, or even pretreatment planning documents to predict highway placement (Baum-Snow 2007; Duranton and Turner 2008). However, such instruments' exogeneity, and their satisfaction of the exclusion restriction, is often questionable, the inferential target unclear. Finally, other work has attempted to identify factors that predict highway placement, matching comparable places to evaluate highways' effects (e.g., Rephann and Isserman 1994).

This article adopts the latter approach, using matching and linear regression to account for the "assignment mechanism" under which planners decided where to build highways. The Interstate program fits well with this research design: a well-documented plan was adopted before construction, enabling one to reconstruct, and control for, the factors leading to nonrandom highway placement. Key planning criteria appear in the 1944 *Interregional Highways*

3. State highway departments, not local officials, had substantial discretion over highway routing (Caro 1975, 711). Highway engineers' "production orientation" led them to treat highways as the primary solution to traffic congestion and placement of highways as a technical, apolitical process (Rose and Seely 1990).

report, which laid out an early version of the present-day Interstate System (United States, Public Roads Administration, 1944). From the postwar period to the late 1960s, highway engineers had substantial latitude to select highway routes, using well-documented technical criteria, most of which appeared in the 1944 report. This differs substantially from present-day roadbuilding and its *ad hoc* projects as commonly studied in the distributive politics literature (e.g., Lee 2003). Accounting for the criteria used in roadbuilding during this period, an unbiased estimate of highways' effects is tenable.[4] Modeling highway planners' decision-making process, the next two sections present highways' effects on political geography at two geographic scales: on the suburban counties in which they were built and on metropolitan areas.

HIGHWAYS AND SUBURBAN POLITICAL DEVELOPMENT

To begin, I estimate highways' effect on the political composition of suburbs, combining data from a Federal Highway Administration database of Interstate construction through 2008, county-level Census data through 1950, and the county-level Democratic share of the presidential vote from 1948 to 2008.

Data and Methods

To estimate the highways effect on the development of suburban counties, I begin by defining suburban counties as those with geographic centroids 20 to 100 kilometers from the center of the 100 most populous cities in 1950. A 100-kilometer radius captures approximately a one-hour commute under typical Interstate highway speeds. Such areas would be most susceptible to highway-induced development and are the areas most relevant to potential commuters deciding where to live in a metropolitan area.[5] County data permit longitudinal comparisons that are untenable using more contemporary precinct-level presidential election results (e.g., Ansolabehere and Rodden 2012; King and Palmquist 1998) or commercial voter lists (Ansolabehere and Hersh 2012). Counties often delimit school districts, public services, and other factors relevant to residential sorting, making them units of interest in their own right. The full suburban county sample of $n = 988$ used in matching and regression analyses appears in Figure 2.[6]

Highways have two unusual features that are accounted for in the estimation strategy presented here: their permanence and the importance of when they were built. Once an Interstate is built, it is rarely removed, so adopted methods need not allow the treatment to vary after highways are built. However, one must account for variation in construction timing. Most Interstates were built during a relatively unrestricted construction boom through the late 1960s. By 2000, an Interstate built in the late 1950s would have influenced a county's development for twice as long as one built in the late 1970s. Most Interstate construction was front-loaded before 1965. Of the counties that would eventually have Interstates, 51% had one by 1965 and nearly all (96%) had one by 1980. To account for timing, analyses are separated into three nonoverlapping periods: the initial period of highway construction (1956 through 1963), the middle period of highway construction (1964 through 1971), and a late period of highway construction (1972 through 1979).

I define a county as "treated" if at least one Interstate highway opened during the period in question, based on the Federal Highway Administration's PR-511 database of highway construction segments as assembled and geocoded by Baum-Snow (2007). I then examine highways' effect on the Democratic share of the presidential vote in subsequent elections. To account for regional heterogeneity, I repeat the process for three groups: all suburban counties, Southern suburban counties, non-Southern suburban counties.

To account for factors that led to nonrandom assignment of highways to counties, I match comparable counties using coarsened exact matching (CEM) and perform least squares regression on each matched sample. For each of the three treatment cohorts, for each region, and for each presidential election year following the treatment cohort, counties with an Interstate are matched to comparable counties in which an Interstate had not yet been built. A least-squares regression model is then estimated on each sample using the same treatment variable and matching covariates (Ho et al. 2007; Iacus, King, and Porro 2011). CEM places observations in multidimensional bins created using coarsened versions of the covariates, then assembles a sample only of the treated counties (those with an Interstate) and untreated counties (those without) that match

4. Indeed, even if technocratic criteria were used to justify politically motivated decisions post hoc, controlling for these factors also accounts for political manipulation.

5. Any definition of a "metropolitan area" is always sensitive to researcher choice (Rosenbaum 1999). An analysis of findings' sensitivity to radius choice and various population density thresholds appears in the supporting information.

6. The closest city center is defined using the point location in the StreetMap USA Cities layer, usually located in the central business district (ESRI 2008). Data were projected using the North American Lambert Conformal Conic Projection.

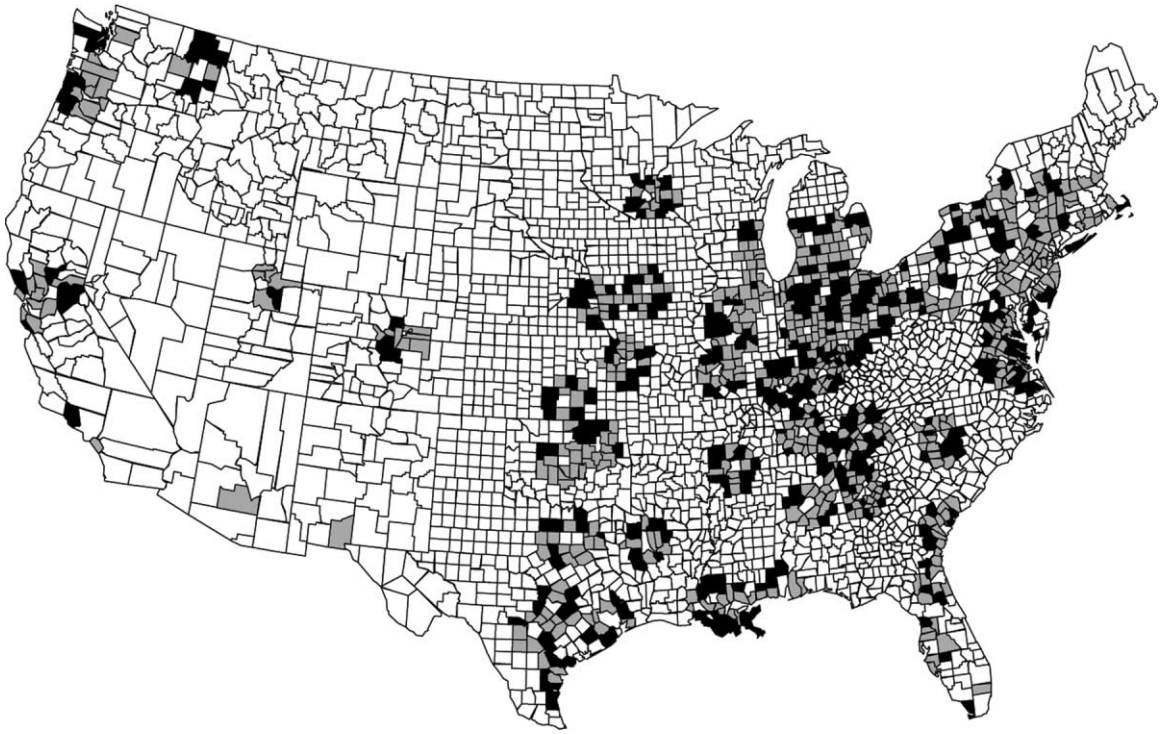

Figure 2. Map of the full suburban county sample. Counties containing an Interstate highway through 1996 are lightly shaded, and those without are shaded black.

on each multidimensional subclass.[7] Both treated and untreated observations that are not matched are discarded.[8]

County-level census and political variables used in matching reflect criteria that appear in the *Interregional Highways* report and also capture partisan political factors. Above all, highways were built to serve population centers and markets. *Log population density*, *Crop value per capita*, *Percentage urban* in 1950, and the *Number of manufacturing establishments in 1939* capture variables mentioned in some form in the 1944 report.[9] A dummy variable for *Strategic route* is included to indicate whether a county was on or near a "strategic military route" in 1941 (United States, Public Roads Administration 1944, 33). *Median family income in 1950* is a correlate of pre-1956 automobile ownership, suburban residential development, and partisanship. Other covariates account for additional potential confounders. The *Percentage of 1950 families that were outside the county in 1949* captures baseline suburban migration trends. The *Percentage nonwhite in 1950* is a strong correlate of both partisanship and partisan change. To control for pretreatment trends in the presidential vote and to capture secular trends in partisan change, the county-level *Republican presidential vote share in 1948 and 1952* is included in each regression. In addition, to account for confounding political trends between the time Interstate highways were assigned through legislation and when they were built in each of the three treatment cohorts, a control is included for the presidential vote as of the first year of each treatment cohort.[10] To construct a matched sample, a dummy variable for the *South* is included, accounting for Southern legislative influence over highway policy and because the Southern realignment coincided with highway-induced suburbanization, and the same variable is used to divide the sample into Southern and non-Southern subgroups.

Matching substantially reduces imbalance between treated and untreated suburban counties on most covariates in most posttreatment years. This is true even in later years and in the Southern and non-Southern subsamples. The standardized differences in means for each treatment cohort, region, and election year appears in the supporting information.[11]

Next, on the matched samples generated for each treatment cohort, posttreatment election year, and region, I esti-

7. I coarsen each covariate into at most three categories.

8. The result of this subclassification and trimming of the sample yields a local estimate for observations that could be well matched.

9. The crop value variable also proxies land suitable for construction.

10. Findings that omit this control appear in the supporting information.

11. While remaining imbalance in the matched data requires stronger modeling assumptions at the linear regression stage, it does not, on its own, imply that resulting model-based treatment estimates will be biased.

mate Interstates' effect on the Democratic percentage of the two-party vote using least squares regression, starting in the election years immediately after each treatment period (1964, 1972, and 1980, respectively) to 2008:

$$\mathbf{Y_t} = \beta_{0t} + \beta_z \mathbf{z} + \beta_1 \mathbf{x}_1 + \ldots + \beta_k \mathbf{x}_k + \boldsymbol{\epsilon}, \qquad (1)$$

where Y_t is the county Democratic presidential vote share in year t, and z is a dummy variable representing whether an Interstate was built in the county during the specified treatment cohort. The coefficient β_z captures the effect of interest, and $\mathbf{x}_1 \ldots \mathbf{x}_k$ (unreported) are included to adjust for any remaining bias not eliminated by matching.

To construct accurate confidence intervals and to account for election-specidic deviations from the "normal" vote, I apply a combination of bootstrapping and lowess smoothing over election-specific (or candidate-specific) effects. For each matched sample in each region-year, 1,000 samples were drawn (with replacement) with a probability equal to the CEM matching weights (Iacus, King, and Porro 2011). The linear regression model specified above was estimated on the national and regional matched samples, yielding 1,000 bootstrapped point estimates for the Interstate highway coefficient in each year. Each of the 1,000 sets of annual estimates were regressed on election year using lowess.[12] Quantiles of the smoothed simulations were used to construct 95% and 80% confidence intervals.

Results

Interstate highways made suburban counties in which they were built less Democratic across most of the study period, though these effects vary across both time and region. By far, the largest effects arose from Interstates constructed earlier in the study period and those in the South (Figure 3). On average, building an Interstate in a suburban county between 1956 and 1963 (the initial boom period in highway construction) reduced the Democratic vote share by 2 to 3 points across most of the study period, with declining effects in later years. Most of this effect is attributable to the 5- to 7-point effect in Southern counties, a steady effect that has been significant at the 5% level since 1972. Effects in non-Southern counties were smaller and less persistent, though the Interstate highways built early on still made such counties 1 to 2 points less Democratic than they would have been otherwise between 1980 and 1996. Highways built in later years had smaller effects. Because half of counties were treated in the early cohort, smaller sample sizes in later cohorts reduce power to detect effects, but, on average, point estimates fall in the expected direction.

Two major observations emerge from these data: that the effects are large in the South and small elsewhere, and highways' effects in suburbs faded out over time. These patterns have likely substantive explanations, as well as a methodological explanation related to the application of causal inference in a geographic context.

While many plausible explanations exist for the large effects in the South, two likely explanations arise. First, non-Southern suburbs were more urbanized before the war (McShane 1994; Mieszkowski and Mills 1993), while postwar road building and other federal investments were vital to the South's goal to catch up economically (Ingram 2014; Schulman 1994, 158). Fast-developing, highway-dependent suburbs such as Cobb County, Georgia grew around Interstates, becoming the base of the modern Southern Republican Party (Black and Black 2002, 6–7), while non-Southern counties built around earlier rail and road infrastructure had already suburbanized considerably compared to Southern counties.[13] Second, Southern whites moved into the Republican Party over the study period, and non-Southerners moved to suburbs in the region, explaining a larger Republican swing in Southern counties where highways stimulated suburbanization.[14]

The observed decline in the effect of highways on suburban counties over time can be explained by two phenomena. First, in the South, nonurban whites have become consistently more Republican than whites elsewhere (Gelman et al., 2008), almost amounting to a racial voting bloc, while the South is simultaneously more racially and politically segregated overall than the non-South (Einstein 2011). The second explanation is related to interference among geographic units. Over time, highways' effects on one county are likely to extend to neighbors, and roads would be built to connect counties to Interstates. While this diffusion of highways' effects violates statistical independence and the stable unit treatment value assumption, spillovers are likely to bias effects' magnitude downward, particularly for later time periods as communities matured. Such spillover effects are also likely in cases where Interstates fall near a county boundary. While the effect of Interstates on the difference *between*

12. The lowess function uses a span of one-third of the data points in the smoothing kernel and three "robustifying iterations" (Becker, Chambers, and Wilks 1988).

13. In 1940, non-Southern counties were denser than Southern counties (229 persons per square mile on average versus 123), more urban (28% in "urban" areas versus 20%), and more industrialized (86 manufacturing establishments per county versus 21) (Fitch and Ruggles 2003).

14. Some of the differences may also be due to differences in local matched samples under CEM. Counties that could be easily matched in the South were different from units that could be matched outside the South.

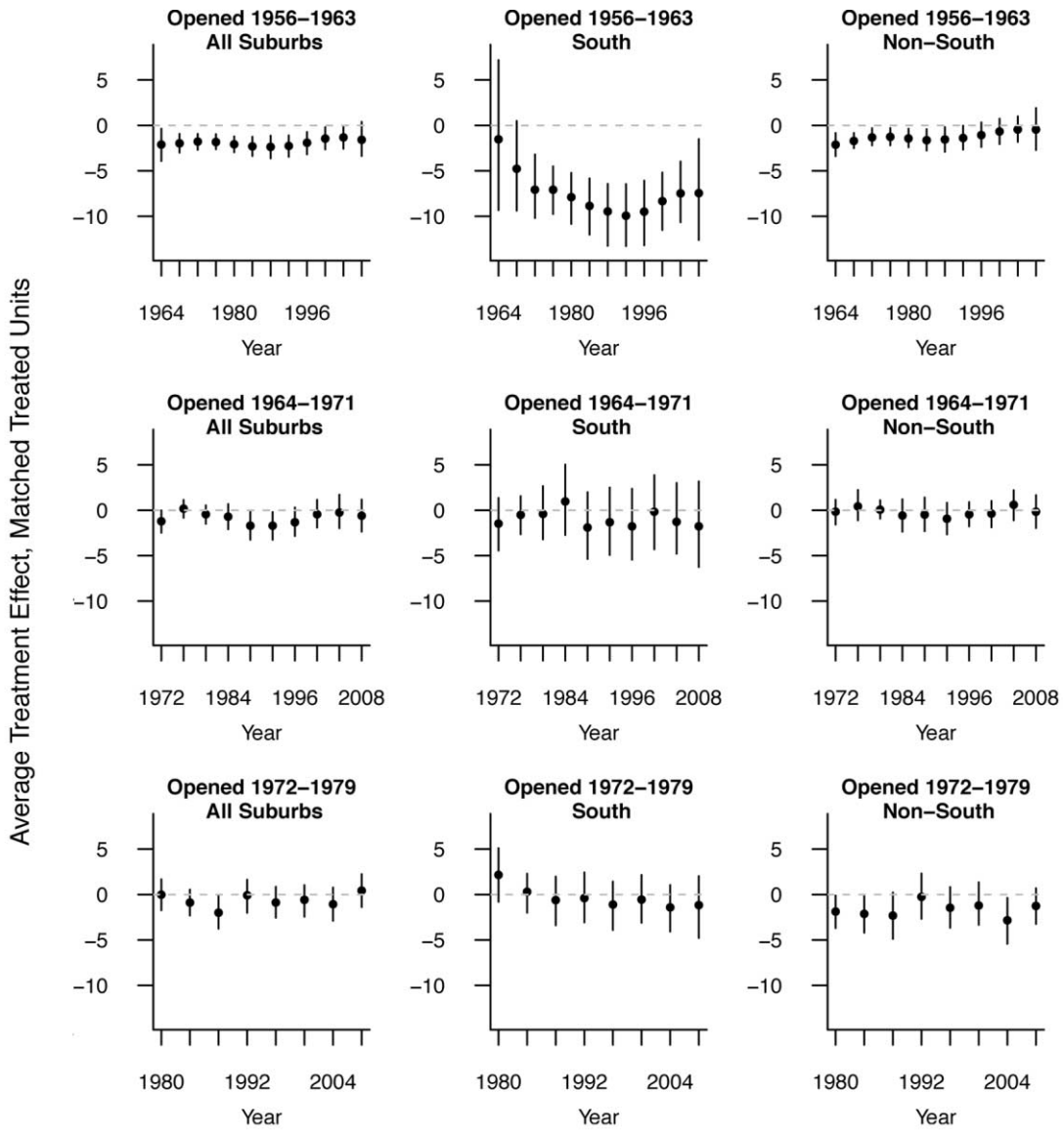

Figure 3. Smoothed OLS estimates of effect of Interstate on a county, using CEM-matched samples. Interstate highways reduced the suburban proportion of the Democratic vote, mostly early on and in the South. Ninety-five-percent confident intervals accompany each estimate. Top row: Interstates opened 1956–63. Middle row: Interstates opened 1964–71. Bottom row: Interstates opened 1972–79.

suburbs with and without Interstates would then appear to decline over time, highways would still, overall, be making counties more Republican.

HIGHWAYS AND URBAN-SUBURBAN PARTISAN SORTING

Having established that Interstates made the suburban counties in which they were built less Democratic over time, I now turn to the question of whether highways increased the urban-suburban gap over time. Highways' estimated effects on suburbs appears to have declined over time, even as overall urban-suburban polarization increased. I address this apparent paradox, showing that highways influenced politics at different geographic scales. Using the density of highway exits as a proxy for transportation connectivity, I show that metropolitan areas with denser highway networks became more polarized.

Data and Methods

I define metropolitan areas as "couplets" formed by aggregating the urban and suburban counties in each metropolitan area. The urban portion of each is assembled by aggregating counties containing the 100 most populous cities as of 1950, while the suburban remainder is assembled by aggregating all other counties with centroids within 100 kilometers of the central city (cities). This results in 84 urban-

suburban couplets containing 100 major cities and their hinterlands. The outcome of interest is the urban-suburban difference in the Democratic vote share in each couplet, $\Delta_{i,t} = \bar{D}_{iut} - \bar{D}_{ist}$, where $\bar{D}_{iut}$ and $\bar{D}_{ist}$ represent, respectively, the urban and suburban Democratic vote share in the metro area i in year t.

To analyze highways' effects at the metropolitan level, the "treatment" variable consists of the density of *Interstate highway exits* in each metropolitan area. Unlike highway mileage, exits provide a measure of the extent to which Interstates are interconnected with the local street network. Economic and residential development occurs on local streets around freeway exits. Second, the number of exits per highway mile has been surprisingly stable since the Interstates were built, since highway planners explicitly aimed to limit construction of new exits.[15] To generate a count of historical exits, I merged the Baum-Snow PR-511 database, based on the Federal Highway Administration's records of the Interstate segments' opening date, with the 2008 ESRI shapefile of exits on the Interstate system as of 2008. Using the count of exits from this combined shapefile, I divided the number of exits open in each metropolitan couplet in each year by the combined land area of each metropolitan area to generate the number of exits per square mile.

Because the explanatory variable is continuous and the sample did not allow effective matching, I use least-squares regression to control for potential confounders of the exit "treatment." Referring again to *Interregional Highways*, the most important factor was population: both highways and exits were built to serve existing population. *Metropolitan area population density in 1950* captures this factor.[16] The *Proportion of counties on a route of strategic military importance in 1941* accounts for the perceived military importance of each metro area. The *Mean number of manufacturing establishments in 1939* accounts for preexisting industrialization and is also a predictor of Interstate construction. To anticipate future changes in urban suburban political geography, the models include the *Lagged urban-suburban difference in the Democratic presidential vote share* in 1948, 1952, and 1956. Race is currently one of the strongest correlates of urban-suburban partisan polarization and is represented by both the *Urban percentage nonwhite minus the suburban percentage nonwhite in 1950* and the *Mean urban and suburban percentage nonwhite in 1950*. A dummy variable for the *South* accounts for preexisting regional differences in infrastructure and other pretrends. Finally, economic prosperity at baseline is accounted for using the *Mean of median family income of counties across the metropolitan area*.[17]

I examine the effect of two versions of the highway-exit-density variable: an untransformed version and a log-transformed version (which implies diminishing marginal impact). These are estimated by least-squares regression:

$$\mathbf{\Delta}_t = \beta_0 + \beta_{zt}\mathbf{z_t} + \beta_2\mathbf{x}_1 + \ldots + \beta_k\mathbf{x}_k + \boldsymbol{\epsilon}, \qquad (2)$$

where β_{zt} represents the effect of a one Interstate-exit-per-square-mile (or the natural logarithm of the Interstate exit per square-mile) difference in exit density at year $t - 4$ and $\mathbf{x}_1, \ldots, \mathbf{x}_k$ are included controls. The analysis otherwise follows the same bootstrapping and smoothing procedure discussed in the suburban-county analysis. One thousand samples were drawn, and β_{zt} was estimated on each, for each election year t.[18] The bootstrapped point estimates were smoothed by lowess, yielding a 1000-by-13 matrix of smoothed point estimates. As before, the estimate and 80% and 95% confidence intervals were constructed from the mean and simulation quantiles.[19]

Results

Figure 4 plots predicted first differences in the urban-suburban Democratic voting gap associated with a typical increase in Interstate exit density (a shift from the 25th to 75th percentile, using 1996 sample quantiles throughout for comparability). The left panel displays this effect for the exit-density variable, the right panel for its log-transformed version. These results show that higher Interstate density in a metropolitan area is associated with greater urban-suburban polarization in the presidential vote. Point estimates are uniformly positive under both versions of the exit-density variable, and the 95% confidence interval permits rejection of the null hypothesis in both cases by the early 1970s. The results suggest that findings are sensitive to the linearity assumption, with larger effects observed with

15. A robustness check using Rand McNally atlases shows that few exits were added to Interstates after initial construction, even in Sun Belt cities where rapid growth might have justified them. See supporting information.

16. Because metropolitan areas are approximately the same area, overall population density is highly correlated with population itself, making a separate population variable unnecessary.

17. Within-couplet urban-suburban differences are calculated using population-weighted (for Census variables) or voter-weighted means (for election variables). The within-couplet means are calculated by taking the unweighted mean of the weighted urban and suburban averages, in each couplet.

18. A small positive value, 10^{-4}, was added to each value before the logarithmic transformation to permit calculation of the logarithmic transformation, but this was only relevant in the earliest years of the program.

19. Region-specific effects were estimated with insufficient power, but point estimates were larger in the South than elsewhere.

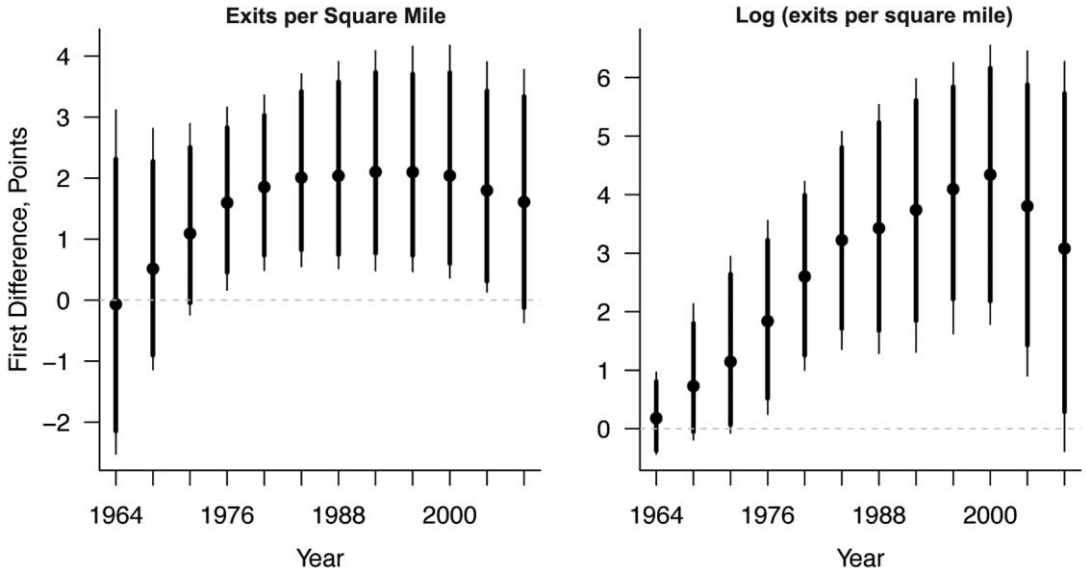

Figure 4. Interstates' predicted effect on the urban-suburban Democratic voting gap. Difference across the interquartile range of exits per square mile in 1996. Left: exit density. Right: log-transformed exit density. Bootstrapped 80% and 95% confidence intervals accompany the estimates.

the log-transformed variable. The predicted first difference across the interquartile range is somewhere between 2 and 4 percentage points across most of the study period.

These effects are substantively comparable to other observed effects of similar interventions. The difference in urban-suburban polarization associated with an increase in exit density across the interquartile range is about one-fourth as large as the average urban-suburban gap during the study period. The magnitude of effects is similar to other observational estimates of public policies' effects on aggregate-level voting in presidential and congressional elections. For example, Levitt and Snyder (1995) find that an increase in federal nontransfer spending of $100 per capita, "approximately $50 million" per house district, boosts incumbent House member vote share by about 2 percentage points. Each presidential disaster declaration adopted in a state increases the incumbent president's vote share by 1 point (Reeves 2011, 1150). Interstates' long-term effects are often larger and persist for decades after the initial highway construction. Interstates thus appear to "lock in" long-term political effects as other policies do not.

INDIVIDUAL-LEVEL MECHANISMS

Thus far, results have been aggregate, which can only allude to individual-level mechanisms that may be some combination of partisan and sorting. Individual-level survey data from the period shed light on these mechanisms. While a representative sample of voters is not available, the Youth-Parent Socialization Panel Study (YPSPS) tracks a sample of $n = 935$ Class-of-1965 high school students across the years 1965, 1973, 1982, and 1997 (Jennings et al. 2005). Conveniently, these Americans came of age and made residential decisions just as a majority of Interstates had been built. In addition to offering extensive data on political attitudes and partisan identification over the life course, the restricted-use data set provides zip codes from 1965 (high school address), 1982, and 1997, which were merged with 2004 zip code polygons.[20] These data were then spatially joined with the PR-511 data in ArcGIS to calculate each zip code's proximity to the nearest Interstate at each year and the proximity to the nearest of the 100 most populous cities as measured by the 1950 census. I categorize self-identified Democrats and Republicans (including independent learners) as of each year according to place of residence: urban (within 10 miles of a 1950 top-100 city), more than 10 miles from such a city but within 10 miles of an Interstate, or more than 10 miles from both a top-100 city and Interstate.

A series of least-squares regression models (Table 1) provide a descriptive accounting of the characteristic of individuals who moved into Interstate suburbs between 1965 and 1997. It is difficult to infer movers' motives from observational data alone, but the purpose of the models presented here is to illustrate how partisan migration from central cities into Interstate suburbs was inseparable from migration on other correlates of partisanship. Each is a

20. While the particular zip code database used in the YPSPS is not documented, a check against historical zip code directories from 1967 and 1982 indicates that the zip codes used are from later in the study period, justifying the use of 2004 boundary files.

Table 1. Least-Squares Regression of Socioeconomic, Racial, and Political Predictors of Migration to Interstate-Highway Suburbs

	Urban High School Graduates (1965)				Nonurban High School Graduates (1965)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(Intercept)	0.33*	0.19*	0.37*	0.15*	0.44*	0.53*	0.39*	0.43*
	(0.11)	(0.08)	(0.09)	(0.12)	(0.04)	(0.08)	(0.06)	(0.10)
Party: I	0.11			0.07	0.03			0.04
	(0.07)			(0.08)	(0.10)			(0.06)
Party: R	0.16*			0.11	0.10*			0.11*
	(0.08)			(0.08)	(0.05)			(0.05)
White race		0.26*		0.22*		−0.05		−0.10
		(0.09)		(0.10)		(0.08)		(0.09)
Middle income (1973)			0.04	0.01			0.04	0.09
			(0.11)	(0.10)			(0.10)	(0.06)
High income (1973)			0.05	0.03			0.05	0.16*
			(0.11)	(0.10)			(0.11)	0.07)
N	266	266	266	266	658	658	658	658

Note—Standard errors in parentheses, calculated using method in Rubin (1987). Reported *N* is average of subsets from the five multiply imputed data sets.
* $p < 0.05$.

linear probability model of 1965 high school graduates' probability of living in a nonurban zip code within 10 miles of an Interstate highway in 1997, as a function of racial, class, and economic variables. Models 1 through 4 predict migration to suburbs along Interstates by graduates of urban high schools. Model 1 is a simple regression of residence in an Interstate suburb against a three-category variable indicating Democratic, Independent, and Republican identifiers as of 1997. The next two columns are also simple regressions, but with *White* race (Model 2) and a three-category variable for *Annual family income in 1973* (Model 3) as the sole predictors.[21] Model 4 includes party, race, and income variables. Models 5 through 8 feature the same predictors as Models 1 through 4, but for graduates of nonurban high schools.[22]

The results of these models confirm that movement of Democrats and Republicans into suburbs along Interstates was real and coincided with economic and racial migration. Urban graduates in the Class of 1965 who identified as Republicans in 1997 were 16 points more likely than initially urban Democrats (the base category of the party variable) to live in suburban or rural zip codes along Interstates. In the bivariate regression in Model 2, white graduates of urban high schools were 26 points more likely than the nonwhites to move from the central city to an Interstate suburb, while point estimates for middle-income and high-income residents (Model 3) were in the expected direction but imprecisely estimated. In Model 4, only the coefficient on white race is statistically significant, though coefficient estimate on party continues to be in the expected direction.

The models indicate that migration of urban Republicans to Interstate suburbs is at least partially related to migration of white and higher-income residents into these suburbs. For nonurban high school alums a different set of factors was at work. Among this group, Republicans were 10 points more likely than Democrats to live in an Interstate suburb by 1997 (Model 5), but neither white race nor income were significant predictors of residence in a suburb near Interstates by 1997 (Models 6 and 7).[23] While they do not qualify as a causal or psychological model of individual-level sorting behavior, these results suggest two major mechanisms by which Interstates led to partisan geographic change. Republicans were more likely than Democrats to migrate to suburban and rural areas along Interstate highways, with concurrent white flight and migration of the middle and upper classes into new

21. Low income had less than $7,000 income, middle income $7,000 to $15,000 income, and higher income residents had income greater than $15,000 per year in 1973 dollars.

22. To reduce bias that results from panel attrition, missing values were imputed using Amelia II multiple imputation software (Honaker, King, and Blackwell 2011).

23. For simplicity, least-squares regression results are presented. In the supporting information, the analyses are replicated using a multinomial logistic regression model in which the location outcome is defined using three residential categories.

neighborhoods along Interstates. These findings are consistent with aggregate-level analyses using Census economic and racial data, which show that Interstates contributed consistently to urban-suburban racial segregation while making suburban counties wealthier.

The YPSPS results also suggest that differences in migration behavior alone are not responsible for the larger effects observed in the South. Migration from urban core to periphery does not vary dramatically across regions. The large partisan effect observed in Southern suburbs may, therefore, result from the interaction of both high migration rates and Southern whites' transition to the Republican party.

DISCUSSION AND CONCLUSION

For the past half century, Democrats and Republicans have segregated themselves on an urban-to-suburban continuum. Interstate highways have been central to these changes, shaping numerous aspects of American metropolitan areas' geography, including their politics. Like any national policy intervention, highways' effects were contingent on preexisting conditions. Their effects were shaped by both the baseline partisan geography where they were built and preexisting sorting trends. Built at a point of rapid social and economic change during the postwar era, Interstates facilitated ongoing suburbanization and white flight, contributing to a larger urban-suburban split where they were built. Highways' effect was strongest in the South, where counties with Interstates made suburban counties five points less Democratic, on average. Metro areas with Interstate network density at the 75th percentile became, over time, four points more polarized than if their exit density had been at the 25th percentile, a finding that holds even after accounting for baseline population density, racial polarization, political polarization, and political confounding variables. A descriptive individual-level analysis suggests the mechanisms underlying these changes. Among urban high school graduates, white flight seems to be a major factor driving migration into outlying neighborhoods along Interstates, while income was a better predictor among nonurban high school graduates. In either group, Republicans were more likely, after 30 years, to be found living in suburbs near Interstates.

Given the individual-level findings, one may ask if these findings are merely a second-order effect of racial and economic segregation. This is, in many respects, the wrong question. Partisan segregation, and the concomitant implications for politics, may occur for a range of reasons while still producing the same long-term consequences for politics. Highways enable an automobile-centered lifestyle among individuals who can afford to, and have not been prevented from, life in suburbs. Studies of household transportation use show that the poor are more likely to walk or take transit (Pucher and Renne 2003), contributing to their apparent preference for cities (Glaeser, Kahn, and Rappaport 2007). Over time, Interstate suburbs became wealthier and were more likely to have higher rates of solo commuting to work outside county from 1970 to 2000, than comparable non-Interstate suburbs (see supplementary information). Over time, such behaviors have become more closely linked to Republican partisanship (Williamson 2008).

These findings suggest that scholarship on policy effects and "policy feedback" should account for geographic, and not just individual-level, mechanisms. Most scholarship on public policies' political effects posit a theory in which individual-level behavioral effects are sometimes moderated through interest groups or organized political activity (Campbell 2003; Mettler 2002; Soss 2000). Spatial policy feedback mechanisms, however, can change politics just by changing their location, yielding geographic communities with different preferences. One of these potential mechanisms is different, geographically defined political economies. For example, low-density Republican areas are almost wholly dependent on private automobiles, while only very high-density, predominantly Democratic areas use public transit to any meaningful degree (Pucher and Renne 2003). Republicans' stated preference for suburban sprawl is consistent with divergent consumption preferences and issue attitudes (Belden, Russonello, and Stewart 2011). A potential implication is that partisan issue sorting (Levendusky 2009) combined with partisan geographic sorting, should lead to a stronger linkage between spatial location, partisanship, and issue attitudes. Thus, changes in political geography can change politics even without a "contextual effect" on individual behavior.

While numerous public policies have influenced the growth of suburbia and the political geography of the two parties, Interstate highways have been central to the development of geographic polarization. Interstate highways enabled mobile residents to express residential preferences linked to their partisanship. An unintended consequence for American politics was the growth of suburban Republican enclaves where highways were built and a greater partisan gap between cities and their periphery.

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