Detour Ahead:
Market Frictions and Path Dependence in Transport Networks

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1 Motivation

San Benito County in CA is in urgent need of an expansion of Highway 156. The project is expected to reduce congestion by 1,902 hours daily and save millions on operating costs. However, although the improvement project began on 1999, it is being delayed today due to complications with right-of-way relocation agreements: the matter is still unsettled with 10% of the property owners.[1] Right-of-way acquisition is the act of taking land from its original owner by another party—with legal rights to take the property—by providing a monetary compensation for its value (Francis, 2009). It is a critical component of transportation project development, which significantly affects a project's final cost and schedule. This issue is also socially sensitive, as it deals with property owners' rights, and is often faced with ardent opposition (Glaeser and Ponzetto, 2018). Further, San Benito's case is not unique: today many cities spend over 30% of their budget for transportation projects on right-of-way acquisitions, and over time, this barrier to project implementation seems to become more expensive, time consuming and difficult (Jeong, 2016).

2 Research Question

In this project, we investigate to what extent frictions in the process of land acquisition shape the provision of transport networks. The development of transport infrastructure requires significant land to host these investment projects. Thus, frictions in the land acquisition process can undermine the ability of public agencies to provide transport infrastructure and determine the choice of route. How large are these frictions in the land acquisition process, and how do they shape the geography of transport networks?

We examine this question in the context of the construction of the Interstate Highway System, that expanded over fifty decades and allows us to observe how changes in the ease to acquire land, due to federal and state-specific legislation, shaped the construction of the highway network. In fact, the "Red Book"—published by the American Association of State Highway and Transportation Officials (AASHTO), and which described the gold standards for highway and street design in U.S. before 1984— emphasized land assembly and acquisition costs as key determinants of freeway route selection.[2] For instance, stating that: "Since the cost of constructing arterial highways will vary

[1] Recent news (9/14/20) about the project can be found here.

[2] The official name of the "Red Book" is "A Policy on Design of Urban Highways and Arterial Streets". The "Blue Book"—"A Policy on Geometric Design of Rural Highways"—details the guidelines for rural highways.

throughout the area, these savings in service should be evaluated in relation to the cost of right-of-way and construction to determine the most economical combination"(AASHTO, 1966, p.89). The book also describes how highway construction can take advantage of land already owned by the government, mentioning undeveloped land areas, areas adjacent to railroads and shore lines of rivers and along the boundaries of parks as good candidates to locate roads, as illustrated by Figure 1.

We exploit a relevant change in regulation: the Uniform Relocation Assistance and Real Property Acquisition Policies Act enacted in 1970, that created the obligation to provide relocation assistance to individuals and businesses displaced by federally-funded projects. This new regulation significantly increased the costs of acquiring land, and affected states and rural versus urban areas differently. In addition, the effects of this regulatory change on the construction of the Interstate Highway System can be tracked with great detail via yearly published statistics on relocation and right-of-way expenses by unit displaced.[3]

In the following section, we describe how we explore the role of land acquisition frictions on highway construction, and the effects of these distortions. The last section provides further details on data sources.

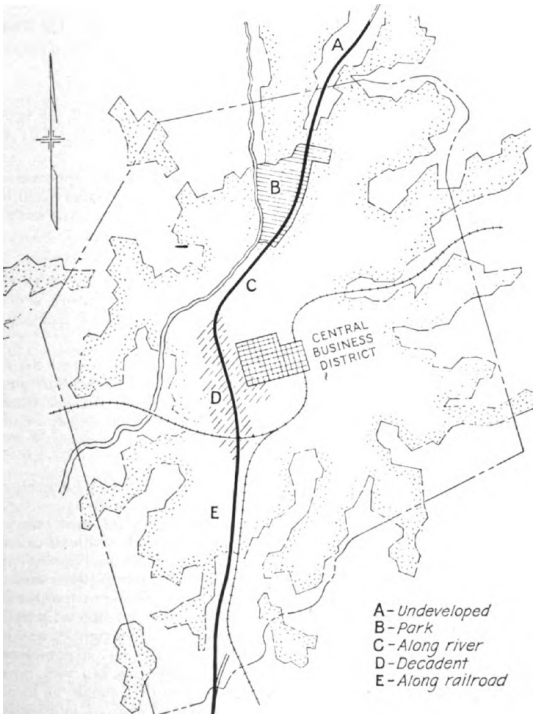


Figure 1: Optimal highway location, suggested by the Red Book (AASHTO, 1966).

3 Methodology

3.1 Role of the Land Acquisition Process in the Design of the Interstate Highway System

First, we study whether states faced any frictions when building the interstate network due to problems related to land acquisition. Land acquisition costs seem to have been a concern since the start of the Interstate system. Indeed, the construction guidelines published by the American Association of State Highway and Transportation Officials over the years consistently mention the need to choose specific highway paths that are inexpensive and feasible.[4]

[3]This data is available from yearly volumes of "Highway Statistics" published by the Department of Transportation. They start in 1946 and span the entire period of our study, and that, after 1970, include relocation expenses by unit displaced and by location.

[4]The "Blue Book", in 1965, mentions that "an economic analysis should be made when the alternate locations and types have been decided."

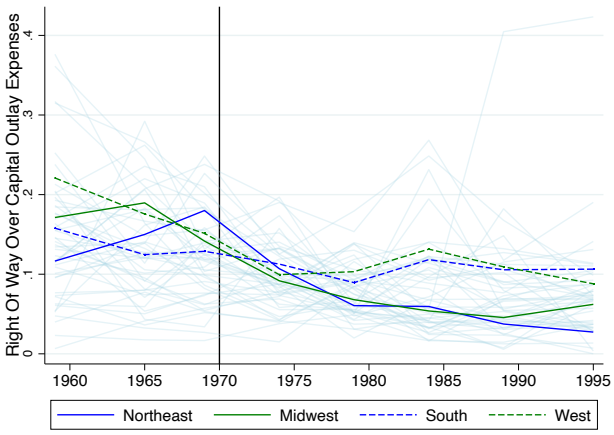
Brooks and Liscow (2019) report that spending on preliminary engineering and Right of way was 17% of total federal spending between 1960 and 1985. To have a clearer picture on the relevance of land market frictions, we digitise data on right-of-way only and total capital outlay disbursements for state-managed highways, for each state and every 5 years. Figure 2 shows that the expenses on right-of-way seem to fall after 1970, while the legal obligations were larger than ever. This seems to point to a reduction in the exercise of eminent domain by the government in the decades post-1970. If this is the case, states might have deviated from the original plan looking for less costly alternatives.

3.2 Deviations from the 1947 Plan and Path-Dependence

Second, we examine if these frictions were large enough to affect the actual construction of the interstate highways, leading to deviations from the original plan. We exploit the new obligation to provide relocation assistance to displaced individuals and businesses from 1970 onwards to show how an increase in land-associated frictions created further deviations from the original 1947 Interstate plan. To do this, we study if (i) deviations from the 1947 plan are more likely to happen after 1970, if (ii) unplanned roads are more likely to be constructed near railways, along parks or near coast lines (as suggested by Brinkman and Lin, (2020)), and if iii) deviations take a less direct path.

Starting from maps of the 1947 plan of the Interstate Highway (Brinkman and Lin, 2020), our strategy is to measure how much the realized construction deviated from the original plan and to examine where these deviations took place. As right-of-way is exercised at the state-level, we can use a difference-in-differences approach and exploit state-level variation to understand if the deviations from the plan after 1970 are different in areas where the exercise of eminent domain became relatively harder or more costly after the approval of the Uniform Relocation Act. The increase in the cost of acquiring private land, more binding in land-constrained states, may have pushed planners to consider less costly alternatives such as following river shores or old railroad lines (Duranton and Turner, 2012). These deviations could have reduced the benefits of the new interstate highway system by tying it to old transportation systems and creating path-dependence. To illustrate the state-level heterogeneity in costs, Figure 2's background shows the data disaggregated by state (light blue lines). The figure also suggests that areas like the Northeast, which includes many large cities where land is costly, saw a particularly sharp decline in the use of right-of-way after 1970, and an increase in 1969 (with the

Figure 2: Share of Land Acquisition Expenses



Notes: Highway capital outlay mainly includes land acquisition costs; preliminary and construction engineering; construction and reconstruction (FHWA, 2000).

Uniform Relocation Act being *announced* in 1968).[5]

3.3 Structural Analysis: Land Acquisition Frictions, Efficient Highways and Welfare

Finally, through the lens of a structural model, we want to explore how these deviations in the construction of highways, due to land acquisition frictions, affected the efficiency of the network. Further, given the nature of land-acquisition costs, intuitively they would lead to more highways—and its associated disamenities—to cross over poor neighborhoods, and we would be also interested in using the model to explore these distributional effects.[6]

We will build a quantitative spatial model with endogenous infrastructure investments in the spirit of previous work (Fajgelbaum and Schaal, 2020; Allen and Arkolakis, 2019; Santamaria, 2020). The model considers, not only the benefits in terms of connectivity that accompany a highway, but its potential toll on welfare due to disamenities associated with living near it. To explore the distributional effects of highway construction, we also consider two types of workers with different skills.

The model would allow us to decompose how deviations of the network from the least cost path depend on land acquisition costs, on frictions induced by reforms re-enforcing citizen voice, relocation expenses, and barriers to efficiently applying right-of-way. This, via counterfactual exercises, allows us to quantify the effects of transport infrastructure under-provision, due to costly land acquisition, on economic outcomes; as well as the **distributional effects** of these deviations. For instance, with right-of-way being costlier in rich areas—both in terms of land cost and citizen voice— more highways would cut across poor neighborhoods.

4 Main Data Sources

Construction and land-acquisition cost (i) Use of yearly data on highway construction and summaries of expenditure costs from 1940-1995 from the Federal Highway Administration as described in Mehrotra et al. (2019), **which contain details on right-of-way expenses by state and by highway, rural road, street, and federal road. These also contain details, by state, on the yearly relocation expenses per unit (household or firm) that had to be relocated** to build the highway. (ii) Details from the "Red Book" from the AASHO for various years, with details on how the criteria for construction and choice of route changes across time, along with details on how cost-estimates for the highway system were revised after the approval of policies regarding citizen voice and environmental concern were approved in the 1960s (Secretary of Transportation, 1971). (iii) Data on land and house values, along with family incomes in different locations where the highway was built.[7]

[5] While the Uniform Relocation Act was announced in 1968 it was only enacted in 1970.

[6] Indeed, a growing body of historical research has addressed how Interstate highway often cut through poor neighborhoods, many times populated with minorities and black residents (Rose & Mohl, 2012)

[7] Data on assessed property values is available from the 1957 and 1992 Census of Government at the census-tract level. The decennial Census includes data on median family income and median home values by census-tract or

Deviations due to land-associated market frictions (i) Data on the location and routes followed by railroads in 1898 from Duranton and Turner (2012) is useful to understand if there is path dependence in the location of future roads, and in particular, if this dependence is stronger in areas where the land acquisition cost is larger. (ii) Data on the 1947 plans of the Interstate Highway, which has been digitized by Brinkman and Lin (2020). (iii) Data on state-owned landholdings from the 1940s, from the Bureau of Land Management.

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