Political Economy of Transport Investments: Evidence from the California High-Speed Rail

Pablo Fajgelbaum
Princeton and NBER

Cecile Gaubert
Berkeley and NBER

Nicole Gorton
UCLA

Eduardo Morales
Princeton and NBER

Edouard Schaal
CREI

1 Background and Research Questions

Investments in transport infrastructure are projected to grow by several hundred billions dollars in the US over the next decade through ambitious legislation like the American Jobs Plan. These policies offer broad guidelines, but the details of what specific projects will be implemented are yet to be decided at different levels of government.

What forces determine the allocation of transport infrastructure investments? While a large literature estimates the impacts of these investments on economic outcomes (Redding and Turner, 2015), understanding the determinants remains largely unexplored. In democratic environments, these decisions are partly shaped by the preferences of voters. However, they may also reflect preferences of policymakers, such as redistribution towards preferred constituencies.[1] Recent methodological tools (Allen and Arkolakis, 2019; Fajgelbaum and Schaal, 2020) allow the computation of optimal policies given preference weights of a planner, but little is known about those weights. In this project we ask: how important are voters' and policymakers preferences in shaping the transport investments that are implemented? To what extent are these preferences a function of political values relative to economic gains?

We study these questions in the context of California's HighSpeed Rail (HSR), a project currently underway that would link northern and southern California.[2] When debated, arguments in favor included potential reductions in freeway and airport congestion which would also reduce pollution, while arguments against included budgetary and feasibility concerns (Bowen, 2008). By 2008, the planned funding included general obligations bonds issued by the state, which by state law require voter approval. Californians voted on the measure in the 2008 General Election; Proposition 1A asked whether they approved of the state issuing 9.95 billion USD in bonds to establish a "clean, efficient high-speed train service linking Southern California, the Sacramento/San Joaquin Valley, and the San Francisco Bay Area". The proposition passed with 52.6% in favor and 93% of presidential election voters casting a vote.

[1] In weak institutional environments, personal connections of politicians play a strong role; see Burgess et al. (2015) and Alder and Kondo (2020).

[2] Plans for a high speed rail network in California formally began in the mid 1990s and construction of the HSR began in 2015. As of today, the first segments are projected to start operating in 2025, with the San Francisco to Anaheim segment (Phase I) completion expected by 2033. Similar existing projects include the French Paris-Lyon line from 1981, the German InterCity Express from 1991, and Japan's Shinkansen line which began operating in 1963 (Leavitt et al., 1993). In the US, plans to link Oklahoma with Dallas-Fort Worth are currently underway, with a Houston-Dallas segment having received federal approval in 2020, but no other similar project has advanced.

The HSR presents a unique setting to observe preferences for a large infrastructure project. The presidential vote in the same election allows us to also observe political preferences. In this project, we will combine detailed voting data with a quantitative spatial framework extended to include optimal investments undertaken by a politically minded government. We will estimate people's preferences for the HSR, the importance of political alignment and economic effects in shaping them, the extent by which policymakers designing the HSR took them into account, and the extent to which these preferences could shape the implementation of future alternative projects.

2 Data and Methods

2.1 Model and Numerical Example

We use a quantitative spatial framework with globally optimal investments implemented by a politically minded authority. We present here the simplest version that illustrates the planning problem. There are $i = 1, .., N$ locations. Utility of individual ω from i when the railway status is $s \in \{n, nb\}$ (built, not built) is given by $u_\omega(i,s) = W(i,s) + a(i,s) + \eta_\omega(s)$, where $W(i,s)$ is real income in location i under railway status s net of fiscal costs to taxpayers.[3] The HSR may impact outcomes through multiple channels, including shorter travel times for commuting or other purposes as well as benefits such as business creation (Bernard et al., 2019).[4] Voting is probabilistic as in Dixit and Londregan (1996), so $a(i,s)$ is a preference for the railway common to every resident of i, capturing systematic support or opposition to the HSR due to residents' values or political views, and $\eta_\omega(s)$ is idiosyncratic to each individual. Assuming an extreme value distribution on $\eta_\omega(s)$ with shape parameter θ_v, the fraction of people in i that vote in favor of the HSR is:

$$\lambda_v(i) = \frac{e^{\theta_v(\Delta a(i) + \Delta W(i))}}{1 + e^{\theta_v(\Delta a(i) + \Delta W(i))}}, \tag{1}$$

where $\Delta a(i) \equiv a(i,b) - a(i,nb)$ and $\Delta W(i) \equiv W(i,b) - W(i,nb)$ are the preference and real income effects of the HSR expected by residents of i.[5] As in Fajgelbaum and Schaal (2020), the HSR is a policy over infrastructure investments that impact $\Delta W(i)$ subject to resource availability constraints. These constraints and the general equilibrium underlying $\Delta W(i)$ define a set $G(\{\Delta W(i)\}) \leq 0$ of real incomes that a planner could implement through infrastructure. Since the HSR will not lower travel times, $\Delta W(i) \geq 0$. Subject to these constraints, a politically minded authority designing the HSR maximizes a weighted sum of utility and favorable votes:

$$\max_{\Delta W(i), \lambda_v(i)} \sum_i \Omega(i) N(i) \Delta W(i) + \gamma \sum_i N(i) \lambda_v(i) \tag{2}$$

We can show that in an interior solution for location i, voting satisfies:

$$\lambda_v^*(i) = \frac{1}{2} + \frac{1}{2}\left(1 - \frac{4}{\gamma\theta_v}\left(\frac{\mu G_i}{N(i)} - \Omega(i)\right)\right)^{1/2}, \tag{3}$$

[3] Spatial equilibrium models as in Redding and Rossi-Hansberg (2017) will give the shape of $W(i,s)$ depending on what forces are assumed. For example, if the only endogenous decision is commuting, then in a model such as Ahlfeldt et al. (2015) we would have $W(i,s) = \frac{1}{\theta_w} \ln\left(\sum_{j'} e^{\theta_w(w(j') - \rho_w \tau(i,j',s))}\right)$, where $w(j)$ is the wage in location j, ρ_w is the elasticity of travel cost to travel time, $\tau(i,j,s)$ is the travel time between i and j given HSR status s, and θ_w measures the dispersion in idiosyncratic wage draws that agents from i have across locations.

[4] The High Speed Rail Authority estimate that business travel would account for roughly 9% of daily trips, commuting for 16%, recreational trips for 33% and other types of trips for the remainder (Systematics, 2016).

[5] We assume perfect forecast. We plan to explore that some locations may be better informed or may have different assessments on the likelihood of HSR completion. Glaeser and Ponzetto (2018) present a theory in which voters' attention on infrastructure spending shape the investment decisions.

where μ is the multiplier of the feasibility constraint $G(\{\Delta W(i)\})$. Favorable HSR votes increase with government weights and fall with the social cost of delivering real income to i through infrastructure, μG_i. Using (1), locations with higher $\Delta a(i)$ receive lower investment $\Delta W(i)$: among locations in an interior solution, investment is higher in locations more averse to the HSR.

However, depending on parameters, a location may not be in an interior solution and be "ignored" by the planner, making the political weights endogenous.[6] To illustrate this feature, we simplify the infrastructure investment to a case where $G_i = 1$, so that the planner just allocates real income subject to a constraint: $G(\{\Delta W(i)\}) = \sum_i \Delta W(i) - \overline{W}$. Because $\lambda_v(i)$ in (2) introduces a non-convexity, standard convex optimization arguments do not apply, but with a small number of locations it is possible to exhaust all the potential combinations of FOCs. Figure 1 shows investment and votes with 4 locations as function of total resources.[7] Pivotal locations, with intermediate preferences for the HSR, are the first to receive transfers. As the size of the budget grows, every location lies in an interior solution, with more averse locations receiving more.

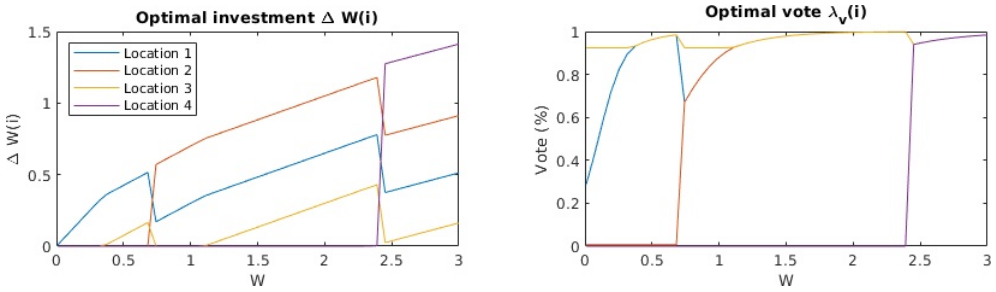


FIGURE 1: EXAMPLE WITH 4 LOCATIONS

Implementing this model with an actual infrastructure planning problem and a large number heterogenous locations poses a computational challenge due to the non-convexities. However, substituting (1) into the objective function turns the problem into a sigmoidal programming as in Udell and Boyd (2013). This approach relies on a branch-and-bound algorithm which solves a sequence of increasingly accurate convex approximations to the objective function and is guaranteed to converge to the global maximum. Preliminary implementations suggest that the method is fast for up to several hundreds of locations.

Using (1) and (3), we will estimate the political parameters $\{\theta_v, \Omega(i), \Delta a(i)\}$ given data on votes $\lambda_v^*(i)$ and exogenous shifters of the marginal cost of delivering welfare through infrastructure, G_i.[8] Below, we present a preliminary reduced-form estimation of (1). Having recovered these preferences, we will ask how important they were in shaping the observed investments. We will then ask how different the optimal investment would be given alternative voting weights γ, planner weights $\Omega(i)$, and voter's preferences $\Delta a(i)$.

2.2 Data and Preliminary Evidence

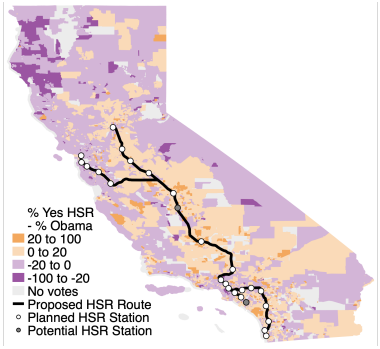
Precinct-level data on the 2008 general election come from UC Berkeley's Statewide Database, while data on covariates come from the 2006-2011 American Community Survey. We use the

[6] This could happen, for example, where investment is too costly.

[7] In the example, political preferences are given by $\Delta a(1) = -0.1$, $\Delta a(2) = -0.5$, $\Delta a(3) = 0.25$, $\Delta a(4) = -1$. We also assume that $\Omega(i) = 1$ and $N(i) = 1$.

[8] This can be obtained combining a spatial equilibrium model with a standard parametrization or matched to data of economic activity in California, combined with engineering information on building cost from sources such as Levinson et al. (1996).

(a) % Voting Yes on HSR - % Voting Obama



(b) % Commuters Saving Time Under HSR

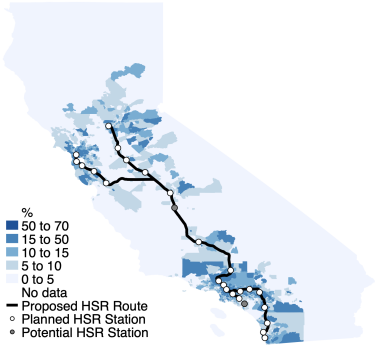


FIGURE 2: VOTING AND COMMUTING

Note: In both figures, the HSR network as proposed in 2008 is shown in a black line with white dots indicating the locations of proposed stations and grey dots indicating the location of potential stations. Figure 2a shows the difference between the percentage of voters voting yes on Proposition 1A and the percentage of voters voting in favor of the democratic presidential candidate Barack Obama in the 2008 general election for each precinct. Orange precincts are those where support for the rail network was higher than support for Obama while purple precincts are those where support for Obama was higher than for the HSR. Figure 2b shows, for each Census tract, the percentage of commuters who would save time on their commute if the HSR were built. Darker blue tracts are those where larger shares of commuters are saving time.

2006-2011 Census Transportation Planning Products (CTPP) for commute flows and times without the HSR. We measure the demand for non-commuting (leisure and non-commuting business) travel from each tract from the 2010 California Household Travel Survey, and use the path of the planned HSR network and planned travel speeds from the HSR Authority's 2008 Business Plan for travel times with the HSR.

Figure (2) shows the network in black and stations in white circles. The left panel shows the difference between positive HSR votes and favorable Obama votes across precincts (orange indicates that support for HSR was higher than for Obama while purple indicates the opposite), and the right panel shows the share of commuters in each census tract who would be saving time if the HSR were built (with darker blue indicating bigger reductions).[9] We see that distance to the HSR is strongly correlated with HSR preferences net of the Obama vote, as are commuting gains.

We implement a preliminary estimation of (1). Inverting that equation we obtain $\ln\left(\frac{\lambda_v(i)}{1-\lambda_v(i)}\right) = \alpha + \theta_v \Delta W(i) + \beta \ln\left(\frac{\lambda_v^P(i)}{1-\lambda_v^P(i)}\right) + \Gamma \cdot X_i + \epsilon_i$. In this preliminary estimation, the expected benefits $\Delta W(i)$ are approximated in different ways without yet using the model.[10] $\lambda_v^P(i)$ is the share of residents in tract i voting in favor of Obama[11] and X_i is a vector of controls including county fixed effects. In Table 1 we find that the stand-ins for $\Delta W(i)$ indeed correlate with the favorable vote. Support for Obama explains 76.8% of the variation in support for the HSR, suggesting that preferences for infrastructure is highly correlated with preferences for other policy positions.

[9] We compute each location's reduction in commute times under the HSR by comparing observed, pre-HSR commute times as measured in the CTPP with an estimated measure of HSR commute times given the locations of stations relative to each origin and destination tract and the planned speed of rail travel between stations.

[10] We use whether there is a station within 10 kilometers of the tract, the share of commuters whose commutes would be reduced under the HSR, and the share of non-commuting trips taken by residents of that tract that could have been taken via HSR.

[11] Including this term is consistent with the assumption that the Obama vote is also probabilistic like that HSR and that the common component of the distribution of idiosyncratic preferences, $a^P(i)$, is correlated with the preference for the HSR, $a(i)$ in (1).

	Dep. Variable: HSR Support Log-Odds Ratio			
	(1)	(2)	(3)	(4)
Obama Support Log-Odds Ratio	0.657***	0.656***	0.649***	0.568***
	(0.00545)	(0.00490)	(0.00509)	(0.00675)
1(HSR station w/in 10km)			0.0134***	0.00524*
			(0.00235)	(0.00226)
Share of Commuters Saving Time		0.0872***	0.0585***	0.0494**
		(0.0138)	(0.0147)	(0.0165)
Share non-commuting trips in HSR network			0.0263**	0.0192*
			(0.00927)	(0.00856)
Controls	No	No	No	Yes
County FE	Yes	Yes	Yes	Yes
N	8053	7983	7500	7223
Within R^2	0.768	0.771	0.776	0.811

Note: Robust standard errors are in parentheses. Regressions are at the Census tract level. Controls used where indicated are the log of the average commute time in the tract, share of the tract that is college educated, log of the median income, share of the tract that is nonwhite, share of the tract that commutes, and share of the tract that rides public transit to commute.

TABLE 1: HSR SUPPORT, OBAMA VOTE, AND COMMUTING

References

Ahlfeldt, G. M., S. J. Redding, D. M. Sturm, and N. Wolf (2015). The economics of density: Evidence from the berlin wall. *Econometrica 83*(6), 2127–2189.

Alder, S. and I. Kondo (2020). Political distortions and infrastructure networks in china: A quantitative spatial equilibrium analysis.

Allen, T. and C. Arkolakis (2019). The welfare effects of transportation infrastructure improvements. *Manuscript, Dartmouth and Yale*.

Bernard, A. B., A. Moxnes, and Y. U. Saito (2019). Production networks, geography, and firm performance. *Journal of Political Economy 127*(2), 639–688.

Bowen, D. (2008). California general election official voter guide.

Burgess, R., R. Jedwab, E. Miguel, A. Morjaria, and G. Padró i Miquel (2015). The value of democracy: evidence from road building in kenya. *American Economic Review 105*(6), 1817–51.

Dixit, A. and J. Londregan (1996). The determinants of success of special interests in redistributive politics. *the Journal of Politics 58*(4), 1132–1155.

Fajgelbaum, P. D. and E. Schaal (2020). Optimal transport networks in spatial equilibrium. *Econometrica 88*(4), 1411–1452.

Glaeser, E. L. and G. A. Ponzetto (2018). The political economy of transportation investment. *Economics of Transportation 13*, 4–26.

Leavitt, D., S. Ennis, and P. McGovern (1993). The cost escalation of rail projects: Using previous experience to re-evaluate the calspeed estimates.

Levinson, D., D. Gillen, A. Kanafani, and J.-M. Mathieu (1996). The full cost of intercity transportation-a comparison of high speed rail, air and highway transportation in california.

Redding, S. J. and E. Rossi-Hansberg (2017). Quantitative spatial economics. *Annual Review of Economics 9*, 21–58.

Redding, S. J. and M. A. Turner (2015). Transportation costs and the spatial organization of economic activity, vol. 5 of handbook of regional and urban economics.

Systematics, C. (2016). California high-speed rail ridership and revenue model.

Udell, M. and S. Boyd (2013). Maximizing a sum of sigmoids. *Optimization and Engineering*, 1–25.