Political Preferences and the Spatial Distribution of Infrastructure: Evidence from California’s High-Speed Rail

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Motivation and Research Question

- Transportation infrastructure projects are typically massive public investments

- Recent research finds inefficiencies to be pervasive
  - Highways: Fajgelbaum and Schaal (20), Allen and Arkolakis (22)
  - Buses: Kreindler et al. (23), Almagro et al (24)
  - Shipping: Brancaccio et al. (2024)

- Why are transport networks seemingly inefficient?

- We study the role of policymakers’ and households’ preferences
  - Policymakers may take into account popular approval and distributional concerns
  - Project design may be tweaked to elicit public support, away from utilitarian benchmark

- We use the context of California High-Speed Rail to shed light on these questions
  - By some accounts, second largest transport project in US history
  - CHSR funding put on the ballot in California in 2008, voting data observed across 8k census tracts
1996: California HSR Authority is established, goal to connect Northern and Southern CA

2008: Prop 1a approved (passed with 52.6%)
- Issue bonds for $10 bn (0.4% CA GDP)
- Projections: $>40 bn; first segment in 2022
- ≥ 200 mph (SF-LA: 2:40’)
- 24 stations over 800 miles

2015: Construction begins, many financial, legal, and implementation troubles since

2022 Updates
- Central Valley segment (170 miles) projected by 2030
- Cost projections > 130b
HSR Planned Route and % Yes on Prop 1a

Figure: California

Figure: LA County
This Paper

1. **Economic Model**
   - Develop and estimate a spatial model of high speed rail passenger travel
     - Commuting/business/leisure travel, modal choice, ticket prices
     - + GE
     - dense areas (SF, LA, closer to the railway stations) benefit more
     - sparsely populated areas (Central Valley) have lower relative gains

2. **Voting Decision**
   - Estimate elasticity of favorable votes to the expected economic gains
   - Voters were significantly responsive to expected income gains
     - 0.1-0.2% additional expected income sways 1% of votes

3. **Policymaker Preferences**
   - Moment inequality estimation of planner preferences over demographic groups and votes
     - Large deviation from utilitarian, strong preference for votes
   - Optimal CHSR design of apolitical planner would have concentrated stations nearer urban centers
     - Doubles the projected economic gains
Literature Review

- **Real income effects of infrastructure** (summary Redding and Turner 15)
  - Donaldson 12, Faber 14, Donaldson and Hornbeck 16,...
  - Rails: Bernard et al. 19, Borusyak and Hull 21, Dong et al. 20, Gupta et al. 21, Severen 21, Tyndall 21, Koster 22,...

- **Quantitative spatial models** (summ Redding and Rossi-Hansberg 17) dive into:
  - Commuting: Ahlfeldt et al. 15, Monte et al. 18, Dingel and Tintelnot 21,...
  - Distributional effects: Tsivanidis 19, Balboni et al. 20, Barwick et al. 21,...
  - Optimal Infrastructure: Alder 19, Fajgelbaum and Schaal 20, Allen and Arkolakis 21

- **Individual’s policy preferences and referenda**
  - Deacon and Shapiro 75,...
  - HSR: Holian and Kahn 13, Kahn and Matsusaka 97
  - Trade: Hicks et al 14, Becker et al 17, Mendez and Van Patten 22

- **Estimation of planner’s preferences**
  - PF: Christiensen 81, Bourguignon and Spadaro 12,...
  - Trade: Goldberg Maggi 99, Adao et al 23
Voting

- Utility of agent $\omega$ in location $i$:

$$u_\omega(s) = \mathbb{E}[\ln W(i, s)] + \ln a(i, s) + \varepsilon^u_\omega(s)$$

- Proposal $s$: Yes/No
- $\ln W(i, s)$: average expected real income
- $\ln a(i, s)$: other considerations (e.g. ideology)

- Assume $\varepsilon^u_\omega(s)$ are Type-I extreme-value ($\theta_V$), then distributed

$$v(i) = \frac{e^{\theta_V(\mathbb{E}[\ln \hat{W}(i)] + \ln \hat{a}(i))}}{1 + e^{\theta_V(\mathbb{E}[\ln \hat{W}(i)] + \ln \hat{a}(i))}}$$

where $\hat{W}(i) = \frac{W(i, Y)}{W(i, N)}$ and $\hat{a}(i) = \frac{W(i, Y)}{W(i, N)}$

- Next: use a model-based prediction for $\hat{W}(i)$ to proxy for $\mathbb{E}[\ln \hat{W}(i) | I_i]$
Economic Model: Effects of HSR

- Direct: time (or cost) savings from inter-city travel

- Indirect:
  - “Economic development”
  - House prices

- Extend a quantitative spatial model à la Ahlfehldt et al 15
  - Residents commute and consume a traded good, housing, and leisure trips
  - Firms produce using land, labor, and business trips
  - (Logit) choice of both destination and travel mode (McFadden 74)
    - time and monetary costs of travel
  - Agglomeration and congestion spillovers
Potential Time and Cost Savings from the CHSR

**Commuting** (ACS, 2006-2010): 42% of residents
- average 32’; 13% of trips are +60’ one-way

**Business and Leisure** (CAHTS, 2012): 25% of residents
- 7m annual business trips, median 92’; Top: Downtown SC, LA, SF, SD
- 63m annual leisure trips, median 104’; Top: Disneyland, Yosemite, Mission Beach

<table>
<thead>
<tr>
<th></th>
<th>% Initial Travelers Directly Better Off</th>
<th>Time Gain</th>
<th>Cost Change</th>
<th>2008 Business Plan</th>
<th>2022 Business Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pub. Trans. or Air</td>
<td>median</td>
<td>75 ptile</td>
<td>med</td>
<td>75p</td>
</tr>
<tr>
<td>Commute</td>
<td>1.0%</td>
<td>28’ (35%)</td>
<td>47’ (45%)</td>
<td>-18%</td>
<td>-1%</td>
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<tr>
<td>Leisure</td>
<td>0.4%</td>
<td>25’ (15%)</td>
<td>50’ (36%)</td>
<td>-55%</td>
<td>-30%</td>
</tr>
<tr>
<td>Business</td>
<td>4.6%</td>
<td>14’ (6%)</td>
<td>29’ (14%)</td>
<td>-62%</td>
<td>-56%</td>
</tr>
</tbody>
</table>
Economic Model: Consumer Primitives

- Consumer $\omega$ from tract $i$ traveling to $j_{C}$ and $j_{L}$ (for commuting, leisure) through modes $m_{C}$ and $m_{L}$

$$v_{\omega}(i,j_{C},m_{C},j_{L},m_{L}) = \max_{C,H,T} B_{i} \frac{C^{1-\mu_{H}-\mu_{L}}H_{C}^{\mu_{H}}}{d_{C}(i,j_{C},m_{C})} \left( \frac{B_{j_{L}}T_{L}}{d_{L}(i,j_{L},m_{L})} \right)^{\mu_{L}} \varepsilon^{C}_{\omega}(j_{C},m_{C}) \varepsilon^{L}_{\omega}(j_{L},m_{L})$$

where

- $C, H, T =$ tradeables, floor space, trips
- $B_{i}$: location-specific amenities
- $d_{k}(i,j,m) = D_{i,m}^{k}T_{m}(i,j)^{\rho}$: traveling disamenities

- Budget constraint:

$$C + r_{i}H + p_{L}(i,j_{L},m_{L})T_{L} + p_{C}(i,j_{C},m_{C})T_{C} = (1 - \text{tax})(e_{i}w_{j_{C}} + \eta_{i}r_{i})$$

- $p_{L}$ and $p_{C}$: costs per trip
Firm $\omega$ from tract $j$ traveling to $j_L$ with mode $m_B$ solve:

$$\max_{H_Y, N_Y, R_B} A_j H_Y^{\mu_H Y} N_Y^{1-\mu_H Y-\mu_B} \left( \frac{A_{j_B}}{d_B(j, j_B, m_B)} T_B \right)^{\mu_B} \varepsilon^B_B(j_B, m_B) - r_j H_Y - w_j N_Y - p_B(j, j_B, m_B) T_B$$

where

- $N, H, T =$ labor, floor space, trips
- $A_j$: location-specific TFP
- $d_B(i, j, m_B) = D^B_{i, m_B} \tau(i, j, m_B)^\rho$: business trip disamenities
- $p_B(j, j_B, m_B)$: cost per business trip
Real Income Measurement: Time+Cost Shocks

- Uncertainty and delays:
  \[ \ln \hat{W}(i) = (1 - R) \ln (1 - \text{tax}) + R \ln \hat{V}(i) \]

- \( R \) incorporates time discount and expected time to completion

- Real income change in tract \( i \):
  \[ \hat{V}(i) = \frac{\left( \sum_j \sum_m \lambda^C_{i,j,m} \left( \hat{I}_{i,j,m} \hat{\rho}_{i,j,m} \right)^{\theta_C} \right)^{\frac{1}{\theta_C}}}{\left( \sum_j \sum_m \lambda^L_{i,j,m} \left( \hat{p}_{i,j,m} \hat{\rho}_{i,j,m} \right)^{-\theta_L \mu_L} \right)^{-\frac{1}{\theta_L}}} \]

- \( \lambda^C_{i,j,m}, \lambda^L_{i,j,m} \): pre-HSR travel shares
- \( \hat{I}_{i,j,m} = \frac{w_{i,j}}{l_{i,j,m}} (1 - \text{tax}) - \frac{p_{i,j,m}}{l_{i,j,m}} \hat{p}_{i,j,m} \): disposable income
- \( \hat{\rho}_{i,j,m} \): time change on best route
- \( \hat{p}_{i,j,m} \): travel cost change on best route
Real Income Measurement: Time+Cost Shocks+GE

- Real income change in tract $i$:

$$\hat{V}(i) = \left( \frac{\sum_j \sum_m \lambda_{i,j,m}^C \left( \hat{r}_i^{1-\mu_H} \hat{B}_i \hat{l}_{i,j,m} \hat{r}_i^{\rho} \hat{\mu} \right)^{\theta_C}}{\sum_j \sum_m \lambda_{i,j,m}^L \left( \hat{B}_j \hat{\rho}_i \hat{l}_{i,j,m} \hat{r}_i^{\rho} \hat{\mu} \right)^{-\theta_L \mu_L} + \frac{1}{\sigma_L}} \right)^{-\frac{1}{\sigma_C}}$$

- Wages adjust due to business trips:

$$\hat{w}_{i}^{1-\mu_B-\mu_{HY}} \hat{r}_{j}^{\mu_{HY}} = \hat{A}_i \left( \sum_j \sum_m \lambda_{i,j,m}^B \left( \frac{\hat{A}_j}{\hat{B}_j^B \hat{\rho}_i \hat{l}_{i,j,m} \hat{r}_i^{\rho}} \hat{B}_i \hat{\mu} \right)^{\theta_B \mu_B} \right)^{\frac{1}{\sigma_B}}$$

+ market-clearing (land, labor)
+ spillover conditions (amenities, productivity)
Parametrization

- 7,866 census tracts (avg. working pop: 2,600)

- Times and costs by transport mode (GoogleMaps, Amtrak, …, CHSR Business Plan)
  1. walk or bike
  2. only car (>90% of travelers)
  3. public transport (bus, rail) + CHSR
  4. car + air + CHSR

- $\rho, \theta_L, \theta_B, \theta_C$ estimated from travel decisions (ACS, CHTS)

- $\mu_L, \mu_B$ calibrated to spending shares

- Use model-generated $\lambda_{i,j,m}^{k}$ due to sparsity of travel data

- With indirect effects:
  - Workers, wages, land prices (U.S. Census, LEHD, Zillow)
  - Spillover elasticities from Ahlfehldt et al. (2015)

- Costs: 2008 Business Plan and 2022 BP (2x ticket, 0.65 completion not before 2030, $130b cost)
Time Elasticities from Travel Decisions

- **Commuting:**
  \[
  \lambda_C(i,j,m) \propto \left( \frac{l(i,j,m)}{D_C(i,m)} \right)^{\theta_C} \tau(i,j,m)^{-\theta_C \rho}
  \]

  - Yields: \( \theta_C = 2.73^{***} \), \( \theta_C \rho = 2.99^{***} \), \( \rho = 1.09^{***} \)
  - \( D_C(i,m) \) varies substantially across tracts
    - car preferred to public transport, public transport relative to biking
    - younger and more educated tracts have a weaker preference for car
    - nonwhite tracts strongly prefer public transport

- **Leisure and Business Trips** \( (k = L, B) \):
  \[
  \tilde{\lambda}_k(i,j,m) \propto \left( \frac{Z_k(i,j)}{D_k(i,m)} \right)^{\mu_k \theta_k} \tau(i,j,m)^{-\rho \mu_k \theta_k} p_k(i,j,m)^{-\mu_k \theta_k - 1}
  \]

  - \( Z_k(i,j) \): amenities (e.g., national park) or returns to business trips (e.g., industry similarity)
  - \( \mu_L \theta_L \rho = 1.08^{***} \). With \( \mu_L = 3.4\% \) (CEX) \( \rightarrow \theta_L = 29.1^{***} \)
  - \( \mu_B \theta_B \rho = 1.42^{***} \). With \( \mu_B = 1.2\% \) (GBTA) \( \rightarrow \theta_B = 108.9^{***} \)
Distribution of Local Income Effects

<table>
<thead>
<tr>
<th>Winning tracts:</th>
<th>more</th>
</tr>
</thead>
<tbody>
<tr>
<td>along the HSR line, closer to stations</td>
<td></td>
</tr>
<tr>
<td>more prone to public transit, longer commutes</td>
<td></td>
</tr>
<tr>
<td>LA and SF gain more, grow in employment</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\hat{W}(i)$</th>
<th>p10</th>
<th>p50</th>
<th>p90</th>
<th>Agg</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008 Business Plan</td>
<td>-0.11%</td>
<td>0.05%</td>
<td>0.46%</td>
<td>0.16%</td>
</tr>
<tr>
<td>2008 Business Plan, with GE</td>
<td>-0.05%</td>
<td>0.13%</td>
<td>0.58%</td>
<td>0.24%</td>
</tr>
<tr>
<td>2022 Business Plan</td>
<td>-0.34%</td>
<td>-0.26%</td>
<td>-0.06%</td>
<td>-0.21%</td>
</tr>
<tr>
<td>2022 Business Plan, with GE</td>
<td>-0.31%</td>
<td>-0.23%</td>
<td>-0.06%</td>
<td>-0.17%</td>
</tr>
</tbody>
</table>
Voting Decision

Log-odds of favorable votes:

\[
\ln \left( \frac{v(i)}{1 - v(i)} \right) = \theta_V \mathbb{E} \left[ \ln \hat{W}(i) \mid I_i \right] + \ln \hat{a}(i)
\]

- Assume:

\[
\mathbb{E} \left[ \ln \hat{W}(i) \mid I_i \right] \equiv \ln \hat{W}(i) - \epsilon_W(i)
\]

- Use controls for \( \hat{a}(i) \)

\[
\ln \hat{a}(i) \equiv \sum_{k=1}^{K} \beta_k X_k(i) + \epsilon_a(i)
\]

- County fixed effects
- Favorable votes in 2008 Prop. 10 (alternative fuels) and 2006 Prop. 1B (transport funding)
- Demographic characteristics
- Time to reach stations
Voting Decision

\[ \ln \left( \frac{v(i)}{1 - v(i)} \right) = \theta V \ln \hat{W}(i) + \sum_{k=1}^{K} \beta_k X_k(i) + \epsilon(i) \]

- **Expectational error of voters**
  - Instrument for \( \hat{W}(i) \) with \( \hat{W}_{08}(i) \in \mathcal{I}_i \) using 2008 data

- **Omitted variables**
  - Instrument: counterfactuals with randomly placed stations along alternative routes

\[ \hat{W}_{08}^{IV}(i) = \frac{1}{100} \sum_{n=1}^{100} \ln \left( \hat{W}_{08}^{cf}(i, n) \right) \]

- **Model misspecification**
  - Use different models and different restrictions on the sample
# Voting Equation, Baseline

<table>
<thead>
<tr>
<th>Inst. Var.:</th>
<th>(1)</th>
<th>None - OLS (2)</th>
<th>(3)</th>
<th>(4)</th>
<th>ln((\hat{W}_{08})) (5)</th>
<th>Random Station (6)</th>
<th>Random Path (7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\log(\hat{W}_{19}))</td>
<td>41.91^a</td>
<td>18.29^a</td>
<td>15.83^a</td>
<td>15.13^a</td>
<td>17.96^a</td>
<td>20.90^a</td>
<td>22.05^a</td>
</tr>
<tr>
<td></td>
<td>(1.82)</td>
<td>(1.30)</td>
<td>(1.05)</td>
<td>(1.09)</td>
<td>(1.30)</td>
<td>(1.76)</td>
<td>(1.83)</td>
</tr>
<tr>
<td>Log-odds Dem. Sh.</td>
<td>0.30^a</td>
<td>0.39^a</td>
<td>0.38^a</td>
<td>0.38^a</td>
<td>0.39^a</td>
<td>0.39^a</td>
<td>0.39^a</td>
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<tr>
<td></td>
<td>(0.01)</td>
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<tr>
<td>Environ.: Prop. 10</td>
<td>1.15^a</td>
<td>2.44^a</td>
<td>2.44^a</td>
<td>2.42^a</td>
<td>2.40^a</td>
<td>2.40^a</td>
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<tr>
<td></td>
<td>(0.06)</td>
<td>(0.05)</td>
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<td>(0.05)</td>
<td>(0.05)</td>
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<td>(0.05)</td>
</tr>
<tr>
<td>Transp.: Prop. 1b</td>
<td>1.55^a</td>
<td>0.82^a</td>
<td>0.82^a</td>
<td>0.81^a</td>
<td>0.81^a</td>
<td>0.80^a</td>
<td>0.80^a</td>
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<tr>
<td></td>
<td>(0.05)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
<td>(0.04)</td>
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<tr>
<td>Sh. non-White</td>
<td>-0.16^a</td>
<td>-0.17^a</td>
<td>-0.17^a</td>
<td>-0.18^a</td>
<td>-0.18^a</td>
<td>-0.18^a</td>
<td>-0.18^a</td>
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<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
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<tr>
<td>Sh. College</td>
<td>0.75^a</td>
<td>0.74^a</td>
<td>0.74^a</td>
<td>0.74^a</td>
<td>0.74^a</td>
<td>0.73^a</td>
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<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
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<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
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<tr>
<td>Sh. Under 30</td>
<td>0.18^a</td>
<td>0.17^a</td>
<td>0.17^a</td>
<td>0.17^a</td>
<td>0.17^a</td>
<td>0.17^a</td>
<td>0.17^a</td>
</tr>
<tr>
<td></td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(0.03)</td>
<td>(0.03)</td>
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<tr>
<td>Log. Dist. Station</td>
<td>-0.01^a</td>
<td>-0.01^c</td>
<td>-0.00</td>
<td>-0.00</td>
<td>-0.00</td>
<td>-0.00</td>
<td>-0.00</td>
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<td></td>
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</tr>
</tbody>
</table>

| F-stat       | 1197 | 672 | 466 |
| Num. Obs.    | 7861 | 7861 | 7861 | 7861 | 7861 | 7861 | 7861 |

Note: ^a denotes 1% significance level. Robust standard errors in parenthesis. All specifications control for county fixed effects.
Implications

- Cannot reject the joint hypothesis that agents cared about real income as predicted by the model
  1. Support for our estimated model as a predictor of the spatial distribution of economic impacts
  2. Economic voting is a driver of policy preferences over transport infrastructure
  3. Policymakers may want to invest where marginal impact on public support is greater

<table>
<thead>
<tr>
<th>Model Variant</th>
<th>$\theta_V$</th>
<th>Gain to Sway 1 pp (median tract)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008 Business Plan</td>
<td>22.0</td>
<td>0.2%</td>
</tr>
<tr>
<td>2008 Business Plan, with GE</td>
<td>18.1</td>
<td>0.2%</td>
</tr>
<tr>
<td>2022 Business Plan</td>
<td>44.6</td>
<td>0.1%</td>
</tr>
<tr>
<td>2022 Business Plan, with GE</td>
<td>35.8</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

Note: table reports $\theta_V$ and percentiles the inverse of $\frac{dv(i)}{d\hat{W}(i)} = \frac{\theta_V v(i) (1 - v(i))}{\hat{W}(i)}$
Policymakers' Preferences

- Optimal design solves:

\[
\max_{d \in \mathcal{D}^{24}} \mathbb{E} \left[ \sum_{i=1}^{J} \lambda_U(i) N_R(i) \ln \hat{W}(i; d) + \lambda_V \sum_{i=1}^{J} N_R(i) v(i; d) \right]
\]

- \( d \equiv (d_1, \ldots, d_{24}) \) are coordinates of 24 stations
- \( \mathcal{D} \) is the set of coordinates along CHSR or alternative I5 route
- Pareto weights: \( \lambda_U(i) \equiv \sum_{k=0}^{K} \beta_k Z_k(i) \)
  - \( Z_k(i) \in \{\text{Density}, \text{Share College}, \text{Share Non-White}\} \)
- For any alternative design:

\[
\sum_{i=1}^{J} \left( \lambda_U(i) + \lambda_V \frac{\partial v(i)}{\partial \ln \hat{W}(i)} \right) N_R(i) \Delta \ln \hat{W}(i, d^n) - \epsilon(d^n) \leq 0
\]

- Inequalities define intervals for \( (\lambda_U, \lambda_V) \)
- Compute confidence set using modified method of moments (Andrews and Soares, 2010)
Example of Perturbation with ↓Welfare and ↑Votes

(a) Welfare Change

\[ \sum_i N(i) \Omega(i) \Delta \ln \hat{W}(i) = -0.0005 \]

(b) Voting Semi-elasticity

\[ \sum_i N(i) \Delta v(i) = 0.0002 \]

⇒ Not picked by the planner, hence \( \lambda_V \) cannot be too high
Real Income vs. Vote Trade-off

- Increase votes and reduce real income $\rightarrow$ Upper bound on Preference for Votes
- Decrease votes and increase real income $\rightarrow$ Lower bound on Preference for Votes
## Planner’s Preferences

<table>
<thead>
<tr>
<th>Observable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>[0.00, 1.13]</td>
<td>[0.00, 0.14]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share college</td>
<td>[0.23, 0.50]</td>
<td>[0.12, 0.50]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share non-white</td>
<td></td>
<td>[-0.33, 0.50]</td>
<td>[-0.23, 0.14]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Votes</td>
<td>[2.60, 11.07]</td>
<td>[4.24, 21.26]</td>
<td>[5.52, 8.95]</td>
<td>[3.45, 18.23]</td>
<td>[6.79, 9.14]</td>
</tr>
<tr>
<td>Constant</td>
<td>[1.00, 1.00]</td>
<td>[0.98, 1.00]</td>
<td>[0.99, 1.00]</td>
<td>[0.98, 1.01]</td>
<td>[0.99, 1.01]</td>
</tr>
</tbody>
</table>

The brackets indicate the min and the max of the 95% confidence set for each covariate.

⇒ **Strong preference for votes** and for college-educated locations
Apolitical Planner ($\lambda = 0$)

Robustness
Apolitical Planner \( (\lambda = 0) \) - Changes versus Baseline CHSR

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate Welfare vs. Baseline CHSR</td>
<td>0.16%</td>
</tr>
<tr>
<td>[min max] across tracts</td>
<td>[-1.42%, 4.54%]</td>
</tr>
<tr>
<td>Aggregate Vote vs. Baseline CHSR</td>
<td>-0.15%</td>
</tr>
<tr>
<td>[min max] across tracts</td>
<td>[-12.89%, 1.35%]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>( \Delta ) Real Income by Quartile</th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>0.01%</td>
<td>0.05%</td>
<td>0.14%</td>
<td>0.43%</td>
</tr>
<tr>
<td>Share college</td>
<td>0.18%</td>
<td>0.16%</td>
<td>0.12%</td>
<td>0.17%</td>
</tr>
<tr>
<td>Share non-white</td>
<td>0.04%</td>
<td>0.07%</td>
<td>0.18%</td>
<td>0.32%</td>
</tr>
<tr>
<td>Voting elasticity</td>
<td>0.37%</td>
<td>0.14%</td>
<td>0.09%</td>
<td>0.05%</td>
</tr>
</tbody>
</table>

⇒ The policymakers gave up 50% of the total potential gains (0.16%+0.16%) for votes!
- With 2022 beliefs, 40% smaller losses (relative to -0.21% with CHSR)
Apolitical Planner ($\lambda = 0$) - Reallocation

Apolitical planner redistributes towards low voting gradient locations:

(c) Welfare Change

(d) Voting Semi-elasticity
Optimal Stations along Alternative I5 Route

- Apolitical planner prefers baseline CHSR → Political preferences did not drive route choice
Conclusion

- How do policymakers’ and households’ preferences shape transport infrastructure projects?
  - Study the HSR: large project with spatially disaggregated voting data

1. Voters responded significantly to the local projected economic impact of the CHSR
   - Supports model as a predictor of the spatial distribution of economic impacts
   - Economic voting is a significant driver of policy preferences over transport infrastructure

2. The CHSR design implies strong planner preferences for gaining votes
   - Deviations that would have increased aggregate welfare but reduced votes were not implemented

3. Apolitical planner would have concentrated stations closer to urban areas, where it was harder to sway votes
   - This would have doubled the projected gross economic benefits of the CHSR

→ Attaining popular approval was an important driver of transport network design
## Distributional Effects

<table>
<thead>
<tr>
<th></th>
<th>2008</th>
<th>2008</th>
<th>2008 GE</th>
<th>2022</th>
<th>2022 GE</th>
</tr>
</thead>
<tbody>
<tr>
<td>dist. to station</td>
<td>-0.00087***</td>
<td>-0.00100***</td>
<td>-0.00115***</td>
<td>-0.00047***</td>
<td>-0.00058***</td>
</tr>
<tr>
<td>% public transit</td>
<td>0.03817***</td>
<td>0.03399***</td>
<td>0.03489***</td>
<td>0.01668***</td>
<td>0.01714***</td>
</tr>
<tr>
<td>% car</td>
<td>0.00466***</td>
<td>0.00106**</td>
<td>0.00101*</td>
<td>0.00050**</td>
<td>0.00046*</td>
</tr>
<tr>
<td>commute time</td>
<td>0.00003</td>
<td>0.00118***</td>
<td>0.00135***</td>
<td>0.00052***</td>
<td>0.00063***</td>
</tr>
<tr>
<td>LA fixed effect</td>
<td>0.00109***</td>
<td>0.00096***</td>
<td>0.00057***</td>
<td>0.00052***</td>
<td>0.00052***</td>
</tr>
<tr>
<td>SF bay area f.e.</td>
<td>0.00032***</td>
<td>0.00053***</td>
<td>0.00030***</td>
<td>0.00037***</td>
<td>0.00037***</td>
</tr>
<tr>
<td>Central Valley f.e.</td>
<td>-0.00111***</td>
<td>-0.00071***</td>
<td>-0.00051***</td>
<td>-0.00047***</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>0.684</td>
<td>0.714</td>
<td>0.656</td>
<td>0.717</td>
<td>0.666</td>
</tr>
<tr>
<td>N</td>
<td>7,866</td>
<td>7,866</td>
<td>7,866</td>
<td>7,866</td>
<td>7,866</td>
</tr>
</tbody>
</table>
Potential CHSR Routes
Pareto Weights: Confidence Set for $\beta$

Note: Parameters presented with spherical normalization $\sum \beta_i^2 = 1$
Optimal Station Placement

Note: Parameters presented with spherical normalization $\sum \beta_i^2 = 1$