Spatial Frictions and Market Segmentation: Evidence from China's Electric Vehicle Charging Networks

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The Puzzle

China ended its decade-long national EV purchase subsidy at the close of 2022. Local champions nonetheless continue to hold disproportionate market shares in their headquarter provinces. If local governments can no longer write checks, what sustains the border?

We argue the mechanism has shifted — from fiscal transfers to physical infrastructure. Automakers build proprietary, non-interoperable charging networks that function as spatial moats around home markets.

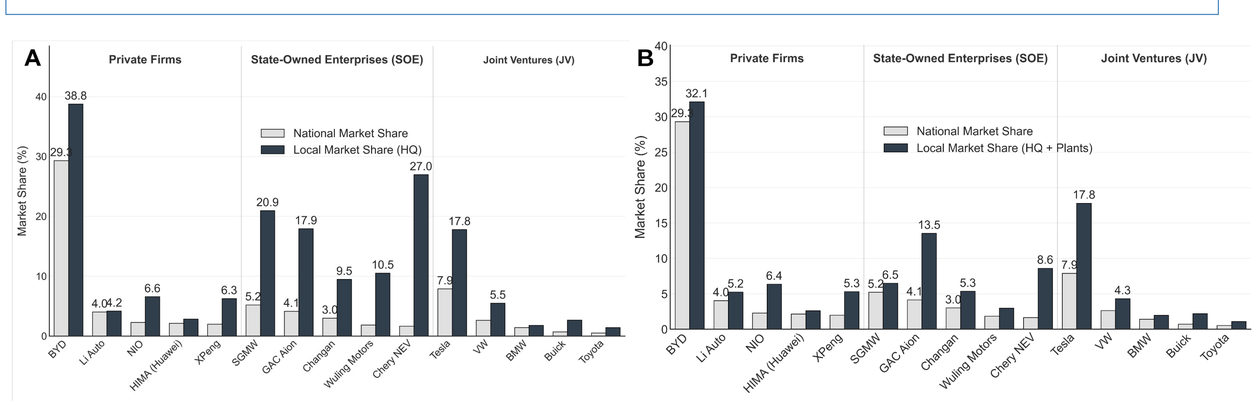


Figure 1. Home Bias and Local Protectionism in the EV Product Market. A: HQ cities; B: HQ and production-base cities. Selected brands have higher market shares in their home markets than nationally.

How the Moat Works

Charging connectors are standardized nationwide (**GB/T 20234**). Exclusion happens above the hardware layer:

- proprietary communication protocols
- software-imposed power capping
- brand-restricted access and VIP queuing

Local governments supply exclusive land rights and infrastructure subsidies to local champions; the champions build closed networks in return. The result is a nationally fragmented charging landscape.

Why now: In July 2025, the NDRC and three ministries mandated "non-discriminatory open access" for automakers' self-built high-power networks. We simulate access equalization motivated by this policy.

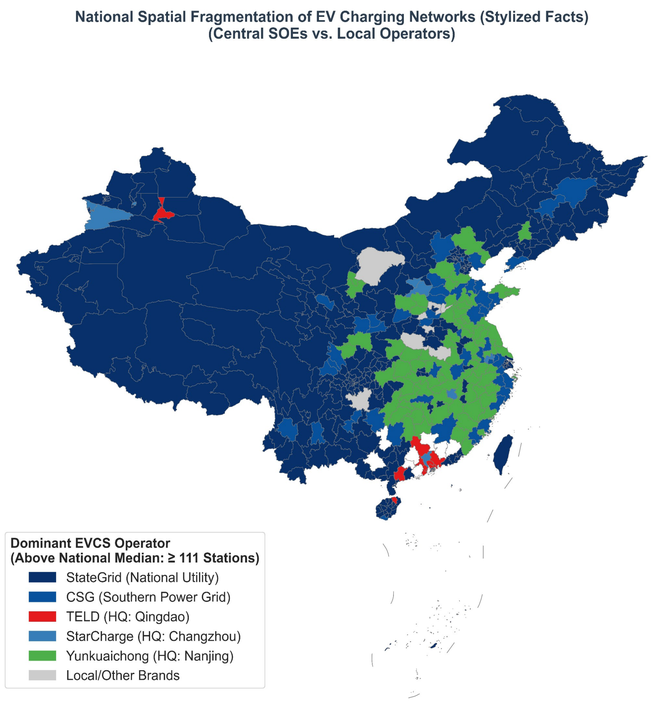


Figure 2. National Spatial Fragmentation of EV Charging Networks (Stylized Facts)： Charging networks are carved up geographically: each color marks a different dominant operator.

Data & the CMA Index

Data：

- Millions of geocoded charging-station POI records, all Chinese cities, 2012–2024; operator and brand affiliation parsed by NLP
- Universe of new EV registrations from mandatory insurance records, city × model × year
- Trim-level vehicle attributes; hand-built headquarter geography and ownership type for every automaker

Measurement： We derive brand-specific access from the consumer's own spatial choice problem. Network friction along a route is the line integral of detour penalties; the ex-ante value of a brand's network is the inclusive value over destinations:

$$F_{od|j} = \int_{x \in \Gamma_{od}} \phi\big(dist(x, \mathcal{S}_j), R_j\big) dx$$

$$CMA_{oj} \equiv \ln\Big(\sum_{d \in \mathcal{D}} \exp\big(W_d - \tau_1 Time_{od} - \tau_2 F_{od|j}\big)\Big)$$

A brand locked out of local proprietary stations faces inflated friction — those stations are mathematically invisible to its drivers — and its CMA falls. This measures fragmentation directly, rather than inferring it from unobserved residuals.

Reduced-Form Evidence

Three steps rule out the obvious alternatives:

Border-pair design. Comparing adjacent city pairs within 150 km reduces differences in geographical and market conditions. The home-market discontinuity survives.

Mechanism. An average controlled direct effect (ACDE) decomposition attributes 39.4% of the home-market premium to proprietary charging access.

Hard vs. soft moats. Protocol-locked exclusive stations (0.197) bite roughly twice as hard as nominally public networks subject to discriminatory throttling (0.099).

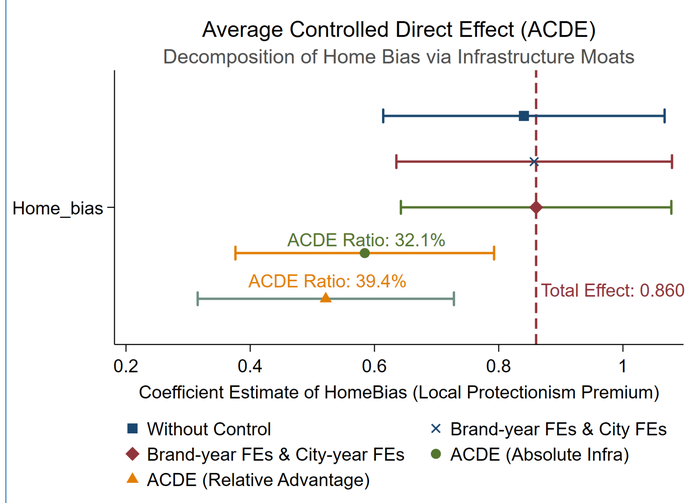


Figure 3. ACDE Decomposition via Infrastructure Moats Controlling for charging access absorbs 39.4% of the home-market premium.

Structural Model

Random-coefficient demand with CMA entering utility directly, closed with multiproduct Bertrand–Nash pricing.

$$\delta_{jc} = \beta_0 + X_j\bar{\beta} - \bar{\alpha}p_j^0 + \bar{\lambda}\mathrm{CMA}_{jc} + \rho\mathrm{Home}_{jc} + \zeta_c + \eta_t + \kappa_{\mathrm{seg}} + \xi_{jc}$$

- Price instrumented with a nickel–NMC cost shifter and, in RC-Logit, rival-product characteristics
- Price and CMA random coefficients use simulated city income distributions
- City, year, and segment fixed effects
- Marginal costs via diagonal pricing inversion; LBD assessed separately

Estimates. Own-price elasticity −1.215. CMA enters positively and significantly (1.424, t = 2.45). Consumers differ in their valuation of charging access.

Counterfactual: Universal Interoperability

We equalize charging access across brands and re-solve the pricing equilibrium.

- Sector-wide expansion. Substitution comes from internal combustion vehicles, not merely reshuffling among EVs.
- Consumer surplus rises 8.70% at fixed prices, 9.20% when firms reprice.
- Distributional.
- Wuling +10.7%, ORA +9.9%, NETA +6.7%. Li Auto declines by 3.8%, while Tesla gains 6.2%. Other brands gain 6.4% in aggregate.

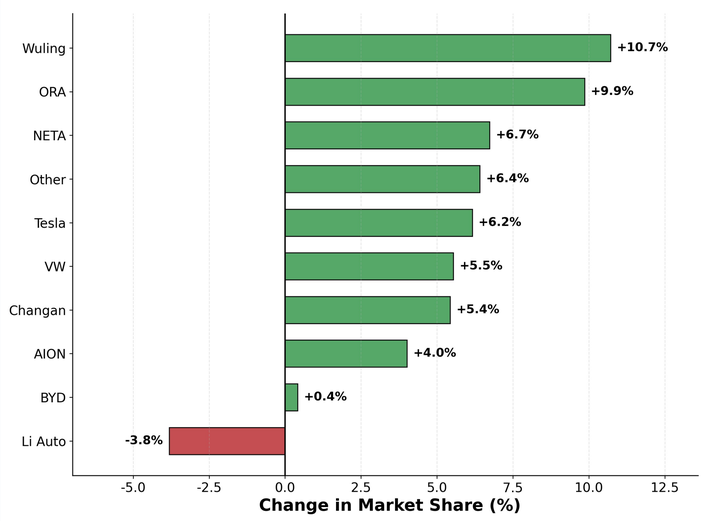


Figure 4. Counterfactual Market Share Change by Brand Budget brands gain most; Li Auto declines by 3.8%. Other brands gain 6.4% in aggregate.

Conclusions

- Local protectionism survived the end of subsidies by migrating from fiscal transfers into private infrastructure.
- Proprietary networks are measurable: POI data plus a discrete-choice inclusive value deliver brand-city access directly.
- Opening access is not redistribution from strong to weak — it releases demand that limited charging access was suppressing. The sector grows, and the most constrained brands gain most.
- Uneven gains highlight potential conflicts over network access.

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