

# Distributional Effects and Equity Issues of Electric Vehicles Rebate Allocation

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## INTRODUCTION

**Transportation electrification benefits:** Plug-in Electric Vehicles (PEVs) are emerging, clean alternatives to conventional gasoline- and diesel-powered vehicles that can reduce tailpipe emissions and other environmental externalities when powered by low carbon intensity electricity.

**Incentives and policies for EVs:** Federal and several state-level incentives and policies are implemented since 2010, aiming to reduce financial barriers of prospective owners and increase PEVs sales. PEV ownership incentives include price subsidies, rebates cashback, tax credits, gasoline tax exemptions, and financial vehicle lease plans.

**Clean Vehicle Rebate Project (CVRP) :** The State of California (CA) and California Air Resources Board (CARB) have set goals related to reducing greenhouse gas emissions from the light-duty vehicle transportation sector. Starting in 2010, the California Clean Vehicle Rebate Project (CVRP) has appealed to more than **350,000** CA consumers who purchased alternative fuel vehicles; consistently over the years above **73%** of the PEV buyers stated that CVRP was extremely or very important to make it possible to acquire such a vehicle.

## OBJECTIVE

- We study the distributional effects of EV rebates by employing both equity coefficients and spatial analysis to uncover uneven allocation of PEV rebates in CA among income and advantaged/disadvantaged communities (DACs).
- We evaluate potential equity issues of rebates allocation for PEVs adoption, and we conduct CVRP amount spatial autocorrelation analysis, characterizing similarities or dissimilarities among neighboring clusters.
- We conduct a detailed before-and-after income-cap policy implementation comparison (see Fig.1) of the rebate rates to assess potential changes in their share, using CA PEVs rebate panel data from 2010 to 2018.



Fig.1. Ratio of total CVRP consumers to total PEV registrations per quarter over the period of the analysis (2010-2018).

## METHOD

**Gini and Suits coefficient:** derived using the Lorenz Curve (see Fig. 2).  
✓ Access horizontal equity issues across all census tracts.  
✓ Evaluate the vertical equity among income groups.

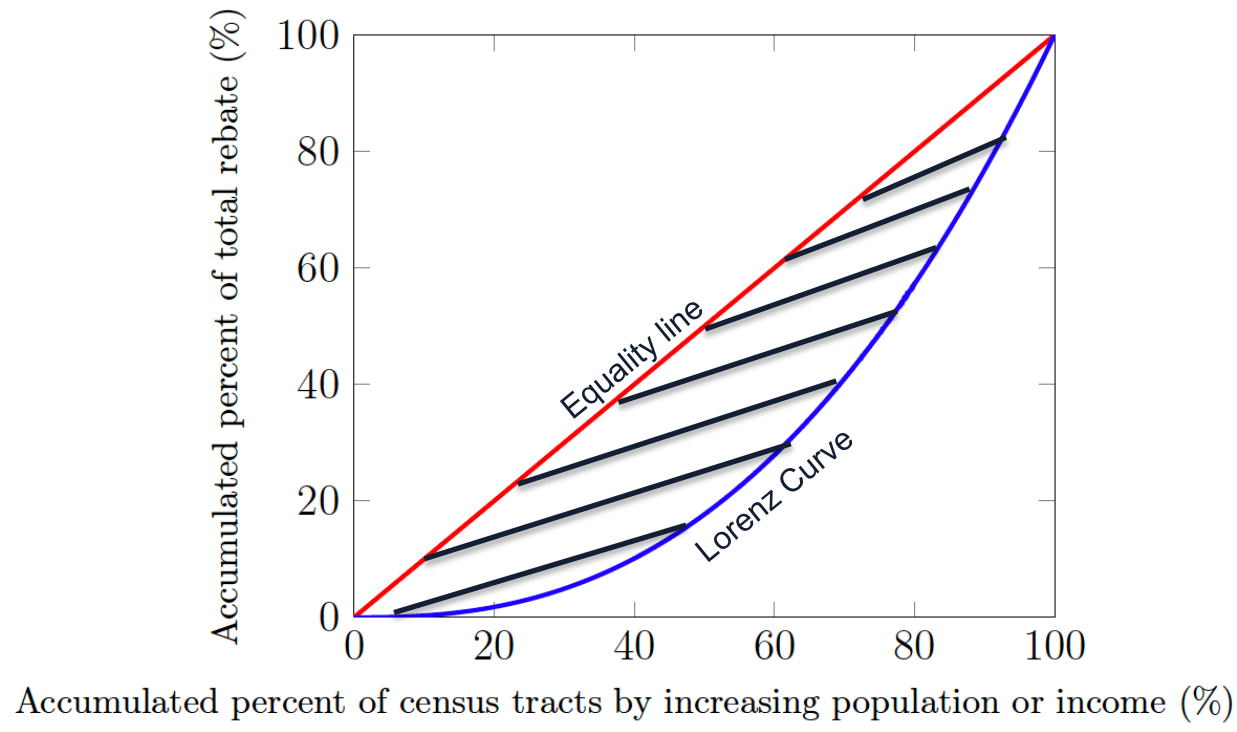


Fig. 2. Lorenz curve and Gini coefficient (ratio of shaded area and lower triangle).

**Local Moran's I statistic:** null hypothesis is the absence of census tracts spatial association.  
✓ Points in the first quadrant (High-High) correspond to high rebate areas surrounded by high rebate neighboring areas, showing spatial association clusters.  
✓ The red slope line suggests a positive spatial autocorrelation.

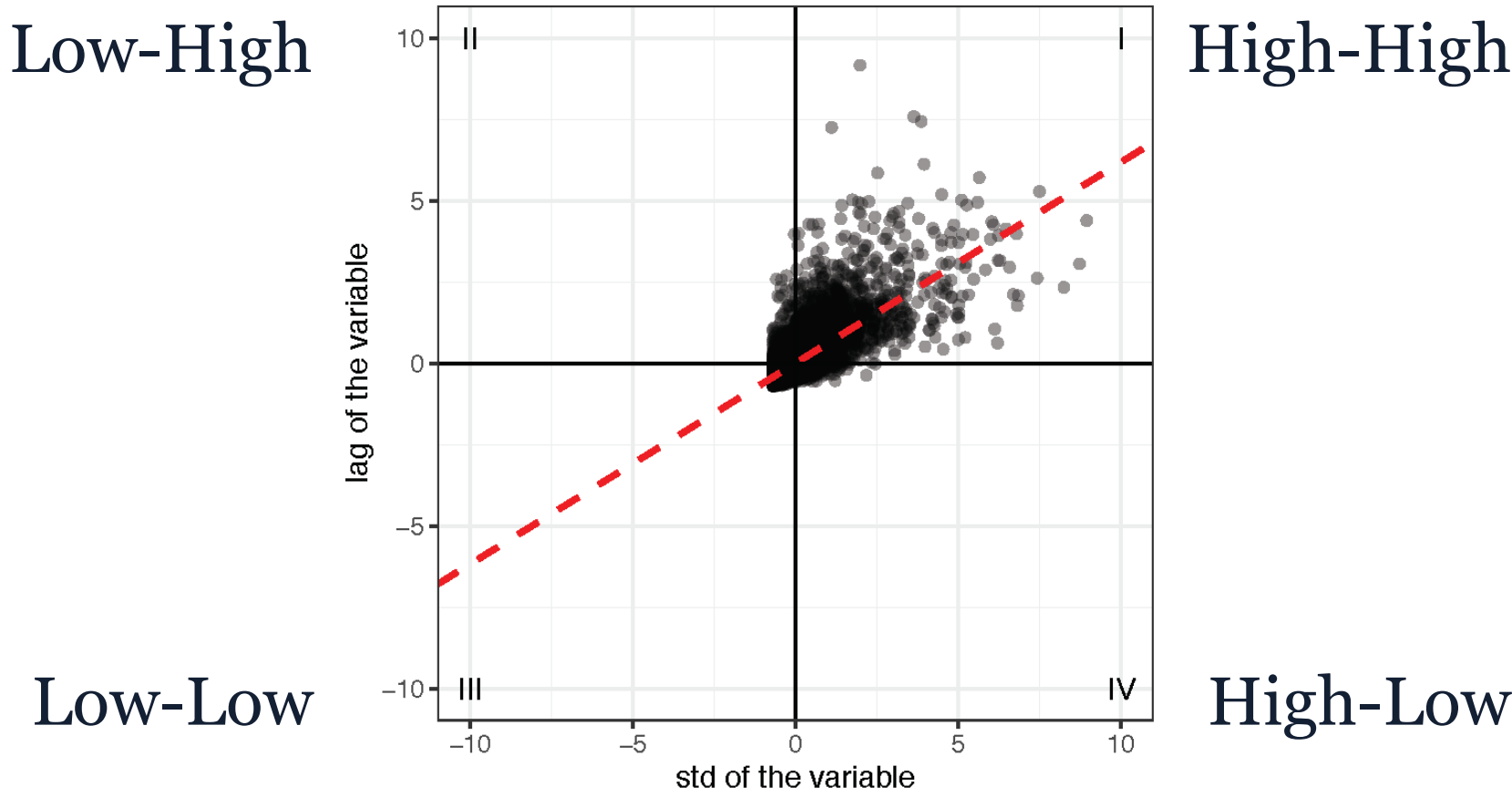


Fig. 3. Scatterplot for Moran's I statistics.

## DATA OVERVIEW

### Socio-economic Variables

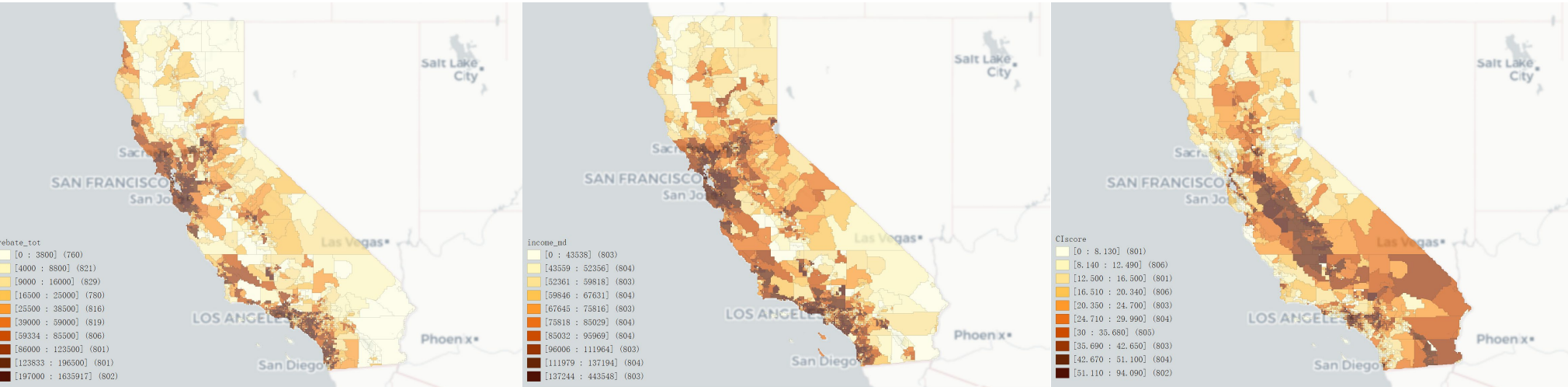


Fig. 4. Spatial distribution of total rebate, median income, and CES 3.0 score (DACs).

### Rebate Distribution

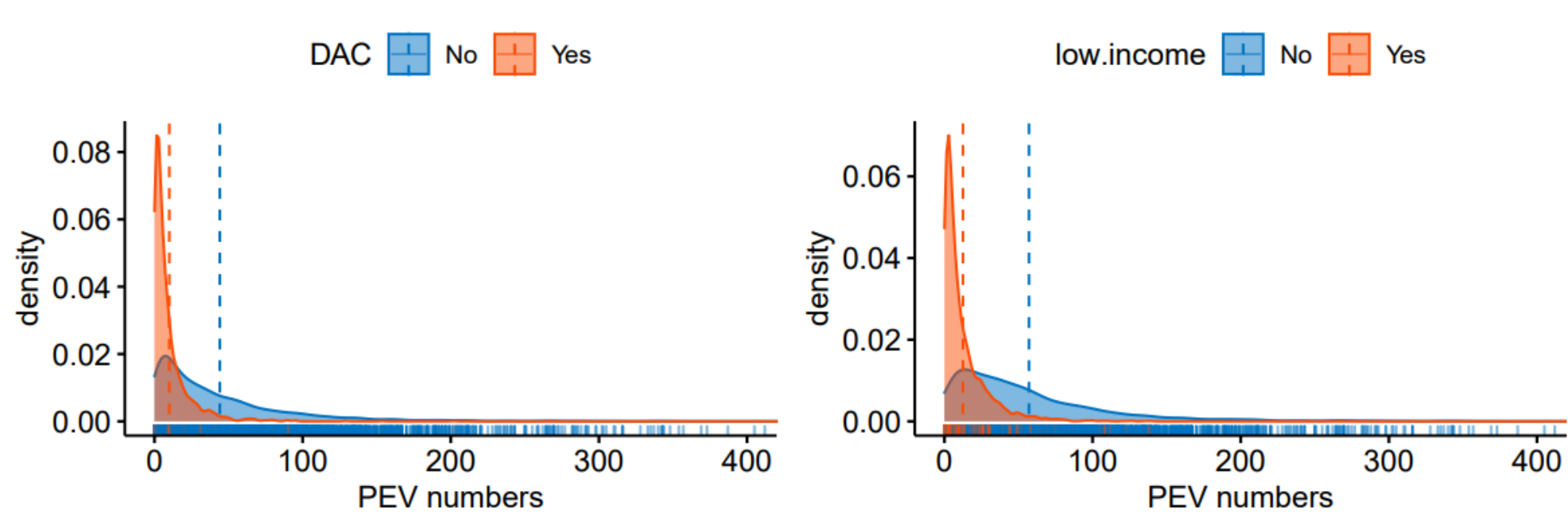


Fig. 5. Density of new PEVs purchased that leveraged the CVRP for two groups: (1) residing in DACs, and (2) residing in low-income communities.

## TEMPORAL ANALYSES

**Rebate Distribution:** total rebate, income, and DAC level for 2010-2018.

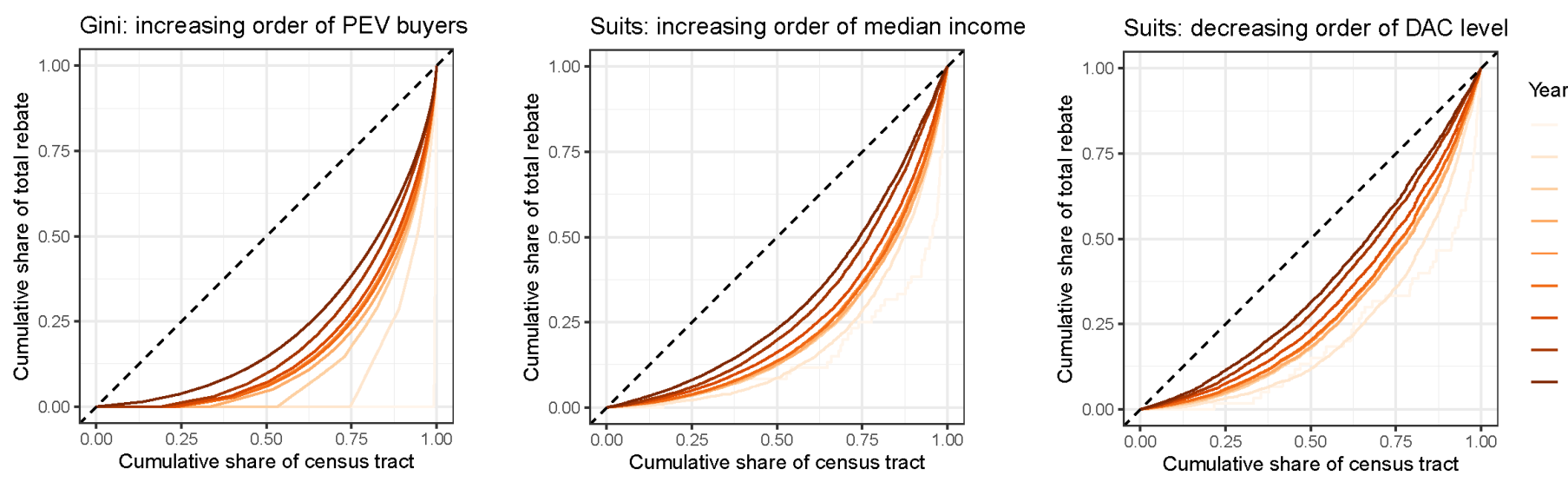


Fig. 6. Lorenz curves for each year: (1) Gini: total rebate, (2) Suits: income and total rebate, and (3) Suits: DAC and total rebate.

- ✓ By 2015, the bottom 75% of low-income census tracts received only 37% of the total CVRP rebate share.
- ✓ After the income-cap was implemented in 2016, the rebate shares attributed to the bottom 25% of DACs rise from less than 7% to more than 11% in 2018.

**Income-cap Policy Effects:** income vs. total rebate and DAC level.

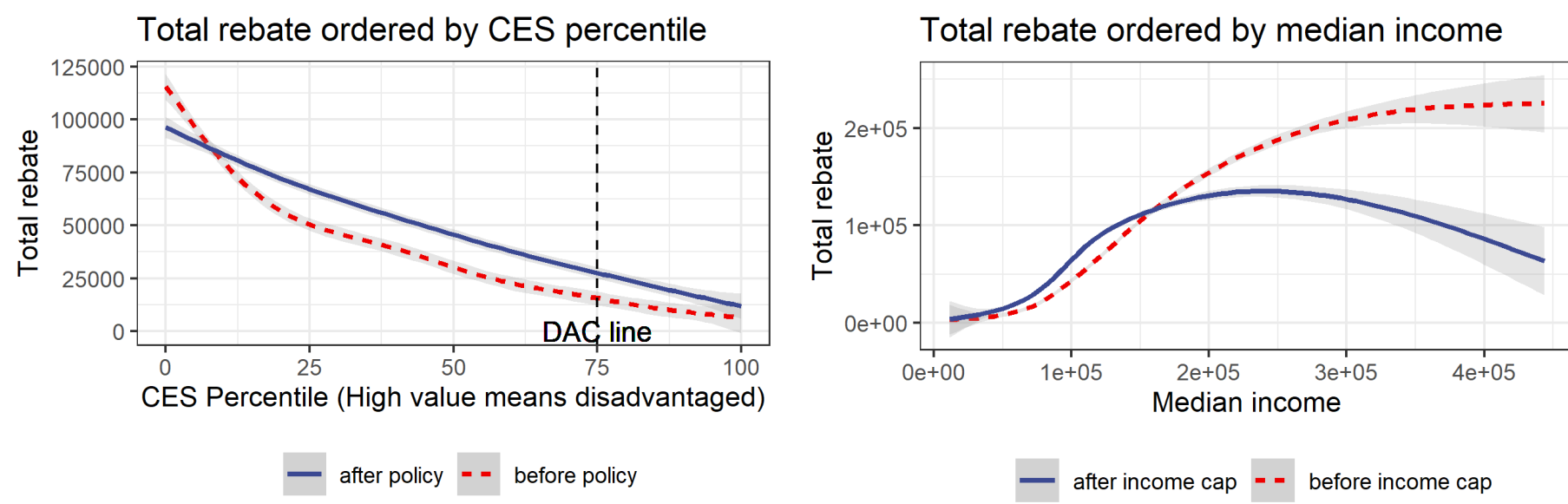


Fig. 7. Before and after income-cap policy total rebates amount (USD) ordered by (1) scaled CES 3.0 score and (2) median household income.

- ✓ Increasing total rebate amount as the level of community disadvantage (measured by the CES 3.0 score) increases.
- ✓ After the income-cap policy implementation in year 2016, the share of rebates increases in both low-/mid-income communities and DACs at a 95% confidence level.

### Before-and-after Income-cap Lorenz Curve

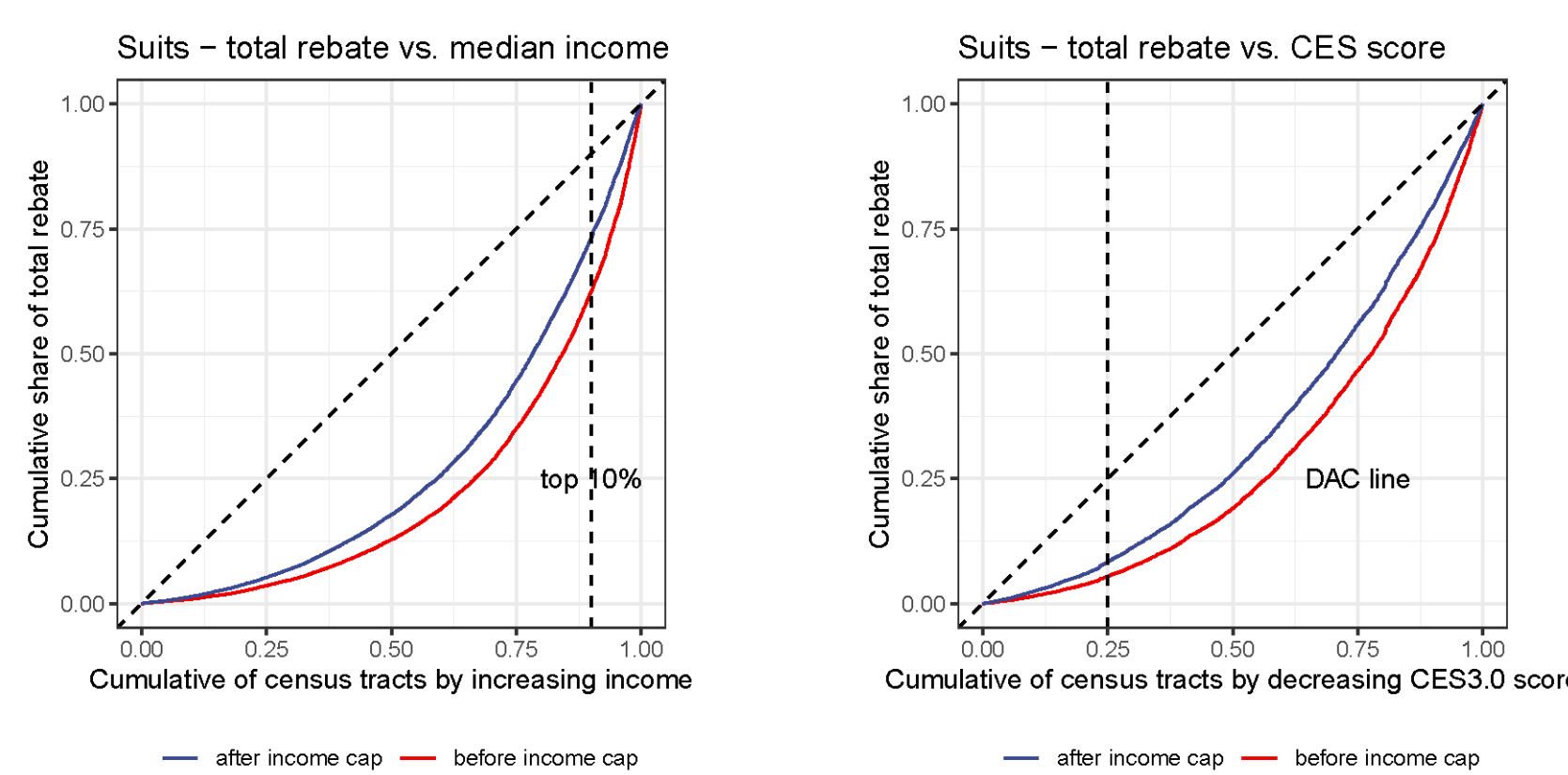


Fig. 8. Total rebate amount before and after the income-cap policy implementation.

- ✓ **Income groups:** the bottom 90% income group receives about 67.5% and 75% of total of the rebates amount, before and after the income cap, respectively.
- ✓ **DACs and non-DACs:** the bottom 50% of the most disadvantaged, receives approximately 5% more in rebates after the income cap.

## SPATIAL ANALYSES

**Clusters Mapping:** Locations of High-income surrounded by High-rebate, Low-income Low-rebate, High-income Low-rebate, and Low-income surrounded by High-rebate clusters, are shown here:

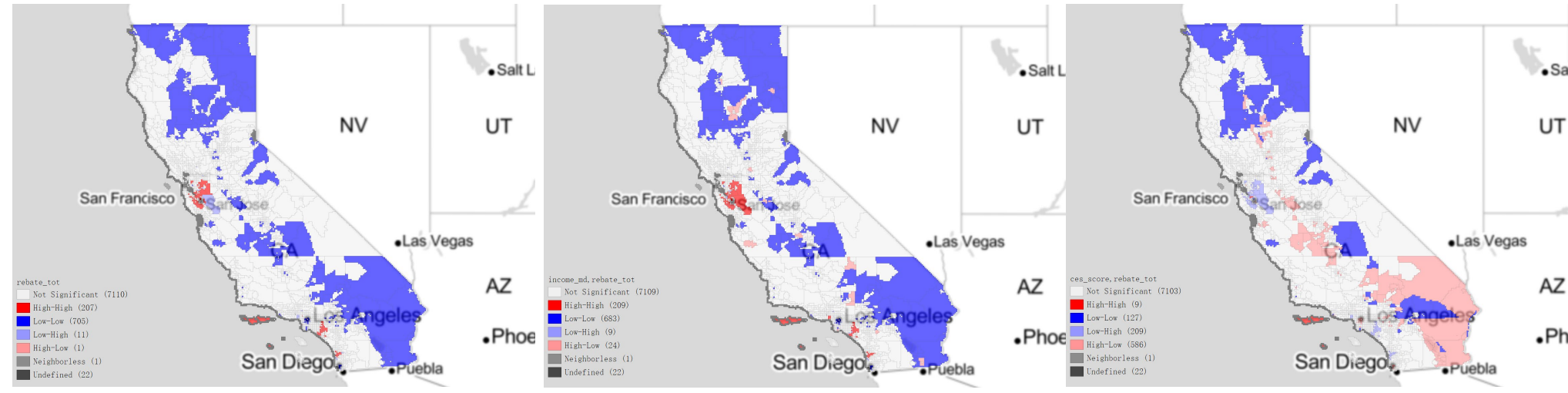


Fig. 9. Cluster maps at the census tract level.

- ✓ Most of the High-High clusters represent metropolitan regions like Los Angeles - Orange County and San Francisco - Bay Area.
- ✓ Few Low-High areas and High-High areas are adjacent in these maps, suggesting neighborhood effects regarding PEVs purchasing behavior through CVRP.
- ✓ Stricter income-cap policies could be applied based on DAC/non-DAC status, ensuring greater rebate amounts go to prospective PEV purchasers who reside in both low-income communities and DACs.

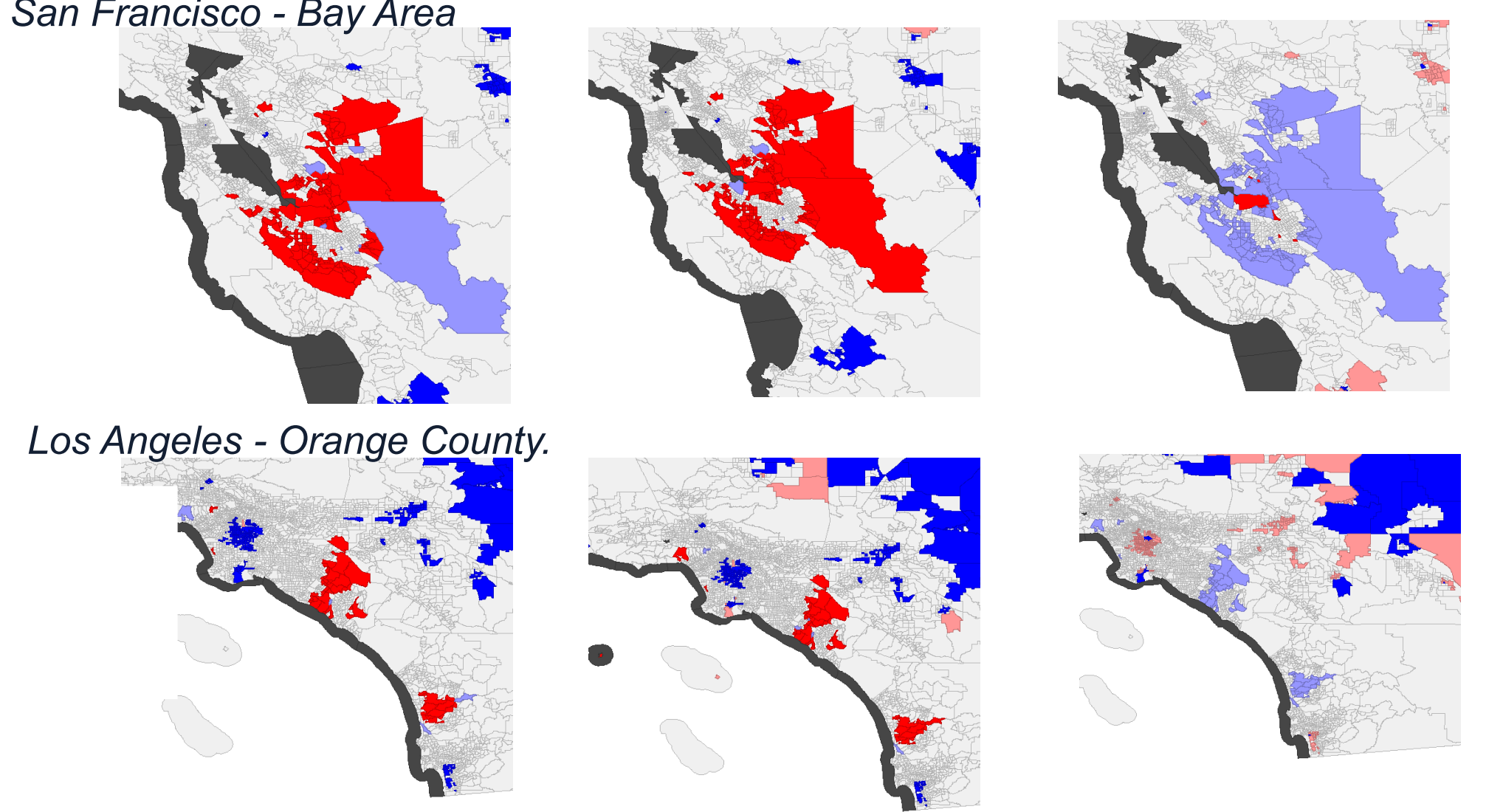


Fig. 10. Detailed look: San Francisco - Bay Area & Los Angeles - Orange County.

## CONCLUSIONS

- Policy-making at state or local level supports meeting clean transport goals by subsidizing PEVs through programs like CVRP.
- This research emphasizes the importance of assessing distributional effects of PEVs rebates as it evaluates the implications of such a policy across CA income groups and disadvantaged communities.
- The process of mapping spatial patterns pertaining to the allocation of CVRP funding and census tracts economic profiles can assist with prioritizing future investments and reducing existing disparities in PEVs adoption.
- Clusters characterized by low income or as highly disadvantaged that have limited rebates amount use could be targeted for increased PEVs subsidies.