
# Equity in Solar PV Adoption in New Mexico

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# Acknowledgments


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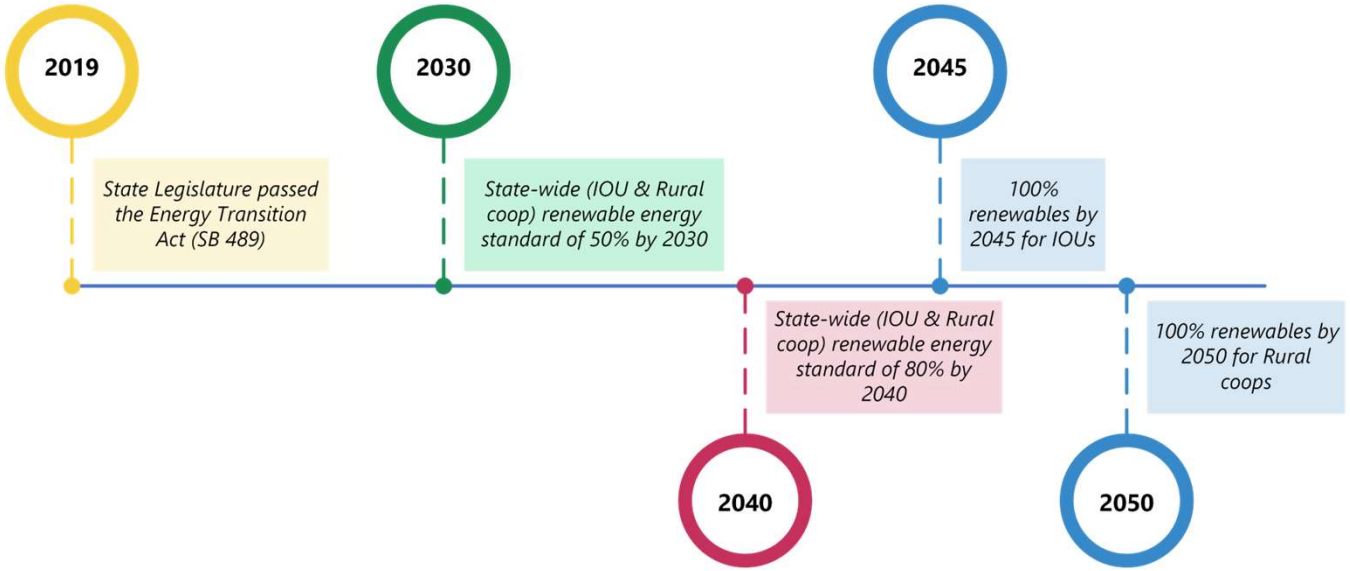
- Graduate student: Jiaqing Zhao
- Undergraduate students: James Ryder Cockrell, Vicente Lyon, Rhoan McMaster
- Reviewer: Robert Berrens
- UNM Economics staff and Research for a Better New Mexico Committee



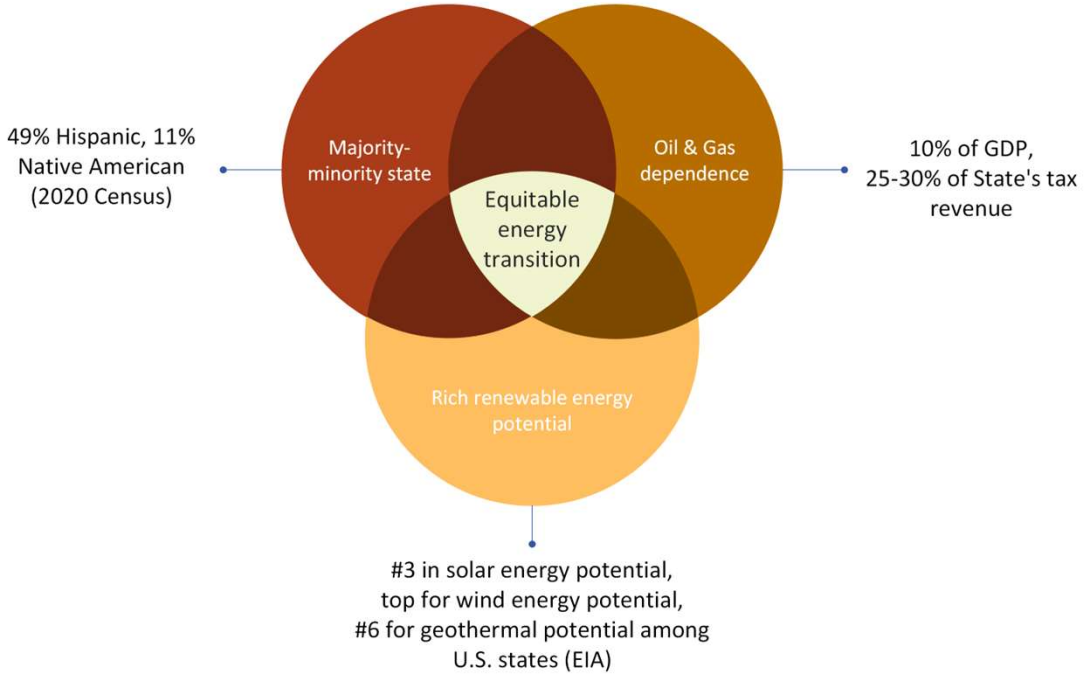

# Moving towards a zero-carbon future

- New Mexico's Energy Transition Act aims to achieve 100% renewables of all electricity supplied by 2050



# Equitable energy transition in NM

- Majority-minority state with dispersed income distribution
- Historical reliance on the Oil & Gas industry
- Abundant renewable energy resources
- Equity in access, adoption, and the distribution of benefits



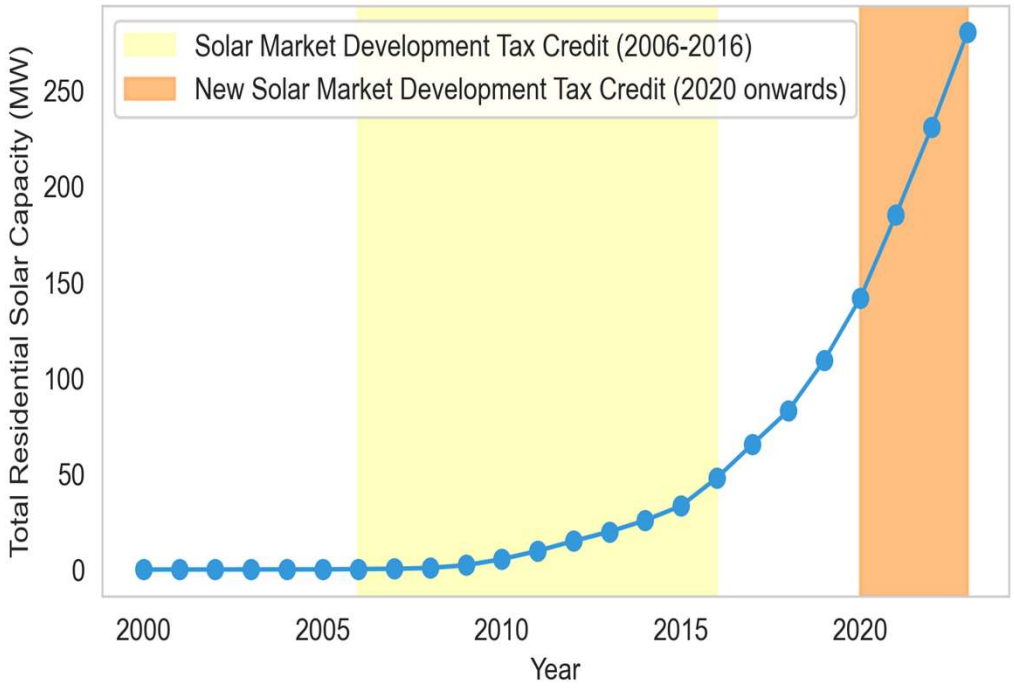
# Research Questions

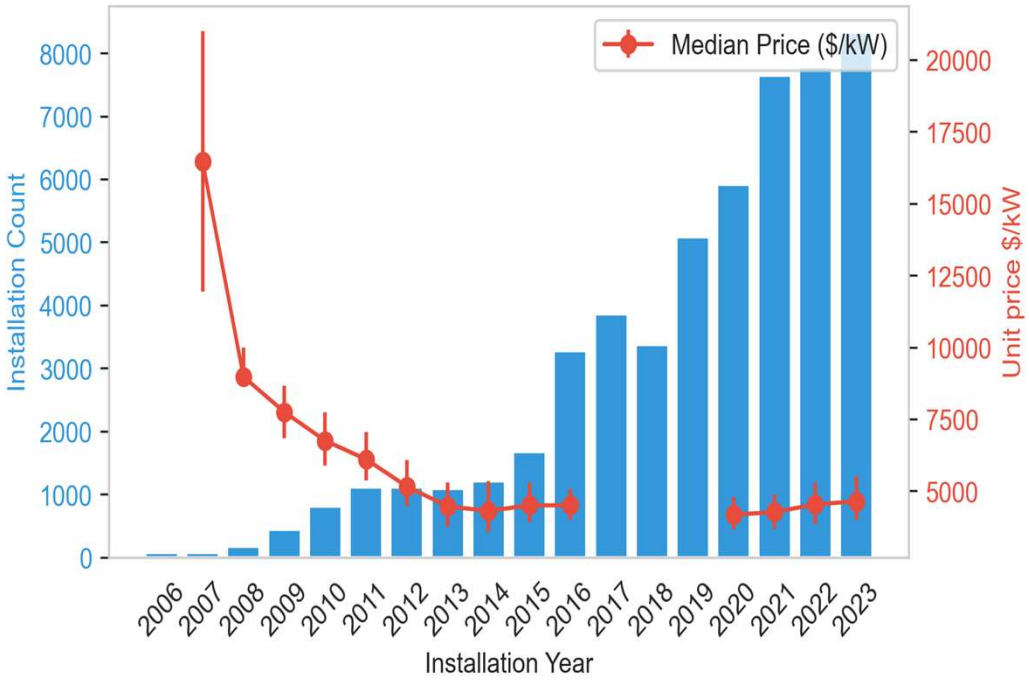
- Focusing on the residential solar photovoltaic (PV) sector
  - What is the current state of solar PV adoption in New Mexico across different demographic groups?
  - Adoption equity
    - Are the adoptions equitably distributed?
    - Does the state solar tax incentive reduce inequality in solar adoption?
  - Distributional equity
    - Are the benefits of the state solar tax incentive equitably distributed?

# Data and Methods

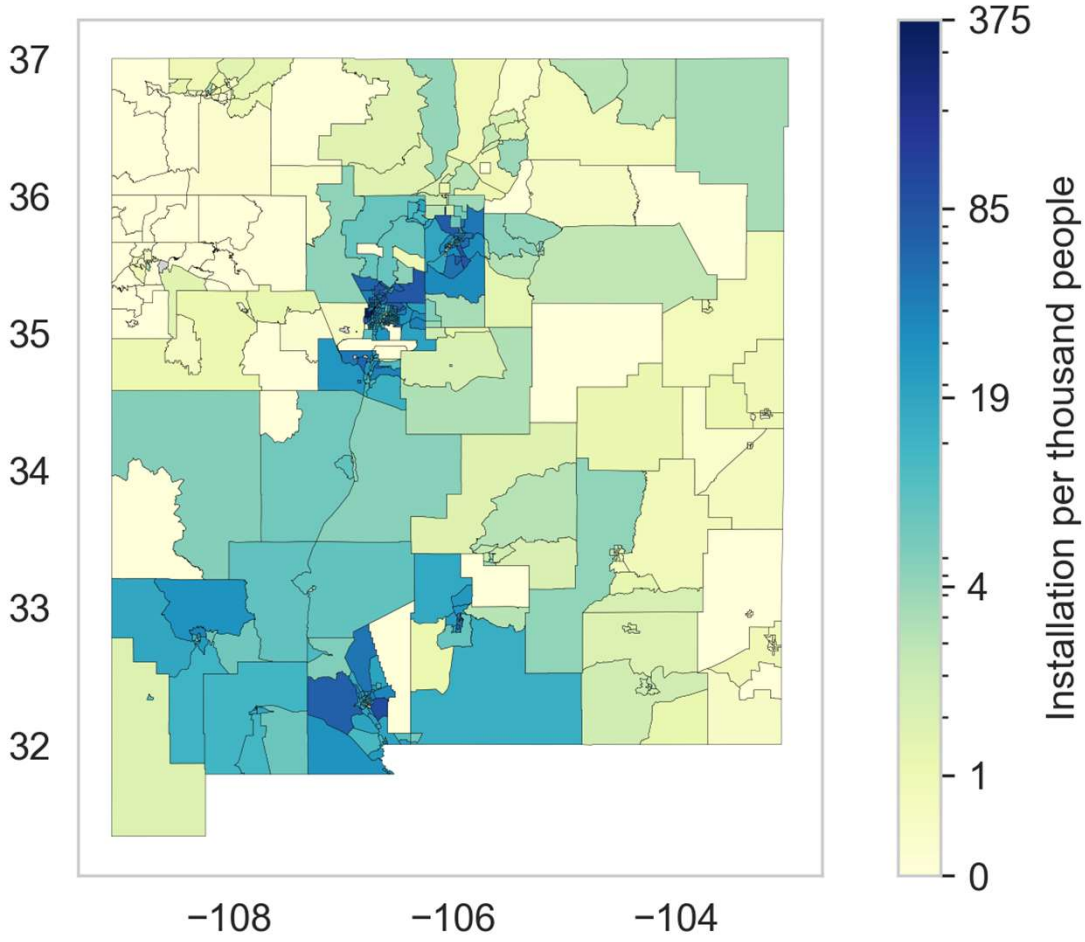
- Data & Sources
  - System level solar installation data (EMNRD, PRC, PNM, LADPU) of 53,043 unique residential systems (representing >98% of all residential solar systems in New Mexico up to 2023)
  - Census-tract level demographics data (Census Bureau)
  - Housing characteristics data (Zillow)
  - Electricity prices (EIA)
  - Spatial weather data (Solargis)
  - Community characteristics (Climate and Economic Justice Screening Tool)
- Methods
  - Descriptive analysis
  - Regression analysis

# Time trend of solar installations



# Spatial distribution of solar PV

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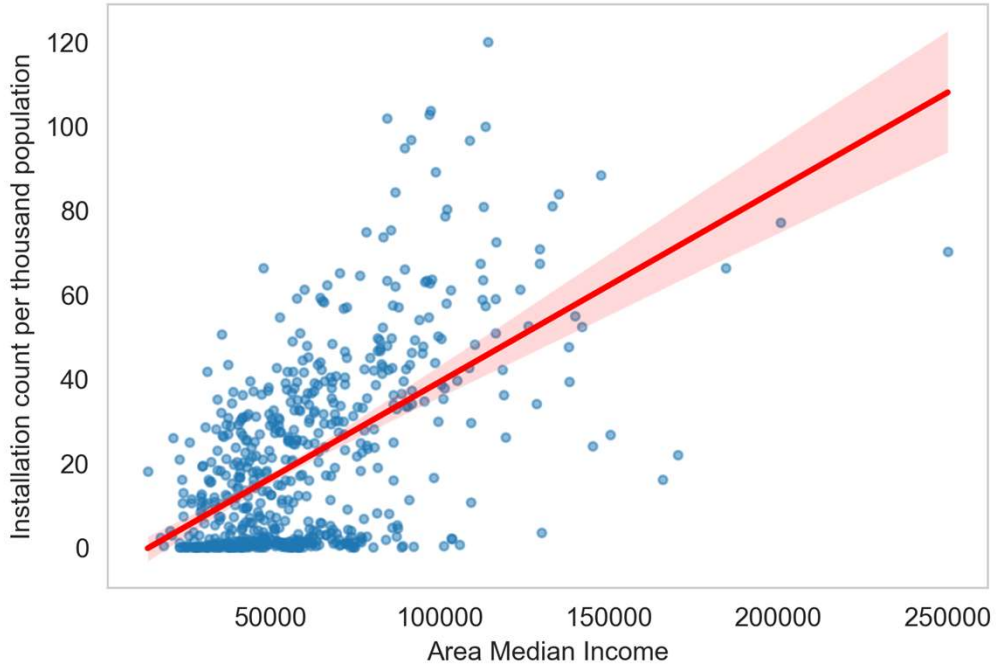
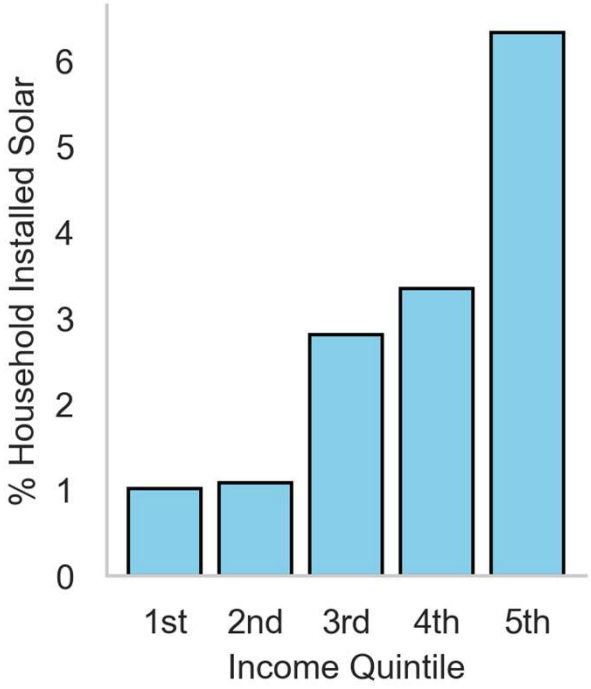
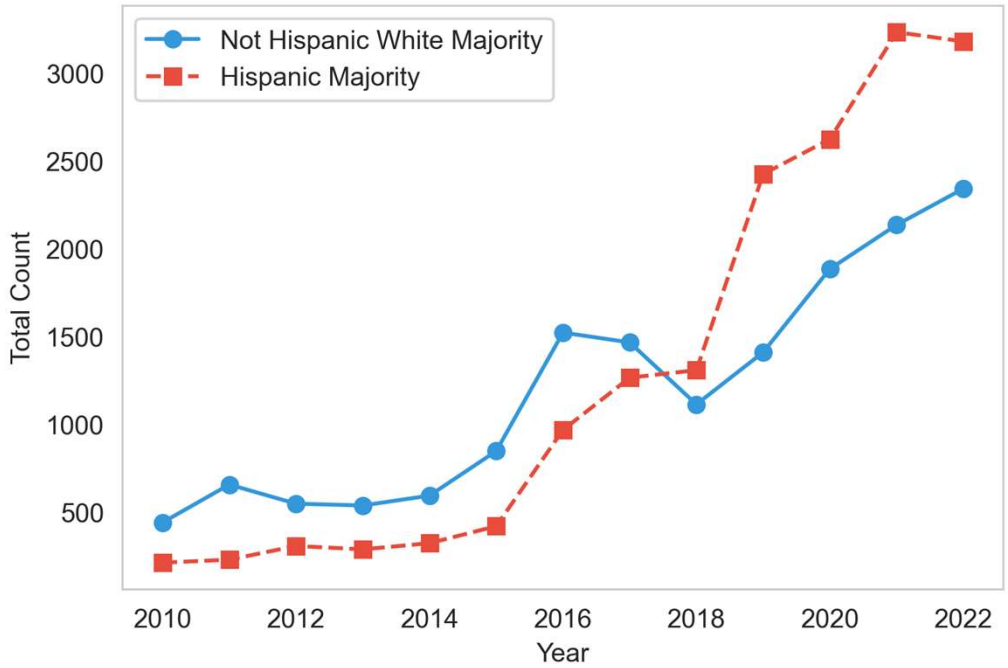
# Solar PV distribution by income



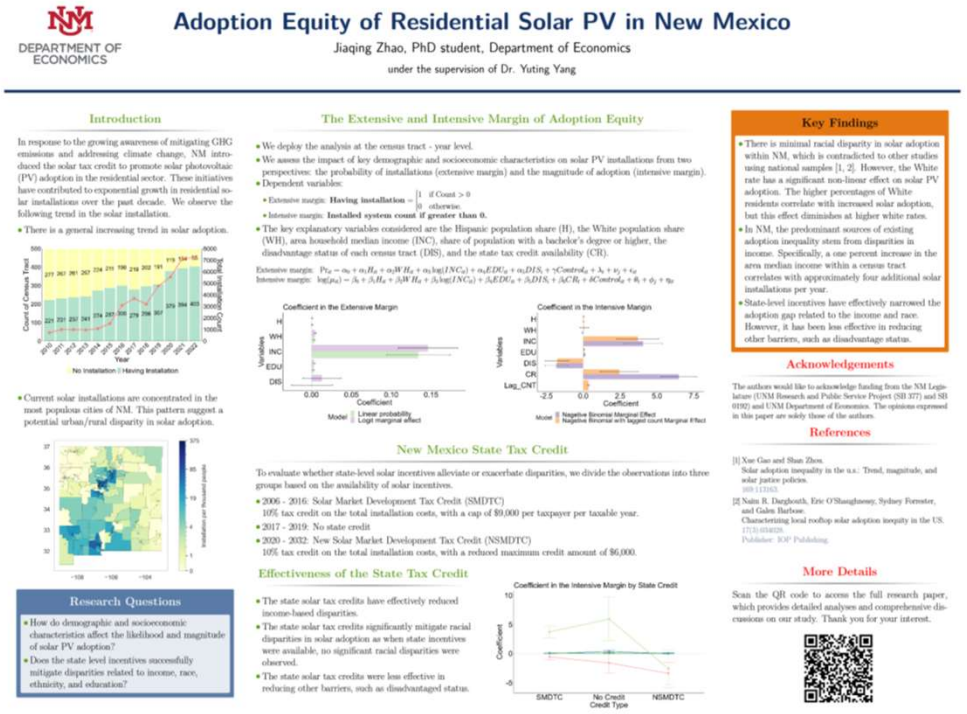



# Solar PV distribution by race and ethnicity



# Adoption equity

Please see Poster #3 presented by Jiaqing Zhao



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## Adoption Equity of Residential Solar PV in New Mexico

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under the supervision of Dr. Yuting Yang

### Introduction

In response to the growing awareness of mitigating GHG emissions and addressing climate change, NM introduced the solar tax credit to promote solar photovoltaic (PV) adoption in the residential sector. These initiatives have contributed to exponential growth in residential solar installations over the past decade. We observe the following trend in the solar installation.

- There is a general increasing trend in solar adoption.

- Current solar installations are concentrated in the most populous cities of NM. This pattern suggest a potential urban/rural disparity in solar adoption.

### Research Questions

- How do demographic and socioeconomic characteristics affect the likelihood and magnitude of solar PV adoption?
- Does the state level incentives successfully mitigate disparities related to income, race, ethnicity, and education?

### The Extensive and Intensive Margin of Adoption Equity

- We deploy the analysis at the census tract - year level.
- We assess the impact of key demographic and socioeconomic characteristics on solar PV installations from two perspectives: the probability of installations (extensive margin) and the magnitude of adoption (intensive margin).
- Dependent variables:
  - Extensive margin: **Having installation** $= \begin{cases} 1 & \text{if Count} > 0 \\ 0 & \text{otherwise.} \end{cases}$
  - Intensive margin: **Installed system count if greater than 0.**
- The key explanatory variables considered are the Hispanic population share (H), the White population share (WH), area household median income (INC), share of population with a bachelor's degree or higher, the disadvantage status of each census tract (DIS), and the state tax credit availability (CR).

Extensive margin: $Pr_{it} = \alpha_0 + \alpha_1 H_{it} + \alpha_2 WH_{it} + \alpha_3 \log(INC_{it}) + \alpha_4 EDU_{it} + \alpha_5 DIS_i + \gamma Control_{it} + \lambda_t + \nu_j + \epsilon_{it}$

Intensive margin: $\log(\mu_{it}) = \beta_0 + \beta_1 H_{it} + \beta_2 WH_{it} + \beta_3 \log(INC_{it}) + \beta_4 EDU_{it} + \beta_5 DIS_i + \beta_6 CR_i + \delta Control_{it} + \theta_t + \phi_j + \eta_{it}$

### New Mexico State Tax Credit

To evaluate whether state-level solar incentives alleviate or exacerbate disparities, we divide the observations into three groups based on the availability of solar incentives.

- 2006 - 2016: Solar Market Development Tax Credit (SMDTC)
  10% tax credit on the total installation costs, with a cap of $9,000 per taxpayer per taxable year.
- 2017 - 2019: No state credit
- 2020 - 2032: New Solar Market Development Tax Credit (NSMDTC)
  10% tax credit on the total installation costs, with a reduced maximum credit amount of $6,000.

### Effectiveness of the State Tax Credit

- The state solar tax credits have effectively reduced income-based disparities.
- The state solar tax credits significantly mitigate racial disparities in solar adoption as when state incentives were available, no significant racial disparities were observed.
- The state solar tax credits were less effective in reducing other barriers, such as disadvantaged status.

### Key Findings

- There is minimal racial disparity in solar adoption within NM, which is contradicted to other studies using national samples [1, 2]. However, the White rate has a significant non-linear effect on solar PV adoption. The higher percentages of White residents correlate with increased solar adoption, but this effect diminishes at higher white rates.
- In NM, the predominant sources of existing adoption inequality stem from disparities in income. Specifically, a one percent increase in the area median income within a census tract correlates with approximately four additional solar installations per year.
- State-level incentives have effectively narrowed the adoption gap related to the income and race. However, it has been less effective in reducing other barriers, such as disadvantage status.

### Acknowledgements

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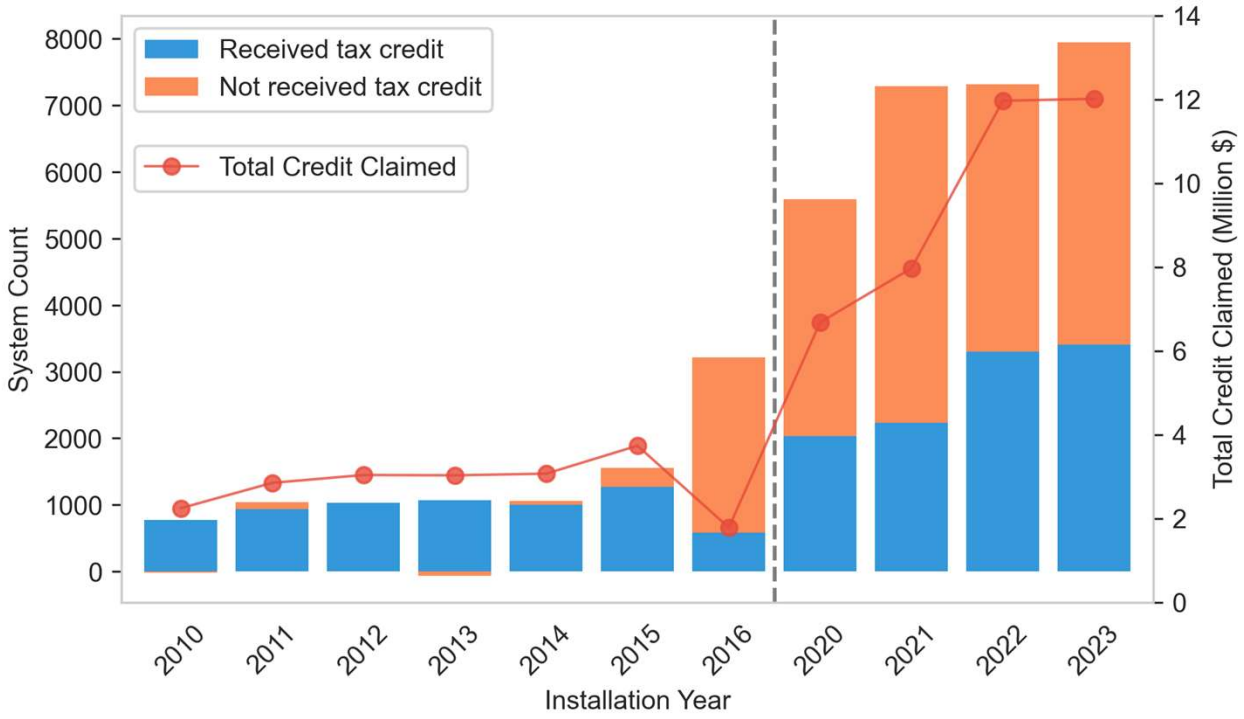
### References

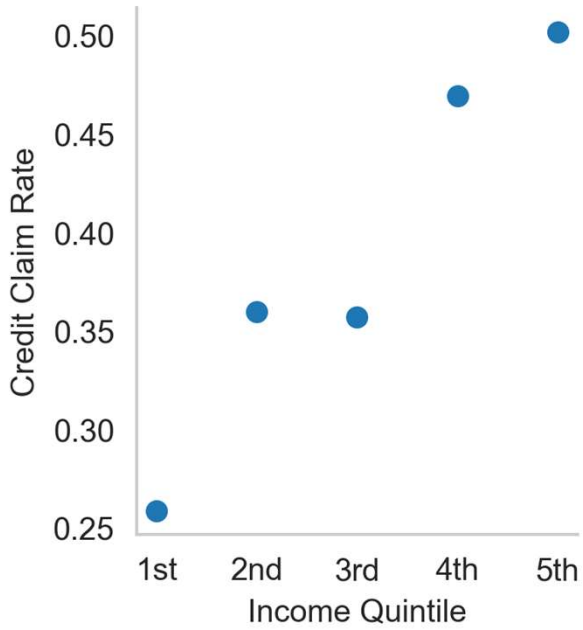
[1] Xue Gao and Shan Zhou.
Solar adoption inequality in the u.s.: Trend, magnitude, and solar justice policies.
[2] Nate R. Darghouth, Eric O'Shaughnessy, Sydney Forrester, and Galen Barbose.
Characterizing local rooftop solar adoption inequity in the US.
Publisher: IOP Publishing.

### More Details

Scan the QR code to access the full research paper, which provides detailed analyses and comprehensive discussions on our study. Thank you for your interest.

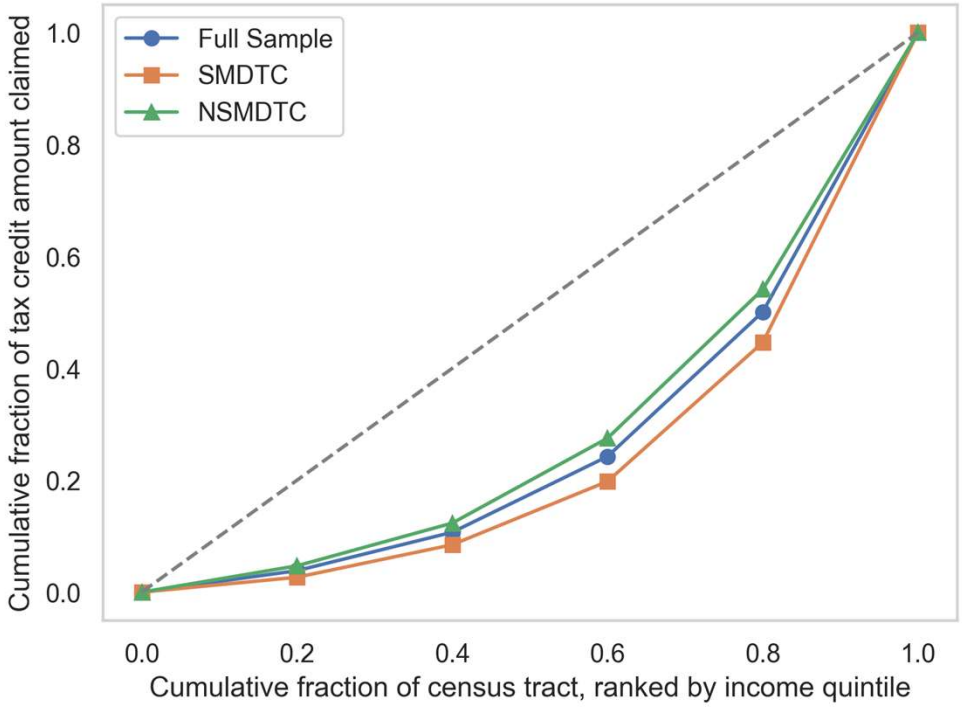
# State tax credit claim



# Distributional equity

- Households in top quintile census tracts receive 46% of the state tax credit. Bottom quintile receive less than 6%.
- Key drivers (conditional on being solar adopters)
  - Systems with higher capacity → higher electricity consumption
  - Households with higher housing value → wealthier households
  - Households in census tracts with higher education level, lower Hispanic rate, and lower mortgage rate → potential information barrier



# Conclusions and Policy Implications

- Fast but uneven growth in the residential solar PV sector in New Mexico, with higher adoption rates observed in urban areas and higher-income neighborhoods.
- Low racial, but high income disparity in solar adoption. Effective state-level incentives to narrow racial and income adoption disparity.
- Tax credit benefits concentrated among wealthier households with higher electricity consumption.
- Policy implications
  - Continuous monitoring and adjustment of incentive programs to ensure inclusiveness and effectiveness in reducing disparities in solar adoption.
  - Innovative policy design, such as community solar, to increase uptake in disadvantaged communities.

# Thanks!

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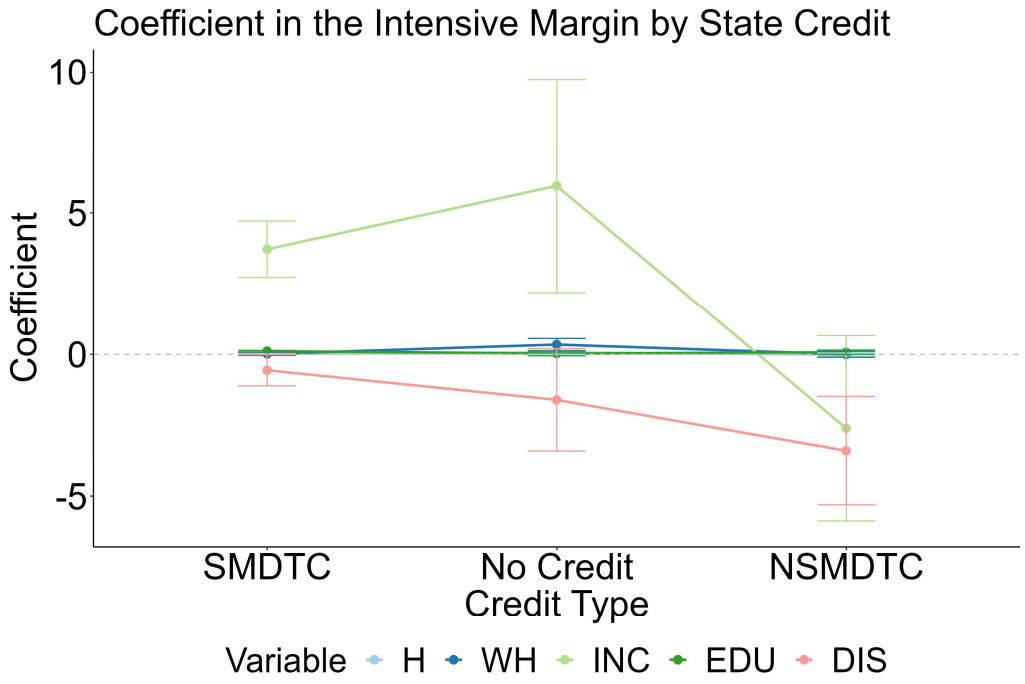
# Adoption equity

- How do *demographic* and *socioeconomic* characteristics affect the likelihood and magnitude of solar PV adoption?
  - Census tracts that have a higher share of white population, higher income level, and higher education level see a higher probability of having any solar installation.
  - Conditional on having solar installations, census tracts that have a higher income level, higher education level, and not characterized as disadvantaged see more installations. The racial and ethnic disparity is very small.

# Effects of state solar tax credit

- Solar Market Development Tax Credit
  - SMDTC: Jan 2006 – Dec 2016
  - NSMDTC: March 2020 – No end date
- Reduced income and racial disparity in the years with state tax credit
- Less effective in reducing disparity from disadvantaged status



# Challenges and Caveats

- Lack of household level demographics data to have more accurate conclusions
- Cannot causally identify the effectiveness of state solar incentives in the absence of a control group