Energy Transition in Chilean Households: Rural Households and Firewood Use

Dateset: CASEN survey & Chilean Centre for Climate and Resilience Research (CR2)

Reference:Fercovic, J., Foster, W., & Gulati, S. (2024). Slow burn: Weak energy transition in a growing economy. Energy Economics, 136, 107756.

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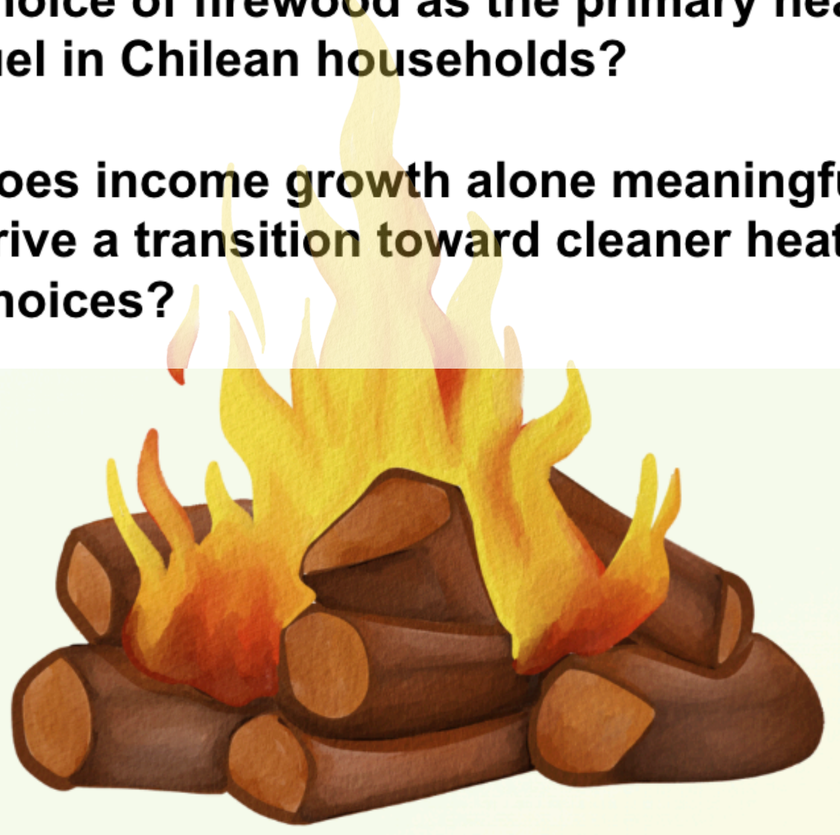
Motivation & Research Question

Research Question

1. **How does household income influence the choice of firewood as the primary heating fuel in Chilean households?**

2. **Does income growth alone meaningfully drive a transition toward cleaner heating choices?**



Policy Relevance

- Chile is now a high-income country, yet many households still rely on firewood for heating.
- Firewood heating drives a large share of PM2.5 emissions, with major health and environmental costs.
- If income effects has low impact on fuel choice, then income growth alone cannot deliver the residential energy transition policymakers hope for.

Original Paper Summary

Key Findings

In 2018, 39% of Chilean households used firewood as their primary heating fuel.

Residential firewood heating accounts for 65% of Chile's total PM2.5 emissions on average, reaching 100% in some municipalities.

A 10% household income increase reduces the probability of choosing firewood heating by only about 0.1% (≈0.001 percentage points), a statistically significant but economically trivial change.

Without targeted policy changes, household firewood heating is predicted to increase by 16% from 2017 to 2050.

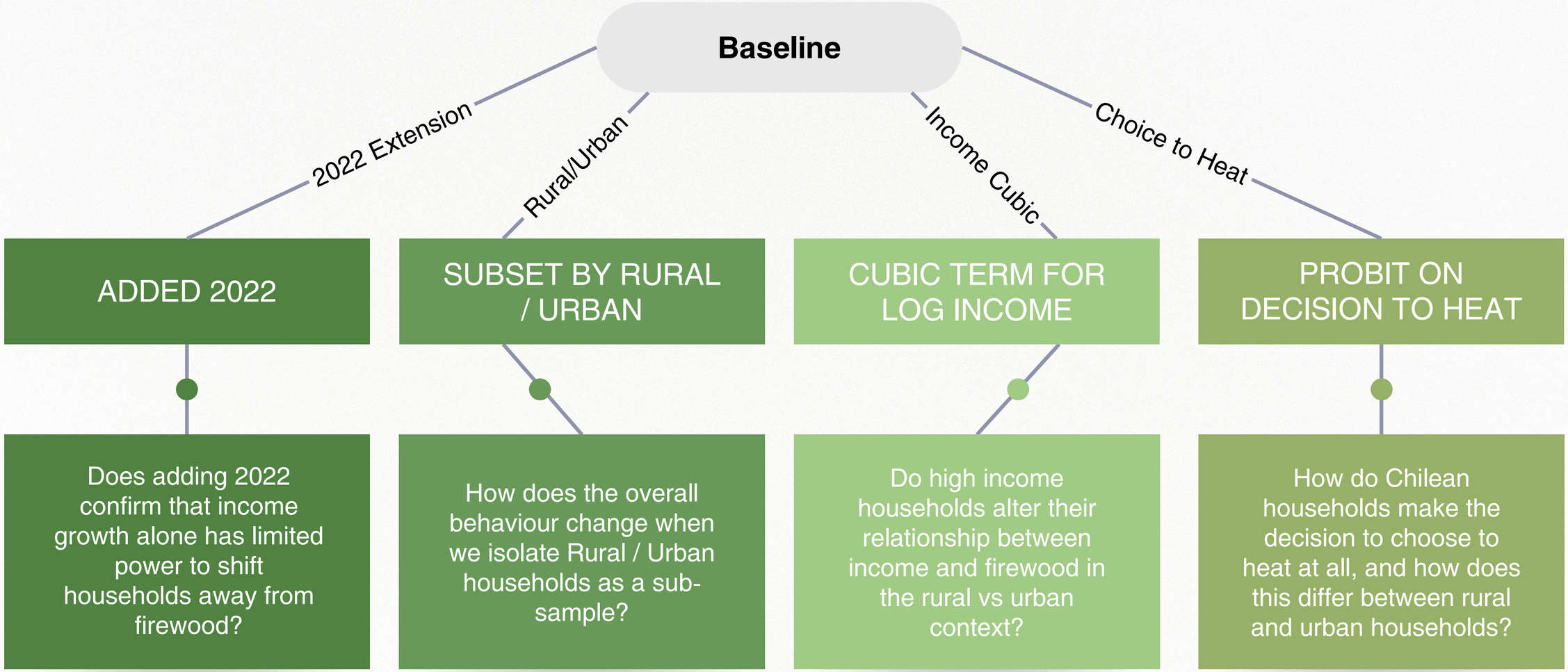
Identified Gaps

The dataset spans only two years, so it is difficult to assess whether the income to firewood relationship is stable over time.

The first-stage Heckman model is used mainly as a diagnostic tool, so it does not deeply examine how income or access constraints shape households' ability to heat.

While rural households are consistently highlighted as key firewood users, the structural reasons behind rural dependence are not examined in detail.

OUR EXTENSIONS



DATA & MODEL

CASEN (2015, 2017, 2022) + Hasen et al. (2013) Forest Data (2015, 2017, 2019)

Probit

- We kept the **probit** model to stay **consistent** with Fercovic et al. (2024) and ensure **comparability**.
- Although **logit** performed marginally **better** in exploratory analysis, using probit avoids introducing **unnecessary methodological differences.**
- Even without the 2 stage Heckman correction, probit **preserves** the original paper's modelling framework.

Key Variables

- Log Household **Income** (squared & cubed)
- Average Minimum **Temperature**
- **Household Size**
- **Ownership** Dummy (Owner, Ceded, Renter, Other)
- **Rural** vs **Urban** Dummy
- **Forest Cover**
- **Forest Loss**
- **Year**

Diagnostics

- Model comparisons:
  - 2022 Extension:
    - **M1**: 0.279
    - **M2**: 0.283
  - Rural vs Urban:
    - **M3**: 0.087
    - **M4**: 0.222
    - **M5**: 0.283

DATA & MODEL

CASEN (2015, 2017, 2022) + Hasen et al. (2013) Forest Data (2015, 2017, 2019)

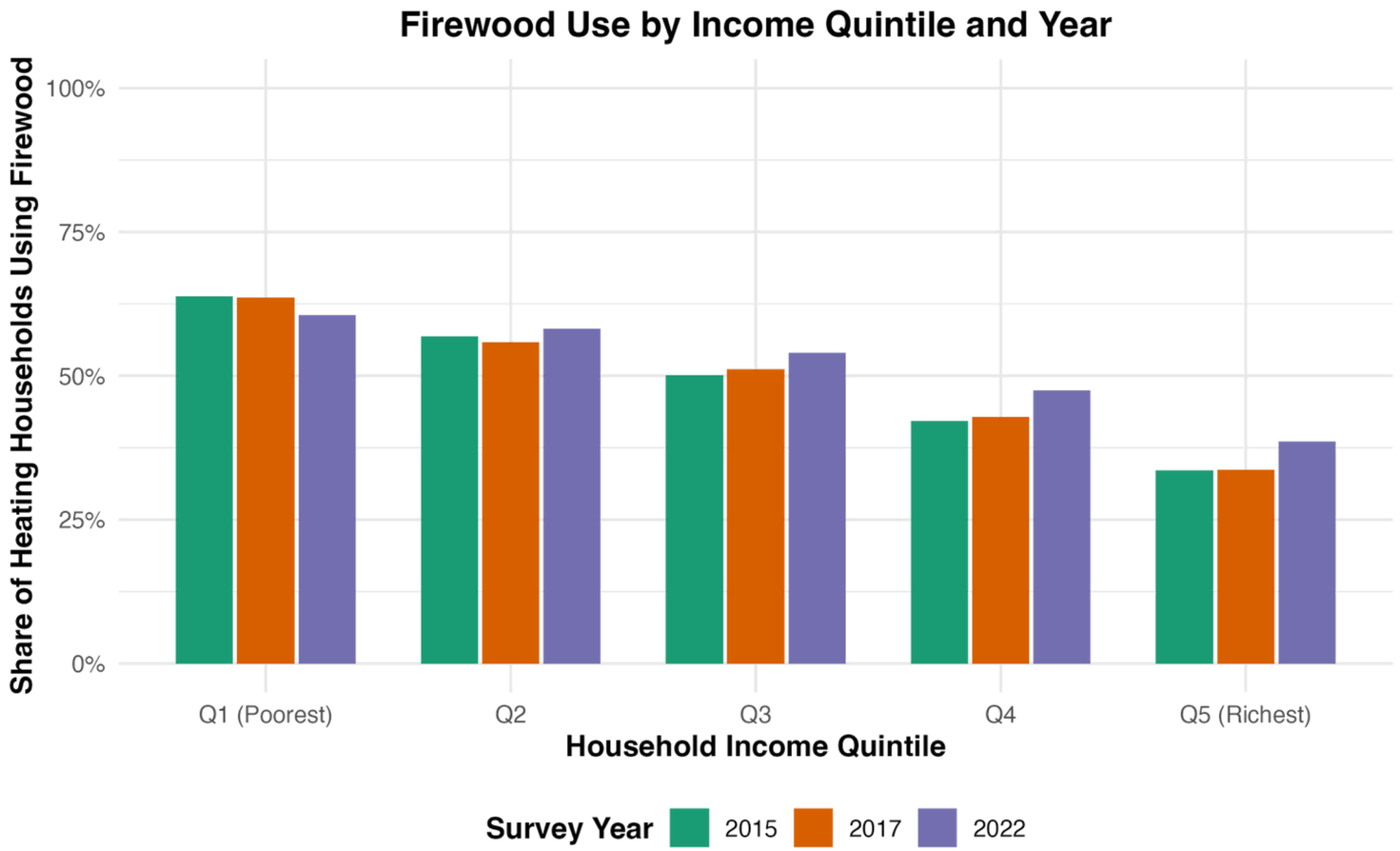
$$\begin{aligned}\text{Firewood}_i = {} & \beta_0 + \beta_1 \ln Y_i + \beta_2 (\ln Y_i)^2 + \beta_3 (\ln Y_i)^3 + \beta_4 T_i + \beta_5 H_i + \beta_6 \text{Owner}_i \\ & + \beta_7 \text{Ceded}_i + \beta_8 \text{Other}_i + \beta_9 \text{Rural}_i + \beta_{10} F_i + \beta_{11} L_i \\ & + \beta_{12} (\text{Rural}_i \times L_i) + \beta_{13} (\ln Y_i \times T_i) + \varepsilon_i,\end{aligned}$$

$$\Pr(\text{Firewood}_i = 1 \mid X_i) = \Phi(X_i \beta)$$

EXTENSION HIGHLIGHT

2022 Extension

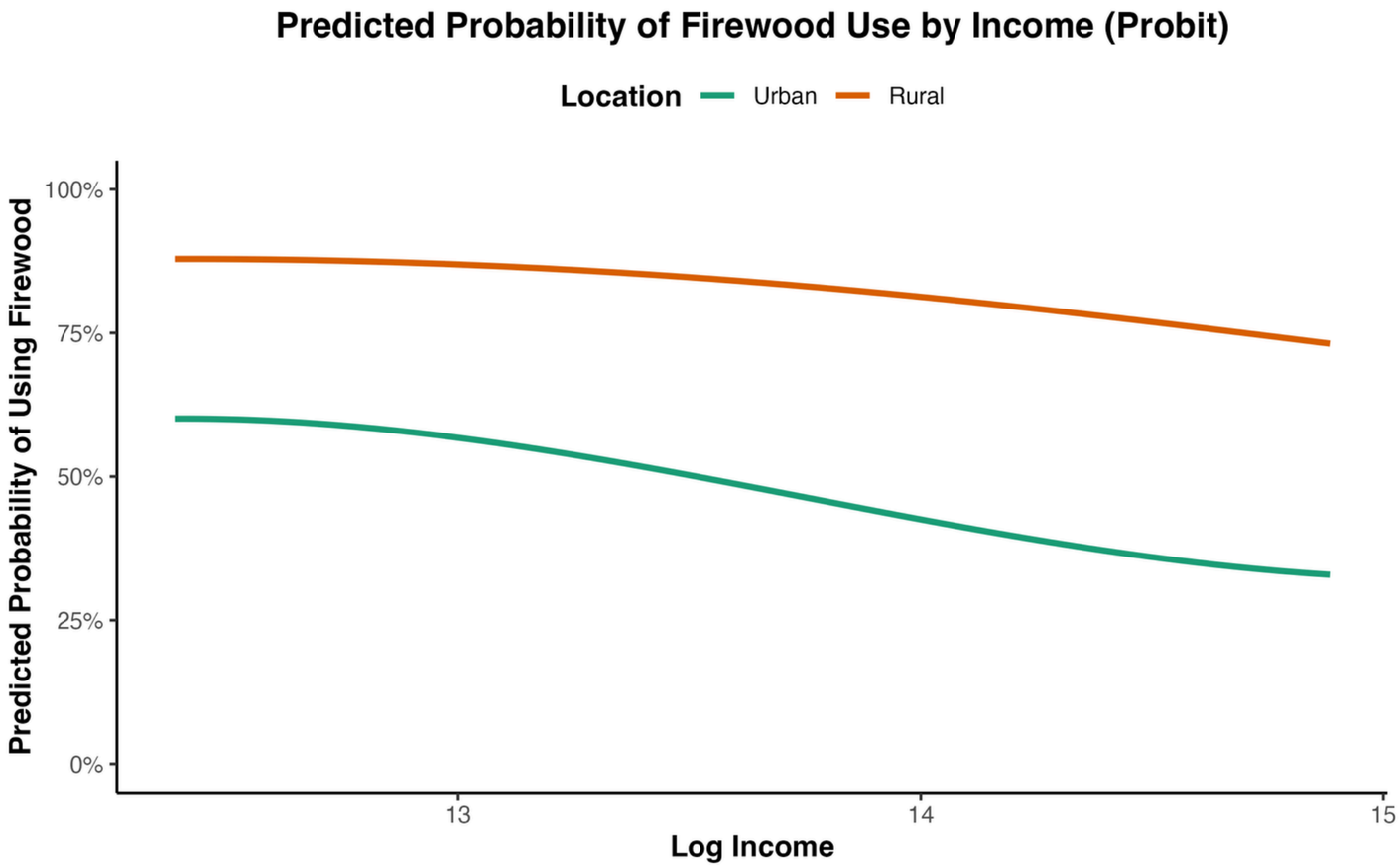
- Tests whether the original finding, **income growth alone cannot shift households away from firewood,** still holds five years later.
- Findings by Fercovic et al. (2024) remain true even after 2022 data has been included.



EXTENSION HIGHLIGHT

Rural vs. Urban

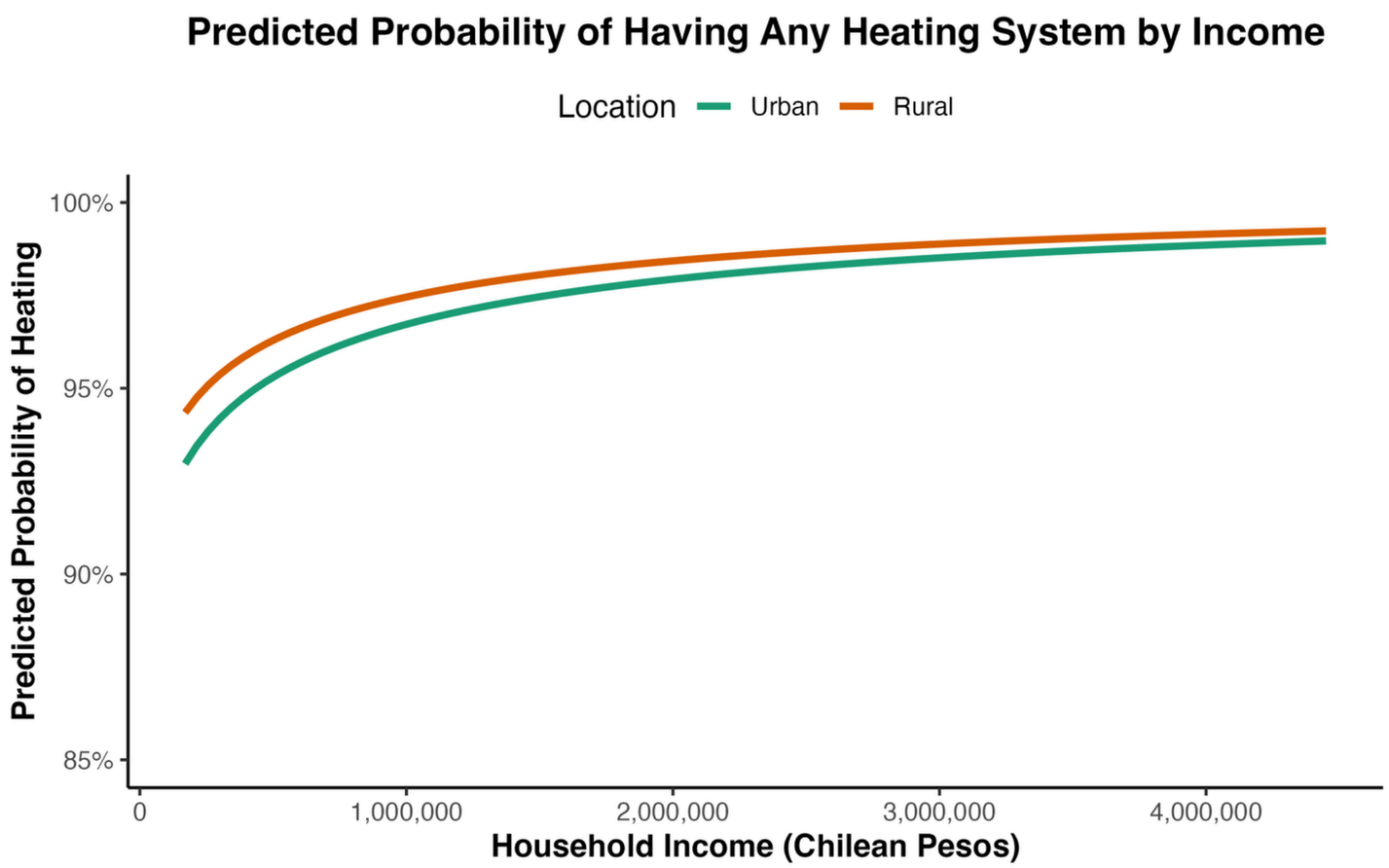
- Reveals **heterogeneity** hidden in the pooled model:
  - **Urban** households has a **significant cubic term** for log income, suggesting that high income levels has a taper off effect on firewood reduction
  - **Rural** households **does not** have a significant cubic term, suggesting ongoing energy transition related to income



EXTENSION HIGHLIGHT

Heating Decision

- Provides **context** for how the decision to heat is affected by **rural vs urban** status:
  - Income is the strongest driver for access to heating
  - Figure holds all covariates at their means, showing that income drives the convergence towards access to heating



POLICY OR INDUSTRY IMPLICATIONS

INCOME GROWTH IS NOT ENOUGH

Policies should not rely on rising incomes alone to phase out firewood heating.

TARGET RURAL HOTSPOTS

Prioritize rural communes with high firewood dependence for subsidies and cleaner fuel infrastructure.

HEATING ACCESS VS FUEL CHOICE

Complement fuel-switching incentives with programs that expand access to safe heating systems,

KEY TAKEAWAYS & LIMITATIONS

Insights

- 2022 extension confirms a weak residential energy transition in Chile
- Rural–urban heterogeneity shows that the transition is weakest in rural areas

Limitations

1. Proxied 2019 forest variables for 2022 data
2. Observational probit limits causal interpretation

Next Steps

1. Identify key drivers of clean-heating adoption in rural areas
2. Conduct a tCO_2e assessment comparing emissions from biomass harvested for household heat versus alternative development paths

Thank You!

We welcome any questions.