Downscaling results from a representative household to urban and rural households in Latin America

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Background

• RH results overlook impacts for household types
• iPETS includes heterogeneity

• Method should capture demographic trends
• Differences in income, consumption, savings

• Analyze heterogeneous impacts
  – Climate policy & climate impacts
Integrated Population-Economy-Technology Science Model

- **Households**: Consumption & Savings, Capital, Land & Labor
- **Final Goods**: Outputs of producers
  - **Final Goods Producers**: Consumption, Investment, Government, Exports/Imports
  - **Intermediate Goods Producers**: Oil & Gas, Coal, Electricity, Refined Fuels, Agriculture, Materials
- **Labor**: Inputs for production
- **Capital**: Inputs for production
- **Energy**: Inputs for production
  - **Land Use**: Land for production
- **CO₂ Emissions**: Outputs of production

The model represents the flow of inputs (Households, Final Goods, Labor, Capital, Energy, Land) through production (Final Goods Producers, Intermediate Goods Producers) to outputs (Final Goods, CO₂ Emissions).
iPETS model setup

HH Characteristics
- Labor supply
- Preferences etc.

Population Projection

HH Outcomes
- Consumption
- Income
- Savings etc.

Characteristics by Type
- Urban/Rural
- Age
- Size
- Education, ...

Outcomes by Type
- Urban/Rural
- Size
- Income
- Education, ...

Upscaling

Downscaling

Household Survey Data

China, India, Indonesia, EU, Russia, USA, Japan, Mexico, Brazil
Aggregate households -&gt; same total results

Disaggregate household outcomes

• Possible to obtain same results from downscaling as multiple household run?

• Methods:
  – Multiple household in iPETS (benchmark)
  – Recursive-dynamic microsimulation model
  – Forward looking microsimulation model

## Approaches

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2-period dynamic model

maximize $\log C_{it} + \beta \log C_{it+1}$

s.t. \{\begin{align*}
C_{it} + X_{it} &= L_{it} + r t K_{it} \\
C_{it+1} &= K_{it+1} \\
K_{it+1} &= (1 - \delta) K_{it} + X_{it}
\end{align*}\} \\

Simple OLG model, capital income in first period

Estimate $\beta$ from benchmark run or RH
Application

• Latin America
  – Economic data: GTAP7
  – Household data: HH surveys for Mexico and Brazil

• SSP2 baseline scenario

• Downscale to 2 household types:
  – Urban & Rural
Population

[Graph showing population growth with three trends: Total, Urban, and Rural, from 2000 to 20100.]
Labor income assumptions

**Per capita labor income (survey)**

- Total
- Urban
- Rural

**Per capita labor productivity from demographic change**

- Total
- Urban
- Rural

**Demographic changes:**
- Urbanization
- Ageing
- Household size
Downscaled labor income

![Graph showing the downscaled labor income from 2000 to 2100, with three lines representing Rural, Urban, and Total. The graph shows a steady increase in all categories over the years.]
Savings & capital income

Savings rate

Per capita capital income

Rural  Urban  Total

15%  17%  19%  21%  23%  25%  27%

2000  2020  2040  2060  2080  2100

2000  2020  2040  2060  2080  2100
Total income
Consumption preferences

Changes over time due to:
Income change, Urbanization, Household composition change
Consumption preferences

Urban:
- Food
- Transport
- Other

Rural:
- Food
- Transport
- Other
Final energy use per capita
Final energy use pc (10 $/t\text{CO}_2+4\%\text{pa})
Wrapping up

- Method for downscaling results from representative household to multiple household types
- Capture trends and differences

Next steps:
- Education household types
- Explore
  - details: multi prices? Different responses?
  - uncertainty: $\beta$ values, other parameters
- Impacts analyses