Welfare trade-offs of energy-efficient homes: poverty, environment and comfort
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  - Quasi-experimental evaluation of heating efficiency program in the Netherlands
  - Leverage two
  - Retrofit: Large experiment, targeting based on observable
  - Randomness of the treatment: No self-selection
- Results:
  - Program reduced natural gas use by 22% on average
    Even more for more "intensive" insulation, i.e. 30%
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- Quantitative/welfare analysis
  - Decomposition of welfare:
    Cost reduction (i.e. good consumpt° increase) vs. thermal comfort effects ($\sim$ rebound effect)
  - Counterfactual: with higher energy prices, renovation improve welfare

From welfare decomposition to quantitative model for policy counterfactual

- Reduced form evidence inform on the partial equilibrium effects
  - HHs change their decisions but effect is limited
- General equilibrium effects?
  - Will the cost of the renovation/insulation be passed-through the rents/costs of the housing? (or opportunity cost of social housing!)

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  - Reduction in natural gas use for those HHs change the equilibrium price of natural gas

  $\Rightarrow$ *Leakage effects* for the other non-treated households

  $\Rightarrow$ Is total effect on emissions ambiguous?
- Counterfactual policies:
  - Use a quantitative model for analyze the effects of different policies
    - Insulation of larger houses / richer households? Subsidized? Regulated?
    - Question of cash transfers? financial support for energy consumption? carbon taxation?

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- Think of a subsistence level $\underline{\theta}$: spirit non-homothetic/Stone Geary preference

$$f_2(\theta) = (2\bar{\theta} - \theta)(\theta - \underline{\theta}) \qquad \theta^\star = \bar{\theta} \quad \& \quad \underline{\theta} < \theta < 2\bar{\theta}$$

  - Suppose $\theta_0 < \underline{\theta}$ then utility drops with temperature, and implies that natural gas is a necessity good (which seems like it is?).
  - Moreover, get $\underline{g} = \underline{\theta}/q$, and so q changes $\underline{g}$.

Other questions on the specification

- Continuum of "intensity" of treatment: graph a comparison between intensity (i.e. expected reduction in gas use) and realized reduction.
- You have 3 "quality" indices (A-B, C-D, E-F-G), why not having that in the theoretical specification? or a continuum?
  - Imply reallocation, higher benefit for E-G than for C-D, having differential impact across households.
  - As seen in the Retrofit intensity distribution: from 10% to 90%
- Parabolic specification: for the richest, why "optimal comfort" $\theta = \bar{\theta}$ only arises when $w \to \infty$ or $q \to \infty$ and not a finite number?
- Heterogeneity in taste? Some people prefer to spend a large amount to get comfort? In the specification above it would imply heterogeneity in $\bar{\theta}$ and $\underline{\theta}$.