Rebuild or Relocate?

Recovery after Natural Disasters

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UC Berkeley

November 17, 2025
E-Axess Forum

Motivation

- Recent natural disasters have renewed debate on effectiveness of US post-disaster policies
- Currently federal policy focuses on “preserving communities"
  - rebuilding subsidies for homeowners with property damage ex-post, if approved
  - investment in local infrastructure

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  - rebuilding subsidies for homeowners with property damage ex-post, if approved
  - investment in local infrastructure
- This paper: **evaluate welfare effects of natural disasters and policy response**
  - new measurement of distributional effects of Hurricane Maria in 2017
  - quantitative general equilibrium model with migration, housing, infrastructure

Findings

- Homeowners with property damage **undervalue** rebuilding subsidies ($0.74/$1 spent)
  - lose eligibility in case of mortgage default or sell before completing repairs
  - uncertainty about eligibility and timing, approval process and repairs slow
  - risky, non-tradable asset → makes for poor insurance

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- Welfare losses are large **even** for renters and homeowners without direct damage
  - with direct damage: lower housing consumption, wealth, home equity, higher default risk
  - all households: worse infrastructure, higher housing costs
  - few can afford to migrate → inelastic local housing demand, inelastic supply

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  - few can afford to migrate → inelastic local housing demand, inelastic supply
- Alternative policies yield large welfare improvements at similar cost
  - migration subsidies: allows people to leave, spillovers to housing costs
  - unconditional cash transfers: don't tie people to damaged house, relax financial constraints

This paper

- Setting: Hurricane Maria struck Puerto Rico in 2017, over 70% housing damaged
- Facts on post-disaster behavior from high-frequency flight data and original survey
  - many migrate, but high migration costs prevent an even larger number from leaving
  - others stay, cope without electricity, homeowners default, repair with rebuilding subsidy

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  - heterogeneous households rent or own with long-term defaultable mortgage
  - temporary and permanent migration, pecuniary and non-pecuniary costs
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  - heterogeneous households rent or own with long-term defaultable mortgage
  - temporary and permanent migration, pecuniary and non-pecuniary costs
  - infrastructure input in firms' production and housing services
- Quantify model using survey and flight data
- Alternative policies: improved screening process, migration subsidies, cash transfers

Literature

- Government policy and natural disasters Vigdor 2008, Hornbeck 2012, Deryugina 2017, Gregory 2017, Gallagher & Hartley 2017, Fu & Gregory 2019, Boustan, Kahn, Rhode, & Yanguas 2020, Balboni 2021, Fried 2021, Wagner 2022, Nakamura, Sigurdsson & Steinson 2022, Hsiao 2023, Roth Tran & Wilson 2024, Collier, Howell, Rendell 2024

  ➔ new measurement, interaction of policy with rich household heterogeneity

- Shocks and the spatial distribution of economic activity Ferreira, Gyourko, Tracy 2010, Kennan & Walker 2011, Desmet & Rossi-Hansberg 2015, Gröger & Zlyberberg 2016, Bazzi 2017, Morten 2019, Caliendo, Dvorkin, Parro 2019, Alessandria, Bai & Ding 2020, Bilal & Rossi-Hansberg 2021, Lagakos, Mobarak & Waugh 2023, Bilal & Rossi-Hansberg 2023, Fonseca & Liu 2023, Kleinman, Liu, Redding 2023, Leduc & Wilson 2023, Aladangady, Krimmel & Scharlemann 2024

  ➔ direct measure of pecuniary and non-pecuniary costs, housing friction

- Mortgages and mortgage default Kiyotaki, Michaelides, Nikolov 2011, Mian, Sufi, Trebbi 2015, Corbae & Quintin 2015, Campbell & Cocco 2015, Piazzesi & Schneider 2016, Favilukis, Ludvigson, van Nieuwerburgh 2017, Greenwald 2018, Adelino, Schoar Severino 2018, Kaplan, Mitman & Violante 2020, Ganong & Noel 2023, Greenwald & Guren 2024

  ➔ physical destruction shock to home equity, equilibrium price movements, in-kind transfers

Outline

Relocation and rebuilding after a natural disaster

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Setting: Puerto Rico and Hurricane Maria

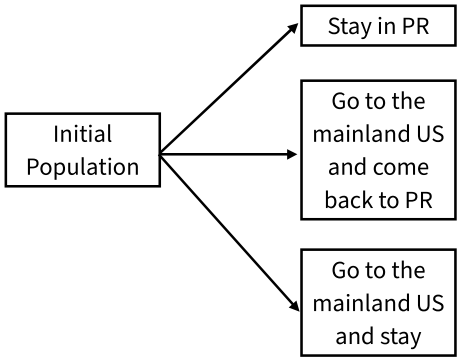
- Unincorporated US territory
  - “foreign in a domestic sense"
  - Puerto Ricans are US citizens
  - no legal barriers to migration
  - large diaspora population
- Hurricane Maria 2017
  - deadliest US hurricane since 1900
  - majority of houses damaged
  - damage to utilities, roads, etc.
  - $<$ 10% homeowners insured

Data on post-disaster household behavior

- Census: PRCS

Initial Population

Data on post-disaster household behavior



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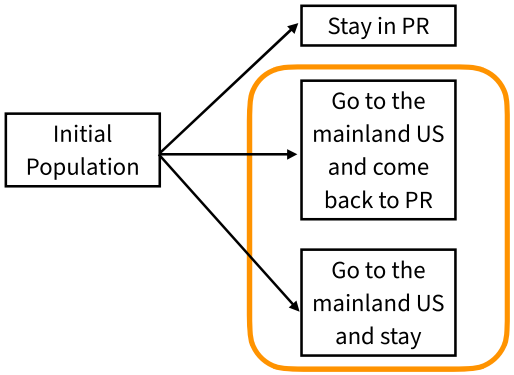

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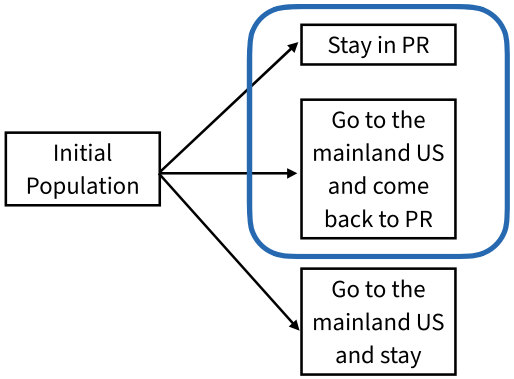

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  - June 2023, May 2024, N = 1,000
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    English birthplace income ownership
  - experiences after Hurricane Maria
  - migration costs, wages + rents in Mainland US
  - demographics, wealth, income

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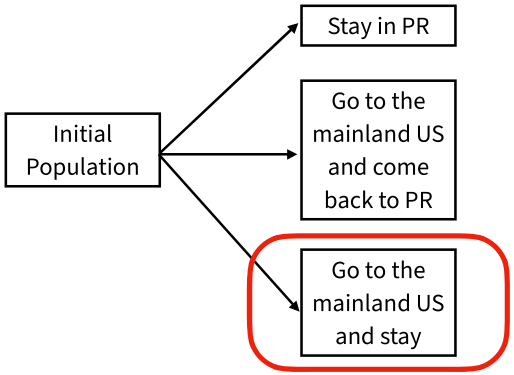

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- Infer from Δ PRCS population distribution

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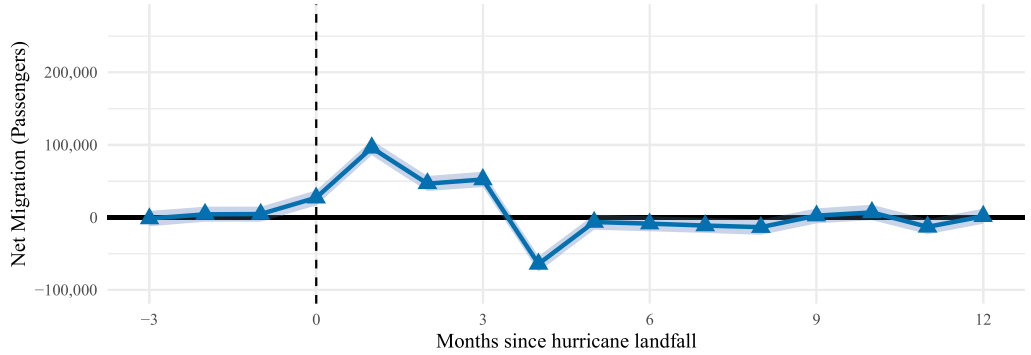

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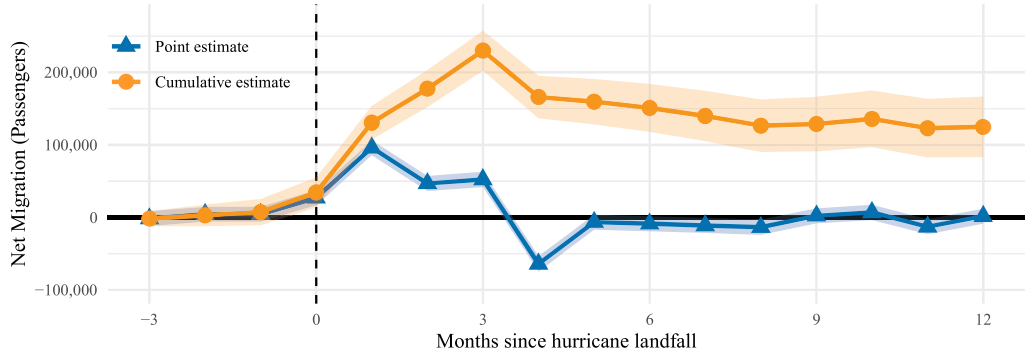

- Short-run **7%** migrate to Mainland US, long-run **60%** stay **40%** return one-way tickets empty seats

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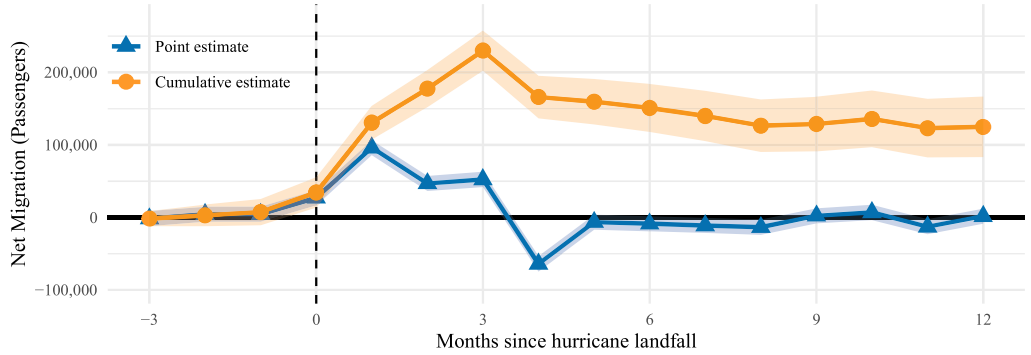

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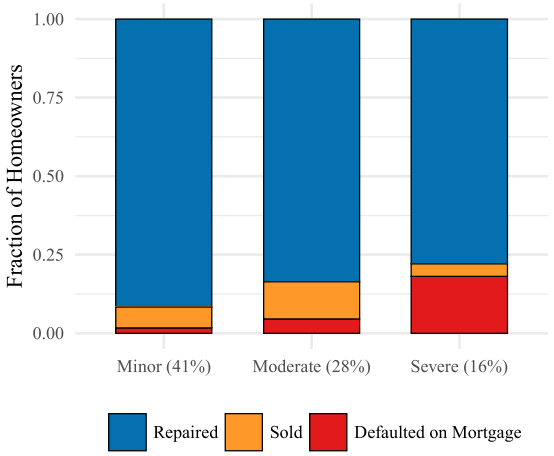
- Survey migration costs *directly*, E[costs] > liquid assets for many
- **50%** could not afford desired post-Maria migration

Property damage drives homeowner decisions

- FEMA damage definitions details



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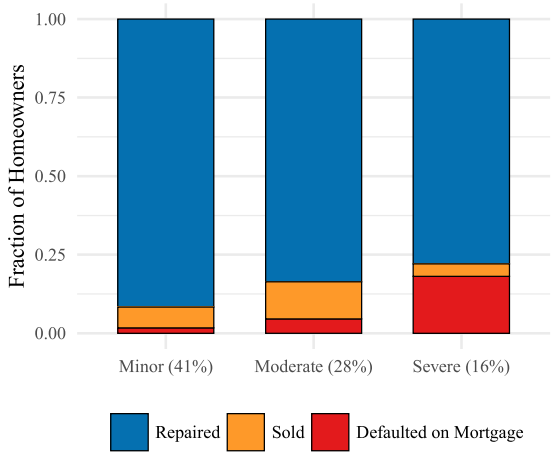

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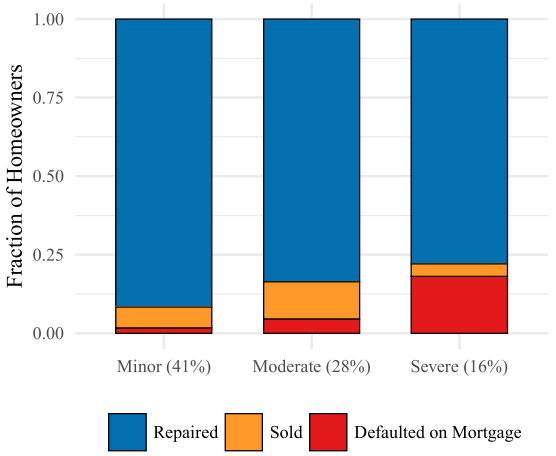

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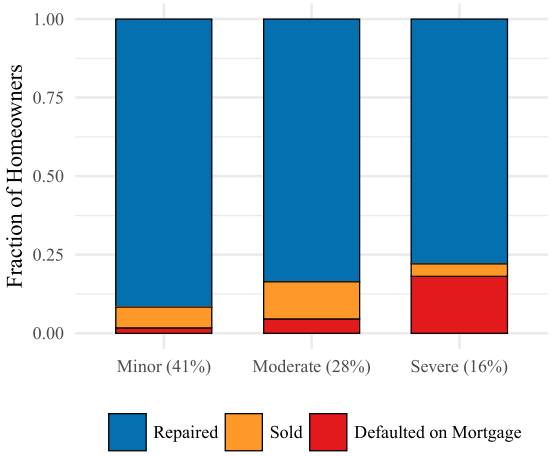
- Most report government funding
  - rest finance from savings, family/friends
  - very few insured
- No reliable electricity for months details



Summary of empirical facts

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2. Mortgage default rates are increasing in property damage
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3. With government support, nearly all homeowners eventually repair
   - → choice to self-finance or apply for assistance, risk of denial
   - → interaction of rebuilding and migration decisions

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  - competitive firm produces w/labor, capital, infrastructure (financed by local output tax)
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  - u(housing, consumption, living near other PRs), bequest motive
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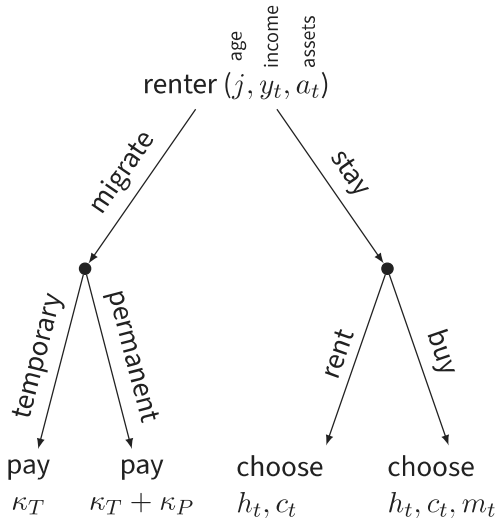
- Natural disaster: one-time unanticipated capital destruction shock

Renter decisions

renter problem



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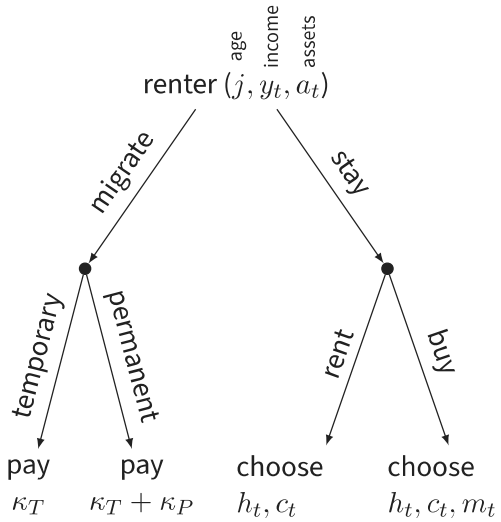
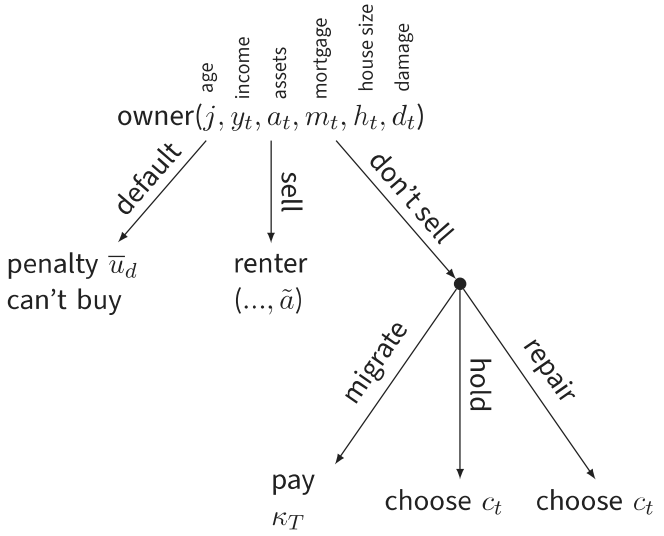


- **migrate**
  - no income, utility in migration period $\bar{u}_m$
  - pay idiosyncratic cost from assets
  - **temporary**: back in PR next period
  - **permanent**: $V^{\text{US}}(j+1, y_{t+1}, a_{t+1}, N^{\text{US}})$
- **stay**
  - earn income
  - **rent** from set of undamaged homes
  - **buy** only undamaged homes

Owner decisions

- **default**
  - utility cost, retain assets
  - cannot buy one period
- **sell** become a renter
  - can buy again
  - can migrate immediately
- **don't sell**
  - pay mortgage, taxes, maintenance
  - **migrate**: only temporary
  - **hold**: live in house w/potential d_t
  - **repair**: pay now, repaired tomorrow



Current post-disaster policy, equilibrium, natural disasters

- **Policy**: transfers for infrastructure, rebuilding subsidies, not locally financed
  - households choose to apply, $\pi_t^{\textbf{approve}}$ (limited # of inspectors, documentation, etc.)
  - **approved**: min$(h_t d_t p_t^c$, **subsidy cap**$)$, house repaired tomorrow
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- **Equilibrium**: agents optimize, market clearing:
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- **Natural disaster:** one-time unanticipated capital destruction shock repeated risk increasing risk
  - the economy converges to a new steady state
  - population size indeterminacy in steady state ➔ population depends on policy response

Tracing a natural disaster through the model

- Direct impacts:
  - damage to owner occupied housing, rental housing → housing scarce
  - destruction of infrastructure, firm capital → reduced housing services, output
- Three groups: homeowners **with property damage**, **without damage**, **renters**

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- Three groups: homeowners **with property damage**, **without damage**, **renters**
- Equilibrium effects work through prices and size of population (homophily)
  - **rents**: mortgage default raises rents, migration alleviates pressure
  - **construction costs**: subsidies to rebuild raise costs, affects user cost of housing
  - **house prices**: tied to construction costs and rents, changes LTV constraint

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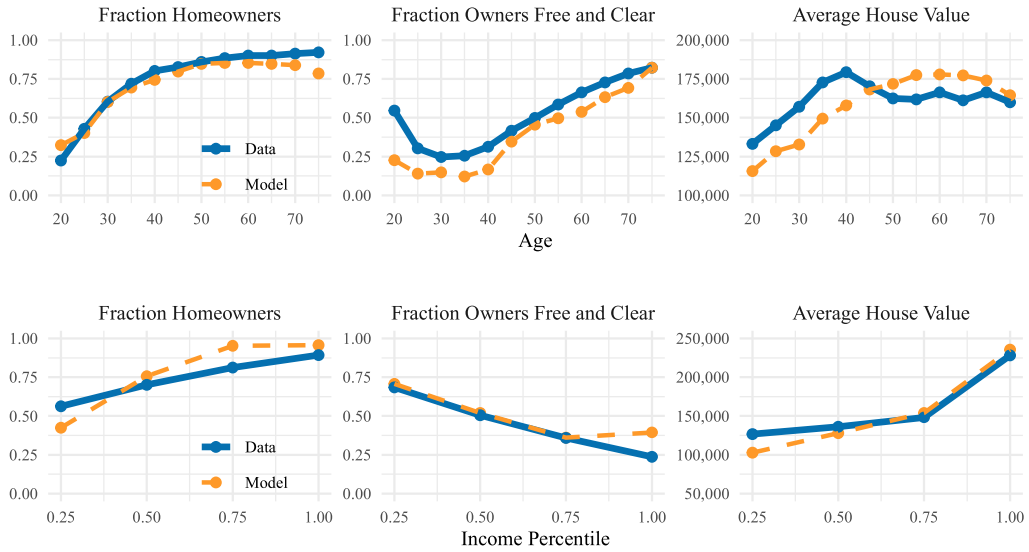
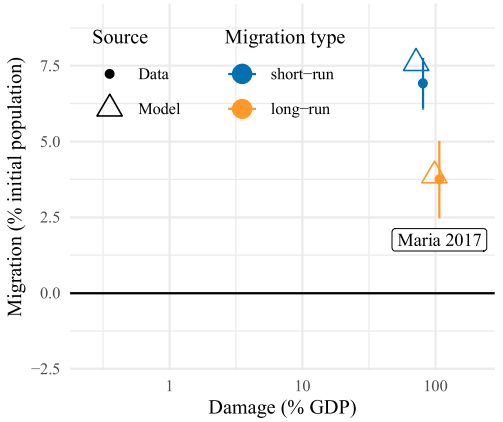


Step 2: transition dynamics in PR after Hurricane Maria

migration costs policy regime

- $\bar{u}_m$: utility in period of migration
  - target: migration after Maria
  - non-targeted: migration after past hurricanes



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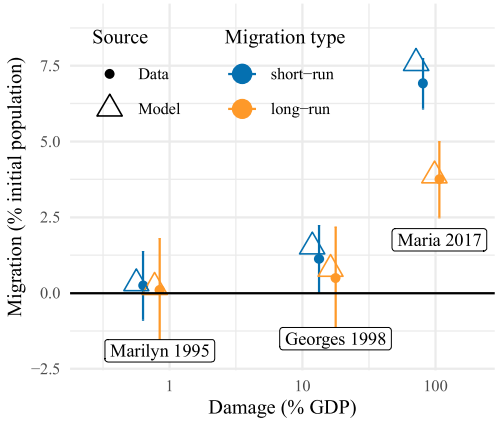

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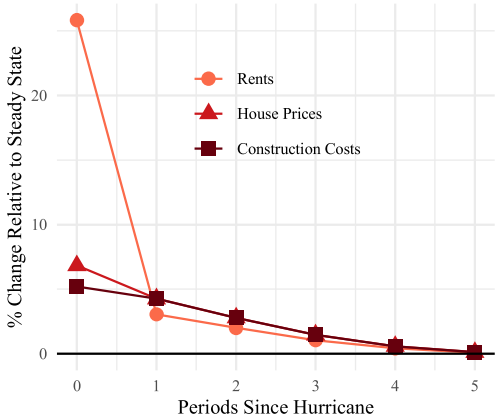
- ψ_1: congestion in construction sector
  - target: Δ house price (**8%**, **7%**)
  - non-targeted: elasticity of rents wrt damage
  - Santiago-Bartolomei, Lamba-Nieves, Figueroa 2022
  - estimate 1.2 $\times$ 25% shock = 30% rent increase



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Current and alternative post-disaster policy

1. Absent federal policy, natural disasters result in large welfare losses
   - counterfactual: same shock, no federal transfers
2. Current post-disaster policy partially mitigates effects
   - not cost effective, households undervalue rebuilding subsidies
3. Migration costs are key to how households cope with natural disasters
   - counterfactuals: higher/lower migration costs, migration subsidies
4. Unconditional post-disaster policies result in large welfare gains
   - counterfactual: unconditional cash transfer

Absent federal policy, natural disasters result in large welfare losses

- Homeowner with direct property damage: **26%** CE loss
  - large **permanent** wealth shock, **50%** avg shock to pre-hurricane net worth shock distribution
  - home-equity position is key, low → default on mortgage, high → full loss mortgage default decision
  - damaged house delivers lower service flow: no roof + no utilities

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- Renter: **6.2%** CE loss
  - lower wages, **much higher rents**, worse housing for rent
  - higher house prices → harder to transition to homeownership

summary

Current post-disaster policy partially mitigates effects welfare by housing tenure and net worth

- Homeowner with damage benefit most: **15%** vs 26% CE loss
  - rebuilding subsidies provide in-kind transfers for home equity losses
  - incentive to hold onto damaged house, mortgage default rate falls: **17% → 7%**
  - fewer defaults → lower rents in equilibrium rents
  - wealthier, less financially constrained → wait out delays in approval process

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- Owner without damage (**4.0%** vs 5.5% CE loss), Renters (**4.7%** vs 6.2% CE loss)
  - faster infrastructure rebuilding → all housing nicer, "TFP" shock to private firms, higher wages
  - more rebuilding → higher construction costs, house prices during recovery house prices
  - raises value of staying in PR, lower permanent out-migration **7% → 4%**

real estate investors, construction firm, lenders summary

How do households value policy?

- Need measure of policy value at individual level to compare to budget cost
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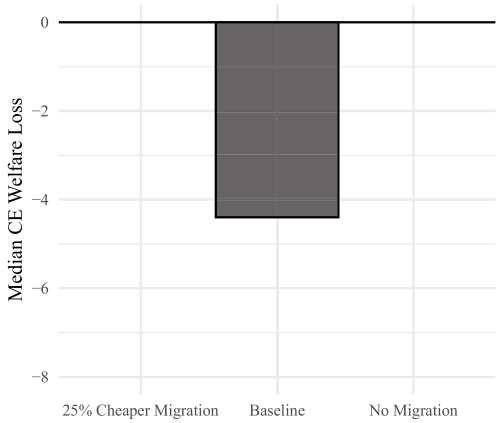
- What patterns in the **data** would lead to higher policy valuation?
  - infer higher value of staying in house/PR: less mortgage default, stronger homophily
  - lower cost of waiting for rebuilding subsidy: more temporary migration

summary

Migration costs are key to how households cope with natural disasters



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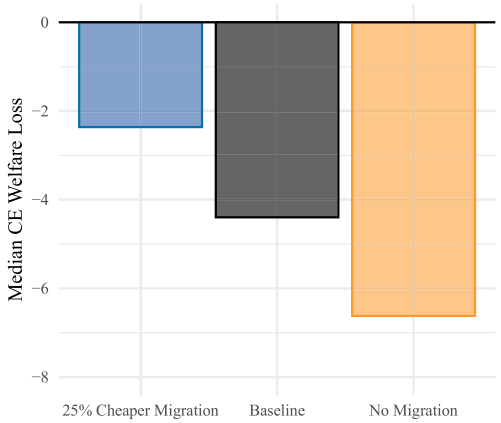

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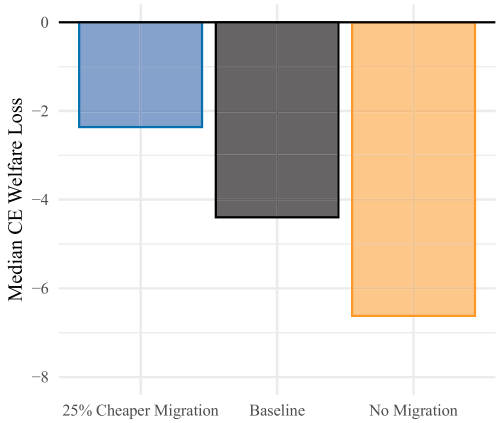

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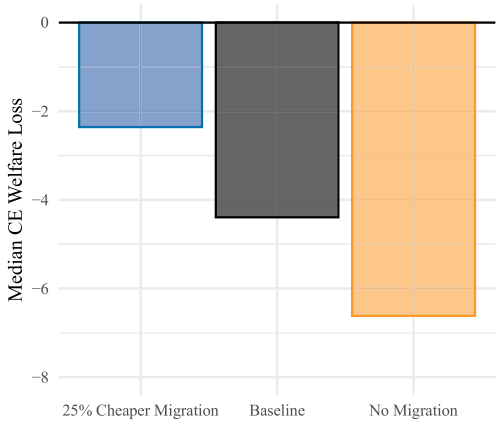

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- Migration subsidies particularly effective
  - $750 subsidy → 0.7pp increase in migration
  - mostly **temporary** moves
  - shifts housing demand curve → lower rents
  - low cost ($60), large benefits ($1,000)

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- Equilibrium: higher housing costs, more temporary and permanent migration prices migration
- Suggests large benefits switch from **indemnity** insurance → **parametric** insurance
  - payouts conditioned on *aggregate* rather than *individual* shock
  - applies to private market natural disaster insurance, similar forces affect household wtp
  - home equity transfers to "risky" locations even less effective with increasing disaster risk

Outline

Relocation and rebuilding after a natural disaster

Model of natural disasters, migration, housing, and infrastructure

Quantification

Current and alternative post-disaster policy

Conclusion

Conclusion

- Homeowners with property damage **undervalue** rebuilding subsidies
  - lose eligibility in case of mortgage default or sell before completing repairs
  - uncertainty about eligibility and timing, approval process and repairs slow
  - risky, non-tradable asset → makes for poor insurance
- Welfare losses are large **even** for renters and homeowners without direct damage
  - with direct damage: lower housing consumption, wealth, home equity, higher default risk
  - all households: worse infrastructure, higher housing costs
  - few can afford to migrate → inelastic local housing demand, inelastic supply
- Alternative policies yield large welfare improvements at similar cost
  - migration subsidies: allows people to leave, spillovers to housing costs
  - unconditional cash transfers: don't tie people to damaged house, relax financial constraints