The Macroeconomics of Housing and the Dynamics of Wealth Inequality

First WID.world Conference

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Housing Matters

- Economic characteristics of housing
  - **Largest expenditure category**: 18.2 % in 2015 (BEA, NIPA Table 2.3.5.)
  - **Necessity good**: expenditure share varies inversely with income
  - **Relative price of housing** increased continuously over time ▸ prices
- Theory suggests further price changes (Borri and Reichlin 2016; Grossmann and Steger 2017)
- Growing public concern on distributional and welfare consequences
  - **Affordability dimension** (static): Share of rent burdened / severely rent burdened (Quigley and Raphael, 2004, JEP) $\longrightarrow$ toxic mix of stagnating wages and rising rents
  - **Wealth-formation dimension** (dynamic): Rising rents suppress the capability of the poor to accumulate wealth

$\rightarrow$ We focus on the dynamics of wealth inequality in an economy with housing

Research question and method

Research question

- How does economic growth – associated with increasing real house prices and rents – affect
  1) the distribution of wealth?
  2) agent-specific welfare?

Method

- Frictionless **housing & macro model** that is designed to think **long term**, augmented by **household heterogeneity** à la Caselli and Ventura (2000, *AER*)
- Model-based experiments; numerical techniques; analytical insights

→ Fundamental mechanisms that operate in the absence of idiosyncratic shocks & incomplete markets (or other types of imperfections).

Related literature

- **Saving and wealth inequality**: De Nardi and Fella (2017, *RED*)
  - Most Bewley-Huggett-Aiyagari models study impact of alternative mechanisms on shape of stationary wealth distribution
  - Exceptions: Gabaix, Lasry, Lions, and Moll (2016, *Ectra*); Kaymak and Poschke (2016, *JME*); Hubmer, Krusell and Smith (2016, NBER WP)
  - Caselli and Ventura (2000, *AER*) setup: Álvarez-Peláez and Díaz (2005, *JME*)
- **Housing & Macro**: Piazzesi and Schneider (2016)
  - short run: Davis and Heathcote (2005, *IER*); Iacoviello (2005, *AER*); Iacoviello and Neri (2010, *AEJ:M*); Kiyotaki et al. (2011, *JMCB*); Favilukis et al. (2015, *JPE*); Kydland et al. (2016)
  - long run: Grossmann and Steger (2017, IMF WP); Borri and Reichlin (2016); Miles and Sefton (2017)

→ Theory to think about wealth dynamics and welfare effects triggered by economic growth in an economy with housing

Household sector: infinitely lived agents

- **Demographic structure**
  - J groups of agents indexed by $j \in \{1, 2, ..., J\}$
  - Total population of measure $\mathcal{L} = const.$
  - Group size $n_j = \frac{\mathcal{L}}{J}$ for all j
  - Aggregate labor supply $L = \mathcal{L}$
- **Dynamic problem agent j**

$$\max_{\{c_j(t), s_j(t)\}_{t=0}^{\infty}} \int_0^{\infty} u(c_j(t), s_j(t)) e^{-\rho t} \mathrm{d}t$$

s.t.

$$\dot{W}_j(t) + c_j(t) + p(t) s_j(t) \leq r(t) W_j(t) + w(t) l_j$$

- $W_j(t) \equiv P^H(t) N_j(t) + K_j(t) + P^Z(t) Z_j^Y(t)$
- *Exogenous* heterogeneity: $W_j(0)$
- Ascending order: $W_1(0) \leq W_2(0) \leq ... \leq W_J(0)$

Utility: motivation # 1

- Instantaneous utility ($\bar{s} \equiv \frac{1}{J} \sum_j s_j$):

$$u(c_j, s_j) = \frac{\left[(c_j)^{1-\theta} \left(s_j - \phi \bar{s} \right)^{\theta} \right]^{1-\sigma} - 1}{1-\sigma}$$

Karl Marx (1847)

A house may be large or small; as long as the neighboring houses are likewise small, it satisfies all social requirement for a residence. ***But let there arise next to the little house a palace, and the little house shrinks to a hut.****[...] the occupant of the relatively little house will always find himself more uncomfortable, more dissatisfied, more cramped within his four walls.*

- Evidence on status concerns wrt housing: Leguizamon and Ross (2012), Turnbull et al. (2006), Frank (2005, AER p&p)

Utility: motivation # 2

- For $\phi > 0$ housing is a necessity good
- Housing expenditure share

$$e_j \equiv \frac{ps_j}{c_j + ps_j} = \frac{\theta}{1-(1-\theta)\frac{\phi}{\mathfrak{s}_j}},$$

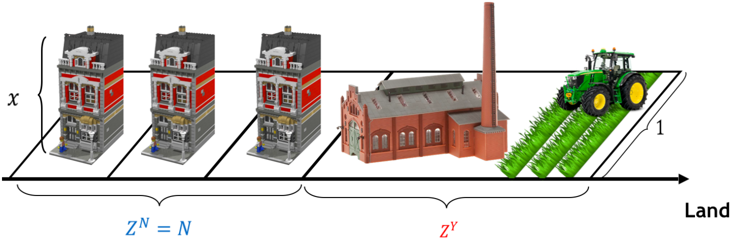
with $\mathfrak{s}_j \equiv s_j/\bar{s}$

- Replicate following stylized fact

US, 2006-15 in percent	aggregate	income quintile				
		1st	2nd	3rd	4th	5th
data (BLS, CEX)	19	25	21	20	19	18
model, $\phi = 0$	19	19	19	19	19	19
model, $\phi = 0.7$	19	25	24	23	21	13

- Pattern is extremely robust across space and time (contemporary UK, Germany, France; Schwabe's Law from 1868)

Production sectors (Grossmann and Steger, 2017)



- **Real estate development** (extensive margin)

  $\dot{N} = \tilde{I}^N, \; Cost = P^Z \tilde{I}^N + \frac{\xi}{2}(\tilde{I}^N)^2$

- **Construction** (intensive margin)

  $\dot{X} = I^X - \delta^X X, \; I^X = B^X (M)^\eta (L^X)^{1-\eta}$

- **Housing services**

  $h = x^\gamma$

- **Numeraire sector**

  $Y = B^Y (K)^\alpha (L^Y)^\beta (Z^Y)^{1-\alpha-\beta}$

- **Market clearing**
  - Numeraire

    $Y = C + M + I^K + I^N$
  - Housing

    $Nh = S$
  - Land

    $Z = Z^N + Z^Y$

General equilibrium

A **general equilibrium** is a sequence of quantities, a sequence of prices, and a sequence of operating profits of housing services producers

$$\left\{Y(t), K(t), X(t), N(t), x(t), h(t), M(t), L^{Y}(t), L^{X}(t), Z^{Y}(t)\right\}_{t=0}^{\infty},$$
$$\left\{\left\{c_j(t), s_j(t), W_j(t), K_j(t), Z_j^{Y}(t), N_j(t)\right\}_{j=1}^{J}\right\}_{t=0}^{\infty},$$
$$\left\{p(t), P^{Z}(t), q^{N}(t), q^{X}(t), w(t), r(t), R^{Z}(t), R^{X}(t)\right\}_{t=0}^{\infty}, \{\pi(t)\}_{t=0}^{\infty}$$

for initial distributions $\left\{K_j(0), Z_j^{Y}(0), N_j(0)\right\}_{j=1}^{J}$ and given $\left\{B^{X}(t), B^{Y}(t)\right\}_{t=0}^{\infty}$ such that

i) households maximize lifetime utilities;

ii) representative firms in X sector and Y sector, representative real estate developer, and housing services producers maximize PDV of infinite profit stream, taking prices as given;

iii) labor markets clear: $L^{X}(t) + L^{Y}(t) = L$;

iv) all asset markets clear:

$$K(t) = \sum\nolimits_j \frac{\mathcal{L}}{J} K_j(t),\ \ N(t) = \sum\nolimits_j \frac{\mathcal{L}}{J} N_j(t),\ \ Z^{Y}(t) = \sum\nolimits_j \frac{\mathcal{L}}{J} Z_j^{Y}(t) = Z(t) - N(t);$$

v) perfect arbitrage across all assets holds;

vi) market for housing services clears: $\sum_j \frac{\mathcal{L}}{J} s_j(t) = N(t)h(t)$;

vii) market for Y good clears: $Y(t) = C(t) + I^{K}(t) + I^{N}(t) + M(t)$ (redundant due to Walras' law);

Solution approach

1. Representative agent
   - Relaxation algorithm (Trimborn et al., 2008, *MD*)
   - Result: sequence of all *aggregate* variables
2. Solve for all *group-specific* sequences of wealth and consumption
   - Exploit recursive structure of (discretized) FOCs
   - Exact solution given the approximation error in step 1

Calibration (US)

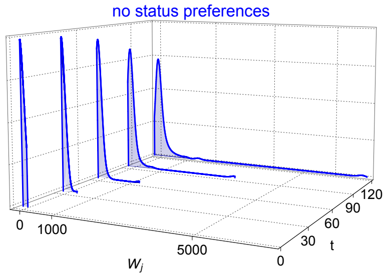
i) Set $J = 100$ and feed in the wealth percentiles for the US in 2010 (WID.world)

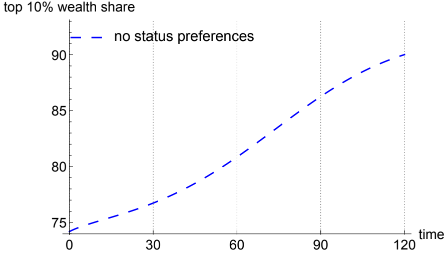
ii) Exogenous TFP growth in $B^Y(t)$ & $B^X(t)$ (Moro and Nuño, 2012, *EL*)

iii) State variables: (a) aggr. US saving rate (2010): 9.4 percent (Piketty & Zucman, 2014); (b) employment share construction (2004-2010): $l_X = 2.7$ percent (Henderson, 2015; BEA, 2015); (c) growth rate of $X(t)/N(t)$ over next 30 years: 1.5 percent (Davis and Heathcote, 2007)

Calibration details

Dynamics of wealth inequality: divergence





- Economic growth (average annual growth rate of GDP per capita: 2.2 percent)
  $\Rightarrow$ increasing rents (not shown)
  $\Rightarrow$ rising wealth inequality (even for $\phi = 0$)

Divergence mechanism

- Growth rate of household-specific wealth

$$\hat{W}_j(t) \equiv \underbrace{sav_j(t)}_{\text{divergence channel}} \underbrace{\frac{r(t)W_j(t) + w(t)l_j}{W_j(t)}}_{\text{convergence channel}}$$

- Global wealth divergence is defined as $\frac{\partial \hat{W}_j(t)}{\partial W_j(t)} > 0$ for all j

Proposition 5

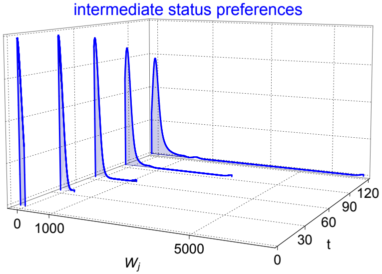
A necessary and sufficient condition for wealth divergence at a given instant of time t reads as follows

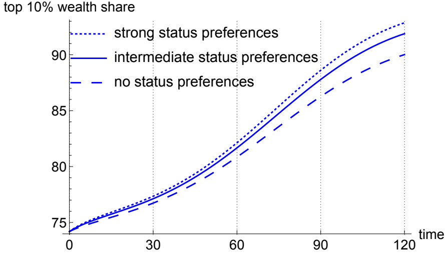
$$\mu(t)\tilde{w}(t) > w(t). \tag{1}$$

- If (1) holds, the divergence channel, $\frac{\partial sav_j}{\partial W_j} > 0$, is dominating.

Saving rates

Dynamics of wealth inequality: amplification





- Economic growth (average annual growth rate of GDP per capita: 2.2 percent)
  $\Rightarrow$ increasing rents (not shown)
  $\Rightarrow$ rising wealth inequality
- **Intensification of status concerns amplifies wealth divergence**

Amplification mechanism

- Wealth divergence is said to be *amplified* by status preferences in housing (heterogeneous housing expenditure shares) if

$$\frac{\partial}{\partial\phi}\left(\frac{\partial\hat{W}_j}{\partial W_j}\right) > 0.$$

Proposition 6

Increasing ϕ amplifies wealth divergence if the intertemporal IES is smaller than unity and real rents are increasing over time (or, empirically less plausible, real rents decline and the IES is above unity), i.e.

$$\frac{\partial}{\partial\phi}\left(\frac{\partial\hat{W}_j}{\partial W_j}\right)\begin{cases} >0 & \text{if } (\sigma-1)\ln\frac{p(s)}{p(t)}>0 \\ =0 & \text{if } (\sigma-1)\ln\frac{p(s)}{p(t)}=0 \\ <0 & \text{if } (\sigma-1)\ln\frac{p(s)}{p(t)}<0 \end{cases},$$

where $s \geq t$.

▸ MPCs over time

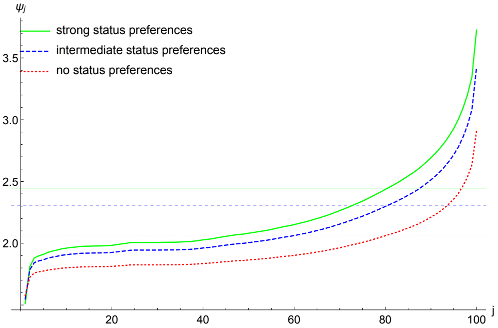
Welfare effects

Consumption-equivalent welfare measure (Jones and Klenow, 2016, *AER*; Lucas, 1987)

$$\int_0^\infty e^{-\rho t}\frac{\left[\psi_j \mathcal{C}_j^0(t)\right]^{1-\sigma}-1}{1-\sigma}\mathrm{d}t \overset{!}{=} \int_0^\infty e^{-\rho t}\frac{\left[\mathcal{C}_j^1(t)\right]^{1-\sigma}-1}{1-\sigma}\mathrm{d}t$$

$\mathcal{C}_j^i \equiv c_j^{1-\theta}(s_j-\phi\bar{s})^\theta$; $i=0$ $(i=1)$ denotes the baseline (alternative) scenario

scenario	TFP
baseline (0)	constant
alternative (1)	grows



Welfare effects: amplification mechanism

Proposition 7

The welfare gain for an agent j of switching in period t from scenario 0 to 1 is given by

$$\psi_j(t) = \left(\frac{\mu^1(t)}{\mu^0(t)}\right)^{\frac{\sigma}{\sigma-1}} \underbrace{\frac{W_j^1(t) + \tilde{w}^1(t)l_j}{W_j^0(t) + \tilde{w}^0(t)l_j}}_{\text{wealth channel}} \underbrace{\left(\frac{\mathcal{P}_j^1(t)}{\mathcal{P}_j^0(t)}\right)^{-1}}_{\text{rent channel}}.$$

- Ideal price index $\mathcal{P}_j = \frac{p^\theta}{\theta^\theta(1-\theta)^{1-\theta}} \frac{1-\theta}{1-e_j}$
- $\frac{\partial \mathcal{P}_j}{\partial e_j} > 0$ and $\frac{\partial^2 \mathcal{P}_j}{\partial e_j \partial p} > 0$ for $\phi > 0$

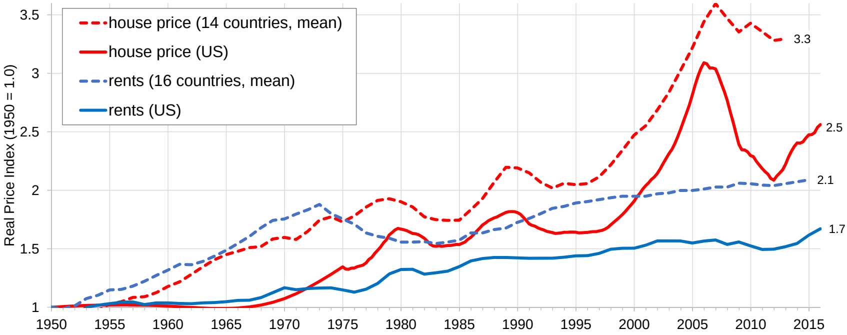
$\rightarrow$ Amplification: for $\phi > 0$ a poor agent has a higher housing expenditure share and rising rents imply a stronger increase in $\mathcal{P}_j^1$

Conclusion

- **Research question:** How does economic growth – associated with increasing real house prices and rents – affect
  1) the distribution of wealth?
  2) agent-specific welfare?
- **Numerical experiments**: Economic growth – associated with increasing real house prices and rents – triggers
  1) an increase in wealth inequality
  2) asymmetric welfare effects to the benefit of wealthy households

  $\rightarrow$ Amplification: endogenous heterogeneity in housing expenditure shares
- **Analytical insights**
  - Condition for global wealth divergence: sufficiently high MPC
  - Condition for amplification: IES below unity and rising rents
  - Asymmetric welfare effects of economic growth
    - ★ Poor individuals are hit especially strong by rising rents
    - ★ Rich individuals benefit from rising house prices

House prices and rents in the long run



Source: US house prices: Davis and Heathcote (2007, *JME*); US rents: BLS; average price index: Knoll, Schularick, Steger (2017, *AER*); average rent index: Knoll (2017).

- Theory suggests further increases in the future (Borri and Reichlin 2016; Miles and Sefton, 2017; Grossmann and Steger 2017)

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Calibration (1)

Parameter	Value / process	Note
α	0.28	Grossmann and Steger (2017)
β	0.69	Grossmann and Steger (2017)
δ^K	0.07	Grossmann and Steger (2017)
δ^X	0.015	Grossmann and Steger (2017)
ξ	100	Grossmann and Steger (2017)
γ	0.9	Grossmann and Steger (2017)
η	0.38	Grossmann and Steger (2017)
B_t^X	$B_{t+1}^X - B_t^X = 0.03 \cdot B_t^X \frac{1-B_t^X}{1}, B_0^X = 0.71$	Moro and Nuño (2012, *EL*)
B_t^Y	$B_{t+1}^Y - B_t^Y = 0.03 \cdot B_t^Y \frac{10-B_t^Y}{10}, B_0^Y = 1$	Moro and Nuño (2012, *EL*)
$\mathcal{L}$	1	no population growth
Z	1	fixed land endowment
ρ	0.025	standard value
ϕ	0.7	match average e_j of bottom income quintile (BEA)
θ	0.066	match $\bar{e}$=0.19 (BEA)
σ	3	$IES_{\mathcal{C}} = 1/3$ (Havránek, 2015)
$\left\{W_j(0)\right\}_j$	Percentiles in the US	World Wealth and Income Database

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Calibration (2)

- Initial wealth distribution
  - $J = 100$, in order to match wealth percentiles from WID for the year 2014
  - $\frac{1}{J} W_j(0) = \mathcal{W}_j W(0)$, where $\mathcal{W}_j$ empirical wealth-share and $W(0)$ total wealth in the model
- TFP processes for $B^Y(t)$ and $B^X(t)$
  - Initial relative TFP, $\frac{B(0)^Y}{B(0)^X}$: match 1.4
    average 2003-2007, Moro and Nuño (2012)
  - Long-run relative TFP, $\frac{B^Y}{B^X}$: match average growth rate of 2 percent over first 30 years
    average 1977-2007, Moro and Nuño (2012)
  - Normalization: $B^Y(0) = 1$
  - Level of final TFP, B^Y: average annual per capita income growth rate of 2.2 percent

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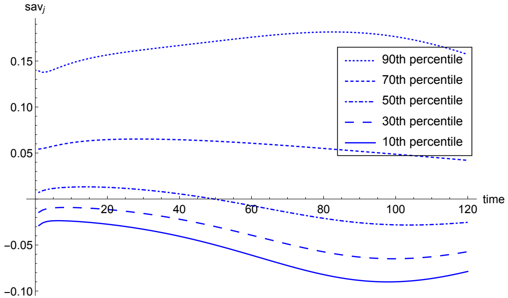
Evolution of saving rates for different percentiles



$$sav_j = 1 - \frac{\mu(W_j + \tilde{w}l_j)}{rW_j + wl_j} = \underbrace{\frac{(r-\mu)W_j}{rW_j + wl_j}}_{\text{capital income component}} + \underbrace{\frac{(w-\mu\tilde{w})l_j}{rW_j + wl_j}}_{\text{labor income component}}$$

$$\hat{W}_j = \left[\frac{(r-\mu)W_j}{rW_j + wl_j} + \frac{(w-\mu\tilde{w})l_j}{rW_j + wl_j}\right] \cdot \frac{rW_j + wl_j}{W_j} = \underbrace{r-\mu}_{\substack{\text{capital income}\\ \text{component}}} + \underbrace{\frac{(w-\mu\tilde{w})l_j}{W_j}}_{\substack{\text{labor income}\\ \text{component}}}$$

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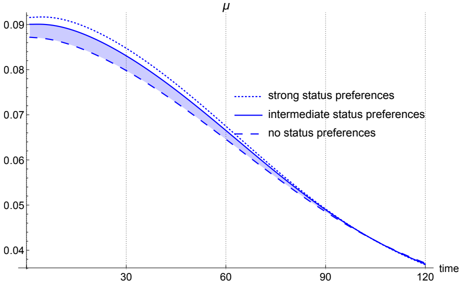
MPC for different degrees of status preferences



- Wealth divergence is more pronounced when μ is large: $\frac{\partial^2 \hat{W}_j}{\partial W_j \partial \mu} > 0$

$$\hat{W}_j = \left[\frac{(r-\mu)W_j}{rW_j+wl_j} + \frac{(w-\mu\tilde{w})l_j}{rW_j+wl_j}\right] \cdot \frac{rW_j+wl_j}{W_j} = \underbrace{r-\mu}_{\text{capital income component}} + \underbrace{\frac{(w-\mu\tilde{w})l_j}{W_j}}_{\text{labor income component}}$$

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Rental affordability crisis

The New York Times | https://nyti.ms/1jEQEDI

BUSINESS DAY

In Many Cities, Rent Is Rising Out of Reach of Middle Class

By SHAILA DEWAN APRIL 14, 2014

MIAMI — For rent and utilities to be considered affordable, they are supposed to take up no more than 30 percent of a household's income. But that goal is increasingly unattainable for middle-income families as a tightening market pushes up rents ever faster, outrunning modest rises in pay.

The strain is not limited to the usual high-cost cities like New York and San Francisco. An analysis for The New York Times by Zillow, the real estate website, found 90 cities where the median rent — not including utilities — was more than 30 percent of the median gross income.

In Chicago, rent as a percentage of income has risen to 31 percent, from a historical average of 21 percent. In New Orleans, it has more than doubled, to 35 percent from 14 percent. Zillow calculated the historical average using data from 1985 to 2000.

Nationally, half of all renters are now spending more than 30 percent of their income on housing, according to a comprehensive Harvard study, up from 38 percent of renters in 2000. In December, Housing Secretary Shaun Donovan declared "the worst rental affordability crisis that this country has ever known."

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