Das House Kapital

Brown Bag Seminar, University of St.Gallen

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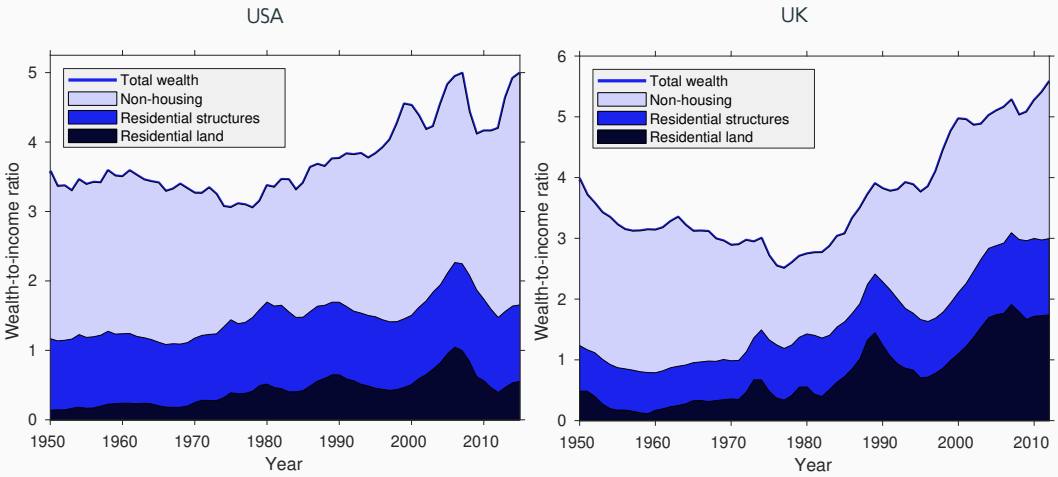
University of St.Gallen, Swiss Institute for Empirical Economic Research, Globalization of Real Estate Network

work in progress, preliminary results

Introduction

Housing became the largest asset class



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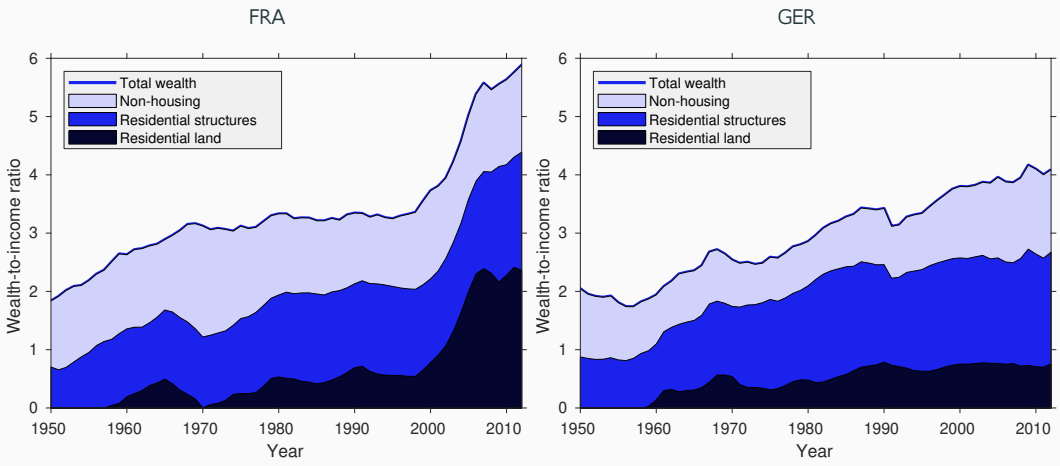

→ Economist (Special Report, 2020): How did housing become the largest asset class?

The paper in one slide

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- Some stylized facts can be explained in steady state, others not $\rightarrow$ transition
- Calibrated model replicates (overpredicts) increase in housing wealth to income ratio, in line with the stylized facts

Macroeconomic relevance of rising housing wealth-to-income ratio

- Increasing housing wealth-to-income ratios implies that average household pays a higher multiple of income to purchase a house (if # of houses per household remained largely constant)

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  $\rightarrow$ Rising wealth share has to be explained by rising housing wealth-to-income ratio $\frac{W^H}{NNP}$

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- Regional economics, urbanization, spatial modeling

Related literature

- Early literature: Ricardo (1817); Nichols (1970)
- Housing wealth, house and land prices: Davis and Heathcote (2007); Piketty and Zucman (2014); Rognlie (2015); Stiglitz (2015); Knoll, Schularick, and Steger (2016)
- Short run: Davis and Heathcote (2005); Hornstein (2009), Iacoviello, and Neri (2010); Favilukis et al. (2017); Piazzesi and Schneider (2016)
- Long run: Hansen and Prescott (2002); Borri and Reichlin (2018); Herkenhoff, Ohanian, and Prescott (2018); Miles and Sefton (2018); Bonnet et al. (2019)
- Declining labor income share: Karabarbounis and Neiman (2013); Piketty (2014); Rognlie (2015); Grossmann et al. (2017); Cette, Koehl, and Philippon (2019); Aghion et al. (2019); Gutierrez Gallardo and Piton (forthcoming)

Outline

1. Introduction
2. Facts
3. Model
4. Steady state
5. Transition
6. Discussion
7. Summary

Facts

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1. Wealth: Wealth-to-income ratio ↑, housing wealth-to-income ratio ↑↑
2. Prices: Real house price ↑↑, construction cost ↑, residential land prices ↑↑↑
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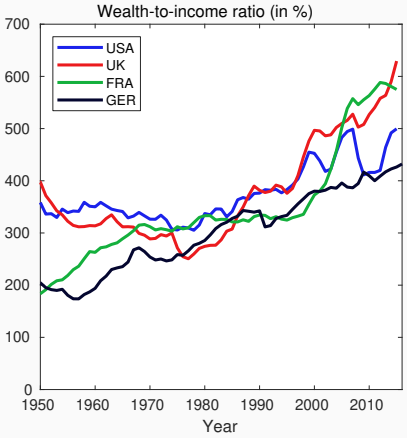

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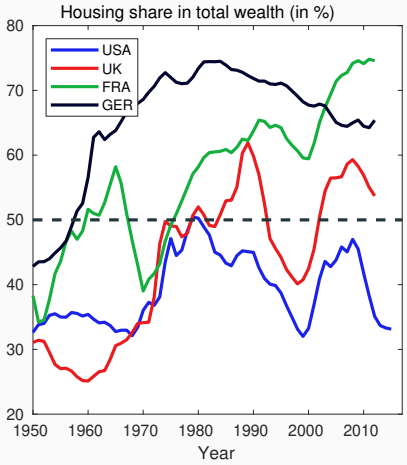

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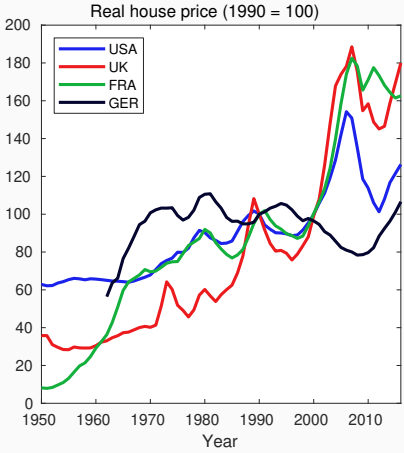

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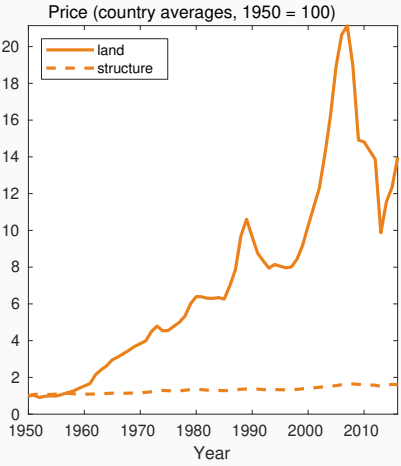

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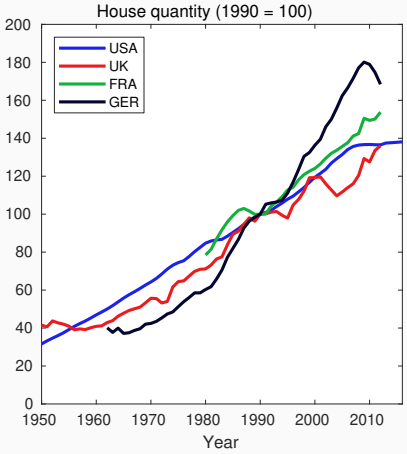

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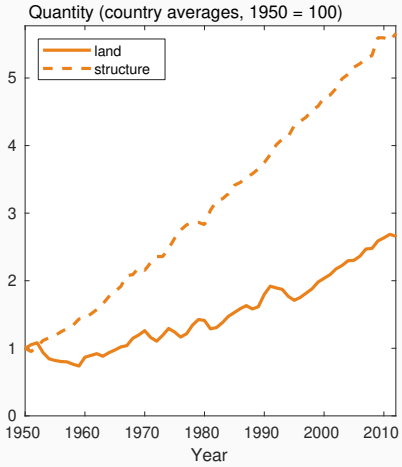

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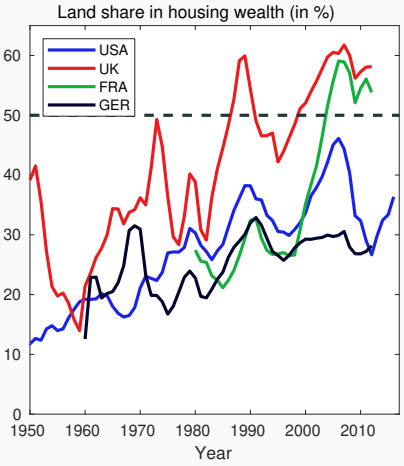

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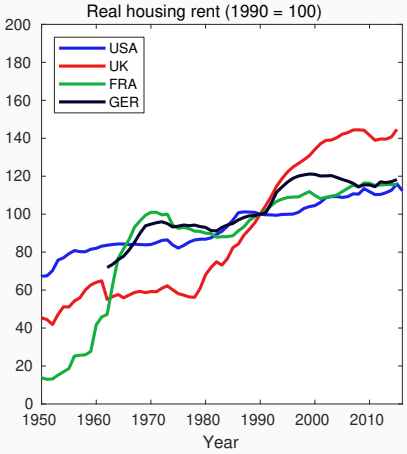

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Stylized facts: numbers

Fact #	Variable	US 1950–2015	UK 1950–2012	FR 1960–2012	DE 1962–2012
	wealth-to-income ratio	1.39	1.4	2.2	1.88
1	housing wealth-to-income ratio	1.42	2.4	3.2	1.93
	non-housing wealth-to-income ratio	1.38	0.9	1.2	1.79
	house price	1.9	4.0	6.0	1.6
2	residential land price	8.4	9.6	32.2	2.3
	residential structure price	1.2	2.1	1.1	1.4
	house quantity	4.4	3.3	2.2	4.2
3	residential land quantity	2.8	2.1	1.6	3.5
	residential structure quantity	5.5	4.3	6.3	4.3
4	land's share in housing wealth	2.8	1.5	3.8	1.2
5	housing rent	1.7	3.1	2.8	1.6

Model

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General model characteristics

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- Three stocks: capital K, residential structure X, fixed land Z (residential land N and non-residential land Z^Y)

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Specific characteristics (relative to literature)

- Fixed quantity of overall land & endogenous land allocation
- Three stocks: capital K, residential structure X, fixed land Z (residential land N and non-residential land Z^Y)
- Housing stock: two-dimensional object (reproducible X & non-reproducible N)

canonical model

Households

Representative household chooses $\{C_t\}_{t=0}^{\infty}$ and $\{S_t\}_{t=0}^{\infty}$ to maximize

$$U = \int_0^{\infty} e^{-\rho t} L_t \frac{\left[\left(\frac{C_t}{L_t}\right)^{1-\theta}\left(\frac{S_t}{L_t}\right)^{\theta}\right]^{1-\sigma} - 1}{1-\sigma} dt, \tag{1}$$

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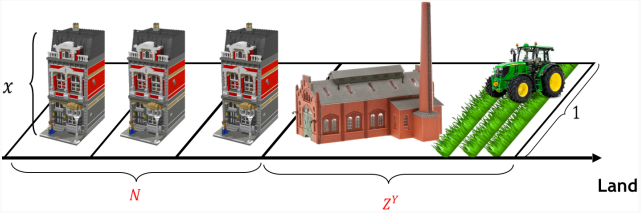
subject to

$$\dot{W}_t = r_t W_t + w_t L_t + \Pi_t^N - C_t - q_t S_t, \; W_0 = \textit{given}, \; \textit{NPGC}. \tag{2}$$

Notes: The measure of households is normalized to one. Each household consists of measure L_t members. Each household member supplies one unit of labor inelastically such that labor supply per household is L_t. Households maximize "the sum" of per-capita utility.

Production sectors



Numeraire sector

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

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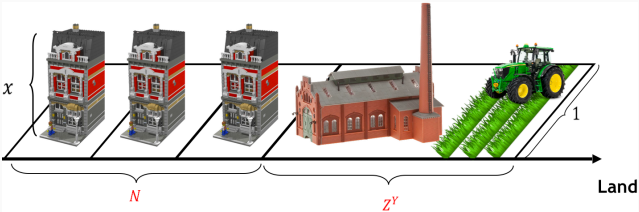

Housing sector

- Housing services supply: S

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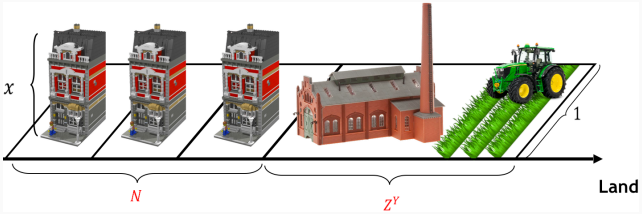

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- Real estate development: $\dot{N}$

extensive

$$Cost = P^Z \dot{N} + w \frac{\xi}{2} \left(\dot{N}\right)^2$$

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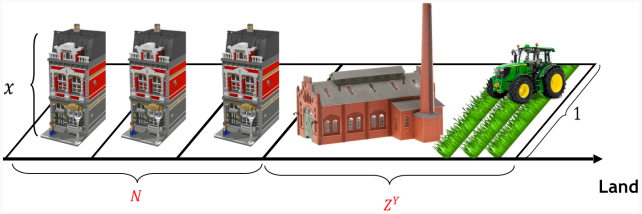

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$$Cost = P^Z \dot{N} + w \frac{\xi}{2} \left(\dot{N} \right)^2$$

- Construction: $\dot{X}$ intensive

$$\dot{X} = (M)^{\eta} \left(B^X L^X \right)^{1-\eta} - \delta^X X$$

Numeraire sector

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Y problem | S problem | N problem | X problem

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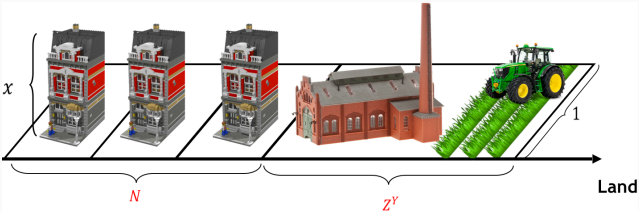

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Numeraire sector

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Resource constraints

- Labor: $L^Y + L^X + L^N = L$
- Land: $N + Z^Y = Z$

Y problem | S problem | N problem | X problem

Asset market

- Wealth consists of 4 assets

$$W = \underbrace{P^N N + P^X X}_{\text{housing wealth}} + \underbrace{P^Z Z^Y + K}_{\text{non-housing wealth}}$$

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- No-arbitrage conditions hold in equilibrium

$$r = \frac{\dot{P}^N}{P^N} + \frac{R^N}{P^N} = \frac{\dot{P}^X}{P^X} + \frac{R^X}{P^X} = \frac{\dot{P}^Z}{P^Z} + \frac{R^Z}{P^Z}$$

General equilibrium

A **general equilibrium** is a sequence of quantities and prices

$$\left\{ Y_t, K_t, X_t, N_t, M_t, L_t^Y, L_t^X, L_t^N, Z_t^Y, C_t, S_t, W_t, q_t, w_t, r_t, P_t^Z, P_t^N, P_t^X, R_t^Z, R_t^N, R_t^X \right\}_{t=0}^{\infty}$$

for initial conditions K_0, N_0, X_0 and given $\left\{ B_t^X, B_t^Y, L_t \right\}_{t=0}^{\infty}$ such that

i) households maximize eq. (1) subject to eq. (2)

ii) firms in construction sector, numeraire sector, real estate developers, and housing services producers maximize profits, taking prices as given

iii) labor market clears: $L_t^X + L_t^Y + L_t^N = L_t$

iv) land market clears: $N_t + Z_t^Y = Z$

v) asset markets clears: $W_t = K_t + P_t^N N_t + P_t^X X_t + P_t^Z Z_t^Y$

vi) perfect arbitrage across all assets holds

vii) market for housing services clears

viii) market for numeraire good clears: $Y_t = C_t + I_t^K + I_t^{Z^Y} + I_t^N + M_t$ redundant due to Walras' law

$I_t^{Z^Y} \equiv P_t^Z \dot{Z}_t^Y$, $I_t^N \equiv P_t^N \dot{N}_t + wL^N$

Steady state

Steady state growth rates: differential technological growth

Variables	Growth rate
r	0

Notes: Parameters g^Y and g^X denote growth rates of the technology variable in the numeraire sector, B^Y, and the technology variable in the construction sector, B^X, respectively. The house price is defined as a Laspeyres price index. Land share in housing wealth is defined as $\lambda_t \equiv \left(P_t^N N_t\right) / \left(P_t^N N_t + P_t^X X_t\right)$.

Details on g^Y–g^X–relation

Steady state growth rates: differential technological growth

Variables	Growth rate
r	0
$Y, K, M, w, R^Z, R^N, P^Z, P^N, C, NNP, W$	g^Y

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$P_t^H \equiv \frac{P_t^N N_0 + P_t^X X_0}{P_0^N N_0 + P_0^X X_0}$	$\lambda_t g^Y + (1-\lambda_t)(1-\eta)\left(g^Y - g^X\right)$

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Details on g^Y–g^X–relation

Stylized facts: steady state phenomena?

#	Stylized fact: explanation		Steady state?	Condition / comments
1	Wealth-to-income ratios	$\frac{P^H H + P^Z Z^Y + K}{NNP} \uparrow$ and $\frac{P^H H}{NNP} \uparrow$	no	wealth-to-income ratios constant in steady state

Notes: The expression g_x denotes the growth rate of an endogenous variable x.

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2	Prices	$g_{P^N}, g_{P^X}, g_{P^H} > 0$ $g_{P^N} > g_{P^H} > g_{P^X}$	yes	$g^Y > \max\{g^X, 0\}$ $g^X > -\frac{\eta}{1-\eta} g^Y$

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3	Quantities	$g_X > g_N \geq 0$	yes	$g^X > -\frac{\eta}{1-\eta} g^Y$
4	Land share	$\frac{P^N N}{P^N N + P^X X} \uparrow$	no	land share constant in steady state

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3	Quantities	$g_X > g_N \geq 0$	yes	$g^X > -\frac{\eta}{1-\eta} g^Y$
4	Land share	$\frac{P^N N}{P^N N + P^X X} \uparrow$	no	land share constant in steady state
5	Rents	$g_q > 0$	yes	$g^X < \frac{1-\eta\gamma}{(1-\eta)\gamma} g^Y$

Notes: The expression g_x denotes the growth rate of an endogenous variable x.

Transition

Research question: Why did housing wealth increase since 1950?

- To answer this question, we must study transitional dynamics

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- To answer this question, we must study transitional dynamics
- Can the calibrated model replicate the empirical data on housing wealth?
- And: Is this explanation compatible with observations on prices, quantities, and the other remaining stylized facts?

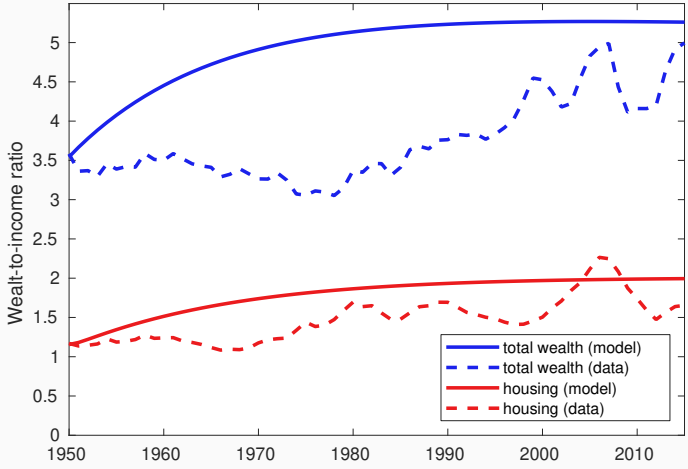
Calibration strategy

The model is calibrated to the US (and the UK) over 1950–2015 at an annual frequency

- We do not impose that the economy is in steady state
- Calibrated outside the model: θ, σ, δ^K, δ^X, β, and $\{L_t\}_{t=0}^{\infty}$
- Calibrated jointly inside the model: 10 parameters to match 10 moments

exogenous parameters | targeted moments | endogenous parameters

Stylized fact 1: housing wealth



Notes: Overall wealth-to-income and housing wealth-to-income ratio.

all variables housing rent and *r*

Wealth decomposition

$$\frac{\text{wealth}}{\text{income}} \uparrow$$

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$$\frac{\text{wealth}}{\text{income}} \uparrow = \frac{\text{housing wealth}}{\text{income}} \uparrow + \frac{\text{non-housing wealth}}{\text{income}}$$

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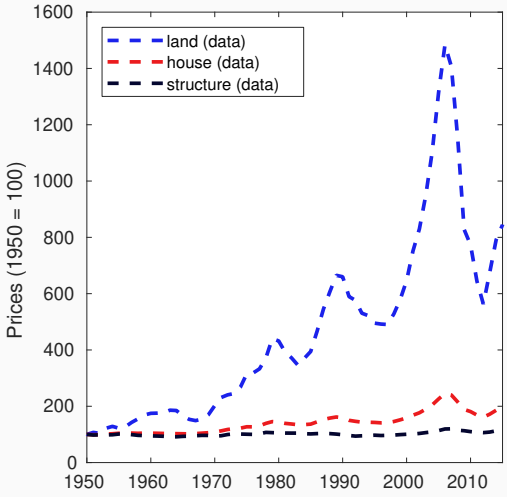
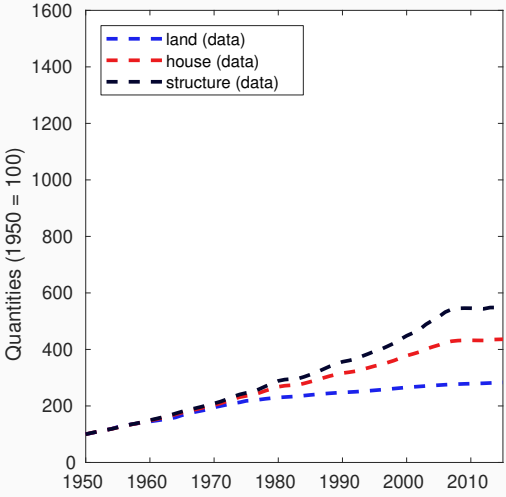
$$\frac{\text{housing wealth}}{\text{income}} = \frac{P^{\text{housing}} \uparrow \times Q^{\text{housing}}}{\text{income}} = \frac{P^{\text{structures}} \times Q^{\text{structures}}}{\text{income}} + \frac{P^{\text{land}} \uparrow \times Q^{\text{land}}}{\text{income}}$$

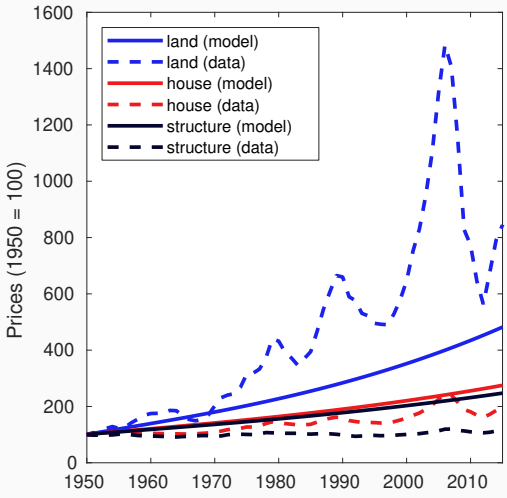
Notation: P is price, Q is quantity

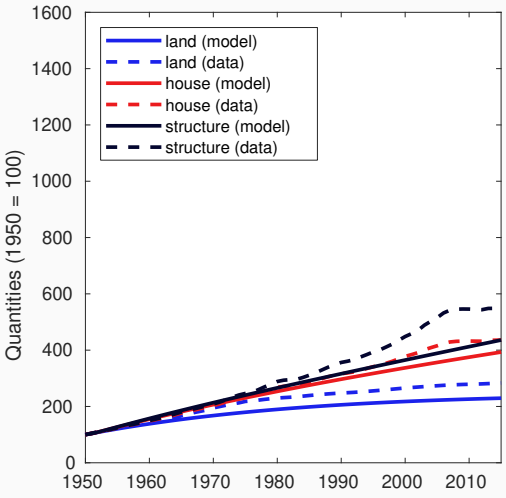
Prices & quantities - stylized facts 2 & 3





Prices & quantities - stylized facts 2 & 3





Other stylized facts and the relevant model elements

stylized fact	variable	data (US)	model (4) baseline
1	$\frac{W}{NNP}$	1.39	1.55
	$\frac{P^N N + P^X X}{NNP}$	1.42	1.80
2	P^H	1.93	2.75
	P^N	8.45	4.82
	P^X	1.16	2.47
3	N	2.80	2.29
	X	5.49	4.36
4	$\frac{P^N N}{P^N N + P^X X}$	2.84	1.02
5	q	1.70	**1.70**

Notes. All values are growth factors of the respective variable between 1950 and 2015. Bold numbers highlight targeted moments.

Other stylized facts and the relevant model elements

stylized fact	variable	data (US)	model (1) Ramsey
1	$\frac{W}{NNP}$	1.39	1.24
	$\frac{P^N N + P^X X}{NNP}$	1.42	–
2	P^H	1.93	–
	P^N	8.45	–
	P^X	1.16	–
3	N	2.80	–
	X	5.49	–
4	$\frac{P^N N}{P^N N + P^X X}$	2.84	–
5	q	1.70	–

Notes. All values are growth factors of the respective variable between 1950 and 2015. Bold numbers highlight targeted moments.

Other stylized facts and the relevant model elements

stylized fact	variable	data (US)	model (1) Ramsey	model (2) + exog. X & N
1	$\frac{W}{NNP}$	1.39	1.24	1.22
	$\frac{P^N N + P^X X}{NNP}$	1.42	–	1.14
2	P^H	1.93	–	6.85
	P^N	8.45	–	6.84
	P^X	1.16	–	6.86
3	N	2.80	–	1.00
	X	5.49	–	1.00
4	$\frac{P^N N}{P^N N + P^X X}$	2.84	–	1.00
5	q	1.70	–	6.48

Notes. All values are growth factors of the respective variable between 1950 and 2015. Bold numbers highlight targeted moments.

Other stylized facts and the relevant model elements

stylized fact	variable	data (US)	model (1) Ramsey	model (2) + exog. X & N	model (3) + endog. X
1	$\frac{W}{NP}$	1.39	1.24	1.22	4.91
	$\frac{P^N N + P^X X}{NP}$	1.42	–	1.14	10.44
2	P^H	1.93	–	6.85	57.18
	P^N	8.45	–	6.84	496.83
	P^X	1.16	–	6.86	1.89
3	N	2.80	–	1.00	1.00
	X	5.49	–	1.00	4.25
4	$\frac{P^N N}{P^N N + P^X X}$	2.84	–	1.00	7.93
5	q	1.70	–	6.48	**1.70**

Notes. All values are growth factors of the respective variable between 1950 and 2015. Bold numbers highlight targeted moments.

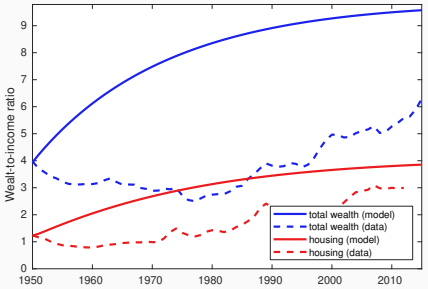
Other stylized facts and the relevant model elements

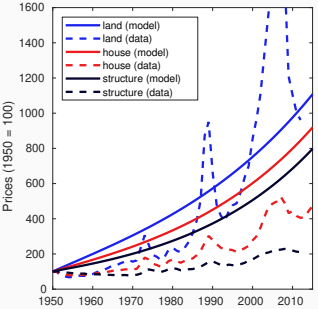
stylized fact	variable	data (US)	model (1) Ramsey	model (2) + exog. X & N	model (3) + endog. X	model (4) baseline
1	$\frac{W}{NP}$	1.39	1.24	1.22	4.91	1.55
	$\frac{P^N N + P^X X}{NP}$	1.42	–	1.14	10.44	1.80
2	P^H	1.93	–	6.85	57.18	2.75
	P^N	8.45	–	6.84	496.83	4.82
	P^X	1.16	–	6.86	1.89	2.47
3	N	2.80	–	1.00	1.00	2.29
	X	5.49	–	1.00	4.25	4.36
4	$\frac{P^N N}{P^N N + P^X X}$	2.84	–	1.00	7.93	1.02
5	q	1.70	–	6.48	**1.70**	**1.70**

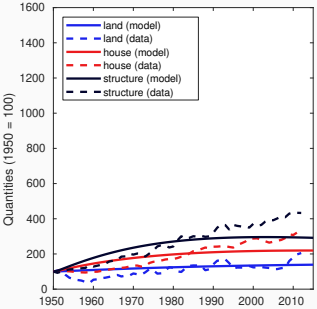
Notes. All values are growth factors of the respective variable between 1950 and 2015. Bold numbers highlight targeted moments.

UK

... same results







Discussion

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The model underestimates the surge in the land share in housing. What's missing?

- CES in housing services production: N and X being weak substitutes
  $\rightarrow$ preliminary results on next slide
- Zoning regulation: supply of residential land, constraining N
- Urbanization: supply of residential land, constraining N
- Homeownership "revolution" and great mortgaging: demand for housing services, θ, increases

Extension: CES in $S = f(N, X)$ (US)

stylized fact	variable	data (US)	model (4) baseline	model (5) $g^X = -\frac{\eta}{1-\eta} g^Y$
1	$\frac{W}{NNP}$	1.39	1.55	1.70
	$\frac{P^N N + P^X X}{NNP}$	1.42	1.80	2.01
2	P^H	1.93	2.75	3.37
	P^N	8.45	4.82	5.56
	P^X	1.16	2.47	3.07
3	N	2.80	2.29	2.08
	X	5.49	4.36	3.94
4	$\frac{P^N N}{P^N N + P^X X}$	2.84	1.02	0.96
5	q	1.70	**1.70**	1.93

Notes. All values are growth factors of the respective variable between 1950 and 2015. Bold numbers highlight targeted moments. Model (5) is re-calibrated while model (6) applies the same parameters from (5) except the elasticity of substitution between N and X in the production function of S.

Extension: CES in $S = f(N, X)$ (US)

stylized fact	variable	data (US)	model (4) baseline	model (5) $g^X = -\frac{\eta}{1-\eta} g^Y$	model (6) $EoS = 0.25$
1	$\frac{W}{NNP}$	1.39	1.55	1.70	1.97
	$\frac{P^N N + P^X X}{NNP}$	1.42	1.80	2.01	2.58
2	P^H	1.93	2.75	3.37	6.42
	P^N	8.45	4.82	5.56	8.45
	P^X	1.16	2.47	3.07	2.79
3	N	2.80	2.29	2.08	1.97
	X	5.49	4.36	3.94	4.84
4	$\frac{P^N N}{P^N N + P^X X}$	2.84	1.02	0.96	1.07
5	q	1.70	**1.70**	1.93	2.58

Notes. All values are growth factors of the respective variable between 1950 and 2015. Bold numbers highlight targeted moments. Model (5) is re-calibrated while model (6) applies the same parameters from (5) except the elasticity of substitution between N and X in the production function of S.

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  - Two mechanism, in a growing economy, push the rent and the house price up: i) housing uses the fixed factor intensively and ii) differential technological change

Summary

- Our explanation for the long term increase in housing wealth rests on fundamental principles
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  - Housing wealth comprises a reproducible component & a non-reproducible component
- Main takeaways
  - Our theory offers a candidate explanation for rising housing wealth and the other stylized facts on housing & macro
  - Two mechanism, in a growing economy, push the rent and the house price up: i) housing uses the fixed factor intensively and ii) differential technological change
  - The resulting surge in housing wealth manifests itself primarily as an increase of the residential land price (non-reproducible component of housing wealth)

Appendix

Firm problem: numeraire

Mass one of identical firms that act under perfect competition and maximize

$$\max_{K,L^Y,Z^Y} (K)^{\alpha} \left(B^Y L^Y\right)^{\beta} \left(B^Y Z^Y\right)^{1-\alpha-\beta} - wL^Y - (r+\delta^K)K - R^Z Z^Y$$

FOC

$$r = \alpha \frac{Y}{K} - \delta^K, \qquad w = \beta \frac{Y}{L^Y}, \quad \text{and} \quad R^Z = (1-\alpha-\beta)\frac{Y}{Z^Y}$$

Aggregate capital stock evolves according to

$$\dot{K}_t = I_t^K - \delta^K K_t$$

back

Firm problem: housing services

Mass one of identical firms that act under perfect competition and maximize

$$\max_{X,N} q \underbrace{X^{\gamma} N^{1-\gamma}}_{=S} - (R^X + \delta^X P^X) X - R^N N$$

FOC

$$R^X = \gamma \frac{qS}{X} - \delta^X P^X, \quad \text{and} \quad R^N = (1-\gamma)\frac{qS}{N}$$

back

Firm problem: real estate development (I/II)

Mass one of identical firms take prices as given and face the production function

$$\dot{N} = f(Z^N, L^N) = \begin{cases} \min\left\{Z^N, \sqrt{\frac{2}{\xi} L^N}\right\} & \text{if } Z^N \geq 0 \\ \max\left\{Z^N, -\sqrt{\frac{2}{\xi} L^N}\right\} & \text{if } Z^N < 0 \end{cases}$$

Cost minimization

$$\min_{Z^N, L^N} P^Z Z^N + w L^N$$

subject to

$$f(Z^N, L^N) = \overline{\dot{N}}$$

yields the cost function

$$\mathcal{C}(\dot{N}; P^Z, w) = P^Z \dot{N} + \frac{\xi w}{2} \left(\dot{N}\right)^2$$

Firm problem: real estate development (II/II)

Profit maximization

$$\max_{\dot{N}} P^N \dot{N} - \mathcal{C}(\dot{N}; P^N, P^Z, w)$$

FOC

$$\dot{N} = Z^N = \frac{P^N - P^Z}{\xi w} \quad \text{and} \quad L^N = \frac{\left(P^N - P^Z\right)^2}{2\xi w^2}$$

Profits

$$\Pi^N = \frac{(P^N - P^Z)^2}{2\xi w} = wL^N$$

back

Firm problem: construction sector

Mass one of identical firms that act under perfect competition and maximize

$$\max_{M,L^X} P^X \underbrace{M^\eta \left(B^X L^X\right)^{1-\eta}}_{=I^X} - M - wL^X$$

FOC (interior solution)

$$w = (1-\eta)\frac{P^X I^X}{L^X} \quad \text{and} \quad 1 = \eta \frac{P^X I^X}{M}$$

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Canonical model

- Merits & features
  - Suitable for business cycle phenomena
  - Limited land scarcity
  - No land rivalry
  - Long-run inconsistency: replacement investment require land: $\int_0^\infty \bar{Z} dt = \infty$!

Davis and Heathcote (2005), Hornstein (2009), Iacoviello and Neri (2010), Favilukis, Ludvigson and Van Nieuwerburgh (2017), Borri and Reichlin (2018), ...

Canonical model (cont')

Numeraire good	$Y_t = B_t^Y (K_t^Y)^\alpha (L_t^Y)^{1-\alpha}$	non-residential rent missing
Construction	$X_t = B_t^X (K_t^X)^\gamma (L_t^X)^{1-\gamma}$	intermediate input
Housing services	$\underbrace{B_t^H X_t^\beta \bar{Z}^{1-\beta}}_{\text{gross investment}} = \underbrace{\dot{H}_t}_{\text{net investment}} + \underbrace{\delta^H H_t}_{\text{replacement investment}}$	$\bar{Z}$ is (time-invariant) flow variable
Housing market clearing	$S_t = q_t H_t$	housing consumption
Capital market clearing	$K_t^X + K_t^X = K_t$	
Labor market clearing	$L_t^X + L_t^Y = L_t$	

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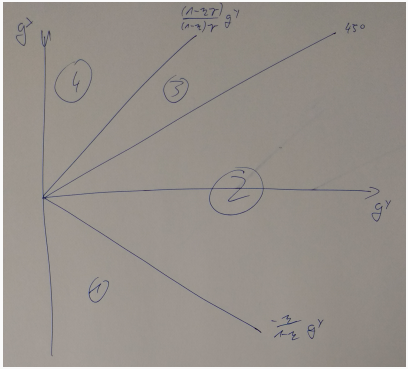
Relation of g^X and g^Y and steady state growth rates

- If $g^X = -\frac{\eta}{1-\eta} g^Y$, then X, I^X, and S are constant while R^X, P^X, and q all grow at the rate g^Y
- If $g^Y = g^X$, then X, I^X grow at the rate g^Y, while R^X, P^X are constant and rents grow at $(1-\gamma)g^Y$ and S at $\gamma g^Y \rightarrow$ large spread in growth rates of P^N (g^Y) and P^X (0)
- Region 1: X, I^X, S decline ↯
- Region 2: no variable declining in the long run
- Region 3: P^X, R^X decline ↯
- Region 4: P^X, R^X, q decline ↯



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Calibrated outside of the model (US)

Parameter	Value	Explanation/Target
θ	0.19	housing expenditure share
σ	$10/3$	intertemporal elasticity of substitution
δ^K	$\ln(1+0.056)$	capital depreciation rate
δ^X	$\ln(1+0.015)$	structure depreciation rate
β	0.613	labor income share in Y sector
$\{L_t\}_{t=0}^{\infty}$	logistic difference equation	population dynamics

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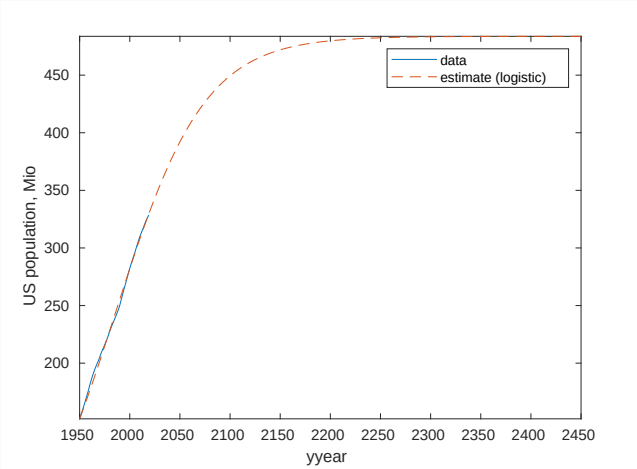
Population dynamics



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Endogenously calibrated parameters (US)

#	Parameter	Explanation	Value
1	ρ	time preference rate	0.040
2	K_0/K	initial capital stock (share of final)	0.227
3	γ	structure's elasticity in S	0.906
4	η	materials elasticity in I^X	0.556
5	X_0/X	initial stock of residential structures (share of final)	0.191
6	α	capital elasticity in Y	0.275
7	g^Y	technical growth in numeraire sector	0.017
8	g^X	technical growth in construction sector	-0.014
9	ξ	intensity of convex adjustment cost in residential land development	759.06
10	N_0/N	initial stock of residential land	0.403

Notes: Initial states, K_0, N_0, X_0, are expressed relative to their respective final steady state values (normalized).

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Targeted moments (US)

#	Moment	Data	Model	rel difference in %
1	$\frac{W}{NNP}$, 1950	3.6	3.6	0.000
2	$\frac{P^N N + P^X X}{W}$, 1950	32.6	32.6	0.000
3	$\frac{P^N N}{P^N N + P^X X}$, 1950	11.8	11.8	0.000
4	long-run $\frac{L^X + L^N}{L}$	2.5	2.5	0.000
5	$\frac{RESI}{GDP}$, 1950	5.6	5.6	0.000
6	$\frac{R^Z Z^Y}{NNP}$, 1950	10.0	10.0	0.001
7	$\frac{NNP_{2015}}{NNP_{1950}}$	6.0	6.0	0.000
8	$\frac{q_{2015}}{q_{1953}}$	1.7	1.7	0.000
9	Half-life of N (years)	22.6	22.6	0.001
10	$\frac{X_{2015}/N_{2015}}{X_{1950}/N_{1950}}$	2.8	2.8	0.000

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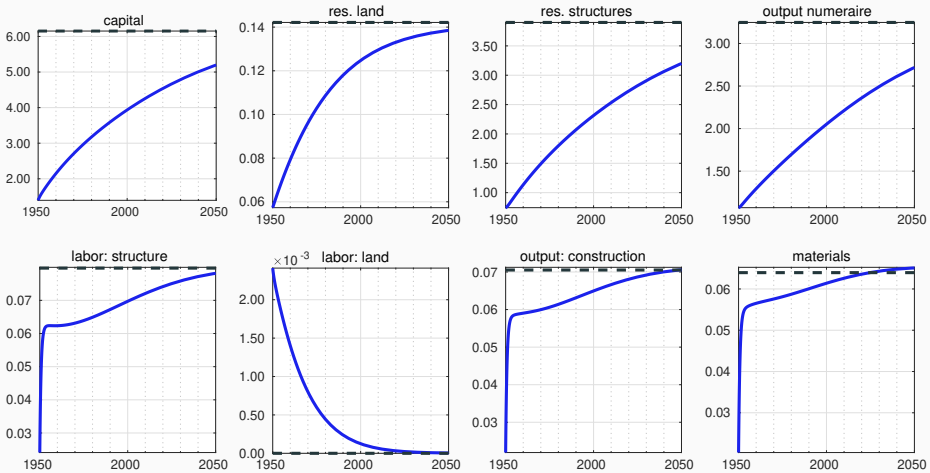
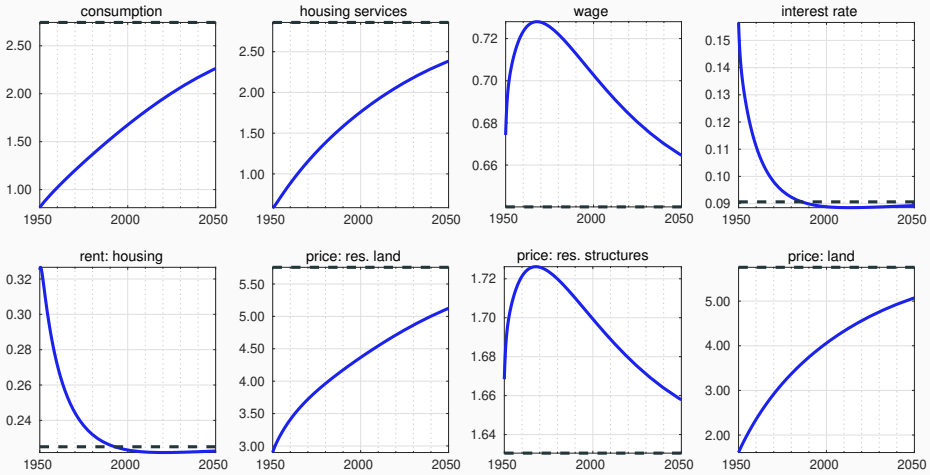
Transition (I/III)



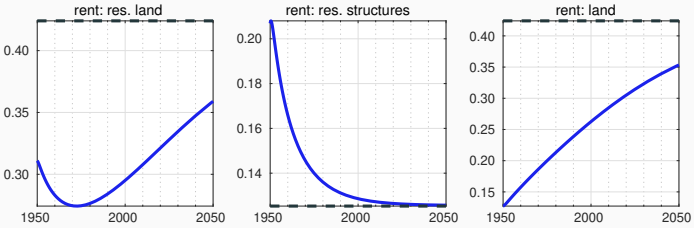
Notes: All variables are normalized.

Transition (II/III)



Notes: All variables are normalized.

Transition (III/III)



Notes: All variables are normalized.

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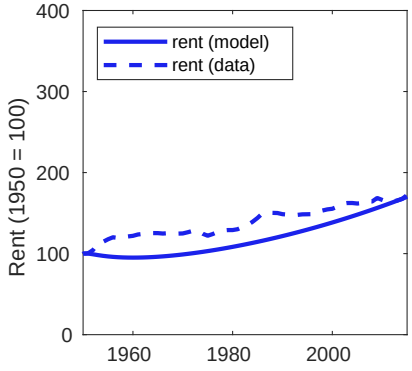
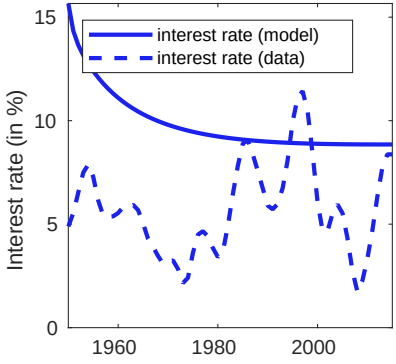
Housing rents and interest rates





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