HOW SHOULD MONETARY POLICY RESPOND TO HOUSING INFLATION?

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Federal Reserve Bank of Minneapolis

Bank of Italy Research Conference

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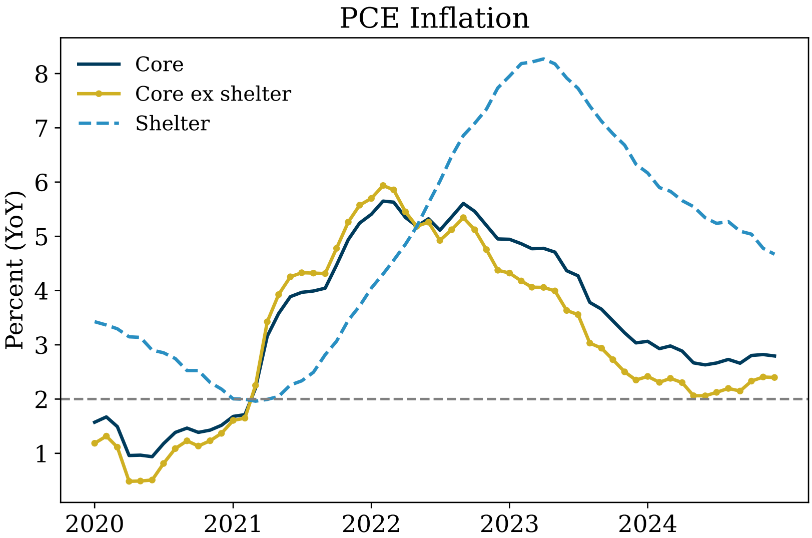
Shelter Inflation Has Kept Inflation High



Optimal Monetary Policy in Multi-Sector Models

- Larger welfare costs of π in sectors with more rigid prices and less elastic supply

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    - More rigid $\Rightarrow$ larger response in demand
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- Rents are sticky & housing supply is highly inelastic

$\Rightarrow$ Monetary policy should respond aggressively to shelter inflation

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- Broader point— 3 considerations: (i) price rigidity; (ii) supply elasticity; (iii) rationing mechanism

Rationing Mechanisms

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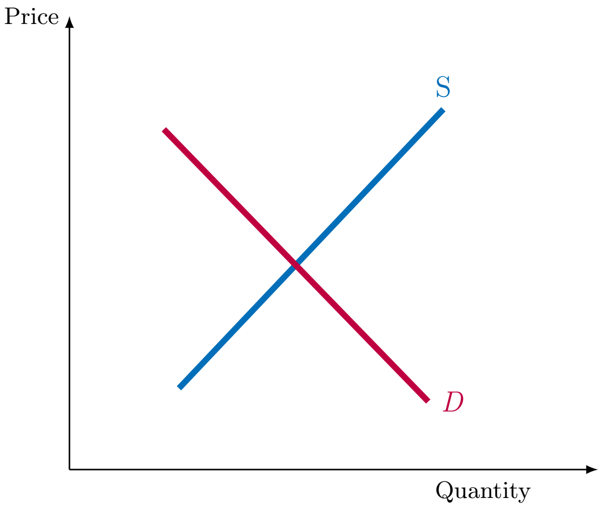

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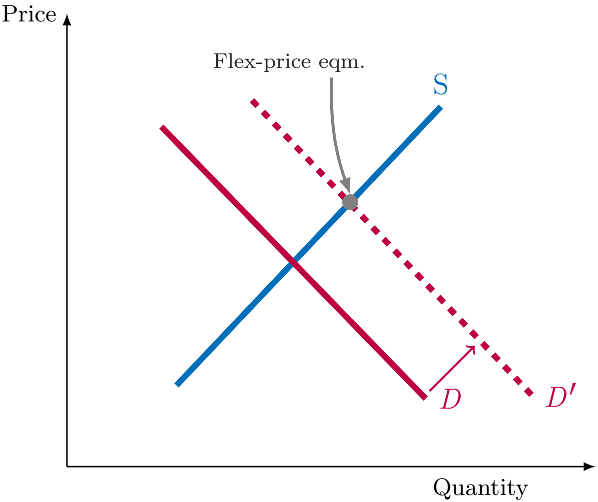

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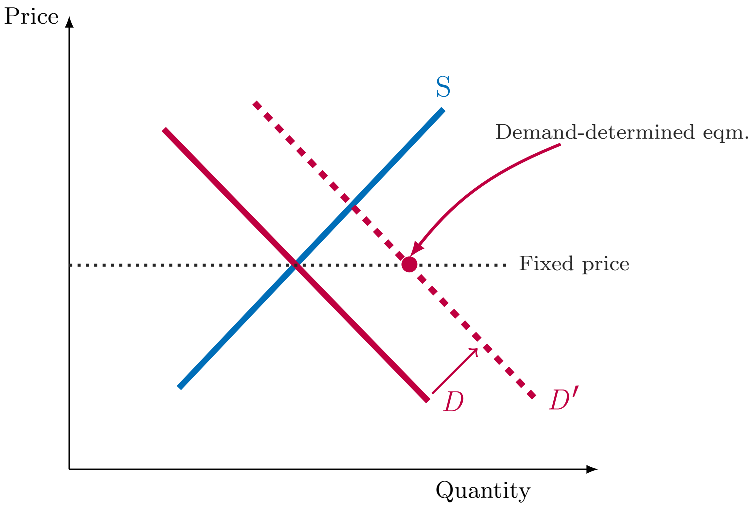

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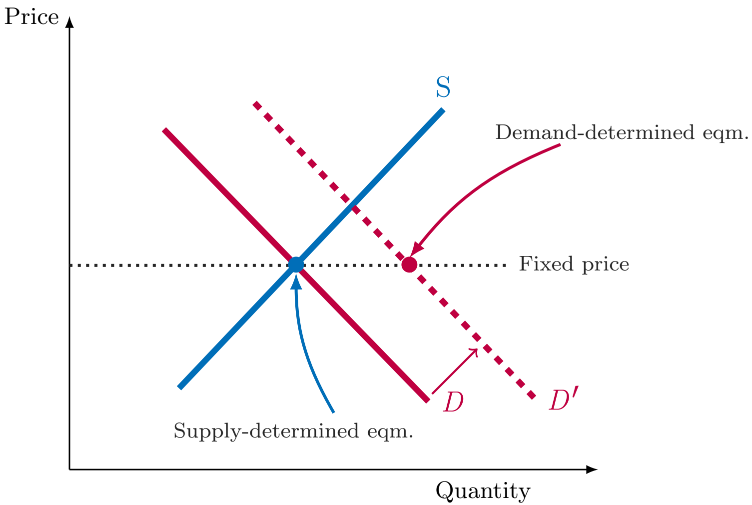

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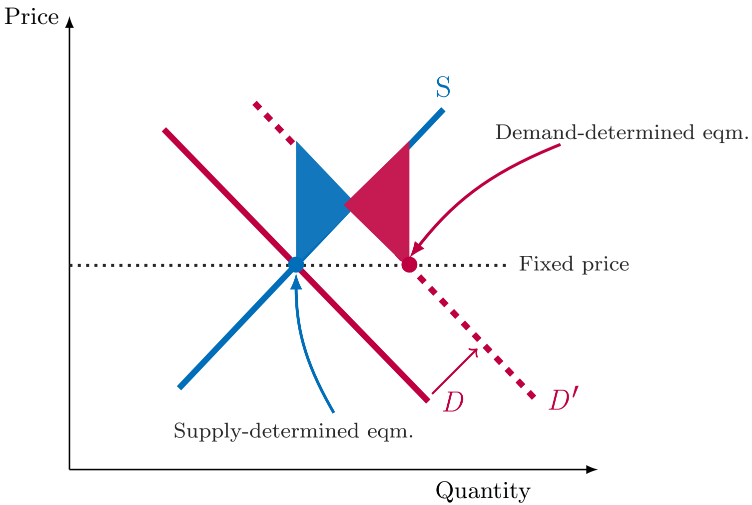

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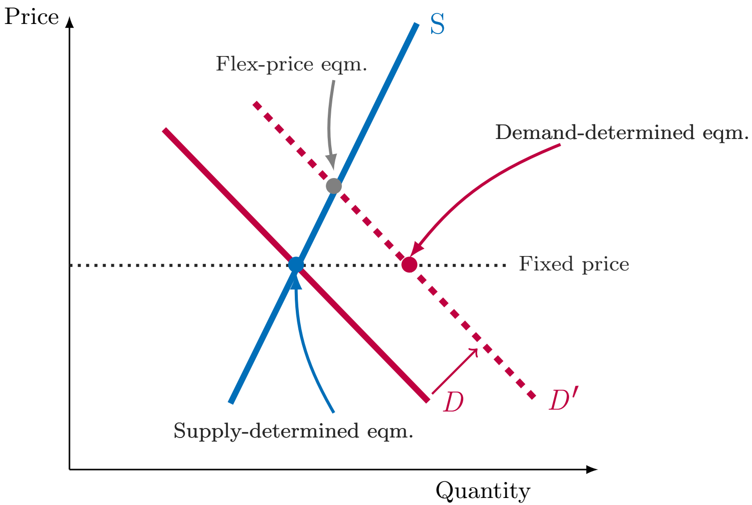

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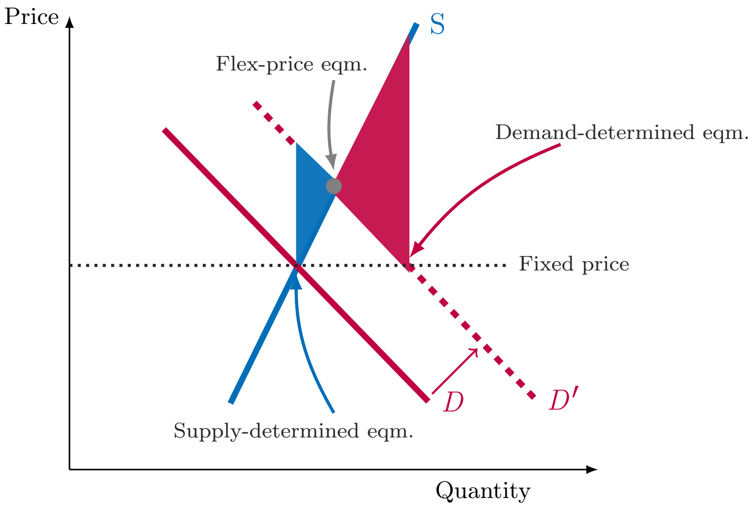

Roadmap

1. Static model: (Barro and Grossman, 1971; Michaillat and Saez, 2015)
   - Prices of goods and rents fixed:
     - Goods: output is demand-determined
     - Housing: disequilibrium resolved via search

mimics supply-determined

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   - Prices of goods and rents fixed:
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       mimics supply-determined
2. Dynamic quantitative model:
   - Staggered pricing for goods and rentals
   - Compare optimal policy, CPI targeting, and goods-price targeting

Outline for Presentation

1. **Static model**

2. Quantitative model

   – Dynamic model and calibration

   – Results

- Rep. household with preferences:

$$U = (1-\omega)\log(c) + \omega\log(h) + (1-\omega)[\varphi\log(m) - (\ell + \rho s)]$$

- c = consumption "goods"
- h = housing services
- m = real money balances
- ℓ = labor supply
- s = search effort
- ρ = cost of search

- Rep. household with preferences:

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- Nominal budget constraint:

$$Rh + Pc + M \leq W\ell + d + T$$

- R = nominal rent
- P = price of goods
- M = money holdings
- W = nominal wage
- d = nominal dividends
- T = tax or transfer

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- Search for housing:

$$h = sf(\Theta)$$

f satisfies $f' < 0$, $\lim_{\Theta\to\infty} f(\Theta) = 0$

- Θ = market tightness

Household Optimality Conditions

- Housing:

$$\frac{\omega}{h} = \frac{1-\omega}{c}\frac{R}{P} + \frac{\rho(1-\omega)}{f(\Theta)}$$

- Labor supply:

$$\frac{W}{P}\frac{1}{c} = 1$$

- Money demand:

$$\frac{M}{P} \equiv m = \varphi c$$

Firms and Landlords

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- Rents fixed at $R = \bar{R}$
- Market tightness: $\Theta = s/\bar{h}$
- Housing utilization rate $h = g(\Theta)\bar{h}$ where $g(\Theta) = f(\Theta)\Theta$ [CRS matching function]

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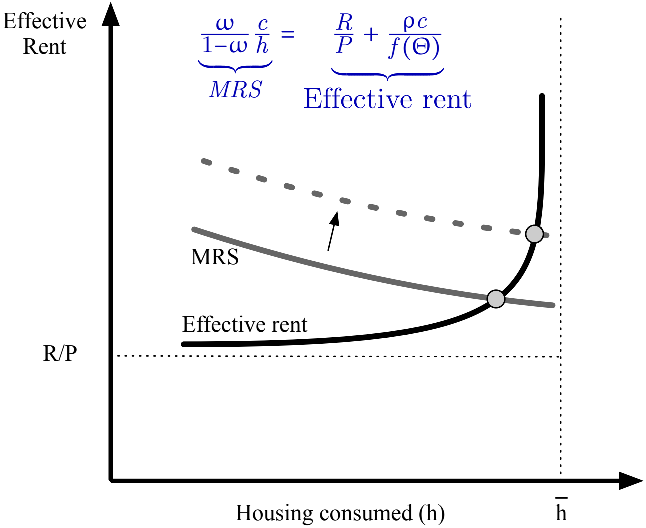
- Total profits: $d = zl - Wl + Rg(\Theta)\bar{h}$

Government

- The government injects the money supply via transfers
- Government budget $M = T$

Equilibrium in the Housing Market



Constrained Efficient Allocation

- Planner directly chooses allocation subject to technology and search frictions:

$$\max_{c,s} \left\{ (1-\omega)\log(c) + \omega \log\left(sf\left(\frac{s}{\bar{h}}\right)\right) - (1-\omega)\left[\left(\frac{c}{z} + \rho s\right)\right]\right\}.$$

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- Optimality conditions:

$$c = z$$

$$\frac{\omega}{h}\left(1 + \frac{f'(\Theta)\Theta}{f(\Theta)}\right) = \frac{\rho(1-\omega)}{f(\Theta)}$$

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- Even flex-price outcome is not necessarily constrained efficient e.g. Hosios (1990)
- Efficient search if $\frac{R}{P} = -\frac{f'(\Theta)\Theta}{f(\Theta)}\frac{\omega}{1-\omega}\frac{c}{h}$

Optimal Monetary Policy

- Choose M to maximize welfare in competitive eq'm with fixed prices

$$\max_{c,s,M} \left\{ (1-\omega)\log(c) + \omega \log\left(sf\left(s/\bar{h}\right)\right) - (1-\omega)\left[\left(\frac{c}{z} + \rho s\right)\right]\right\}$$

subject to

$$\text{Private-sector } s \text{ choice: } \frac{\omega}{sf\left(s/\bar{h}\right)} = \frac{1-\omega}{c}\frac{R}{P} + (1-\omega)\frac{\rho}{f\left(s/\bar{h}\right)}$$

$$\text{Private-sector } c \text{ choice: } c = \left(\frac{1}{\varphi}\right)\frac{M}{\bar{P}}$$

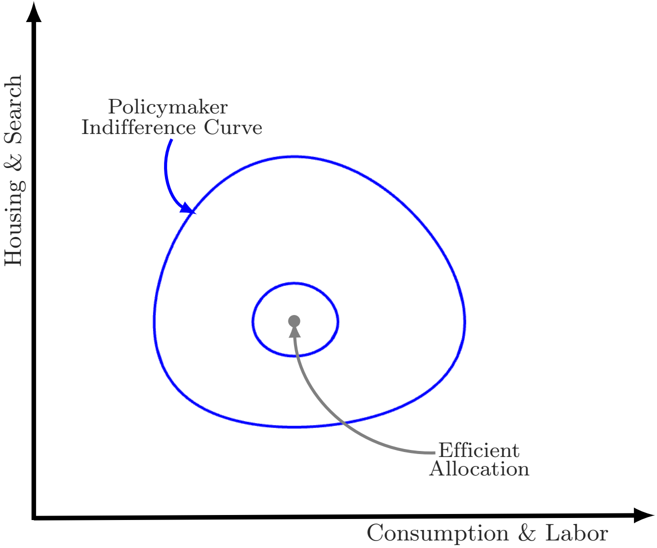
Optimal Monetary Policy

- Targeting rule for optimal policy

$$\underbrace{\rho\frac{1-\omega}{f(\Theta)} - \frac{\omega}{h}\left(1 + \frac{f'(\Theta)\Theta}{f(\Theta)}\right)}_{\text{Housing gap}} = [\text{term} < 0] \times \underbrace{(c - z)}_{\text{Output gap}}$$

$\Rightarrow$ If housing market is tight, then goods market is slack

Tradeoffs for Monetary Policy



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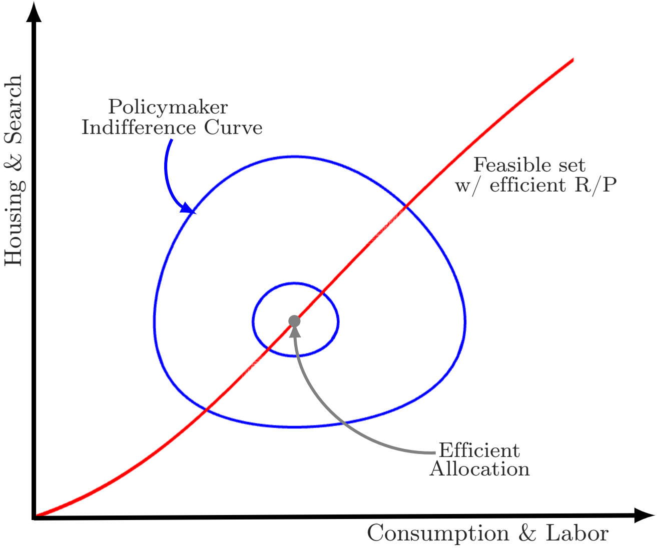

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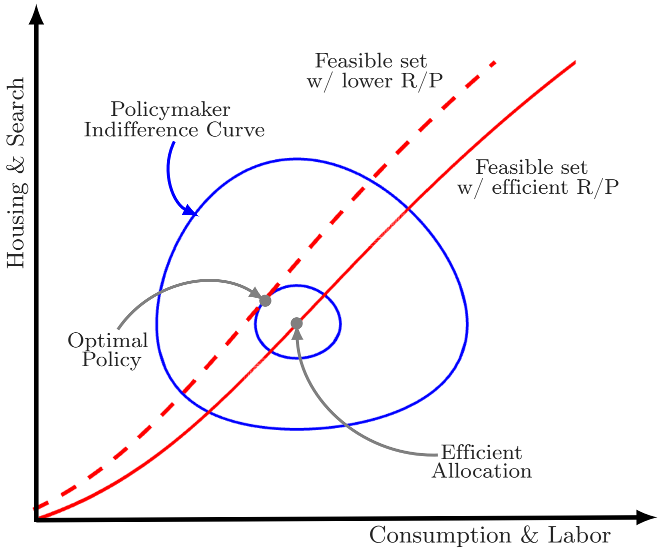
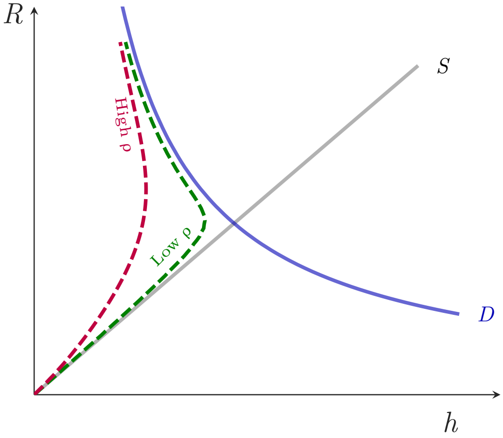


Short-Side Rule

- Allow for housing production for elastic supply
- Notional demand and supply:

$$h_d = \frac{\omega}{1-\omega}\left(\bar{R}/\bar{P}\right)^{-1} c$$
$$h_s = \bar{h}^{\frac{1}{1-\phi}}\left(\phi\bar{R}/\bar{P}\right)^{\frac{\phi}{1-\phi}}$$



Short-Side Rule

Result

Consider a given monetary policy M and let h_d and h_s be the allocation of housing under a demand-determined and supply-determined allocations without search cost. Let h_ρ be the equilibrium allocation with search frictions in housing. Then $h_\rho \leq \min(h_d, h_s)$ and $\lim_{\rho \to 0} h_\rho = \min(h_d, h_s)$.

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Environment

- Preferences:

$$\sum_{t=0}^{\infty} \beta^{t} \left\{ (1 - \omega_t) \log c_t + \omega_t \log \left(h^{o} + h_{t+1} \right) - \psi (1 - \omega_t) \left(\ell_t + s_t \right) \right\},$$

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- Search

$$h_{t+1} = (1-\delta) h_t + f(\Theta_t) s_t$$

$$\Theta_t \equiv s_t / [\bar{h} - (1-\delta) h_t]$$

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- NK production of goods:

$$c_t = \left(\int_0^1 y_{jt}^{\frac{\eta-1}{\eta}}\, dj\right)^{\frac{\eta}{\eta-1}}$$

$$y_{jt} = z\ell_{jt} \qquad \forall$$

Price Setting

- Intermediate goods producers face Calvo friction
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- Rent for new and renegotiated match adjusts gradually. Combination of:
  - Nash bargained rent r_t^* (with weight $1-\chi$)

    and
  - Average outstanding rent $\bar{r}_t$ (with weight χ)

Nominal Rigidities and Policy Tradeoffs

Result

The decentralized equilibrium coincides with the constrained efficient allocation if

1. Bargaining power = matching function elasticity (Hosios)
2. $\chi = 0$ (rents fully determined by Nash bargaining)
3. No price dispersion across intermediate goods
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$\Rightarrow$ $\chi > 0$ is only reason to depart from $\pi^{\text{goods}} = 0$

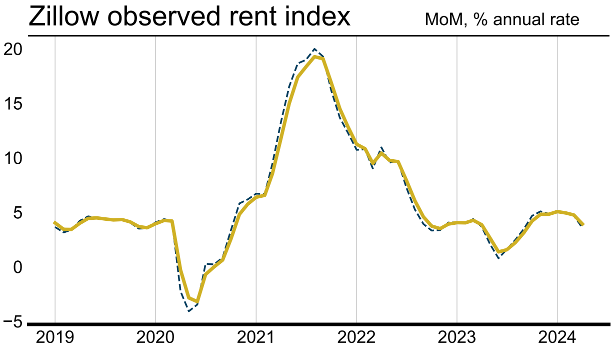
Estimating χ

State space model:

- CPI-shelter = average rent (Δ 6m)
- Zillow rent = Nash rent
- BLS NTR = typical new rent

- All series observed with measurement error
- Estimate by ML
- $\chi = 0.52$

Estimating χ



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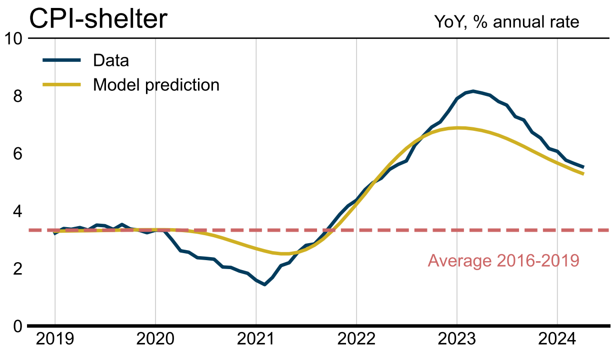

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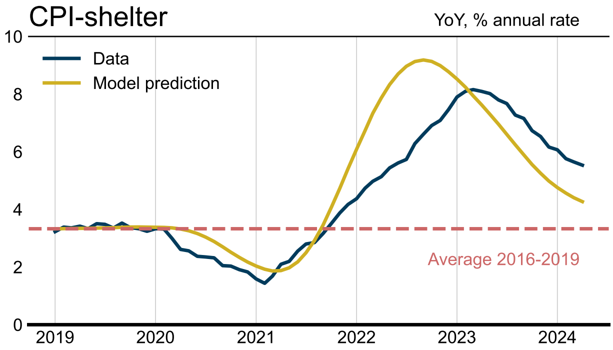

Counterfactual with $\chi = 0$

Roles of δ, ξ, and h^o

- δ and ξ play a role in that they affect estimation of χ
  - Lower values induce longer periods of fixed rents within a match
  - Average rents become more inertial even with $\chi = 0$

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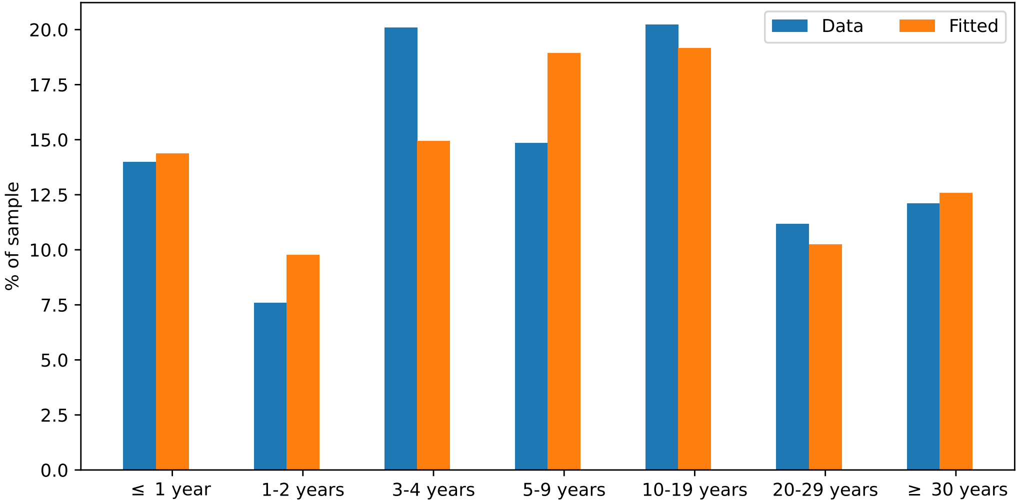
- δ and h^o determine how many people search before the rent adjusts
- ξ set so leases turnover after one year (on average)
- δ estimated from American Community Survey → "how long have you lived here?"
  - Assume two types: low- and high-δ
  - Find 29% have high-$\delta = 0.035$, remainder have low-$\delta = 0.005$

How Long Have You Lived Here? (ACS)



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- Resources used in housing sector are the scope for misallocation
- Use tenant bargaining power to target search effort
  - High bargaining power $\Rightarrow$ low rents relative to MRS $\Rightarrow$ lots of search
- Empirical target: share of output devoted to brokers' commissions (1.2% $\times$ PCE)
  - Conservative: nominal rigidities in rents can distort the whole real estate sector
- Resources used in real estate are small relative to housing budget share (15%)

Finishing Calibration

- Use Cobb-Douglas matching function and set elasticity based on Hosios condition
- Calvo friction: 8.3 month median price duration Klenow-Malin (2010)

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Experiments, policies, and computation

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  1. CPI inflation targeting $\pi^{\text{CPI}} = 0$
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  3. Optimal policy

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  1. CPI inflation targeting $\pi^{\text{CPI}} = 0$
  2. Goods inflation targeting $\pi^{\text{goods}} = 0$
  3. Optimal policy
     - Optimal nonlinear perfect-foresight transition path
     - Stack transition paths in x $(nT \times 1)$
     - $f(x) = 0 \quad (n-1)T$ private-sector equilibrium conditions
     - Solve $\max_x U(x)$ s.t. $f(x) = 0$ using Newton's method

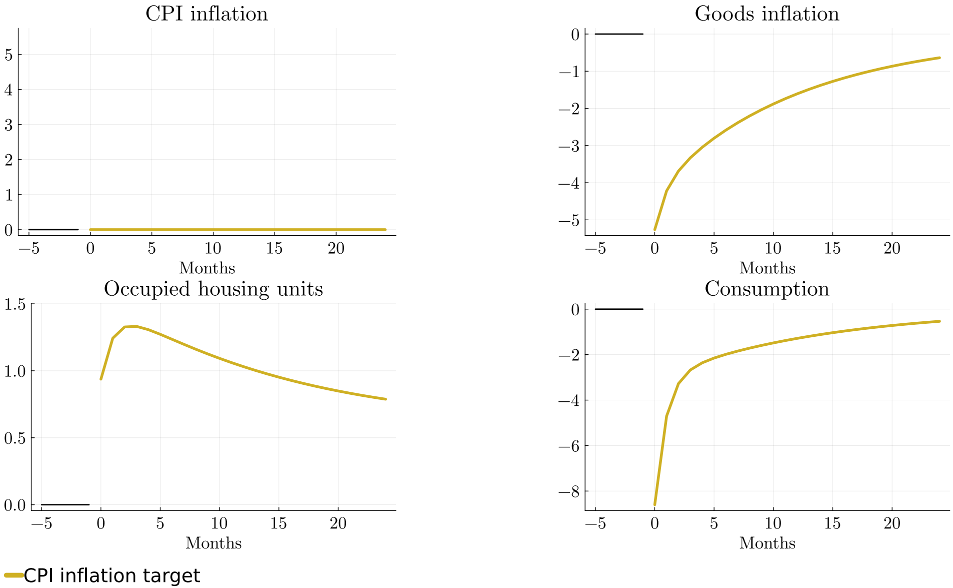
Increased Preference for Housing

- Higher relative price of housing could reflect change in demand for space

  Mondragon-Wieland (2022)

- Simulate permanent increase in ω_t such that housing budget share rises from 15% to 18%

Increased Preference for Housing



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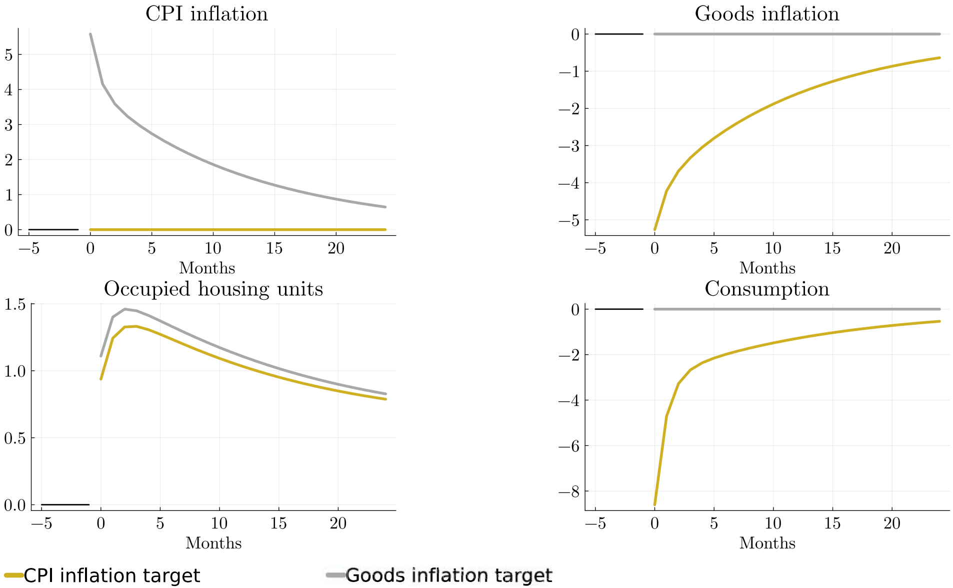

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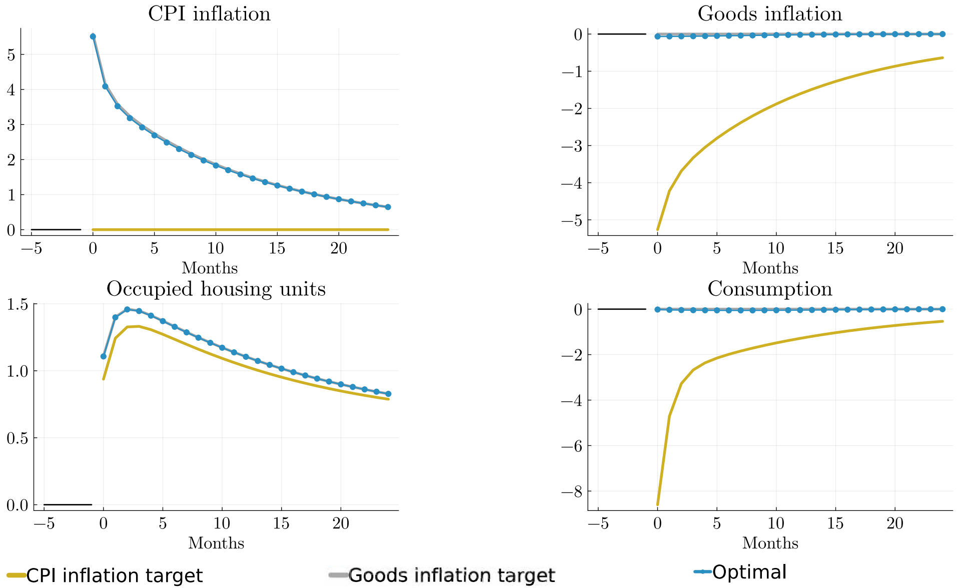
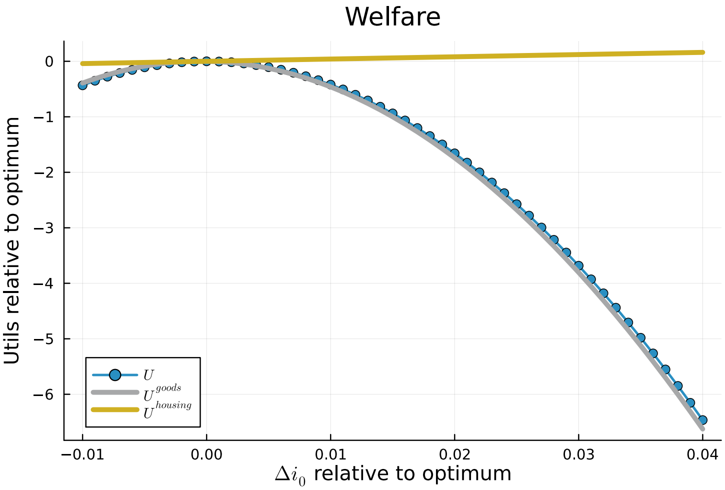


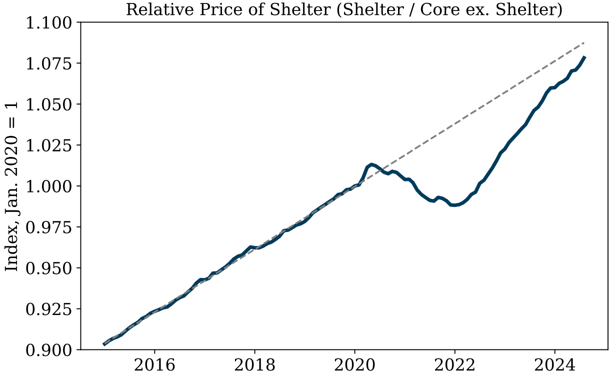
Why ignoring housing inflation is optimal?



Increased Preference for Housing

- With housing production ▸ Figure
- Without inelastic housing demand ($h^o = 0$) ▸ Figure
- With median price duration of 3.4 months ▸ Figure

Rents Need to Catchup



- Relative price of shelter fell below trend in '21 & '22
- A period of "catchup" ensues
- Simulate a 5% deflation of real contract rents
- Affects allocation due to $\chi > 0$

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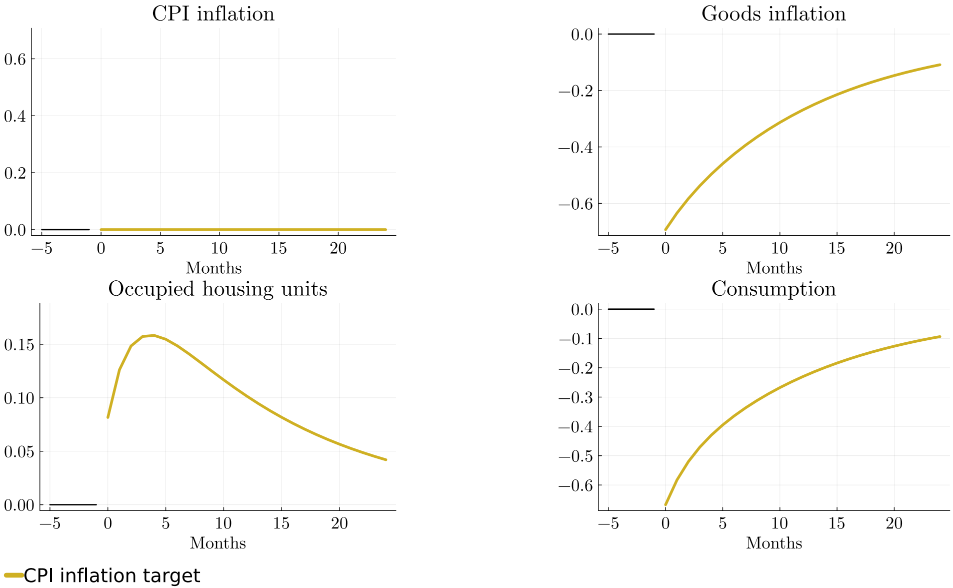

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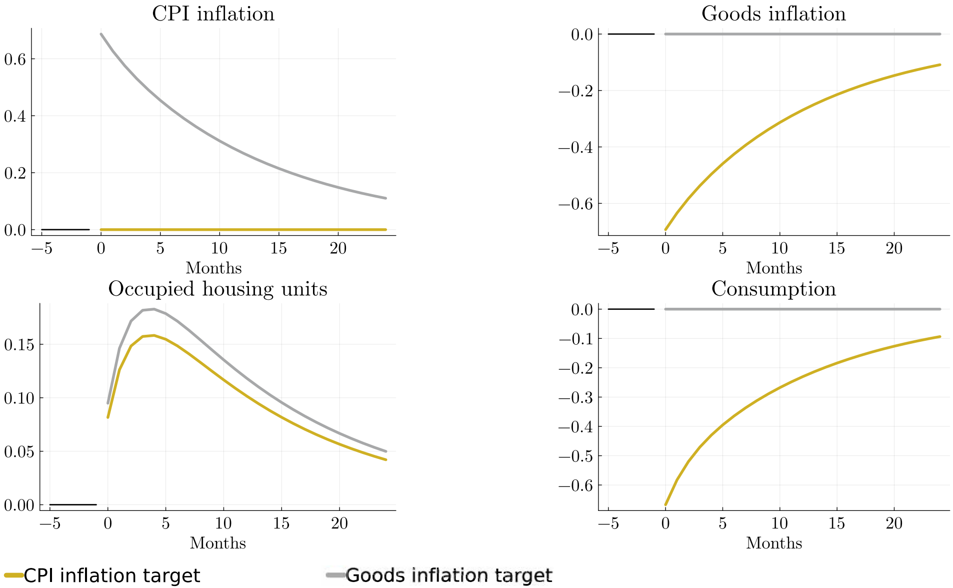

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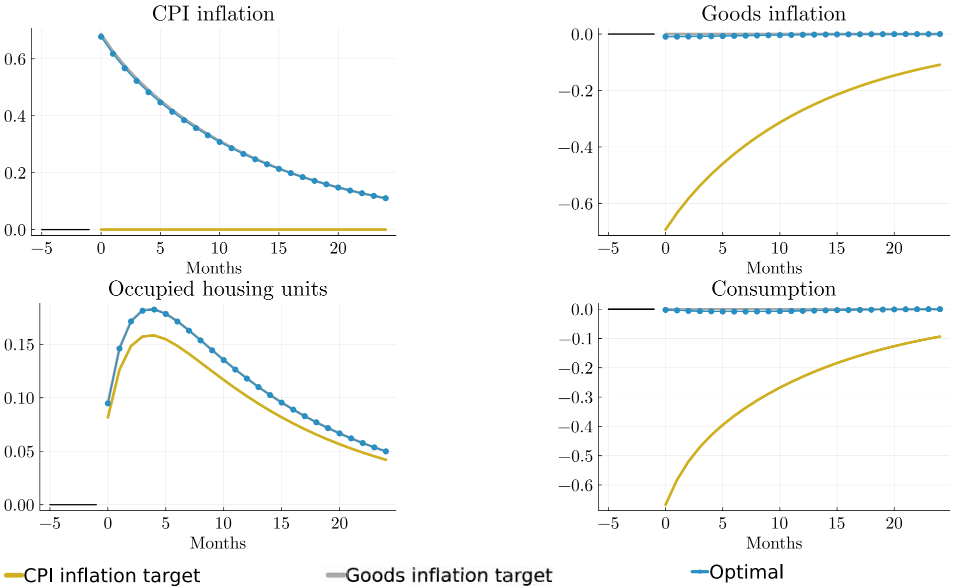

Conclusion

- Welfare costs of π are closely related to the rationing mechanism that resolves disequilibrium
- We take the view that the standard NK mechanism is implausible for housing services
- In a model with rationing via search frictions, it is optimal to ignore housing inflation
- Relevance: what measure of π should we target?

Conclusion

- Welfare costs of π are closely related to the rationing mechanism that resolves disequilibrium

- We take the view that the standard NK mechanism is implausible for housing services

- In a model with rationing via search frictions, it is optimal to ignore housing inflation

- Relevance: what measure of π should we target?
  ECB: "We recognise that the inclusion of costs related to owner-occupied housing in the HICP would better represent the inflation rate that is relevant for households. The European Statistical System is investigating how these costs could be included in the inflation measure."

Additional Slides

- Rep. household with preferences

$$u(c, h, -s_c, -s_h, m)$$

  - u is increasing, concave, additively separable
  - Household supplies one unit of labor

- c = consumption "goods"
- h = housing services
- m = real money balances
- $s_\cdot$ = search effort

- Rep. household with preferences

$$u(c, h, -s_c, -s_h, m)$$

  - u is increasing, concave, additively separable
  - Household supplies one unit of labor
- Nominal budget constraint

$$Rh + Pc + Pm \leq We + D + T$$

- R = nominal rent
- P = price of goods
- W = nominal wage
- e = employment
- D = nominal dividends
- T = tax or transfer

- Rep. household with preferences

$$u(c, h, -s_c, -s_h, m)$$

  - u is increasing, concave, additively separable
  - Household supplies one unit of labor
- Nominal budget constraint

$$Rh + Pc + Pm \leq We + D + T$$

- Search

$$c = s_c f_c(\theta_c)$$

$$h = s_h f_h(\theta_h)$$

$f \geq 0$ and $f' < 0$

- $\theta_\cdot$ = market tightness

Household Optimality Conditions

- Consumption

$$u_c = \lambda + \frac{u_{s_c}}{f_c}$$

- Housing

$$u_h = \lambda\, r + \frac{u_{s_h}}{f_h}$$

- Money demand

$$u_m = \lambda$$

- Lowercase r and w are normalized by P.

Firms and Labor market

- Firms produce goods according to $y = A\ell^{\alpha}$
- Hire labor in a frictional labor market: $e \equiv \ell + \rho_\ell v \leq v f_\ell(\theta_\ell)$
- Sell into frictional goods market: sales $= g_c(\theta_c)\,y$
- g_c is positive and increasing in θ_c

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- Sell into frictional goods market: sales $= g_c(\theta_c)\, y$
- g_c is positive and increasing in θ_c
- Goods prices and wages are fixed
- $\max_{\ell,v} \{P g_c A\ell^{\alpha} - W(\ell + \rho_\ell v)\}$ subject to labor market constraint above
- FOC:

$$\underbrace{g_c \alpha A \ell^{\alpha-1}}_{\text{MPL increases in } \theta_c} = \underbrace{\left(1 + \frac{\rho_\ell}{f_\ell - \rho_\ell}\right) w}_{\text{Effective labor cost increases in } \theta_\ell}$$

Landlords

- Landlords inelastically supply one unit of housing
- Rents fixed
- Housing utilization rate $h = g_h(\theta_h)$
- Total profits: $D = Pg_c(\theta_c)A\ell^\alpha - We + Rg_h(\theta_h)$

Matching

- All matching functions are CRS.
- Goods matching:

$$
\begin{aligned}
c &= \mathcal{M}_c(s_c, y) \\
\theta_c &\equiv \frac{s_c}{y} \\
f_c(\theta_c) &= \frac{\mathcal{M}_c(s_c, y)}{s_c} = \mathcal{M}_c(1, \theta_c^{-1}) \\
g_c(\theta_c) &= \frac{\mathcal{M}_c(s_c, y)}{y} = \mathcal{M}_c(\theta_c, 1) = f_c(\theta_c)\theta_c
\end{aligned}
$$

- Labor matching and housing matching are analogous with $\mathcal{M}_\ell$ and $\mathcal{M}_h$

Government

- The government injects the money supply via transfers

- Government budget $M = T$

Competitive equilibrium

Competitive equilibrium can be expressed as a system of the following four equations in $\{\lambda, \theta_c, \theta_\ell, \theta_h\}$

$$
\begin{aligned}
u_m(m) &= \lambda \\
u_c(c) &= \lambda + \frac{u_{s_c}(s_c)}{f_c(\theta_c)} \\
u_h(h) &= \lambda r + \frac{u_{s_h}(s_h)}{f_h(\theta_h)} \\
g_c(\theta_c) A \alpha G_\ell(\theta_\ell)^\alpha &= g_\ell(\theta_\ell) w
\end{aligned}
$$

Competitive equilibrium

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$$
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g_c(\theta_c) A \alpha G_\ell(\theta_\ell)^\alpha &= g_\ell(\theta_\ell) w
\end{aligned}
$$

$$
\begin{aligned}
G_\ell(\theta_\ell) &\equiv g_\ell(\theta_\ell) - \rho_\ell \theta_\ell \\
c &= g_c(\theta_c) A \left[G_\ell(\theta_\ell) \right]^\alpha \\
h &= g_h(\theta_h) \\
s_c &= \theta_c A \left[G_\ell(\theta_\ell) \right]^\alpha \\
s_h &= \theta_h
\end{aligned}
$$

Back

Constrained Efficient Allocation

- Planner directly chooses allocation subject to technology and search frictions (ignoring welfare from m)

$$\max_{c, s_c, \ell, v, h, s_h} u(c, h, -s_c, -s_h)$$

$$\text{subject to}$$

$$\begin{aligned} c &\leq \mathcal{M}_c(s_c, A\ell^{\alpha}) \\ \ell + \rho_\ell v &\leq \mathcal{M}_\ell(v, 1) \\ h &\leq \mathcal{M}_h(s_h, 1) \end{aligned}$$

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- Optimality conditions lead to

$$u_c g_c'(\theta_c^*) = u_{s_c}, \qquad G_\ell'(\theta_\ell^*) = 0, \qquad u_h g_h'(\theta_h^*) = u_{s_h}.$$

Constrained Efficient Allocation

- Even flex-price outcome is not necessarily constrained efficient e.g. Hosios (1990)

Constrained Efficient Allocation

- Even flex-price outcome is not necessarily constrained efficient e.g. Hosios (1990)
- Efficient allocation supported by $\{m^*, \lambda^*, r^*, w^*\}$ that solve

$$
\begin{aligned}
u_m(m^*) &= \lambda^* \\
u_c(c^*) &= \lambda^* + \frac{u_{s_c}(s_c^*)}{f_c(\theta_c^*)} \\
u_h(h^*) &= \lambda^* r + \frac{u_{s_h}(s_h^*)}{f_h(\theta_h^*)} \\
g_c(\theta_c^*) A \alpha G_\ell(\theta_\ell^*)^\alpha &= g_\ell(\theta_\ell^*) w^*
\end{aligned}
$$

Optimal Monetary Policy

- If $w = w^*$ and $r = r^*$, set m to m^*
- Interesting case is when r and/or w distorted
- Notation $\theta = \{\theta_c, \theta_\ell, \theta_h\}$
- Policy problem

$$\max_{m,\lambda,\theta} u\left(c(\theta),\ h(\theta) - s_c(\theta) - s_h(\theta)\right)$$

subject to system of four equilibrium conditions above.

Optimal Monetary Policy

- Gradient of welfare function

$$\nabla u(\theta) = \begin{pmatrix} y\left(u_c g_c' - u_{s_c}\right) \\ \alpha \frac{y}{\ell}\left(u_c g_c - u_{s_c}\theta_c\right) G_\ell' \\ u_h g_h' - u_{s_h} \end{pmatrix}$$

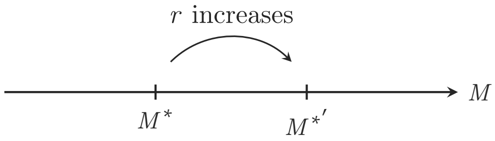
- Targeting rule for optimal policy

$$\nabla u^\top \frac{d\theta}{dM} = 0$$

$\Rightarrow$ If one market is tight, then at least one other must be slack

$\Rightarrow$ Weight on labor distortions is increasing in α

Managing Inefficient Rents: α



Proposition

Define $A(\alpha) = y^*(\ell^*)^{-\alpha}$ *for some constant* y^*. *Let* $M^\star(r,\alpha)$ *be the optimal* M *for a given* r *and* α *with* $w = w^*$ *and* $A = A(\alpha)$. $M^\star$ *satisfies*

$$\left.\frac{d^2 M^\star}{dr d\alpha}\right|_{r=r^*} < 0.$$

Managing Inefficient Rents: Less Elastic Housing Demand

- Lots of housing demand is inelastic: $h + h^o$
- Scale so efficient allocation unchanged; assuming u linear in s_h

$$u\left(c,\ \frac{\bar{h}^*}{\bar{h}^* + h^o}\left(h + h^o\right),\ -s_c, -\frac{\bar{h}^*}{\bar{h}^* + h^o} s_h\right)$$

- Efficient rent scales down, define $r = \widehat{r} \times \frac{\bar{h}^*}{\bar{h}^* + h^o}$

Proposition

Let $M^\star(\widehat{r}, h^o)$ be the optimal M using the modified utility function with $w = w^*$. $M^\star$ satisfies

$$\left.\frac{d^2 M^\star}{d\widehat{r}\ dh^o}\right|_{\widehat{r}=\widehat{r}^*} < 0.$$

Back

Extended Model with Housing Production

- Houses produced out of labor and a fixed factor (land)

$$I_t = z_h m_t^{\tilde{\Phi}}$$

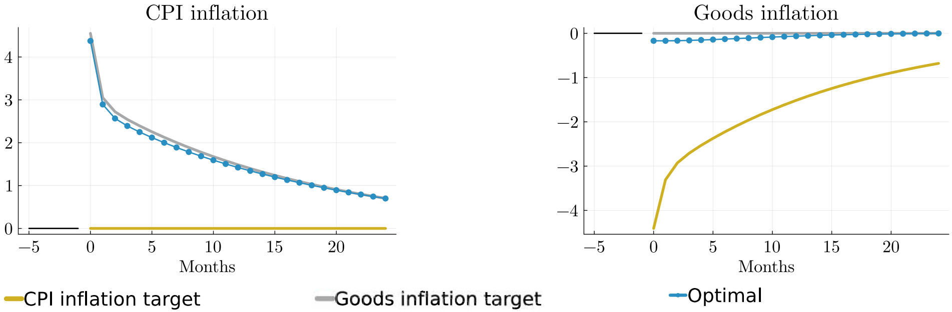
- Supply of housing units:

$$\bar{h}_t = (1 - \kappa)\bar{h}_{t-1} + I_t - \kappa h^o$$

- Housing supply elasticity calibrated to Baum-Snow and Han (2024) estimate of 0.35

- Free entry: value of a vacant unit = construction cost
  - Important to distinguish rigidities in rents from rigidities in construction costs

Extended Model with Housing Production



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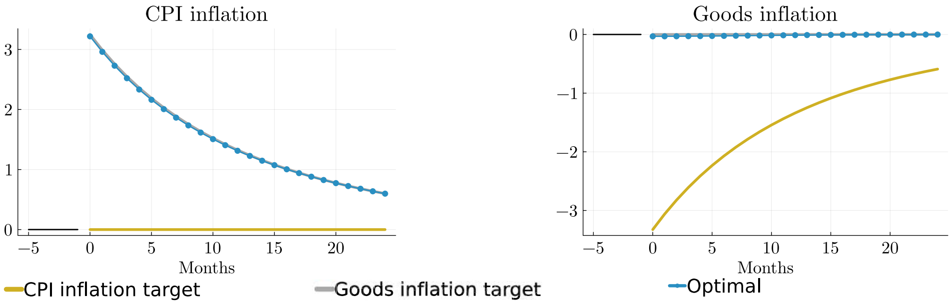
Without Inelastic Housing Demand ($h^o = 0$)



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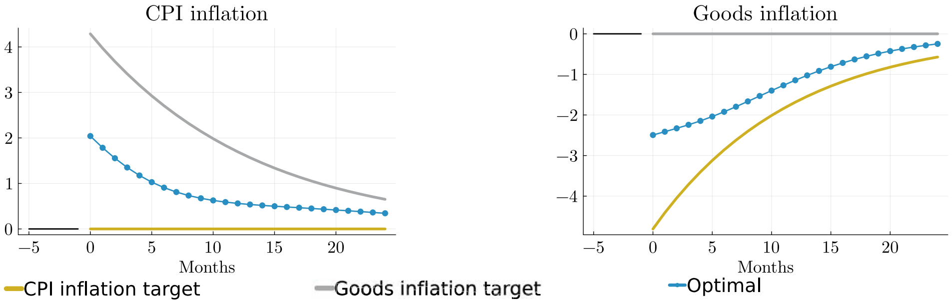
With More Flexible Goods Prices



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