How Should Monetary Policy Respond to Housing Inflation? *

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Abstract

In a standard multi-sector New Keynesian model, optimal policy places greater weight on stabilizing inflation in sectors with lower supply elasticities, such as housing. We argue that this prescription rests on the premise that firms satisfy all demand at posted prices—an assumption particularly ill-suited to housing. We develop a multi-sector model in which trade is voluntary and search frictions ration quantities, with the short-side rule emerging as search costs vanish. Under search rationing, the prescription reverses: optimal policy places less, rather than more, weight on stabilizing inflation in the sectors with lower supply elasticities. Quantitatively, following a housing demand shock, optimal policy stabilizes non-housing inflation and essentially ignores housing inflation. More broadly, optimal monetary policy depends not only on price stickiness and supply elasticity but also on how quantities are rationed.

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1 Introduction

New Keynesian theory is built on the premise that output is demand-determined: a firm that holds its price fixed must meet any increase in demand by hiring additional factors of production. This rationing assumption is central to the welfare costs of inflation and the trade-offs facing monetary policy in multi-sector models. When shocks require relative-price adjustments, monetary policy must balance the costs of inflation across sectors (Aoki, 2001; Benigno, 2004; Woodford, 2003). Because meeting demand at misaligned prices is particularly costly when supply is inelastic, optimal policy places greater weight on stabilizing inflation in sectors with less elastic supply (Eusepi, Hobijn and Tambalotti, 2011).

The requirement that suppliers meet all demand at prevailing prices is untenable in markets such as housing, where supply cannot expand quickly enough to accommodate additional demand. In this paper, we take a search-and-matching approach to determine the quantity traded under nominal rigidities and study optimal monetary policy in a multi-sector economy. Following Michaillat and Saez (2015), search frictions generate non-price rationing, and market tightness governs the ease with which buyers and sellers trade. In the spirit of Barro and Grossman (1971), all trade is voluntary, so firms need not satisfy all demand at the posted price. We show that replacing demand determination with search rationing changes both the welfare costs of nominal rigidities and the optimal monetary policy response. In particular, all else equal, less elastic supply in a sector calls for a lower weight on stabilizing that sector under search rationing but a greater weight when output is demand-determined.

Framework and theoretical results. We start our analysis with a static model where households consume two types of goods, one of which is supplied inelastically. In line with our quantitative model (discussed below), we label this good housing, but, in principle, it could be any good supplied less elastically. The consumer good is produced out of labor and supplied elastically, while the supply of the inelastic good is fixed. All three markets (goods, labor, and housing) face fixed prices, and in each market, buyers and sellers trade through a frictional matching process. The number of trades cannot exceed either the number of buyers or the number of sellers, and meeting probabilities adjust with market tightness.

To highlight how changing the rationing protocol can reverse the model's implications for optimal monetary policy, we contrast a demand-determined protocol, as in the standard New Keynesian literature, with a supply-determined protocol. Figure 1 depicts a scenario where, starting from market clearing, demand shifts upward while the price remains rigid. Under the demand-determined protocol, represented by the purple solid dot, suppliers are assumed to increase their output to meet the higher demand. Under the supply-determined protocol, represented by the blue solid dot, output remains unchanged, and buyers are rationed.

In the figure, the purple and blue triangles illustrate the deadweight losses relative to the flexible-price allocation. Panel (a) depicts a case where these deadweight losses are approximately equal under the two protocols. Panel (b) shows that when supply becomes more inelastic, the deadweight loss increases sharply under the demand-determined protocol but decreases under the supply-determined protocol. This contrast suggests that both the costs of nominal rigidity across sectors and the optimal monetary policy response to sectoral shocks depend crucially on the rationing protocol.

In our search-and-matching model, we first show that as search costs vanish, the volume of trade converges to the minimum of demand and supply: when the price is above its market-clearing level, the limit is demand-determined, and when it is below, the limit is supply-determined. That is, the short-side rule of the disequilibrium literature (e.g., Barro and Grossman, 1971) emerges as the frictionless limit of our economy. In the presence of meaningful search costs, buyers and sellers face costs of transacting—the effort of finding a match—and these costs adjust with market tightness even when the price itself is rigid. Equilibrium trade is therefore neither purely supply- nor demand-determined: both supply and demand conditions shape market tightness and the volume of trade (see Barro, 2026).

Because of search congestion effects as in Hosios (1990), outcomes in the model are not necessarily efficient. If prices are too high, buyers will search too little and too little trade will occur. If prices are too low, buyers will choose an inefficiently high search effort, which crowds out the purchases of others. Monetary policy can only raise or lower demand in all markets simultaneously. If nominal rigidities interfere with the adjustment of relative prices, there can be inefficient levels of search across sectors and the policymaker then faces a trade-off between too much search activity in some markets and too little in others. We derive a targeting rule that implicitly characterizes the optimal policy. We show that as the supply elasticity of goods increases, optimal policy places more weight on stabilizing the goods and labor markets and less weight on stabilizing housing. This result reverses under the standard New Keynesian rationing assumption of demand-determined output.

Application and quantitative results. Our application is the post-pandemic surge in shelter inflation, which for several years was a primary reason that inflation remained above target. Given its large and persistent contribution to recent inflation, a natural question is how monetary policy should respond to housing inflation.

To tackle this question, we extend the analysis to a dynamic model with gradual price

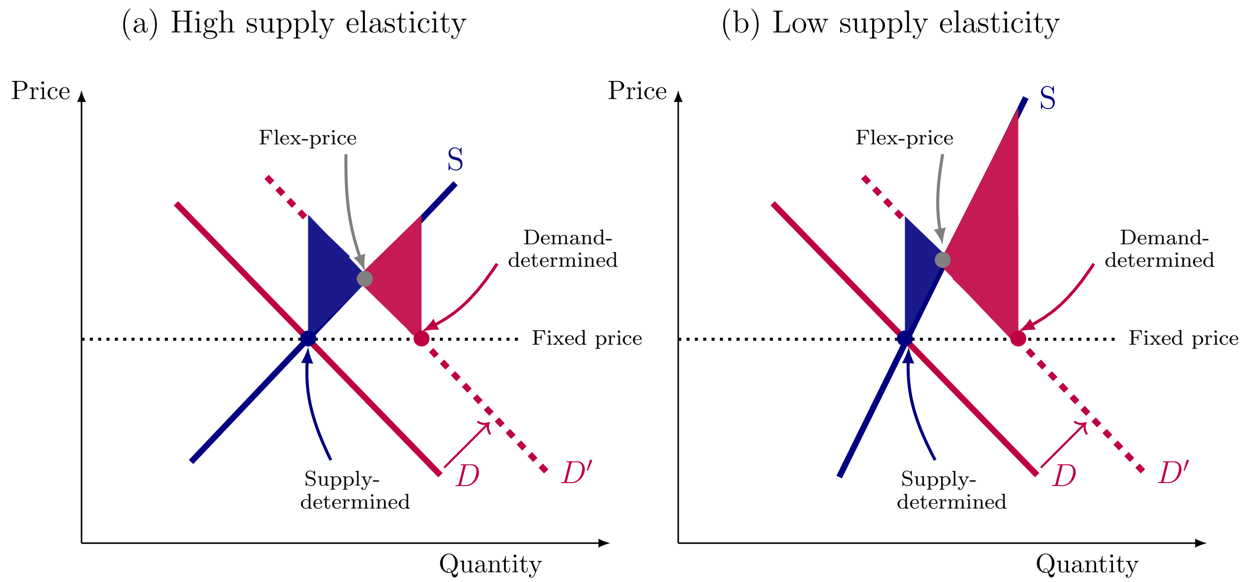

Figure 1: Rationing protocols: Supply- vs. demand-determined

Note: The purple and blue triangles indicate the deadweight losses under the demand-determined and supply-determined equilibria, respectively.

adjustment and long-lived matches in the housing and labor markets. Our main quantitative experiment consists of evaluating the impact of an increase in the preference for housing. This housing-specific shock is motivated by the surge in remote work and the desire for more space following the pandemic (see, e.g., Mondragon and Wieland, 2022). With market rents rising slowly due to nominal rigidities, households capture a larger share of the surplus from a housing match and search excessively relative to the constrained-efficient level. The monetary authority can mitigate excessive search effort by tightening policy, which reduces housing demand. The downside, however, is that a tight monetary policy also inefficiently reduces demand for goods and labor. The question is then how far policy should be willing to depress the goods and labor markets to compensate for overheating in the housing market.

Our quantitative answer is that optimal policy focuses almost exclusively on stabilizing the goods and labor markets and allows rents to rise. Specifically, we compute optimal monetary policy and compare it with two strategies: stabilizing goods inflation and stabilizing overall CPI inflation. We find that the optimal policy is nearly identical to goods inflation targeting. This implies that it is optimal for the monetary authority to allow CPI inflation to rise in response to a housing demand shock and to keep the level of activity in the goods and labor markets close to the efficient level.

Literature. Our paper contributes to the New Keynesian literature examining the consequences of sectoral asymmetries for optimal monetary policy. Aoki (2001) considers a two-sector model where prices are sticky in one sector and flexible in the other, and shows that the optimal policy is to target inflation in the sector with sticky prices. More generally, Woodford (2003) and Benigno (2004) show that when there are multiple sectors with price rigidities, divine coincidence fails, and inflation in the stickier sectors should carry more weight under the optimal policy. Eusepi et al. (2011) provide a quantitative analysis of the weights that minimize the welfare costs of nominal distortions and find that these weights are larger for sectors with more rigid prices as well as more inelastic supply.[1] Our analysis leads to the opposite conclusion: inelastic sectors should receive lower weight.

Our paper contributes to a recent literature revisiting the foundations of macroeconomic adjustment in models with nominal rigidities. Following Barro and Grossman (1971), trade is voluntary, and suppliers are not required to meet all demand at the prevailing price. We build on Michaillat and Saez (2015), who preserve this architecture but model non-price rationing through search frictions. As discussed by Barro (2026), with search frictions, shifts in either supply or demand alter matching probabilities, so both sides of the market can affect the quantity traded. Recently, Holden (2025) allows sticky-price firms to ration demand and shows how this generates a convex, backward-bending Phillips curve; Flynn, Nikolakoudis and Sastry (2026) let firms choose both prices and inputs under uncertainty and link markups to the probability of rationing.[2] Our primary contribution is to characterize optimal monetary policy in a multi-sector framework and show that the rationing mechanism—a central focus of this recent literature—can reverse standard policy prescriptions.

Outline. Section 2 introduces the static model, and Section 3 characterizes optimal monetary policy. Section 4 presents the dynamic model. Section 5 describes the calibration, and Section 6 presents the quantitative results. Section 7 concludes.

[1]Following these contributions, there has been an active recent literature examining the role of sectoral shifts in understanding recent inflation dynamics and the implications for optimal monetary policy. See, for example, Rubbo (2023), La'O and Tahbaz-Salehi (2022), Baqaee, Farhi and Sangani (2024) for production networks; Guerrieri, Lorenzoni, Straub and Werning (2021, 2022) for the role of downward wage rigidity and costly reallocation; Woodford (2022), Gagliardone and Gertler (2023), di Giovanni, Kalemli-Özcan, Silva and Yildirim (2022, 2023) for post-pandemic inflation dynamics; Olivi, Sterk and Xhani (2023) for insights on non-homotheticities and inequality; Fornaro and Romei (2023) and Bianchi and Coulibaly (2024) for discussions on open economy considerations. An older literature considers implications of price stickiness in durable goods: Barsky, House and Kimball (2007), Erceg and Levin (2006) and Barsky, Boehm, House and Kimball (2015).

[2]An earlier paper by Huo and Ríos-Rull (2020) shows that standard sticky-wage models can imply non-voluntary trade with labor demand exceeding households' willingness to supply labor in a substantial fraction of model periods.

2 Static model

This section presents a static multi-sector model with fixed prices and search frictions building on Michaillat and Saez (2015). The economy has two sectors: goods and housing. Trade occurs through matching in the goods, labor, and housing markets.

2.1 Main elements

Preferences and technology. The economy is populated by a representative household with preferences represented by

$$\log(c) + \omega \log(h) + \log(m) - (\rho_c s_c + \rho_h s_h).$$

The household derives utility from consumption goods c, housing services h, and real money balances m, and incurs disutility from search effort s_c and s_h to purchase goods and housing, respectively. The parameter $\omega > 0$ governs the taste for housing relative to goods, and $\rho_c, \rho_h > 0$ govern the cost from searching. The household supplies one unit of labor inelastically, of which a fraction $e \in [0, 1]$ is employed.

Goods are produced from labor according to $y = A\ell^{\alpha}$, where ℓ is production labor and $\alpha \in (0, 1)$ is the elasticity of output with respect to labor. The housing stock is fixed at $\bar{h} > 0$. As $\alpha \to 0$ the goods and housing production functions are both perfectly inelastic; higher values of α increase the relative difference in supply elasticities.

Matching. Households engage in costly search to purchase goods and housing services. As in Michaillat and Saez (2015), the representative household consists of a continuum of identical members who make atomistic search decisions.[3]

Let $q_c \equiv y$ and $q_h \equiv \bar{h}$ denote the quantities offered in the goods and housing markets. In each market $j \in \{c, h\}$, a constant-returns matching function pairs aggregate household search s_j with the quantity offered q_j:

$$\mathbb{M}_j(s_j, q_j) = \left(s_j^{-\gamma_j} + q_j^{-\gamma_j}\right)^{-1/\gamma_j}, \quad \gamma_j > 0, \qquad j \in \{c, h\}.$$

[3] Other examples of models of goods-market search are Ghassibe and Zanetti (2022) and Bai, Ríos-Rull and Storesletten (2026). There is also a more extensive strand of the New Keynesian literature that incorporates labor-market search frictions in the tradition of Mortensen and Pissarides (1999). Typical formulations in this literature, however, retain the assumption that output is demand-determined, with price-setting firms meeting demand at their prevailing prices (Blanchard and Gali, 2007; Thomas, 2008; Gertler, Sala and Trigari, 2008; Ravenna and Walsh, 2011; Christiano, Eichenbaum and Trabandt, 2016).

This matching function, adopted also by Den Haan, Ramey and Watson (2000) and Michaillat and Saez (2015), ensures that the number of matches cannot exceed either household search or the quantity offered for sale: $\mathbb{M}_j(s_j, q_j) \leq \min\{s_j, q_j\}$.

Market tightness is the ratio of aggregate household search to the quantity offered, $\theta_j \equiv s_j/q_j$. The household's probability of finding a unit and the probability that an offered unit is traded are, respectively,

$$f_j(\theta_j) \equiv \frac{\mathbb{M}_j(s_j, q_j)}{s_j}, \qquad g_j(\theta_j) \equiv \frac{\mathbb{M}_j(s_j, q_j)}{q_j}.$$

Constant returns to scale imply that both probabilities depend only on market tightness and $g_j(\theta_j) = f_j(\theta_j)\theta_j$. $f_j(\theta_j)$ is strictly decreasing while $g_j(\theta_j)$ is strictly increasing. By the law of large numbers, goods and housing purchases satisfy $c \leq f_c(\theta_c)s_c$ and $h \leq f_h(\theta_h)s_h$.

In the labor market, firms post v vacancies, which are matched with the household's unit mass of job seekers through $\mathbb{M}_\ell(v, 1)$.[4] Labor-market tightness is therefore $\theta_\ell \equiv v$. The vacancy-filling and worker-matching probabilities are $f_\ell(\theta_\ell)$ and $g_\ell(\theta_\ell) = f_\ell(\theta_\ell)\theta_\ell$, respectively.

Household problem. Taking prices, income, transfers, and matching probabilities as given, the household solves

$$\max_{c, s_c, h, s_h, m} \{\log(c) + \omega \log(h) + \log(m) - (\rho_c s_c + \rho_h s_h)\}$$

$$\begin{aligned} &\text{subject to} \\ Pc + Rh + Pm &= We + d + T, \\ c &\leq f_c(\theta_c)\, s_c, \\ h &\leq f_h(\theta_h)\, s_h. \end{aligned}$$

where P is the goods price, R is the nominal rent, W is the nominal wage, d is profit income, and T is a lump-sum transfer. At an interior optimum, the three constraints hold with equality, and the first-order conditions are given by

$$f_c(\theta_c)\left(\frac{1}{c} - \lambda\right) = \rho_c, \quad \text{(1a)}; \qquad f_h(\theta_h)\left(\frac{\omega}{h} - \lambda r\right) = \rho_h, \quad \text{(1b)}; \qquad \frac{1}{m} = \lambda, \quad \text{(1c)}$$

where $r \equiv R/P$, and λ is the shadow value of one additional unit of wealth measured in goods.[5] The first two conditions equate the expected marginal benefit of search to its marginal

[4] We use the same matching technology in all three markets.

[5] λ is the Lagrange multiplier on the nominal budget constraint scaled by P.

disutility. The surplus from a successful goods match is $1/c - \lambda$, while the surplus from a successful housing match is $\omega/h - \lambda r$. Multiplying each surplus by the corresponding matching probability gives the expected benefit of additional search. The final condition equates the marginal utility of real money balances to the shadow value of wealth measured in goods.

Firms. There is a unit mass of goods producers, which we refer to as firms, and a unit mass of atomistic landlords. Goods-producing firms face matching frictions when hiring workers and selling output. To hire workers, a firm posts v vacancies. Recruiting requires $\rho_\ell \in (0,1)$ units of labor per vacancy. Total employment e is allocated between production, ℓ, and recruiting, $\rho_\ell v$, and cannot exceed the number of filled vacancies:[6]

$$e = \ell + \rho_\ell v \leq f_\ell(\theta_\ell)v. \tag{2}$$

Firms offer all their output for sale, but only a fraction $g_c(\theta_c)$ of it is matched with buyers. Taking prices and matching probabilities as given, a firm maximizes nominal profits,

$$\max_{\ell,\, v} \; P g_c(\theta_c) A \ell^\alpha - W(\ell + \rho_\ell v) \quad \text{subject to (2)}.$$

At an optimum the matching constraint binds, and the first-order condition for production labor is

$$P g_c(\theta_c) A \alpha \ell^{\alpha - 1} = \left(1 + \frac{\rho_\ell}{f_\ell(\theta_\ell) - \rho_\ell}\right) W. \tag{3}$$

This condition equates the expected marginal revenue product of production labor to its effective wage cost, including the labor used in recruitment. Note that the price elasticity of goods supply is $\alpha/(1-\alpha)$, so a higher α corresponds to more elastic goods supply.

Landlords supply the fixed stock $\bar{h}$ inelastically and list units at no cost at the nominal rent R. A fraction $g_h(\theta_h)$ of the housing stock is occupied, so occupied housing is $h = \bar{h}\, g_h(\theta_h)$ and the remainder is vacant. Aggregate profits from goods producers and landlords are therefore

$$d = P g_c(\theta_c) A \ell^\alpha - W(\ell + \rho_\ell v) + R\, \bar{h}\, g_h(\theta_h).$$

[6] As in the case for households, we assume a law of large numbers here, so that there is no uncertainty about the matching outcome.

Allocation as a function of market tightness. Let

$$\boldsymbol{\theta} \equiv (\theta_c, \theta_\ell, \theta_h),$$

collect market tightness in the goods, labor, and housing markets. As the following result shows, this three-dimensional object summarizes the entire real allocation. We restrict θ_ℓ to the domain $f_\ell(\theta_\ell) > \rho_\ell$ for which productive labor is positive.

Lemma 1. *Allocations can be expressed as a function of $\boldsymbol{\theta}$ alone:*

$$\ell = (f_\ell(\theta_\ell) - \rho_\ell)\, \theta_\ell \equiv G_\ell(\theta_\ell), \qquad c = g_c(\theta_c) A \ell^\alpha, \qquad h = \bar{h}\, g_h(\theta_h),$$

together with $y = A\ell^\alpha$, $s_c = \theta_c\, y$, $s_h = \theta_h \bar{h}$, $v = \theta_\ell$, and $e = \ell + \rho_\ell v$, where G_ℓ denotes production labor.

Nominal rigidity. We assume that the goods price P, nominal wage W, and nominal rent R are fixed. Relative prices may therefore deviate from the levels that support the constrained-efficient allocation, creating a trade-off for monetary policy. In the dynamic model below, these relative-price deviations also affect inflation rates.

Government. The government supplies the nominal money stock M through lump-sum transfers. Its budget constraint is given by $T = M$.

2.2 Competitive equilibrium

By Lemma 1, a tightness vector induces an allocation consistent with the matching technology; an equilibrium additionally requires that the induced allocation be optimal for households and firms.

Definition 1 (Fixed-price competitive equilibrium)**.** Given fixed prices $P, W, R > 0$ and a money supply $M > 0$, an interior fixed-price competitive equilibrium is a vector of market tightnesses $\boldsymbol{\theta} \equiv (\theta_c, \theta_\ell, \theta_h)$ such that, at the allocation implied by Lemma 1, the household's optimality conditions (1) hold with $m = M/P$, and the firm's optimality condition (3) holds.

Our definition of fixed-price equilibrium echoes the one in Barro and Grossman (1971) but resolves disequilibrium via search, as in Michaillat and Saez (2015). We next provide a proof of existence and uniqueness.

Proposition 1 (Existence and Uniqueness)**.** *There exists a unique fixed-price competitive equilibrium.*

Proof. In Appendix A.3. □

Comparative statics. We first show that monetary expansion increases market tightness in all three markets, consistent with the results in Michaillat and Saez (2015).

Proposition 2 (Monetary expansion and market tightness)**.** *An increase in the money supply raises market tightness in the goods, labor, and housing markets:*

$$\frac{d\theta_j}{dM} > 0, \qquad j \in \{c, \ell, h\}.$$

Proof. In Appendix A.4. □

With prices fixed, an increase in M raises real balances $m = M/P$ and, because the utility function over real money balances is strictly concave, this lowers the shadow value of wealth by (1c). By (1a) and (1b), the decline in λ raises the private surplus from successful goods and housing matches and strengthens household search incentives. Higher goods-market tightness raises firms' selling probability, inducing vacancy creation and increasing labor-market tightness.

2.3 Short-side rule

We next relate our search equilibrium to the short-side rule, a central feature in the architecture of Old Keynesian general-disequilibrium models (Barro and Grossman, 1971). Voluntary trade implies that the quantity traded cannot exceed either the amount buyers wish to purchase or the amount sellers wish to sell at the prevailing price. The short-side rule postulates that the equilibrium quantity equals the smaller of notional demand and notional supply. We show below that our search model mimics the short-side rule as the marginal cost of search vanishes.

To demonstrate the connection to the short-side rule, we focus on the market for the consumption good and hold constant the effective nominal marginal cost of production labor $\widetilde{W} \equiv \left(1 + \frac{\rho_\ell}{f_\ell(\theta_\ell) - \rho_\ell}\right) W > 0$. Given $\{M, P, \widetilde{W}\}$, a goods-market partial equilibrium is a vector $\{c, \theta_c, \ell, \lambda\}$ satisfying the money-balance and goods-search optimality conditions in (1), the goods allocation $c = g_c(\theta_c) A \ell^\alpha$ of Lemma 1, and the firm's optimality condition (3), with its effective nominal labor cost held fixed at $\widetilde{W}$.

Notional demand is the quantity the household would purchase without the cost from searching, while notional supply is the quantity the firm would produce if all output found a buyer, holding $\widetilde{W}$ fixed. Setting $\rho_c = 0$ in (1a) gives $1/c_d = \lambda$, so notional demand is

$$c_d = \frac{M}{P}. \tag{4}$$

Notional demand thus obeys the quantity equation $Pc_d = M$: it decreases with P and increases with M. Meanwhile, setting $g_c(\theta_c) = 1$ in the resource constraint and the firm's optimality condition yields notional supply,

$$c_s = A\left(\frac{PA\alpha}{\widetilde{W}}\right)^{\alpha/(1-\alpha)}. \tag{5}$$

Thus, c_s increases with P and decreases with $\widetilde{W}$.

Figure 2 illustrates the result formalized below. With P on the vertical axis and consumption on the horizontal axis, the figure plots $c_s(P)$, $c_d(P)$, and equilibrium consumption under high and low search costs, holding $\widetilde{W}$ and M fixed. Voluntary trade implies that equilibrium consumption lies below both notional schedules. As the cost of search declines, equilibrium consumption approaches the smaller of $c_s(P)$ and $c_d(P)$ at each price. The limiting allocation is supply-determined when $c_s < c_d$ and demand-determined when $c_d < c_s$.

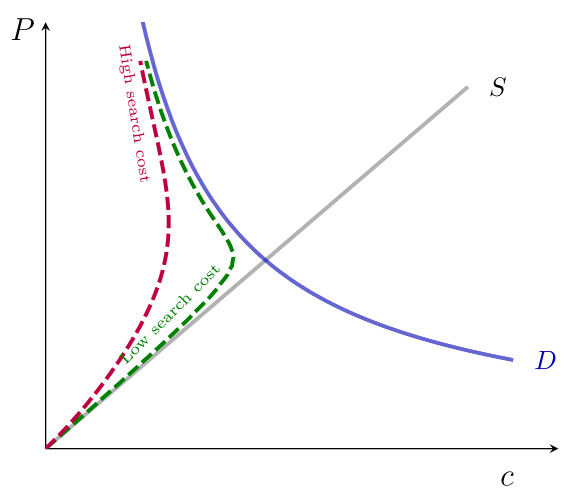

Figure 2: Short-side rule and search equilibrium

Note: D and S denote the notional demand and supply schedules in (4) and (5). The dashed curves plot equilibrium consumption as a function of P for two levels of goods-market search costs, holding M and $\widetilde{W}$ fixed.

Proposition 3 (Short-side rule)**.** *Fix $M, P, \widetilde{W} > 0$. In any goods-market partial equilibrium,*

$$c \leq \min\{c_d, c_s\},$$

and

$$\lim_{\rho_c \downarrow 0} c = \min\{c_d, c_s\}.$$

Proof. In Appendix A.5. □

The proposition provides a search-theoretic foundation for the short-side rule, which is a central piece of the disequilibrium literature (Barro and Grossman, 1971).[7] Positive search costs imply that equilibrium trade lies below both notional schedules. As the marginal disutility of search vanishes, trade converges to the smaller of the two. Thus, trade becomes supply-determined when $c_s < c_d$ and demand-determined when $c_d < c_s$. The same argument applies to the housing market, where notional supply is the fixed stock $\bar{h}$ and notional demand (obtained by setting $\rho_h = 0$ in eq. 1b) is $h_d \equiv \omega M/(rP)$, so that $h \leq \min\{\bar{h}, h_d\}$ and $h \to \min\{\bar{h}, h_d\}$ as $\rho_h \downarrow 0$.

As emphasized by Barro (2026), under the short-side rule, an increase in supply leaves the traded quantity unchanged when there is excess supply, while an increase in demand leaves it unchanged when there is excess demand. When search costs matter, however, shifts in either supply or demand change market tightness and matching probabilities, and therefore affect the quantity traded even when the price is rigid (Michaillat and Saez, 2015). Our search-and-matching model is in this sense neither purely supply-determined nor purely demand-determined.

3 Optimal policy

3.1 Constrained efficient allocations

We first characterize the constrained-efficient allocation, which provides the benchmark for optimal monetary policy. The planner chooses quantities and search effort subject to the production and matching technologies. We abstract throughout from the utility of money balances in the welfare evaluation in the style of the cashless limit (Woodford, 2003).

[7] Michaillat and Saez (2015) focus on the case where notional supply exceeds notional demand and show that the quantity traded in the search model converges to the notional demand. We extend the argument to include cases of demand rationing, where notional demand exceeds notional supply, and show in these cases the quantity traded converges to the notional supply.

The planner solves

$$\max_{c,s_c,\ell,v,h,s_h} \quad \log(c) + \omega \log(h) - (\rho_c s_c + \rho_h s_h)$$

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

As shown in Appendix A.6, the planner's first-order conditions reduce to

$$\frac{g_c'(\theta_c)}{c} = \rho_c, \quad (6a) \qquad \frac{\omega g_h'(\theta_h)}{h} = \rho_h, \quad (6b) \qquad G_\ell'(\theta_\ell) = 0. \quad (6c)$$

The goods- and housing-market conditions equate the marginal utility generated by additional matches to the marginal search cost. Private searchers evaluate an additional unit of effort using the average matching probability $f_j(\theta_j)$, whereas the planner internalizes congestion and uses its marginal product, $\partial \mathbb{M}_j/\partial s_j = f_j(\theta_j)\eta_j(\theta_j) = g_j'(\theta_j)$. Private agents also value a match using private surplus, while the planner uses social surplus. In the labor market, the planner chooses tightness to maximize production labor net of recruiting needs, giving $G_\ell'(\theta_\ell) = 0$.

In the decentralized economy, the level of search in each market may be too high or too low. Search will be too low when prices are too high relative to the money supply and the searching side of the market (households in the goods and housing market and firms in the labor market) receive too little of the surplus. In this situation, the market will be slack and too little consumption will occur. If prices are too low, the economy will be overheated and welfare is reduced due to excessive search costs.

To compare the planner's conditions with private optimality, define the elasticity of matches with respect to the searching side's input by

$$\eta_c(\theta_c) \equiv \frac{\partial \log \mathbb{M}_c}{\partial \log s_c} = 1 + \frac{f_c'(\theta_c)\theta_c}{f_c(\theta_c)}$$

and define η_h and η_ℓ analogously.[8] Note that in each market $j \in \{c, \ell, h\}$, we have $\eta_j \in (0, 1)$.[9] Evaluating the private optimality conditions at the constrained-efficient allocation yields the

[8] The searching input is household search in the goods and housing markets and vacancies in the labor market.

[9] Differentiating the relationship $g_j(\theta_j) = f_j(\theta_j)\theta_j$ gives $g_j'(\theta_j) = f_j(\theta_j)\eta_j(\theta_j)$. It follows that $\eta_j > 0$ because g_j is strictly increasing and f_j is strictly positive. It also follows from the definition of η_j that $\eta_j < 1$ because f_j is strictly decreasing.

shadow value and relative prices that would implement the constrained-efficient allocation in the competitive equilibrium:

$$\lambda^* = \frac{1-\eta_c(\theta_c^*)}{c^*} \tag{7}$$

$$r^* = \frac{(1-\eta_h(\theta_h^*))\,\omega}{h^*\lambda^*} \tag{8}$$

$$w^* = (1-\eta_\ell(\theta_\ell^*))\,\alpha g_c(\theta_c^*)\frac{y^*}{\ell^*}. \tag{9}$$

Suppose that the fixed prices P, R, and W are such that $R/P = r^*$ and $W/P = w^*$, then setting the money supply to $M = P/\lambda^*$ attains the constrained-efficient allocation. Equations (7)-(9) reflect the logic of Hosios (1990) that efficiency in the search equilibrium requires prices that internalize search externalities. For instance, in the goods market the total surplus is $1/c$ and (7) specifies that the consumer should receive a fraction η_c of that surplus.

3.2 Optimal monetary policy

We now turn to optimal monetary policy. The central bank chooses the money supply M to maximize welfare in the competitive equilibrium with fixed prices. For fixed P, R, and W, let $\boldsymbol{\theta}(M)$ denote equilibrium market tightness as a function of M. Using Lemma 1, define

$$\mathcal{U}(\boldsymbol{\theta}) \equiv \log(c(\boldsymbol{\theta})) + \omega\log(h(\boldsymbol{\theta})) - (\rho_c s_c(\boldsymbol{\theta}) + \rho_h s_h(\boldsymbol{\theta}))\,.$$

The central bank's problem is

$$\max_{M>0}\ \mathcal{U}(\boldsymbol{\theta}(M))\,. \tag{10}$$

The central bank has one instrument, but attaining the constrained-efficient allocation requires implementing the three conditions in (6). Unless the fixed wage and rent are consistent with w^* and r^*, it will not be possible to attain efficiency in all three markets at once. If the relative prices are misaligned, the level of aggregate activity consistent with efficiency in one market will leave another market either slack or excessively tight. Optimal policy will balance these inefficiencies across markets.

Optimal policy targeting rule. Define the response of each market to policy by

$$\varepsilon_M^j \equiv \frac{d\log\theta_j}{d\log M} > 0, \qquad j\in\{c,\ell,h\}.$$

As we show in Appendix A.7, the central bank's first-order condition can then be written as the targeting rule

$$\underbrace{\left[1-\frac{1-\eta_c(\theta_c)}{c\lambda}\right]c\,\varepsilon_M^c}_{\text{goods-market}}+\underbrace{\left[w-(1-\eta_\ell(\theta_\ell))\,\alpha g_c(\theta_c)\frac{y}{\ell}\right]e\,\varepsilon_M^\ell}_{\text{labor-market}}$$
$$+\underbrace{\left[r-\frac{(1-\eta_h(\theta_h))\,\omega}{h\lambda}\right]h\,\varepsilon_M^h}_{\text{housing-market}}=0. \tag{11}$$

The three terms in brackets capture the deviation of $\{\lambda, r, w\}$ from the levels implied by the implementation conditions (7)–(9). A positive value of one of these terms corresponds to a case where the associated market is slack (the price is too high) and welfare would increase from expanding activity in that market. A negative value corresponds to a case where the market is too tight. Each of the terms is weighted by the quantity of trade in the market (c, h, and e) and by the sensitivity of market tightness to policy ε_M^j. At the optimum, positive contributions in some markets must offset negative contributions in others.

Illustrating policy trade-offs. Figure 3 represents the policy trade-off in the $(c/c^*, h/h^*)$ plane and plots two distinct objects. At the fixed wage $w = w^*$, any admissible pair (c, h) determines market tightnesses, employment, production, and search, through firm optimality and the matching and production constraints, as derived in Appendix A.8. Substituting this mapping into the central bank's objective gives

$$\mathcal{W}(c,h) \equiv \log c + \omega \log h - \rho_c s_c(c) - \rho_h s_h(h),$$

where $s_c(c)$ and $s_h(h)$, with some abuse of notation, are the search efforts implied by the allocation mapping. The blue iso-welfare curves represent the points that deliver the same welfare, $\mathcal{W}(c,h) = \overline{\mathcal{W}}$. The efficient allocation (c^*, h^*) is shown at point E.

The red policy-feasible curves represent the menu of equilibrium pairs (c, h), as expressed in eq. (A.12). For a fixed goods price P, rent R, and wage W, each money supply M implements one equilibrium pair (c, h); varying M traces the red curve. An increase in M raises real balances and lowers the shadow value of wealth, $\lambda = P/M$. At given c and h, this increases the surpluses from successful goods and housing matches (see (1a)–(1b)), and raises market tightness, following Proposition 2. Equilibrium purchases of goods and housing services therefore rise, moving the economy northeast along the curve.[10] The slope of the policy-feasible curve summarizes the key trade-off: reducing excessive housing-market activity requires sacrificing goods-market activity.

The feasible set depends on the relative prices r and w. The solid red curve corresponds to the efficient relative prices $r = r^*$ and $w = w^*$ and passes through the constrained-efficient allocation E. A fall in the rent to $r < r^*$ shifts the policy-feasible set upward to the dashed red curve. Holding the money supply at its pre-shock level then moves the economy from E to B: goods consumption remains at c^* because the goods-search condition is unchanged, while housing rises above h^*. A monetary contraction moves the economy southwest from B along the new policy-feasible curve, reducing both goods and housing activity. At O, the iso-welfare curve is tangent to the policy-feasible curve and welfare is maximized. The optimal policy therefore leaves the goods market slack, $\theta_c < \theta_c^*$ and partially corrects the housing-market distortion, leaving $\theta_h > \theta_h^*$.

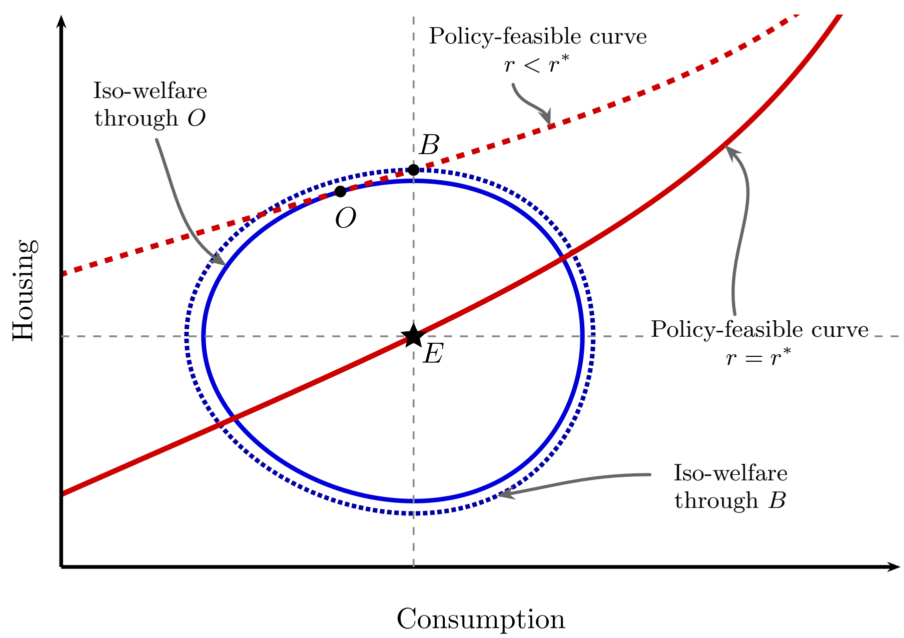

Figure 3: Illustration of the monetary-policy trade-off

Note: E is the constrained-efficient allocation; B holds the money supply unchanged after the rent decrease; O is the optimal policy. Parameters are $\rho_c = \rho_h = \rho_\ell = 0.5$, $\alpha = 0.5$, and $A = P = \omega = \gamma_j = 1$. The nominal wage is set to the efficient level $W = Pw^*$. The dashed red curve corresponds to $R_1 = 0.6R_0$ where $R_0 = Pr$. For the construction of the figure, see Appendix A.8.

[10] Firm optimality (3) and the binding labor-matching constraint (2) imply $c = (w/\alpha)e$. At the fixed real wage, higher labor-market tightness raises employment $e = g_\ell(\theta_\ell)$ and therefore goods consumption. Higher housing-market tightness raises $h = \bar{h}\, g_h(\theta_h)$.

3.3 Managing inefficient rents: Supply elasticity and sectoral stabilization

We now consider the policy response when the real rent differs from its constrained-efficient level, $r \neq r^*$, while the real wage remains at $w = w^*$. By (7)–(9), monetary policy can either jointly implement $\theta_c = \theta_c^*$ and $\theta_\ell = \theta_\ell^*$ or implement $\theta_h = \theta_h^*$, but it cannot implement efficient tightness in all three markets simultaneously. We show that, locally around the constrained-efficient allocation, more elastic goods supply calls for greater weight on stabilizing the goods market relative to housing. A lower prevailing rent calls for a monetary contraction, but a *less aggressive* one when goods supply is more elastic: policy is less willing to create slack in the goods and labor markets to reduce excess tightness in housing.

To isolate this elasticity effect, we adjust productivity as α varies to keep efficient output fixed and set the real wage at the level that implements efficiency in each economy, so that the efficient allocation is the same for every α.[11]

Proposition 4 (Optimal monetary policy)**.** *Let $A(\alpha) \equiv y^*/(\ell^*)^\alpha$, which holds efficient output at y^* for every α, and let $\mathcal{M}(r, \alpha)$ be the solution to (10) for a given r and α with $w = w^*$ as given by (9). Then*

$$\left.\frac{\partial \mathcal{M}}{\partial r}\right|_{r=r^*} > 0 \qquad \textit{and} \qquad \left.\frac{\partial^2 \mathcal{M}}{\partial r\, \partial \alpha}\right|_{r=r^*} < 0.$$

Proof. In Appendix A.9. □

Consider the first inequality. Suppose the economy is initially at the constrained-efficient allocation, with $r = r^*$ and $w = w^*$. A small shock lowers the prevailing real rent to $r < r^*$ while the real wage remains at w^*. The lower rent induces households to search more intensively than is efficient, leaving the housing market excessively tight, $\theta_h > \theta_h^*$. At the pre-shock money supply, the goods and labor markets remain at their efficient tightnesses. Their terms in the targeting rule (11) are therefore zero, whereas the housing-market term is not.

Starting from this post-shock allocation, a marginal monetary contraction yields a first-order welfare gain by reducing excess tightness in housing, whereas its goods- and labor-market welfare costs are second order in the size of the contraction. Optimal policy therefore accepts

[11] Efficient labor-market tightness satisfies $G_\ell'(\theta_\ell^*) = 0$, so θ_ℓ^* and ℓ^* depend only on the labor matching technology and recruiting cost. Using $c^* = g_c(\theta_c^*)y^*$, the planner's goods-market condition can be written as $g_c'(\theta_c^*)/g_c(\theta_c^*) = \rho_c y^*$. Thus, holding y^* fixed also holds θ_c^* fixed, and the implementing wage is $w^* = \alpha c^*/e^*$. The efficient housing-market condition does not involve α, so θ_h^* and h^* are also unchanged.

some slack in the goods and labor markets in exchange for a partial reduction of excess housing-market tightness. At the optimum, goods- and labor-market tightness are below their efficient levels and housing-market tightness remains above its efficient level.

The second inequality reflects how the goods-supply elasticity affects the cost of sacrificing goods- and labor-market stabilization to reduce excess tightness in housing. A reduction in goods demand lowers firms' probability of selling their output, $g_c(\theta_c)$, which reduces their hiring incentives as reflected in the firm's optimality condition (3). Firms post fewer vacancies and employment and production decline. The extent of the decline in production labor following a monetary contraction is impacted by supply incentives as embodied in (3), but is not affected by α to second order.[12] However, the same decline in production labor translates into a larger output loss when α is larger, since $\log(y/y^*) = \alpha \log(\ell/\ell^*)$. The larger output loss raises the welfare cost of tightening without changing the benefit of reducing the housing gap. Optimal policy therefore places greater weight on stabilizing the goods and labor markets relative to housing and contracts less aggressively.

As shown in Appendix A.11, a second-order approximation to the welfare loss around the constrained-efficient allocation is

$$\frac{1}{2}\left[(a_c + \alpha a_\ell)\widehat{c}^{\,2} + a_h \widehat{h}^{\,2}\right] \tag{12}$$

where $\widehat{c}$ and $\widehat{h}$ are the goods- and housing-consumption gaps (log deviations from c^* and h^*), and the coefficients a_c, a_ℓ, a_h, defined in (A.17), are independent of α under the normalization in Proposition 4. The term αa_ℓ reflects the labor-market consequences of a goods-consumption gap, and it scales with α since $a_\ell > 0$. The more elastic goods supply is, the more weight optimal policy places on stabilizing the goods market relative to the housing market. This is the opposite of the New Keynesian prescription, as we discuss next.

The role of the rationing protocol

We now contrast search rationing with demand-determined output, as in the New Keynesian model. Here, more elastic goods supply lowers the welfare cost of the goods-market slack

[12] See Lemma 3, parts (i)–(ii), in Appendix A.9. At the efficient allocation, reductions in employment and recruiting offset to first order and the second-order decline in production labor is the same across α for a given monetary contraction. Evaluating at the common efficient money supply,

$$\left.\frac{\partial^2 \ell}{\partial M^2}\right|_* = G_\ell''(\theta_\ell^*)\left(\left.\frac{\partial \theta_\ell}{\partial M}\right|_*\right)^2,$$

where both factors on the right-hand side are independent of α.

created by tightening, and policy therefore responds more aggressively to rent misalignments when α is higher.

To show this formally, we now modify the model to accommodate demand-determined rationing. Prices, rents, and wages are again fixed in nominal terms, but firms now produce goods and housing to meet demand, and households supply whatever labor is demanded. Because a fixed housing stock cannot accommodate arbitrary demand, we allow housing services to be produced from labor, with $h = n^{\kappa}$ and $\kappa \in (0, 1]$. Preferences are those of Section 2, with the search costs replaced by the disutility of the two labor inputs ℓ and n, used to produce goods and housing, respectively.[13]

The labor inputs are therefore $\ell = (c/A)^{1/\alpha}$ and $n = h^{1/\kappa}$. The economy is on the notional demand schedule (4), and consumption satisfies $c = M/P$ and $h = \omega M/(rP)$.

We have the following proposition.[14]

Proposition 5 (Optimal monetary policy with demand-determined output)**.** *Let* $A(\alpha) \equiv y^{*}\alpha^{-\alpha/(1+\sigma)}$*, which holds efficient output at* y^{*} *for every* α*, and let* $\mathcal{M}_D(r, \alpha)$ *be the optimal policy in the demand-determined economy. Then*

$$\left.\frac{\partial \mathcal{M}_D}{\partial r}\right|_{r=r^{*}} > 0 \qquad \textit{and} \qquad \left.\frac{\partial^2 \mathcal{M}_D}{\partial r\,\partial \alpha}\right|_{r=r^{*}} > 0.$$

Proof. In Appendix A.10. □

As under search rationing, a rent below r^{*} calls for a monetary contraction. However, in contrast to Proposition 4, the optimal monetary contraction is increasing in α. Consider again the same small monetary contraction across economies with different α. Under demand determination, output falls in line with sales: since $c = y = M/P$, the contraction produces the same decline in goods consumption and output for every α. With a more elastic goods supply, both the marginal product of labor in goods production and the marginal rate of substitution between consumption goods and labor become less sensitive to the level of production and the welfare consequences of depressing the level of goods production fall. As a result, optimal policy contracts more aggressively in response to the decrease in rents. Note that the supply-side incentives reflected in (3) in our baseline model do not operate under demand-determined output.

[13]That is, preferences are $\log(c) + \omega \log(h) + \log(m) - \frac{\ell^{1+\sigma}}{1+\sigma} - \frac{n^{1+\sigma}}{1+\sigma}$, where $\sigma > 0$ is the inverse Frisch elasticity of labor supply.

[14]Efficiency in this economy requires $(\ell^{*})^{1+\sigma} = \alpha$ and $(n^{*})^{1+\sigma} = \omega\kappa$, so h^{*}, the implementing rent, and the efficient money supply do not depend on α, whereas efficient production labor does.

As shown in Appendix A.11, a second-order approximation to the welfare loss around this economy's efficient allocation is

$$\frac{1+\sigma}{2}\left[\frac{\widehat{c}^2}{\alpha}+\frac{\omega\widehat{h}^2}{\kappa}\right], \tag{13}$$

In contrast to (12), a higher α lowers the coefficient on the goods-consumption gap, while the housing term is again unchanged. The lower cost of depressing goods consumption therefore calls for a larger monetary contraction.[15]

Takeaway. How monetary policy balances sectoral distortions depends on how quantities are rationed when prices do not clear. Under search rationing, more elastic goods supply raises the welfare cost of the slack created by tightening policy; under demand-determined output, it lowers the cost of the associated consumption shortfall. Policy therefore responds less aggressively to inefficient rents when goods supply is more elastic in the former case and more aggressively in the latter. In the next section, we develop and calibrate a dynamic model to assess how these trade-offs shape the optimal response to housing inflation and the relative emphasis on stabilizing the goods, labor, and housing markets.

4 The dynamic model

We now present an infinite-horizon version of our model, which we will use for quantitative evaluation of the trade-offs in managing an increase in housing inflation. The dynamic model retains the three-market search structure of Section 2, as well as the same preferences and technology, but makes the following three changes. First, matches in the labor and housing markets are long-lived, so search decisions in those markets are forward looking. Second, nominal prices adjust gradually toward the levels that implement efficient search, which links the static relative-price gaps of Section 3 to price changes. Third, part of the housing stock is occupied by households with strong attachment to their homes who do not search or move houses. This assumption implies transacted housing services are only a part of the total housing services measured in the CPI.

[15]These results are consistent with Eusepi et al. (2011), whose optimal price index places a higher weight on sectors with a lower labor share.

4.1 Environment

A representative household has preferences given by:

$$\sum_{t=0}^{\infty} \beta^t \left\{ \log c_t + \omega_t \log\left(h^o + h_t\right) - \rho_c s_{c,t} - \rho_h s_{h,t} \right\},$$

where the taste for housing ω_t now varies over time.[16] We consider a perfect-foresight transition path induced by changes in $\{\omega_t\}_{t=0}^{\infty}$ that are realized at date 0. Housing services $h^o + h_t$ are the housing units occupied between t and $t+1$, of which only h_t is transacted through search. Because shelter inflation measures in the United States include owners' equivalent rent, price indexes place a weight on the housing consumption of households even if they have not made a housing transaction in many years. We include the parameter h^o to stand in for units whose occupants make no mobility or search decisions; for instance, long-tenured homeowners with strong attachments to their homes.

The search process for goods is the same as in Section 2. For production, we set $\alpha = 1$, so output is $y_t = A_t \ell_t$. The labor and housing markets now feature long-lived matches. We normalize both the labor force and the searchable housing stock to one, so $e_t \in [0, 1]$ and $h_t \in [0, 1]$ denote the respective matched stocks. Thus, $\bar{h} = 1$ throughout this section. In each market j, a fraction δ_j of existing matches separates every period, and new matches pair the searching input with the available vacancies:

$$e_t = (1 - \delta_\ell)\, e_{t-1} + f_\ell(\theta_{\ell,t})\, v_t, \qquad \theta_{\ell,t} \equiv \frac{v_t}{1 - (1 - \delta_\ell) e_{t-1}}, \tag{14}$$

$$h_t = (1 - \delta_h)\, h_{t-1} + f_h(\theta_{h,t})\, s_{h,t}, \qquad \theta_{h,t} \equiv \frac{s_{h,t}}{1 - (1 - \delta_h) h_{t-1}}. \tag{15}$$

The matching functions $\mathbb{M}_j$ now pair the searching input (v_t or $s_{h,t}$) with the stock that is unmatched at the start of the period. Employment continues to be split between production and recruiting, $\ell_t + \rho_\ell v_t = e_t$.

Prices and nominal rigidities. Search frictions allow a range of transaction prices to be consistent with voluntary trade. We assume that nominal rigidity takes the form of gradual adjustment toward efficient benchmarks. Let P_t^* denote the nominal price benchmark

[16] This utility function implicitly assumes a unit elasticity of substitution between housing and goods and a unit intertemporal elasticity of substitution. The former is consistent with the evidence presented by Davis and Ortalo-Magné (2011). We also drop real money balances and assume monetary policy can directly control the nominal interest rate, following Woodford (2003).

associated with efficient goods-market search, defined by

$$P_t^* \equiv P_t \frac{1-\eta_{c,t}}{\lambda_t c_t}, \qquad \eta_{c,t} \equiv \eta_c(\theta_{c,t}). \tag{16}$$

Rearranging this equation, we can see that P_t^* is the nominal price at which the static implementation condition (7) holds. We assume that

$$P_t = \chi_c P_{t-1} + (1-\chi_c)\, P_t^*, \tag{17}$$

where the parameter $\chi_c \in [0,1]$ governs the degree of nominal rigidity: larger values imply more gradual adjustment, with $\chi_c = 1$ corresponding to completely rigid prices and $\chi_c = 0$ implying fully flexible goods prices. This gradual nominal-adjustment rule is similar to those used in Hall (2003) and Blanchard and Gali (2007) in the context of imperfect real wage adjustment.[17] Dividing (17) by P_{t-1} yields $\Pi_t \equiv P_t/P_{t-1} = \chi_c/\big(1-(1-\chi_c)\,p_t^*\big)$, where $p_t^* \equiv P_t^*/P_t$.

We assume analogous nominal rigidities for housing and wages:

$$W_t = \chi_\ell W_{t-1} + (1-\chi_\ell)\, W_t^*, \tag{18}$$

$$R_t = \chi_h R_{t-1} + (1-\chi_h)\, R_t^*. \tag{19}$$

The nominal wage and rent benchmarks are $W_t^* \equiv P_t w_t^*$ and $R_t^* \equiv P_t r_t^*$, where w_t^* and r_t^* are the real wage and real rent that implement efficient search as defined by the dynamic analogues of the static implementation conditions (8) and (9), which we provide below.

There are several points to note about our formulation of nominal price adjustment. First, a constrained-efficient transition path corresponds to stable prices in each of the three markets. Second, a shock that changes the efficient relative prices breaks the divine coincidence because the required relative-price adjustment makes it impossible for monetary policy to eliminate distortions in all markets simultaneously.[18] Third, in a zero-inflation steady state, the allocation is efficient.[19]

[17]A micro-founded rigidity, as in the Calvo (1983) or Taylor (1980) models, would yield a similar equation to first order, with the difference that the target would be a forward-looking reset price rather than the efficient price.

[18]To see this, consider an increase in ω_t, which raises r_t^*. The evolution of the real rent satisfies $r_t = r_{t-1}\Pi_t^R/\Pi_t$, where $\Pi_t^R \equiv R_t/R_{t-1}$ is gross new-lease rent inflation and Π_t is gross goods inflation. Tracking r_t^* therefore requires positive rent inflation, negative goods inflation, or both. But (17) and (19) imply that gross goods and rent inflation differ from one only if prices deviate from those that implement the constrained-efficient allocation.

[19]With an inefficient steady state, there would be an incentive for monetary policy to re-optimize even in the absence of shocks. Analysis of optimal monetary policy would then require us to separate the policy response to the shock and to the initial conditions, for example, using the timeless perspective.

In addition to the gradual adjustment of the rent on new leases, we also assume that rents are rigid within a match. R_t is the rent agreed to when a lease is signed at date t; once signed, the rent is fixed in nominal terms until the match dissolves (with probability δ_h per period) or a renegotiation shock arrives (with probability ξ per period), at which point it resets to the current R_t.[20] The rigidity in rents within a match does not, in and of itself, affect search decisions because what matters is how the surplus of the match is split in present value terms. We include it because it is relevant for the measurement of shelter inflation, which reflects the average outstanding rent rather than rents on newly-signed leases. However, there is some interaction between the rigidity in new rents and the rigidity in old rents—distortions in new rents have a larger impact on search incentives if the distorted rent will be locked in for the term of the lease.

4.2 Decision problems

Household's problem. We present the household problem in recursive form. The household's state variables include the housing units rented in the previous period, denoted by h_{-1}, a committed nominal rent bill (before separations and renegotiation), denoted by X_{-1}, and nominal bonds, denoted by B_{-1}. The rent paid today consists of three components: (i) the rent already committed (i.e., the rent on units that do not get separated or renegotiated), given by $(1-\delta_h)(1-\xi)X_{-1}$; (ii) the rent that is renegotiated, which amounts to $(1-\delta_h)\xi h_{-1}R_t$; and (iii) the rent on new matches, which results in a rent bill of $R_t f_h(\theta_{h,t})s_h$.

Each period, the household chooses to consume goods and housing with an understanding that consuming more requires more search effort. We let H_t denote the value function of the household, where the subscript t indexes the evolution of the aggregate states. We can express the problem of the household as follows:

$$H_t(h_{-1}, X_{-1}, B_{-1}) = \max_{\substack{c,h,X,\\ s_c,s_h,B}} \Big\{ \log c + \omega_t \log\left(h^o + h\right) - \rho_c s_c - \rho_h s_h + \beta H_{t+1}\left(h, X, B\right) \Big\},$$

[20] The literature on labor search is also concerned with a similar issue regarding the flexibility of wages for new hires (see, in particular Hazell and Taska, 2025 for recent evidence). While the literature on rent rigidity is less developed, considerations like rent control suggest significant rigidity in new rents. Notice that if the rent is fixed at too low a level, the landlord may want to break the lease in order to obtain the market rent. We assume that this is not possible as the lease forces both parties to commit to both the rent and the (stochastic) term of the lease.

subject to the following constraints (with Lagrange multipliers in brackets)

$$
\begin{aligned}
P_t c + \frac{B}{1+i_t} + X = B_{-1} + W_t e_t + d_t \qquad & [\lambda_t/P_t], \\
c = f_c(\theta_{c,t})\, s_c \qquad & [\mu_{c,t}], \\
h = (1-\delta_h)h_{-1} + f_h(\theta_{h,t})\, s_h \qquad & [\mu_{h,t}], \\
X = (1-\delta_h)(1-\xi)X_{-1} + R_t\left[\xi(1-\delta_h)h_{-1} + f_h(\theta_{h,t})\, s_h\right] \qquad & -[\psi_t/P_t],
\end{aligned}
$$

where d_t denotesdividends from firms and landlords and i_t denotes the nominal interest rate. The average nominal rent on outstanding leases is $\bar{R}_t \equiv X_t/h_t$; this is the rent used when constructing measured shelter inflation. Note that the household supplies labor inelastically and takes the employment rate, e_t, as given. The first-order conditions of this problem yield the following system of equations:

$$
\lambda_t = \beta \frac{1+i_t}{\Pi_{t+1}} \lambda_{t+1} \tag{20}
$$

$$
\rho_c = f_c(\theta_{c,t}) \left(\frac{1}{c_t} - \lambda_t \right) \tag{21}
$$

$$
\psi_t = \lambda_t + \beta(1-\delta_h)(1-\xi) \frac{\psi_{t+1}}{\Pi_{t+1}} \tag{22}
$$

$$
\rho_h = f_h(\theta_{h,t})\,(\mu_{h,t} - r_t \psi_t) \tag{23}
$$

$$
\begin{aligned}
\mu_{h,t} - r_t\psi_t = & \frac{\omega_t}{h^o + h_t} - r_t \lambda_t \\
& + \beta(1-\delta_h)\left[\mu_{h,t+1} - r_{t+1}\psi_{t+1} + (1-\xi)\psi_{t+1}\left(r_{t+1} - \frac{r_t}{\Pi_{t+1}}\right)\right]
\end{aligned} \tag{24}
$$

Equation (20) is the Euler equation for nominal bonds. Equation (21) equates the marginal cost of searching for goods to the expected value of a match: the probability of finding a good times the surplus, which is the marginal utility of consumption less the cost of the good at a relative price of one.

The last three conditions concern housing, where a match commits the household to a stream of nominal rent payments. Equation (22) defines the marginal cost of adding a unit to the rent bill, ψ_t: the household incurs a cost λ_t today and, with probability $(1-\delta_h)(1-\xi)$, carries the same nominal obligation into the next period. Equation (23) is the search condition for housing: the marginal disutility of search equals the probability of finding a unit times the surplus from a new lease, $\mu_{h,t} - r_t\psi_t$, the value of an additional occupied unit net of the rent commitment that comes with it. Finally, equation (24) determines this surplus recursively: it is the service flow $\omega_t/(h^o + h_t)$ less the rent payment valued at the marginal utility of income, plus, if the match survives, the continuation surplus $\mu_{h,t+1} - r_{t+1}\psi_{t+1}$ and the term $(1-\xi)\psi_{t+1}(r_{t+1} - r_t/\Pi_{t+1})$, which captures the gain from rent stickiness within the match: with probability $1-\xi$ the lease is not renegotiated, so the household keeps paying the old nominal rent, worth r_t/Π_{t+1} in real terms, rather than the market rent r_{t+1}.

Firm's problem. The firm chooses how much labor to hire subject to the costs of hiring and recognizing that frictions in the goods market mean that not all of its output is sold. Expressed in real terms, the objective of the firm is to solve

$$\begin{aligned} F_t(e_{-1}) = \max_{\ell,v}\ & \lambda_t \left[g_c(\theta_{c,t}) A_t \ell - w_t(\ell + \rho_\ell v) \right] + \beta F_{t+1}(\ell + \rho_\ell v) \\ \text{s.t. } & \ell + \rho_\ell v \leq (1-\delta_\ell) e_{-1} + f_\ell(\theta_{\ell,t})\, v \qquad [\zeta_{\ell,t}]. \end{aligned}$$

Recall that λ_t is the household's shadow value of wealth. The first-order conditions lead to

$$\zeta_{\ell,t} = \lambda_t \left[g_c(\theta_{c,t}) A_t - w_t \right] + \beta(1-\delta_\ell)\zeta_{\ell,t+1} \tag{25}$$

$$f_\ell(\theta_{\ell,t})\zeta_{\ell,t} = \rho_\ell \lambda_t g_c(\theta_{c,t}) A_t. \tag{26}$$

Equation (25) determines the value of an employment match to the firm, $\zeta_{\ell,t}$: the match yields a flow profit equal to the expected marginal product of labor, $g_c(\theta_{c,t})A_t$, net of the real wage, valued at the household's marginal utility of income, plus the continuation value of the match if it survives, with probability $1-\delta_\ell$. Equation (26) is the first-order condition for vacancy posting: the expected yield of a vacancy—the probability $f_\ell(\theta_{\ell,t})$ of filling it times the value of the match—equals its cost, the forgone output of the ρ_ℓ units of labor used for recruiting. A slack goods market lowers $g_c(\theta_{c,t})$ and hence the return to hiring, discouraging vacancy creation for a given real wage.

4.3 Competitive equilibrium

An equilibrium consists of sequences of prices $\{i_t, \Pi_t, w_t, r_t\}$, market tightnesses $\{\theta_{c,t}, \theta_{\ell,t}, \theta_{h,t}\}$, quantities $\{c_t, e_t, \ell_t, h_t, B_t\}$, search efforts $\{s_{c,t}, v_t, s_{h,t}\}$, X_t, and Lagrange multipliers $\{\lambda_t, \mu_{h,t}, \psi_t, \zeta_{\ell,t}\}$ such that: households and firms optimize, as summarized by (20)–(24) and (25)–(26); quantities satisfy $c_t = f_c(\theta_{c,t})s_{c,t}$, $\ell_t + \rho_\ell v_t = e_t$, the bond market clears $B_{t+1} = 0$, and the laws of motion (14)–(15), with tightness given by its definition in each market and the rent bill X_t evolving as in the household's problem; prices satisfy (17), (18), (19), and a monetary policy rule specified below.

4.4 Constrained planner's problem

The planner chooses quantities and search efforts subject to the production and matching technologies. Letting V_t denote the planner's value function, in recursive form, the problem is

$$V_t(e_{-1}, h_{-1}) = \max_{c,e,h,s_c,v,s_h} \Big\{ \log c + \omega_t \log (h^o + h) - \rho_c s_c - \rho_h s_h + \beta V_{t+1}(e, h) \Big\},$$

subject to the following constraints (with Lagrange multipliers in brackets)

$$c = \mathbb{M}_c\big(s_c,\, A_t(e - \rho_\ell v)\big) \qquad [S_{c,t}]$$

$$e = (1-\delta_\ell)\, e_{-1} + \mathbb{M}_\ell\big(v,\, 1-(1-\delta_\ell)e_{-1}\big) \qquad [S_{\ell,t}]$$

$$h = (1-\delta_h)\, h_{-1} + \mathbb{M}_h\big(s_h,\, 1-(1-\delta_h)h_{-1}\big) \qquad [S_{h,t}].$$

The multiplier $S_{c,t}$ is the marginal social value of goods, while $S_{\ell,t}$ and $S_{h,t}$ are the social values of an employment match and a housing match.

The planner's problem defines the benchmarks towards which relative prices adjust. Because goods-market matches last a single period, the planner's goods-market condition is simply (6a) imposed period by period, and the efficient price is (16). Because matches in the housing and labor markets are persistent, the equations that characterize the match surpluses are dynamic. Despite that complication, the Hosios condition logic of (8)–(9) continues to apply. For housing, the social value of a match and the rent that implements efficient search are given by (see Appendix B.1 for the derivation)

$$S_{h,t} = \frac{\omega_t}{h^o + h_t} + \beta(1-\delta_h)\left[(1 - g_h(\theta_{h,t+1}))\, S_{h,t+1} + \rho_h \theta_{h,t+1}\right] \tag{27}$$

$$\eta_h(\theta_{h,t})\, S_{h,t} = \mu_{h,t} - \psi_t r_t^*. \tag{28}$$

Equation (27) values a housing match just as the household's problem does in (24). The social value is distinguished from the private value in three ways. First, the planner is unconcerned with rent payments as they are simply transfers. Second, the continuation value is scaled by $1 - g_h(\theta_{h,t+1})$ because, had the unit been vacant, it would have been matched anyway with probability $g_h(\theta_{h,t+1})$. And, third, the term $\rho_h \theta_{h,t+1}$ credits the match with the search costs it saves, since with more units matched, the same market tightness requires less search effort.[21] Equation (28) is the Hosios condition: r_t^* is the rent at which the household's surplus from a new lease, $\mu_{h,t} - r_t^* \psi_t$ (cf. (23)), equals the share η_h of the social value.

[21] From the definition of $\theta_{h,t}$, the level of search effort consistent with a given $\theta_{h,t}$ is $s_{h,t} = \theta_{h,t}[1-(1-\delta_h)h_{t-1}]$. Increasing h_{t-1} therefore reduces $s_{h,t}$ by $(1-\delta_h)\theta_{h,t}$ units.

For labor, analogously,

$$S_{\ell,t} = A_t g_c(\theta_{c,t})\lambda_t + \beta(1-\delta_\ell)\left[(1-g_\ell(\theta_{\ell,t+1}))\,S_{\ell,t+1} + \rho_\ell \theta_{\ell,t+1} A_{t+1} g_c(\theta_{c,t+1})\lambda_{t+1}\right] \quad (29)$$

$$\eta_\ell(\theta_{\ell,t})\,S_{\ell,t} = g_c(\theta_{c,t})A_t\lambda_t - \lambda_t w_t^* + \beta(1-\delta_\ell)\,\eta_\ell(\theta_{\ell,t+1})\,S_{\ell,t+1}. \quad (30)$$

Equation (29) is the labor counterpart of (27), with the flow value of a match given by the expected marginal product of labor valued at the household's marginal utility of income. Equation (30) is the labor-market Hosios condition: at w_t^*, the value of a match to a firm that pays the efficient wage for the life of the match equals the share η_ℓ of the social value of the match. Together with the goods-market condition above, these equations determine the constrained-efficient prices $\{p_t^*, w_t^*, r_t^*\}$ along with the social values $\{S_{h,t}, S_{\ell,t}\}$.[22]

5 Calibration

We calibrate the model to a monthly time period and treat 2019 as a steady state; Table 1 summarizes the parameter values. We set the matching-function curvature parameter to $\gamma_j = 1$ in all markets.[23]

Table 1: Calibration of model parameters

Parameter	Target	Value
β	Steady state interest rate	$1.02^{-1/12}$
ω	Housing expenditure share	0.18
$h^o/(h+h^o)$	ACS housing turnover (see text)	0.71
δ_h	ACS housing turnover (see text)	0.035
δ_ℓ	Monthly job-separation rate	0.045
ρ_c	Goods vacancy rate	0.0023
ρ_ℓ	Unemployment rate	0.205
ρ_h	Rental housing vacancy rate	0.173
γ_j	Matching-function curvature	1
ξ	70% of continuing rents unchanged over six months	0.06
$\chi_c = \chi_\ell = \chi_h$	Klenow and Malin (2010)	0.92

[22] In the price adjustment process, $\{p_t^*, w_t^*, r_t^*\}$ are determined by (16) and (27)–(30) evaluated at the competitive equilibrium allocation.

[23] Ngai, Iglhaut, Sheedy, Wu and Zhang (2026) estimate a Cobb-Douglas matching function using data on Chinese real estate transactions and find an elasticity of transactions with respect to buyers of 0.5, which is consistent with our specification in that buyers and sellers contribute equally to the matching process. We do not know of estimates of matching functions for housing rental markets specifically or goods markets. In the context of the labor market, Petrongolo and Pissarides (2001) survey estimates of the matching functions and find an elasticity of hires with respect to unemployed workers in the range 0.5 to 0.7.

The preference for housing, ω, is set to match the housing expenditure share.[24] The parameter h^o is intended to capture housing services consumed by households that are strongly attached to their homes and unlikely to search or relocate. Figure C.1 in the appendix plots the distribution of the length of residence among renters and homeowners in the 2019 American Community Survey. A single hazard rate δ_h cannot fit this distribution because matching the many short residence spells requires a high δ_h, while matching the substantial share of households with residence durations of 20 years or more requires a low one. Instead, we fit a two-type model in which households may have a high δ or a low δ, which we estimate via maximum likelihood. The fitted model allocates 71% of the population a low δ of 0.005 and the remainder a high value of 0.035. Based on this analysis we assume that h^o accounts for 71% of the housing services consumed and we set δ_h to the high value of 0.035. We set the monthly frequency of the renegotiation shock to $\xi = 0.06$ based on the findings of Gallin, Loewenstein, Montag and Verbrugge (2024), who find that about 70% of continuing tenants experience no rent change over a six-month period.

The search costs (ρ_c, ρ_h, and ρ_ℓ) determine the steady-state rates of unsold goods, vacant housing units, and unemployed workers. For labor and housing, there are clear data analogs: the unemployment rate and the housing vacancy rate, which averaged 4.9% and 6.6%, respectively, in 2019. For the goods market, we interpret inventories as a measure of idleness. Our interpretation is that the cost of holding inventories is the cost of having idle goods to facilitate trade, which we view as the empirical counterpart to the model's assumption that some goods are produced but not sold. The Census Bureau reported an inventory-sales ratio of 1.5 in 2019 (averaged across months). This ratio is the level of inventories held by retail trade, wholesale trade, and manufacturing firms divided by the monthly sales of those firms. Nahmias and Olsen (2015) report that inventory holding costs per year are on the order of 37% of the value of inventories. The flow cost of inventory holding is then $1.5 \times 0.37/12 = 4.6\%$ of sales.[25] For the job-separation rate, we set δ_ℓ to match an employment outflow rate of 4.5% from Elsby, Hobijn and Şahin (2015). To gauge the welfare costs of search frictions, note that the vacancy rates represent lost opportunities to produce and consume. Without search frictions, output would be 5% higher and consumption would be 10% higher because there is more output and all of it is consumed. Transacted housing consumption, h, would be 7% higher.

The traditional approach to calibrating the degree of nominal rigidity in the New Keynesian

[24]Housing expenditures including owners' equivalent rent are a share $\omega/(1+\omega)$ of total expenditures. A value of $\omega = 0.18$ matches the 15% share in the data.

[25]This calculation is best thought of as follows: you hold a good for 1.5 months before selling it or 1.5/12 years.

literature makes reference to measures of price adjustment frequencies. In the log-linearized Calvo model of price setting, inflation is related to the reset price by $\log \Pi_t = \frac{1-\phi}{\phi} \hat{p}^R_t$, where $1-\phi$ is the probability that a price changes in a given period and $\hat{p}^R_t$ is the log-deviation in the reset price. If we log-linearize (17), we find $\log \Pi_t = \frac{1-\chi_c}{\chi_c} \hat{p}^*_t$. This logic motivates us to set χ_c based on the same evidence that supports the calibration of ϕ in the Calvo model, namely price adjustment frequencies.[26] Klenow and Malin (2010) find a median price duration of 8.3 months when they exclude sales and product substitutions. This price duration corresponds approximately to $\chi_c = 0.92 \approx 11/12$ (monthly). A median price duration of 8.3 months is on the upper end of the range reported by Klenow and Malin (2010). We use this as our preferred calibration because our model does not include any real rigidities or intermediate input linkages that amplify the effects of nominal rigidities. We set χ_ℓ and χ_h to the same value as χ_c to make clear that our results are not driven by differential degrees of price rigidity across sectors as in the analysis of Aoki (2001).[27] Our results are not sensitive to the exact specification of rent rigidity. Under the logic that policy should place more weight on sectors with stickier prices, our results could potentially be overturned if new rents are actually much more rigid than our calibration implies. However, we show in Appendix Figure C.2 that optimal policy still places a low weight on housing stabilization even at high values of χ_h.

6 Monetary policy responses to housing inflation

We now present our quantitative results. Section 6.1 presents the shock to housing demand that we analyze. Under flexible prices, this shock would induce an immediate increase in real rents. However, with nominal rigidities, this relative price adjustment takes time. In the interim, policy faces a trade-off between stabilizing the goods and labor markets and stabilizing the housing market. Section 6.2 considers alternative monetary policy responses to the housing demand shock and presents our main results on optimal policy. Section 6.3 describes the roles of various model features in our main results. Section 6.4 considers a productivity shock.

[26]We note that the reset price and our efficient price are not identical concepts. One could define the efficient price in the standard New Keynesian model as the price corresponding to zero markup over marginal cost. In studies of optimal policy, it is common to add a production subsidy so that the steady state markup is zero and the reset price is equal to the efficient price in steady state. In response to shocks, the reset price does not follow the efficient price perfectly because the firm sets its price as a function of the expected discounted average marginal cost until the next price adjustment. With mean reverting shocks to marginal cost, the reset price will be less volatile than the efficient price.

[27]Evidence reviewed in Taylor (1999) shows similar degrees of rigidity in wages and prices.

6.1 Simulating pandemic-era shelter inflation

Following the COVID pandemic, advanced economies experienced a rapid increase in inflation. Rising costs for shelter contributed substantially to the inflation surge and, for several years, were a key reason that inflation remained above target, as shown in Figure 4.[28] We now use the model to revisit this episode and ask how monetary policy should respond.

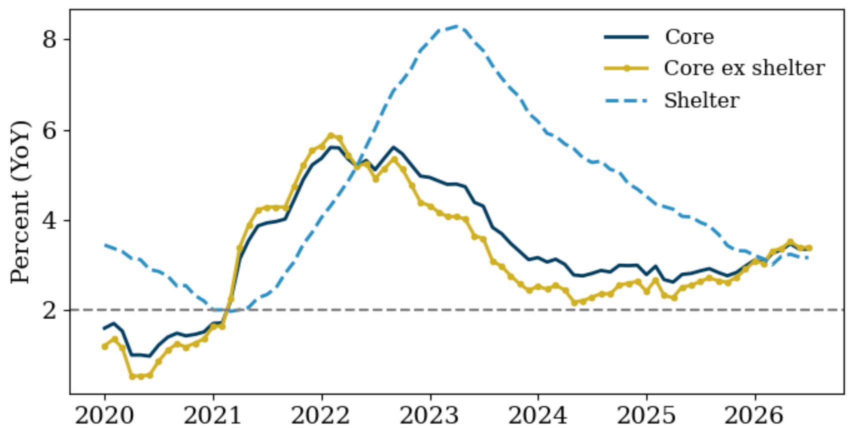

Figure 4: US PCE inflation

Source: Bureau of Economic Analysis. The data are through July 2026.

We simulate a one-time, unexpected, permanent increase in the taste for housing, ω_t, from 0.18 to 0.20, occurring in March 2021. The shock raises the efficient relative price of housing: the household now derives more utility from housing, so the surplus from a housing match is larger. Depending on the monetary policy response, this relative price adjustment can come about through a rise in rents, a fall in goods prices, or some combination of the two. As a starting point, we assume that monetary policy holds nominal goods prices constant, so the entire adjustment occurs through rents.

The bottom-left panel of Figure 5 shows that the efficient relative rent rises immediately following the shock while r_t only responds gradually due to nominal rigidities. The top-right panel plots the resulting growth in R_t alongside the Zillow Observed Rent Index, which reflects asking rents on units currently listed for rent.[29] We choose the scale of the shock to match the magnitude of the rent increase in this figure. Even though the shock is a one-time permanent change, the model's rent inflation dynamics track the Zillow series closely.

[28]While our focus is on the US, shelter inflation made a large contribution to core inflation in other advanced economies, including the UK and Canada.

[29]The Zillow index is smoothed with a three-month moving average and we apply the same smoothing to our model-generated series.

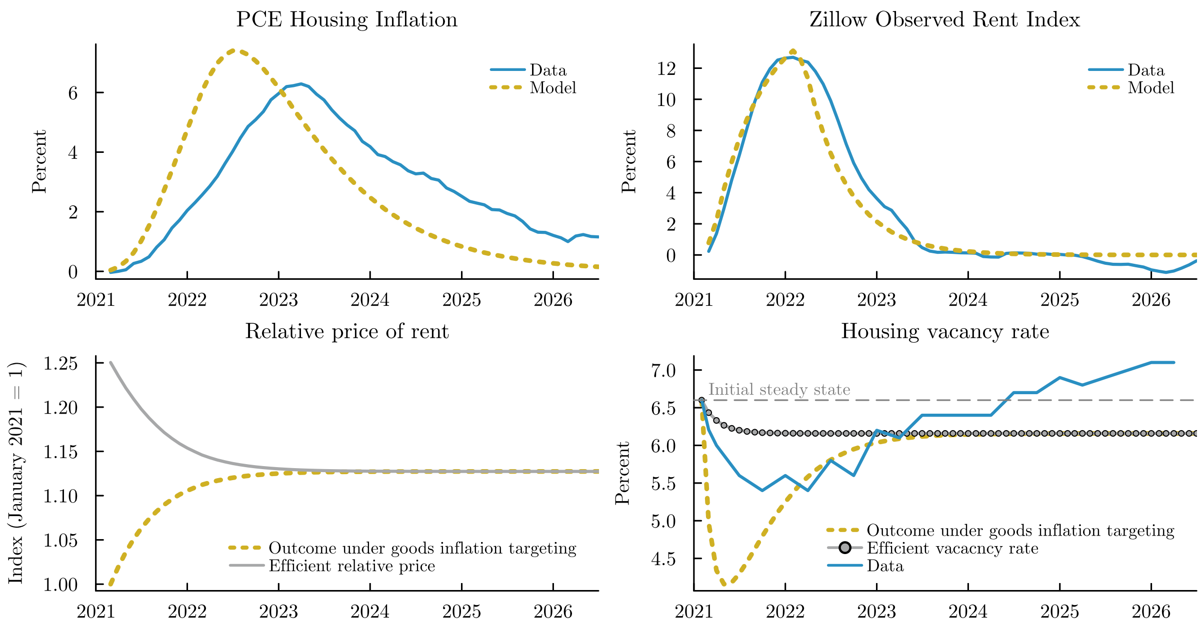

Figure 5: A permanent increase in ω in March 2021 under goods inflation targeting

Note: Inflation rates and market rent growth are expressed in percent at an annual rate and smoothed in alignment with the construction of the corresponding empirical data series. We shift the inflation of the PCE index down by 2 percentage points to account for trend inflation. We shift the growth of the Zillow index down by a further 0.8 percentage points to account for the pre-pandemic difference in its growth rate from that of the PCE index. The model vacancy rate is $100 \times (1 - h)$. The data for the vacancy rate come from the Census Bureau measure and we subtract 0.2 percentage points so the 2021 Q1 data point aligns with the model's initial steady state in February 2021.

Turning to PCE housing inflation, the PCE price index seeks to measure the cost of living and therefore depends on the average rent paid, $\bar{R}_t$ in the model, as opposed to asking rents. The top-left panel of Figure 5 shows that the model generates a similar magnitude of PCE housing inflation albeit somewhat more rapidly than the data.[30]

The bottom right panel of Figure 5 shows the housing vacancy rate. The shock raises the value of housing services relative to search costs so the planner would like the economy to utilize more housing and drive the vacancy rate down. This is shown as the efficient vacancy rate in the figure. Due to rent rigidities and a monetary policy of targeting goods inflation, actual rents do not rise as quickly as is necessary to implement the efficient vacancy rate. As a result, households search more aggressively for housing and the vacancy rate temporarily falls below the efficient level until the rents have properly adjusted. For comparison, the figure also shows data on the vacancy rate of rental housing, which also fell fairly sharply during 2021 although not as much as in the model simulation.

6.2 Monetary policy alternatives

We have just discussed how, in our simulation with a policy of goods inflation targeting, nominal rigidity in rents results in an inefficiently low housing vacancy rate after a housing demand shock. The low vacancy rate is socially inefficient because searching household members do not internalize how their search effort reduces the chances that other searching households find a vacant unit. If households reduced search effort, welfare would improve because the gains from lower search effort would exceed the cost of consuming less housing. By pursuing a tighter monetary policy, the policymaker could reduce the amount households search. However, such a strategy also reduces how much they search for goods and how much firms search for workers. Under the reference point of goods inflation targeting, these goods and labor search efforts are at the efficient levels. So the quantitative question is, how much should policy reduce goods and labor demand to temper housing demand?

Continuing with the unexpected and permanent increase in the preference weight on housing ω, we evaluate three alternative monetary policy responses:

(i) CPI targeting. Under this policy, the monetary authority sets CPI inflation to zero. Gross CPI inflation is defined as $\Pi_t^{1-\nu_h}(\bar{R}_t/\bar{R}_{t-1})^{\nu_h}$, where the fixed housing weight $\nu_h \equiv \omega/(1+\omega)$ reflects total "expenditures" on housing, including owners' equivalent

[30] The Bureau of Labor Statistics surveys households on a six-month frequency and then computes monthly shelter inflation as the sixth root of the six-month change. The BLS measure is used in both the CPI and PCE price indexes. For our model-generated series, we compute the average rent on outstanding leases and then construct a monthly series based on the six-month changes just as the BLS does.

rent. Because the CPI is a cost-of-living price index, it depends on the average rent across all tenants, $\bar{R}_t$, rather than the rent on new leases.

(ii) Goods inflation targeting. Under this policy, the monetary authority sets goods inflation to zero (i.e., $\Pi_t = 1$).

(iii) Optimal monetary policy. Under this policy, the monetary authority maximizes the welfare of the representative household subject to the competitive equilibrium conditions.[31]

We solve for a perfect-foresight, nonlinear transition following the shock under these three different monetary policy strategies.

Figure 6 shows the results. Our main result is that optimal policy is almost indistinguishable from the policy of goods inflation targeting. Under a goods inflation targeting policy, goods inflation is kept at zero; thus, the rise in the relative price of housing implies that the CPI must increase. As the figure shows, this policy maintains consumption at the steady state value. In contrast, under a CPI targeting policy, the increase in the relative price of housing requires a decrease in goods prices to offset the rise in rents. As the figure indicates, this policy results in a recession in the goods sector, with consumption of goods falling by about 0.7%. The bottom panels of Figure 6 show the policy trade-off: tighter policy as in CPI targeting moves the housing vacancy rate up towards the efficient vacancy rate, but at the cost of reducing consumption. Quantitatively, the terms of this trade-off result in the optimal policy ignoring the inefficiency of the housing market and focusing on goods inflation.

6.3 Why is ignoring housing inflation optimal?

To inspect our quantitative findings, we repeat our analysis with several alternative calibrations of the model. We begin with a version of our model in which the housing and goods sectors are symmetric and wages are flexible. With flexible wages, labor market tightness is constant at θ_ℓ^* and so labor utilization and the supply of goods become inelastic. To make the housing market symmetric with the goods market, we set $\delta_h = 1$ and $h^o = 0$, so that every housing match lasts a single period and all housing services are transacted through search. We recalibrate the search costs ρ's to match a 6% idleness rate in each market again for

[31] We assume the government has commitment. To compute the optimal policy, we stack the transition path of the equilibrium variables in the vector $\mathcal{X}$. The dimension of $\mathcal{X}$ is nT where we have n variables per time period and a transition of length $T = 240$ months after which we assume the economy has reached the new steady state. We then stack the $(n-1)T$ equilibrium equations in $\mathcal{F}(\mathcal{X}) = 0$. We then maximize welfare subject to $\mathcal{F}(\mathcal{X}) = 0$ and find the nonlinear solution to this problem using Newton's method.

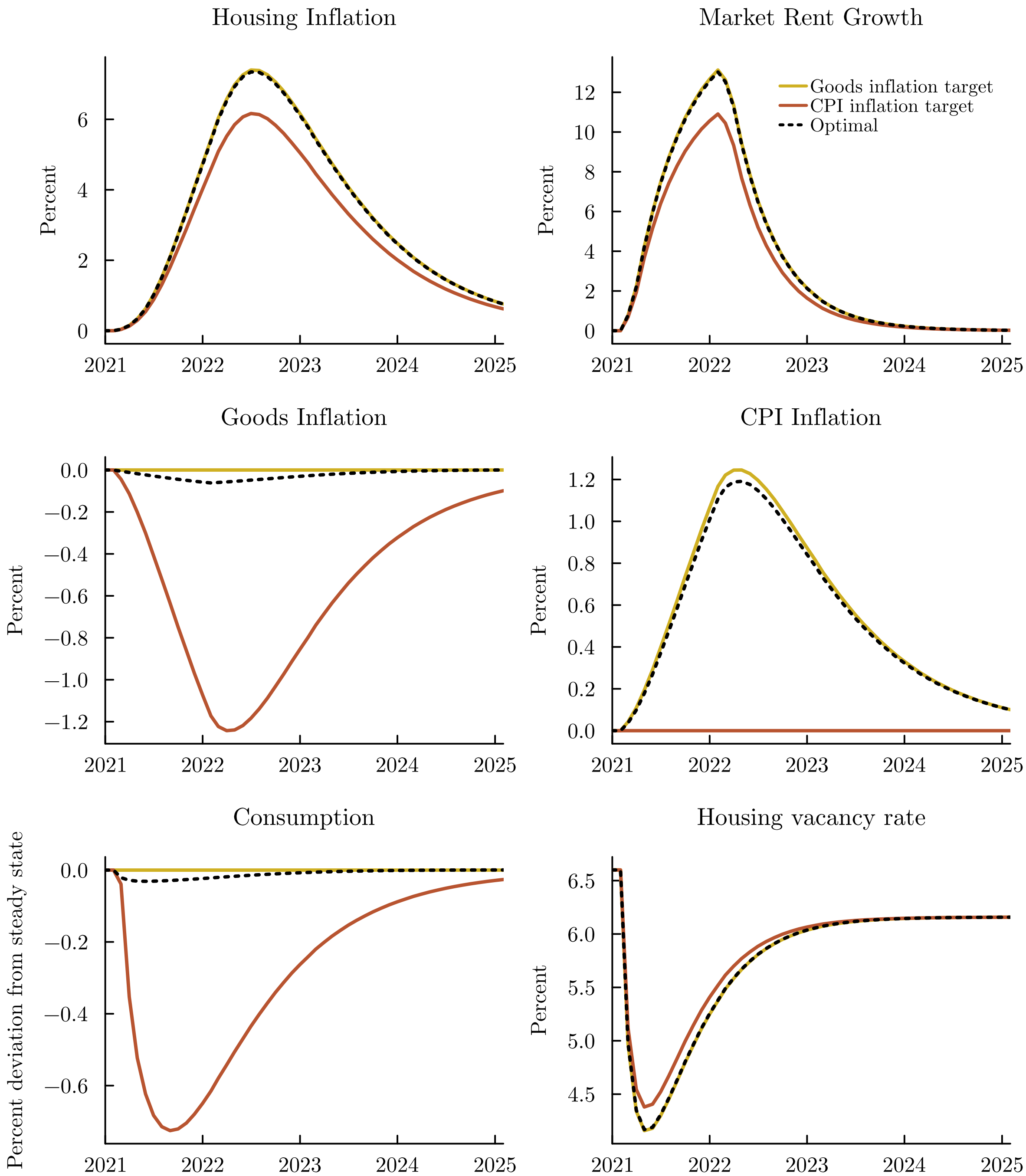

Figure 6: Alternative monetary policy responses to a permanent increase in housing demand ω_t.

Note: Inflation rates and market rent growth are expressed in percent at an annual rate. Goods consumption is expressed in percentage deviations from the initial steady state. The shock is assumed to occur in March of 2021.

symmetry.[32] The top-right panel of Figure 7 shows the results for the CPI inflation rate following the permanent increase in ω_t. In this "symmetric" model, we find that CPI targeting is close to optimal. As wages are flexible, monetary policy cannot influence θ_ℓ or employment and CPI targeting balances the distortions in the goods market against those in the housing market.

For the remaining panels of Figure 7, we consider a series of departures from this symmetric case that add ingredients from our baseline model. These are not cumulative experiments; in each case we add a single ingredient to the symmetric model.

The panel labeled "inelastic homeowners" sets h^o to our baseline value, and optimal policy moves much closer to goods inflation targeting. Including the inelastic homeowners reduces the welfare impact of changes in the utilization rate of transacted housing, allowing policy to focus more on stabilizing other markets. As we discussed in the calibration, this feature of the model allows us to better match the mobility of households across housing units. This is relevant for policy because the shock causes only a *temporary* distortion in the relative price of shelter and only part of the total housing consumption is actively chosen within the span of time while the distortion persists.

The panel labeled "sticky wages" restores the wage rigidity parameter χ_ℓ to its baseline value, while setting $\delta_\ell = 1$ so labor matches remain static as in the other markets. Relative to the symmetric case, optimal policy moves closer to goods inflation targeting. With sticky wages, variation in goods demand affects labor market tightness because goods demand feeds into labor demand and now there is not a countervailing adjustment in the real wage. This raises the benefit of stabilizing the goods market relative to the benefit of housing market stabilization. In the static model, this force is stronger the more elastic goods supply is.

The panel labeled "persistent housing matches" makes housing matches persistent by setting δ_h to its baseline value. In this case we also set $\xi = 1$ so rents are renegotiated every period. Here we find that optimal policy is very close to goods targeting as in our baseline. With persistent matches, housing search becomes forward-looking and less sensitive to current cyclical conditions. As a result, housing market tightness is less sensitive to policy than is goods market tightness, which tilts the trade-off for policy toward goods-market stabilization. Using our full quantitative model, Figure 8 plots iso-welfare curves and the policy-feasible curve for pairs (θ_c, θ_h) immediately after the shock. The policy-feasible curve is upward sloping but relatively flat, reflecting the low sensitivity of θ_h relative to that of θ_c. As a result, the optimum lies where the iso-welfare curve is also nearly flat, so the marginal welfare gain

[32] In unreported results, we have found that the steady state differences in vacancy rates have little impact on these results.

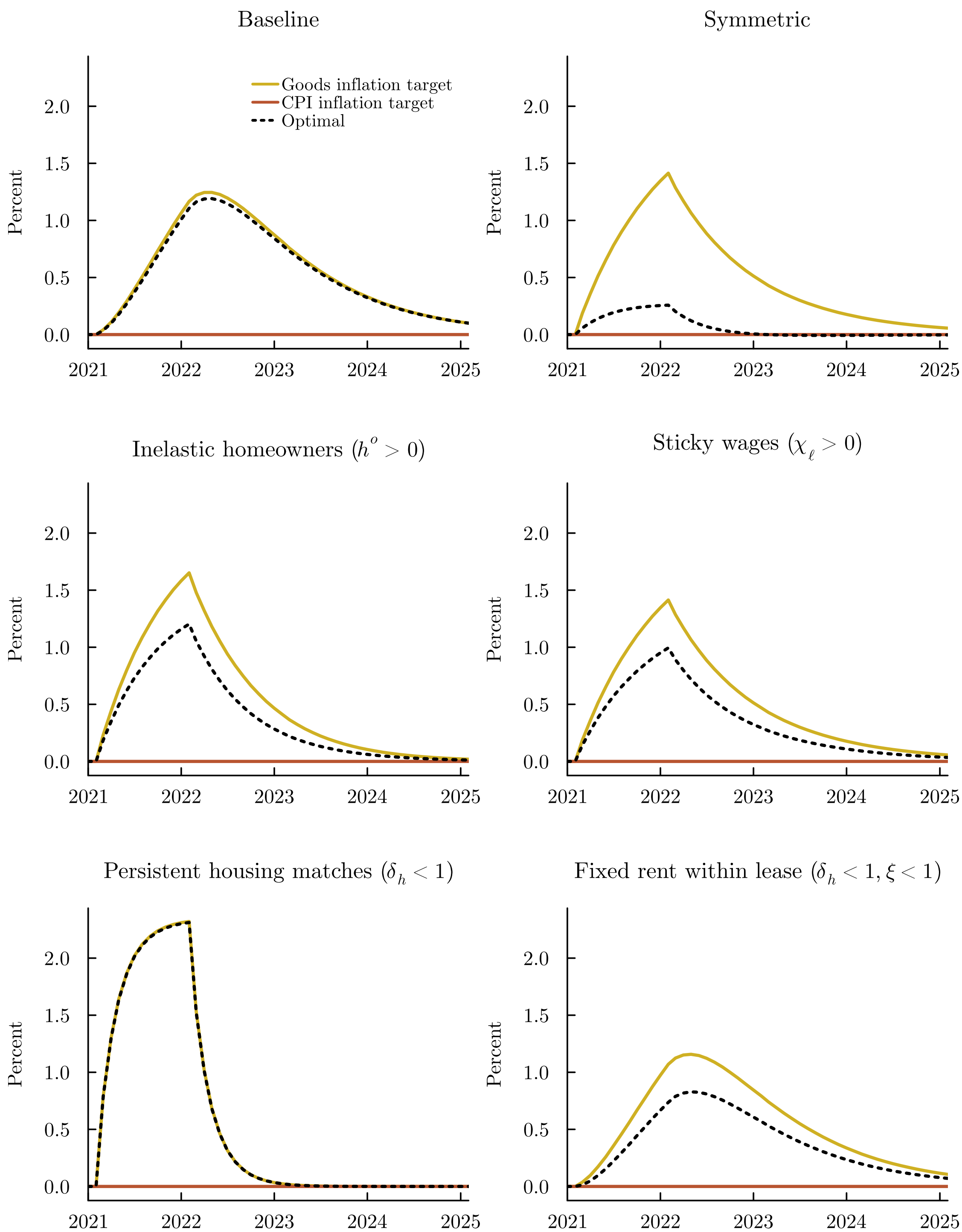

Figure 7: CPI inflation following an increase in ω_t under alternative model calibrations.

Note: In all alternative calibrations we recalibrate the ρ's to target a 6% idleness rate in each market. The following list states the changes in parameters relative to our baseline. Symmetric: $\delta_h = 1$, $h^o = 0$, $\chi_\ell = 0$, $\delta_\ell = 1$. Inelastic homeowners: $\delta_h = 1$, $\chi_\ell = 0$, $\delta_\ell = 1$. Sticky wages: $\delta_h = 1$, $h^o = 0$, $\delta_\ell = 1$. Persistent housing matches: $h^o = 0$, $\chi_\ell = 0$, $\delta_\ell = 1$, $\xi = 1$. Fixed rent within lease: $h^o = 0$, $\chi_\ell = 0$, $\delta_\ell = 1$.

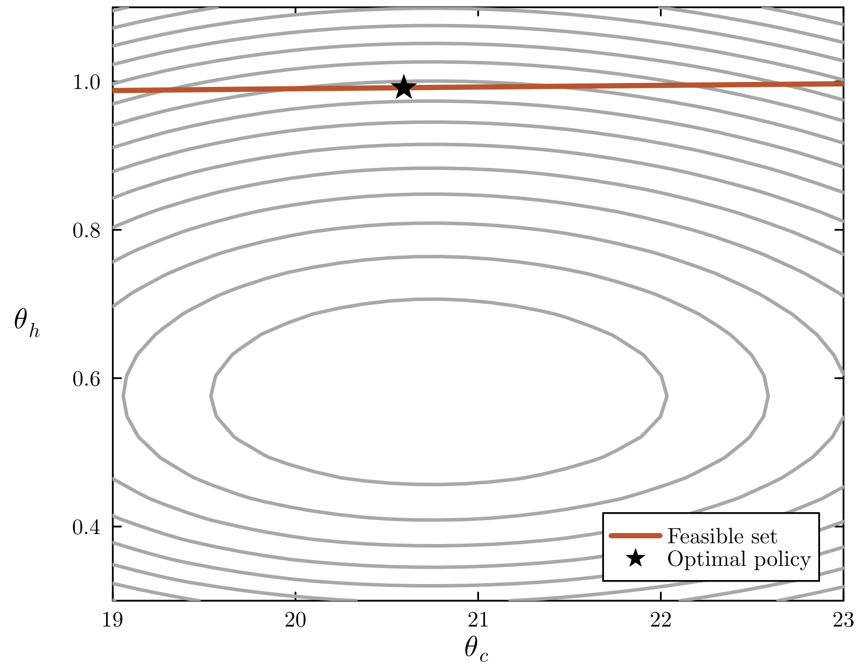

Figure 8: Iso-welfare curves and the policy-feasible curve in the baseline quantitative model

Note: For the policy-feasible path, we vary monetary policy to attain a particular date-0 value of θ_c, holding its subsequent path at the optimum; θ_h and θ_ℓ are determined endogenously at all dates. To construct the iso-welfare curves, we evaluate the policy-maker's objective while varying θ_c and θ_h at date 0 and holding their subsequent paths at the optimum. The planner remains subject to the technological and search constraints and to the firm's vacancy-posting condition, which determines the path of θ_ℓ endogenously.

from further changing θ_c is small. Put differently, θ_c is close to its efficient level.

The panel labeled "fixed rent within lease" restores ξ to its baseline value, so rents are now fixed within a lease rather than renegotiated every period as in the previous panel. This makes two differences. The first is mechanical, as measured shelter inflation tracks the average rent on outstanding leases, $\bar{R}_t$, so when most tenants keep paying the rent agreed at signing, the index responds to the shock only gradually. Second, there is now a small gap between optimal policy and goods targeting. When the rent is fixed for the life of the lease, the incentive to search is more sensitive to the current rent R_t and less sensitive to expectations of future rents. As the distortion in R_t is largest in the immediate aftermath of the shock, the greater sensitivity to current rents magnifies the consequences of the nominal rigidity, thereby pushing in the direction of tighter policy relative to the $\xi = 1$ case.

In sum, three ingredients of our quantitative model each reduce the weight on housing-market stabilization relative to goods-market stabilization: inelastic housing demand, which makes the welfare impact of housing-market variation smaller than housing's CPI weight would imply; an elastic supply of goods together with labor-market distortions, which raise the value of stabilizing the goods market; and persistent housing matches, which make housing demand less sensitive to monetary policy. Combined in the full model, these forces make it essentially optimal to ignore housing inflation and target goods inflation.

6.4 A productivity shock

We have focused on a housing demand shock as the driver of housing inflation. An alternative driver is higher productivity in goods production, as higher goods consumption raises the household's willingness to pay for housing relative to goods, and with it the efficient real rent. To explore this possibility, we simulate a permanent increase in A. This shock differs from the housing demand shock in that it puts the goods and labor markets in conflict: the efficient wage rises, so stabilizing goods prices leaves sticky wages too low and the labor market overheated, while stabilizing wages leaves the goods market slack. Optimal policy balances the two. As before, it remains optimal to ignore housing inflation.

Figure 9 shows the results for a 2% permanent productivity shock. Under goods inflation targeting, rents rise with the higher marginal rate of substitution. With the exception of consumption, the simulation looks qualitatively similar to Figure 6; however, the magnitudes of the inflation and housing vacancy responses are substantially smaller. Consumption rises sharply because more goods are now produced as a result of higher productivity. Following the productivity shock, the efficient wage rises. Under goods inflation targeting, the rigidity in nominal wages means wages are initially too low and the labor market is overheated. The line labeled "wage target" corresponds to a policy that sets $w_t = w_t^*$ at all dates. Under this policy, consumption rises much more gradually and goods inflation is negative, implying the goods market is slack. The housing vacancy rate increases, implying the housing market is also slack. Optimal policy calls for a middle road to balance the labor market distortion with distortions to the other markets.

To demonstrate that it is still optimal to ignore housing inflation in this simulation, we compute optimal policy under an ad hoc objective function that ignores utility from housing consumption and disutility from housing search.[33] Figure 9 shows this as the line labeled "Optimal ignoring housing." The policy that maximizes this objective is nearly identical to the fully optimal policy.

[33]The objective is $\sum_{t=0}^{\infty} \beta^t \{\log c_t - \rho_c s_{c,t}\}$.

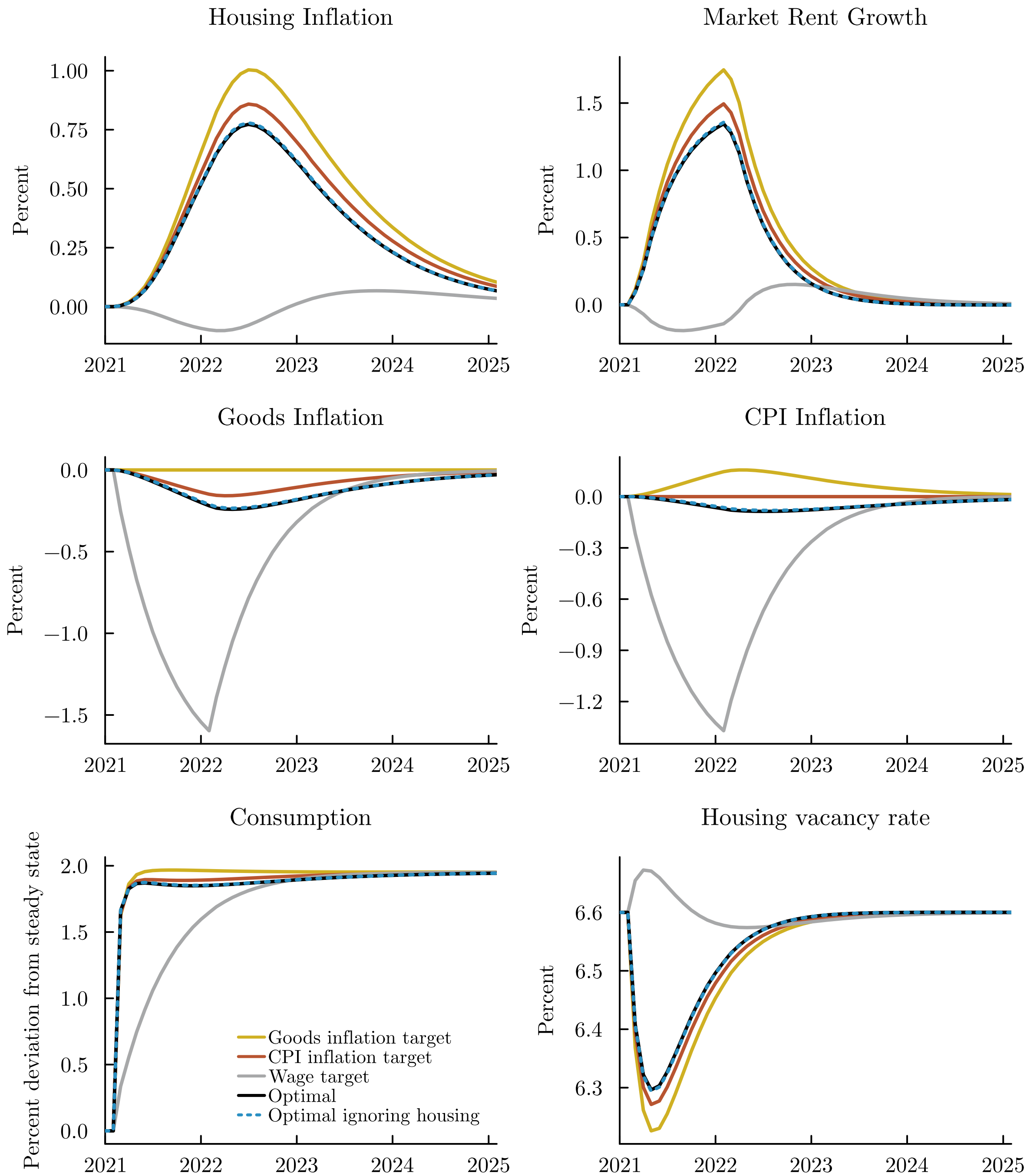

Figure 9: Alternative monetary policy responses to a permanent increase in TFP A_t.

Note: Inflation rates and market rent growth are expressed in percent at an annual rate. Goods consumption is expressed in percentage deviations from the initial steady state. The shock is assumed to occur in March of 2021.

7 Conclusion

The standard New Keynesian architecture rests on the premise that output is demand-determined: at fixed prices, firms accommodate increases in demand by expanding production and hiring additional inputs. We argue that this premise is untenable for certain markets such as housing services, whose supply cannot expand quickly enough in the short run to meet demand. We develop a theory based on rationing via search frictions and show that it delivers very different implications for optimal monetary policy.

We construct a multi-sector model in which goods, labor, and housing all trade through frictional matching. As search costs vanish, trade in each market converges to the minimum of demand and supply, so the framework nests the Old Keynesian short-side rule as a limiting case. With meaningful search frictions, however, quantities depend on conditions on both sides of each market. This alternative rationing mechanism reverses the standard New Keynesian prescription: optimal policy places less, rather than more, weight on stabilizing sectors with inelastic supply. Quantitatively, following a housing-demand shock, optimal policy stabilizes goods-price inflation and essentially ignores housing inflation.

The treatment of housing in central banks' inflation targets has attracted considerable attention in recent years.[34] There are large differences across countries in how official price indices measure housing inflation, and therefore central banks that target inflation measured by these price indices are implicitly responding differently to housing inflation. Within the context of an inflation-targeting policy framework, our analysis can inform the choice of how to measure housing costs in the targeted inflation measure.

More broadly, our paper contributes to a renewed literature on macroeconomic adjustment under nominal rigidities when exchange is voluntary (e.g., Michaillat and Saez, 2015; Barro, 2026; Holden, 2025; Flynn et al., 2026). Our results show that this line of work can have important policy implications, reversing standard prescriptions for sectoral inflation stabilization.

[34] See, for example, Chodorow-Reich, Glaeser, Jaravel and Lipton (2025). In December 2025, Federal Reserve Governor Stephen Miran argued that shelter inflation largely reflected earlier supply-and-demand imbalances and emphasized measures excluding shelter when assessing underlying inflation: https://www.federalreserve.gov/newsevents/speech/miran20251215a.htm. The European Central Bank, by contrast, has suggested modifying its primary inflation measure to increase the weight on housing by including owner-occupied housing costs: https://www.ecb.europa.eu/mopo/strategy/strategy-review/ecb.strategyreview202506_strategy_statement.en.html.

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Online Appendix to "How Should Monetary Policy Respond to Housing Inflation?"

Javier Bianchi, Alisdair McKay, and Neil Mehrotra

A Derivations and Proofs for Sections 2 and 3

A.1 Preliminaries

Throughout the appendix, $j \in \{c, \ell, h\}$. The scalar θ_j denotes tightness in market j, while $\boldsymbol{\theta} = (\theta_c, \theta_\ell, \theta_h)$ denotes the tightness vector. Primes denote derivatives with respect to a function's scalar argument, and a superscript $*$ denotes an efficient value. We use $\mathcal{U}(\boldsymbol{\theta})$ for welfare in tightness space, $\mathcal{W}(c, h)$ for the same objective in the allocation space, and $V(M, r)$ for the indirect policy value.

To ease notation in the proofs below, we drop the subscript on γ_j when it is clear from context which γ is intended. Throughout this appendix we use the following properties of the matching functions of Section 2.

Lemma 2 (Properties of the matching probabilities)**.** *Let $f_j(\theta) = (1+\theta^\gamma)^{-1/\gamma}$ and $g_j(\theta) = \theta f_j(\theta)$, with $\gamma > 0$. For all $\theta \in (0, \infty)$:*

(i) *f_j and g_j are twice continuously differentiable, take values in $(0,1)$, and satisfy $f_j(\theta)^\gamma + g_j(\theta)^\gamma = 1$;*

(ii) *f_j is strictly decreasing and g_j is strictly increasing, with $g_j'(\theta) = f_j(\theta)^{1+\gamma} > 0$;*

(iii) *g_j is strictly concave: $g_j''(\theta) = -(\gamma+1)\,\theta^{\gamma-1}\,(1+\theta^\gamma)^{-(1+2\gamma)/\gamma} < 0$;*

(iv) *the matching elasticity $\eta_j(\theta) \equiv \theta g_j'(\theta)/g_j(\theta) = f_j(\theta)^\gamma = 1/(1+\theta^\gamma)$ is strictly decreasing with $\eta_j \in (0,1)$, and $g_j' = f_j \eta_j$ and $\theta f_j'/f_j = \eta_j - 1$;*

(v) $\lim_{\theta \downarrow 0} f_j = 1$, $\lim_{\theta\downarrow 0} g_j = 0$, $\lim_{\theta \uparrow \infty} f_j = 0$, $\lim_{\theta\uparrow\infty} g_j = 1$.

Proof. Constant returns give $g_j(\theta) = (1+\theta^{-\gamma})^{-1/\gamma}$ and $f_j(\theta) = g_j(\theta)/\theta$; (i) and (v) are immediate. Differentiating, $f_j' = -\theta^{\gamma-1}(1+\theta^\gamma)^{-(1+\gamma)/\gamma} < 0$ and $g_j' = (1+\theta^\gamma)^{-(1+\gamma)/\gamma} = f_j^{1+\gamma}$, giving (ii); differentiating again gives (iii). For (iv), $\eta_j = \theta g_j'/g_j = f_j^\gamma$, so $g_j' = f_j \cdot f_j^\gamma = f_j \eta_j$, and differentiating $\log f_j = \log g_j - \log\theta$ gives $\theta f_j'/f_j = \eta_j - 1$. $\square$

The equilibrium system. It will be useful to summarize the equations that characterize a fixed-price competitive equilibrium. Combining the household and firm optimality conditions with Lemma 1 and the definition $m = M/P$, we obtain

$$\frac{P}{M} = \lambda, \tag{A.1}$$

$$\frac{1}{c} = \lambda + \frac{\rho_c}{f_c(\theta_c)}, \tag{A.2}$$

$$\frac{\omega}{h} = \lambda r + \frac{\rho_h}{f_h(\theta_h)}, \tag{A.3}$$

$$g_c(\theta_c)\, A\alpha\, G_\ell(\theta_\ell)^\alpha = g_\ell(\theta_\ell)\, w, \tag{A.4}$$

where $w \equiv W/P$, $r \equiv R/P$, $c = g_c(\theta_c)AG_\ell(\theta_\ell)^\alpha$, and $h = \bar{h}\, g_h(\theta_h)$. Equations (A.1), (A.2), and (A.4) determine $\{\lambda, \theta_c, \theta_\ell\}$; (A.3) then determines θ_h.

A.2 Proof of Lemma 1

Proof. Labor supply is normalized to one and the housing stock is $\bar{h}$, so $v = \theta_\ell$ and $s_h = \bar{h}\,\theta_h$. The binding labor-matching constraint gives $e = f_\ell(\theta_\ell)v = g_\ell(\theta_\ell)$, hence $\ell = e - \rho_\ell v = G_\ell(\theta_\ell)$ and $y = A\ell^\alpha$. Constant returns make each matching probability a function of its own tightness, so the binding goods and housing constraints give $s_c = \theta_c y$, $c = f_c(\theta_c)s_c = g_c(\theta_c)y$, and $h = f_h(\theta_h)s_h = \bar{h}\, g_h(\theta_h)$. □

A.3 Proof of Proposition 1

Proof. Equation (A.1) determines $\lambda = P/M$ directly. We next establish a unique solution for θ_h using (A.3), which we rewrite here

$$\frac{\omega}{\bar{h}\, g_h(\theta_h)} = \lambda r + \frac{\rho_h}{f_h(\theta_h)}.$$

The left-hand side is strictly decreasing in θ_h as g_h is strictly increasing, and it diverges as $\theta_h \to 0$ because $g_h \to 0$. The right-hand side is strictly increasing in θ_h because f_h is strictly decreasing, and it diverges as $\theta_h \to \infty$ as $f_h(\theta_h) \to 0$. It follows that there is exactly one solution (Lemma 2(ii) and (v)).

Turning to θ_c and θ_ℓ, define $\bar{\theta}_\ell \equiv f_\ell^{-1}(\rho_\ell)$. The domain on which consumption is positive is $\theta_\ell \in (0, \bar{\theta}_\ell)$, where $G_\ell(\theta_\ell) > 0$. Rewrite (A.4) as

$$\begin{aligned} g_c(\theta_c) &= \frac{w}{A\alpha} g_\ell(\theta_\ell) G_\ell(\theta_\ell)^{-\alpha} \\ &= \frac{w}{A\alpha} g_\ell(\theta_\ell)^{1-\alpha} \left(1 + \frac{\rho_\ell}{f_\ell(\theta_\ell) - \rho_\ell}\right)^{\alpha}, \end{aligned}$$

where the second line uses $G_\ell(\theta_\ell) = \frac{g_\ell(\theta_\ell)}{1+\frac{\rho_\ell}{f_\ell(\theta_\ell)-\rho_\ell}}$, which follows from the definition of G and $g = f \cdot \theta$. The right-hand side is strictly increasing in θ_ℓ because g_ℓ is strictly increasing and f_ℓ is strictly decreasing (Lemma 2(ii)). As g_c is strictly increasing in θ_c, the equation above implies θ_ℓ is an increasing function of θ_c. At the lower boundary, $\theta_c \downarrow 0$ implies $\theta_\ell \downarrow 0$. At the upper boundary, the left-hand side converges to one, while the right-hand side diverges as $\theta_\ell \uparrow \bar{\theta}_\ell$. Hence θ_ℓ converges to the unique interior value $\widehat{\theta}_\ell < \bar{\theta}_\ell$ at which the right-hand side equals one.

From (A.4) we can solve for $c = g_c(\theta_c) A G_\ell(\theta_\ell)^\alpha = g_\ell(\theta_\ell)\frac{w}{\alpha}$. Eq. (A.2) becomes

$$\frac{\alpha}{w\, g_\ell(\theta_\ell)} = \lambda + \frac{\rho_c}{f_c(\theta_c)}. \tag{A.5}$$

As θ_ℓ is an increasing function of θ_c, the equation above can be viewed as one equation in θ_c. The left-hand side is decreasing in θ_c (as g_ℓ is strictly increasing and θ_ℓ increases with θ_c) while the right-hand side is increasing (as f_c is decreasing, Lemma 2(ii)), so there can be at most one solution. Existence can be established by first noting that the left-hand side diverges as $\theta_c \to 0$ because $\theta_\ell \to 0$ and $g_\ell(\theta_\ell) \to 0$. The right end point is more subtle because we need to establish that there is a crossing before θ_ℓ rises to the point where $G_\ell(\theta_\ell) = 0$ and consumption is zero. Above we noted that $\lim_{\theta_c \to \infty} \theta_\ell = \hat{\theta}_\ell < \bar{\theta}_\ell$, which implies that we can take the limit as $\theta_c \to \infty$ without leaving the feasible domain of θ_ℓ. With that subtlety out of the way, we note that the right-hand side of (A.5) diverges as $\theta_c \to \infty$. □

A.4 Proof of Proposition 2: monetary expansion and tightness

Proof. From (A.1), we have that $M = P/\lambda$. Given a fixed P, we can perform the comparative static with respect to λ and use that λ is inversely related to M. We start with $d\theta_h/d\lambda$. (A.3) gives an implicit relationship between θ_h and λ.

$$\lambda r + \frac{\rho_h}{f_h(\theta_h)} - \frac{\omega}{\bar{h}\, g_h(\theta_h)} = 0.$$

Using the implicit function theorem we have

$$\begin{aligned}\frac{d\theta_h}{d\lambda} &= -\frac{r}{\mathcal{E}} \\ \mathcal{E} &\equiv -\frac{\rho_h f_h'(\theta_h)}{f_h(\theta_h)^2} + \frac{\omega\, g_h'(\theta_h)}{\bar{h}\, g_h(\theta_h)^2}.\end{aligned} \tag{A.6}$$

Note that $\mathcal{E} > 0$ as $f_h' < 0$ and $g_h' > 0$ (Lemma 2(ii)). It follows that $d\theta_h/d\lambda < 0$.

Next, rewrite (A.4) as

$$g_c(\theta_c)\alpha A = [g_\ell(\theta_\ell)]^{1-\alpha}\left[1 + \frac{\rho_\ell}{f_\ell(\theta_\ell) - \rho_\ell}\right]^{\alpha} w \tag{A.7}$$

where we have used

$$G_\ell(\theta_\ell) = \frac{g_\ell(\theta_\ell)}{1 + \frac{\rho_\ell}{f_\ell(\theta_\ell)-\rho_\ell}}.$$

The left-hand side of (A.7) is increasing in θ_c and the right-hand side is increasing in θ_ℓ. By the implicit function theorem, θ_c is an increasing function of θ_ℓ.

It will be important to establish that y does not move too much relative to θ_c. Towards that end, rewrite (A.7) as

$$y = A\,[g_\ell(\theta_\ell)]^{\alpha}\left[1 + \frac{\rho_\ell}{f_\ell(\theta_\ell) - \rho_\ell}\right]^{-\alpha} = \frac{w}{\alpha}\,[g_c(\theta_c)]^{-1}\, g_\ell(\theta_\ell) \tag{A.8}$$

and take the total derivative

$$dy = \frac{w}{\alpha}\,[g_c]^{-1}\, g_\ell' d\theta_\ell - \frac{w}{\alpha}\frac{g_\ell}{g_c^2} g_c' d\theta_c$$

and divide by (A.8)

$$\frac{dy}{y} = \frac{g_\ell'}{g_\ell} d\theta_\ell - \frac{g_c'}{g_c} d\theta_c. \tag{A.9}$$

Now turn to (A.2) stated as an implicit relationship among the variables

$$\lambda + \frac{\rho_c}{f_c(\theta_c)} - \frac{1}{g_c(\theta_c) y} = 0.$$

Take a total derivative, using $c = g_c(\theta_c)y$:

$$d\lambda - \frac{\rho_c f_c'}{f_c^2}\, d\theta_c + \frac{1}{c}\left(\frac{g_c'}{g_c}\, d\theta_c + \frac{dy}{y}\right) = 0.$$

Plugging in for dy/y using (A.9), the terms in $d\theta_c$ inside the parentheses cancel, leaving

$$d\lambda - \frac{\rho_c f_c'}{f_c^2}\, d\theta_c + \frac{1}{c}\frac{g_\ell'}{g_\ell}\, d\theta_\ell = 0.$$

The term multiplying $d\theta_c$ is positive (as $f_c' < 0$) and the term multiplying $d\theta_\ell$ is positive. From above, we know that $d\theta_\ell$ and $d\theta_c$ have the same sign. Therefore $\text{sign}(d\theta_c) = \text{sign}(d\theta_\ell) = -1 \times \text{sign}(d\lambda) = \text{sign}(dM)$. $\square$

A.5 Proof of Proposition 3: short-side rule limit

Proof. The notional demand and supply curves are defined in equations (4) and (5). The partial equilibrium of the goods market satisfies (A.2), which we can rewrite as

$$f_c(\theta_c)\left[\frac{1}{c} - \frac{1}{c_d}\right] = \rho_c. \tag{A.10}$$

Since $\rho_c \geq 0$ and $f_c(\theta_c) \in [0,1]$, $1/c \geq 1/c_d$ and therefore $c \leq c_d$. Using the resource constraint, (3), and (5)

$$c = g_c(\theta_c)^{1/(1-\alpha)} c_s. \tag{A.11}$$

Since $g_c(\theta_c) \in [0,1]$ and $\alpha \in (0,1)$, $c \leq c_s$. If $c \leq c_d$ and $c \leq c_s$ it must be that $c \leq \min\{c_d, c_s\}$.

To establish limits, we must show that as $\rho_c \downarrow 0$, $c \to \min\{c_s, c_d\}$. In the limit, the right-hand side of (A.10) goes to zero so the left-hand side must also go to zero. This gives us $f_c \to 0$, $1/c \to 1/c_d$, or both. We consider three cases.

If $c_d < c_s$, we will show $1/c \to 1/c_d$, and hence $c \to c_d$, which will be the case if f_c remains positive in the limit. Towards a contradiction, suppose $f_c \to 0$. By Lemma 2(v), $f_c \to 0$ requires $\theta_c \to \infty$ and hence $g_c \to 1$ and (A.11) implies $c \to c_s$, so c is converging to $c_s > c_d$ violating $c \leq \min\{c_d, c_s\}$.

If $c_d > c_s$, we will show $f_c \to 0$, and in the previous step we have shown that $f_c \to 0$ means $c \to c_s$. In (A.10), use $c \leq c_s < c_d$, so $1/c - 1/c_d \geq 1/c_s - 1/c_d > 0$. Therefore, if the right-hand side of (A.10) goes to zero, $f_c \to 0$.

By the properties of f_c and g_c, θ_c and c are monotone in ρ_c. If $c_d = c_s$, either $1/c \to 1/c_d$ or it does not. If it does, $c \to c_d = c_s$. If it does not, as the right-hand side of (A.10) goes to zero it must be that $f_c \to 0$ and $c \to c_s = c_d$. $\square$

A.6 Planner conditions

Substituting Lemma 1 into the planner's objective gives

$$\log[g_c(\theta_c)AG_\ell(\theta_\ell)^\alpha] + \omega \log\left[\bar{h}\, g_h(\theta_h)\right] - \rho_c\theta_c AG_\ell(\theta_\ell)^\alpha - \rho_h\, \bar{h}\, \theta_h.$$

This is the objective $\mathcal{U}(\boldsymbol{\theta})$ of (10): the planner and the central bank maximize the same function, and differ only in the instruments available to them. Differentiating with respect to goods-, labor-, and housing-market tightness yields

$$\begin{aligned}
\frac{\partial \mathcal{U}}{\partial \theta_c} &= \frac{g_c' y}{c} - \rho_c y, \\
\frac{\partial \mathcal{U}}{\partial \theta_\ell} &= \alpha \left(\frac{g_c}{c} - \rho_c\theta_c\right) \frac{y}{\ell} G_\ell', \\
\frac{\partial \mathcal{U}}{\partial \theta_h} &= \bar{h} \left(\frac{\omega g_h'}{h} - \rho_h\right).
\end{aligned}$$

At a solution of the goods-market first-order condition, $\rho_c\theta_c y = \eta_c(\theta_c) < 1$. Hence $g_c/c - \rho_c\theta_c = (1-\eta_c)/y > 0$, so the labor-market first-order condition holds if and only if $G_\ell' = 0$. The three first-order conditions therefore reduce to (6).

A.7 Derivation of the targeting rule (11)

Let $\mathcal{U}_j \equiv \partial\mathcal{U}/\partial\theta_j$. At a policy optimum,

$$\frac{d\mathcal{U}}{d\log M} = \mathcal{U}_c\theta_c\varepsilon_M^c + \mathcal{U}_\ell\theta_\ell\varepsilon_M^\ell + \mathcal{U}_h\theta_h\varepsilon_M^h = 0.$$

Using the derivatives in Appendix A.6, the private optimality conditions, $g_j' = f_j + f_j'\theta_j$, and $f_j'\theta_j/f_j = \eta_j - 1$ (Lemma 2(iv)), each welfare contribution can be written in common consumption units as

$$\begin{aligned}
\frac{\theta_c}{\lambda}\mathcal{U}_c &= \left[1 - \frac{1-\eta_c}{c\lambda}\right] c, \\
\frac{\theta_\ell}{\lambda}\mathcal{U}_\ell &= \left[w - (1-\eta_\ell)\alpha g_c \frac{y}{\ell}\right] e, \\
\frac{\theta_h}{\lambda}\mathcal{U}_h &= \left[r - \frac{(1-\eta_h)\omega}{h\lambda}\right] h.
\end{aligned}$$

Dividing the policy first-order condition by $\lambda > 0$ and substituting these three expressions gives (11).

A.8 Construction of the policy-trade-off diagram of Figure 3

This appendix constructs the two families of curves in Figure 3. An iso-welfare curve holds welfare fixed while allowing (c, h) to vary. A policy-feasible curve instead holds the rent fixed and records the equilibrium allocations implemented as the money supply varies. We set $\gamma = 1$ and normalize the goods price and housing stock to $P = \bar{h} = 1$. Because the matching functions are identical across markets in this illustration, we suppress the market subscript on f and g.

Allocation mapping. For $\gamma_j = 1$ for $j = c, h$, the matching probabilities and their inverse are

$$f(\theta) = \frac{1}{1+\theta}, \qquad g(\theta) = \frac{\theta}{1+\theta}, \qquad g^{-1}(z) = \frac{z}{1-z}.$$

At the fixed wage, firm optimality implies $we = \alpha c$. Combining this condition with the labor-matching and production constraints gives

$$\begin{aligned} e(c) &= \frac{\alpha c}{w}, & \theta_\ell(c) &= \frac{e(c)}{1-e(c)}, \\ \ell(c) &= e(c) - \rho_\ell \frac{e(c)}{1-e(c)}, & y(c) &= A\left[e(c) - \rho_\ell \frac{e(c)}{1-e(c)}\right]^\alpha. \end{aligned}$$

The allocation mapping requires $0 < e(c) < 1 - \rho_\ell$, $0 < c < y(c)$, and $0 < h < 1$. Inverting $c = g(\theta_c)y(c)$ and $h = g(\theta_h)$ yields

$$\theta_c(c) = \frac{c}{y(c) - c}, \qquad s_c(c) = \frac{c\, y(c)}{y(c) - c}, \qquad \theta_h(h) = s_h(h) = \frac{h}{1-h}.$$

Iso-welfare curves. Substituting these expressions into the policy objective, excluding utility from real balances, gives the welfare function. Its level sets satisfy

$$\mathcal{W}(c, h) \equiv \log c + \omega \log h - \rho_c \frac{c\, y(c)}{y(c) - c} - \rho_h \frac{h}{1-h} = \overline{\mathcal{W}}.$$

Policy-feasible curve. The household search conditions are $f(\theta_c)(1/c - 1/M) = \rho_c$ and $f(\theta_h)(\omega/h - R/M) = \rho_h$. Since $f(\theta_c) = [y(c) - c]/y(c)$ and $f(\theta_h) = 1 - h$, they become

$$\frac{1}{M} = \frac{1}{c} - \rho_c \frac{y(c)}{y(c) - c}, \qquad \frac{R}{M} = \frac{\omega}{h} - \frac{\rho_h}{1-h}.$$

Eliminating M gives the policy-feasible curve for a fixed nominal rent R (which equals the real rent under the normalization $P = 1$):

$$\frac{\omega}{h} - \frac{\rho_h}{1-h} = R\left[\frac{1}{c} - \rho_c \frac{y(c)}{y(c)-c}\right]. \tag{A.12}$$

A.9 Proof of Proposition 4

Overview. Define the value function $V(M,r) = \mathcal{U}(\boldsymbol{\theta}(M,r))$ as the value from setting policy M when the rent is r. Optimal policy sets $V_M(\mathcal{M},r) = 0$. By the implicit function theorem,

$$\frac{\partial \mathcal{M}}{\partial r} = -\frac{V_{Mr}}{V_{MM}}.$$

Let $\nabla\mathcal{U}$ be the gradient of $\mathcal{U}$ with respect to $\boldsymbol{\theta}$ and let $\nabla^2\mathcal{U}$ be the Hessian. Differentiating $V(M,r) = \mathcal{U}(\boldsymbol{\theta}(M,r))$ gives

$$\begin{aligned} V_M &= \boldsymbol{\theta}_M^\top \nabla\mathcal{U} \\ V_{Mr} &= \boldsymbol{\theta}_{Mr}^\top \nabla\mathcal{U} + \boldsymbol{\theta}_M^\top \nabla^2\mathcal{U}\,\boldsymbol{\theta}_r \\ V_{MM} &= \boldsymbol{\theta}_{MM}^\top \nabla\mathcal{U} + \boldsymbol{\theta}_M^\top \nabla^2\mathcal{U}\,\boldsymbol{\theta}_M. \end{aligned}$$

At $\boldsymbol{\theta} = \boldsymbol{\theta}^*$, $\nabla\mathcal{U} = 0$ by construction. Therefore,

$$\frac{\partial \mathcal{M}}{\partial r} = -\frac{\boldsymbol{\theta}_M^\top \nabla^2\mathcal{U}\,\boldsymbol{\theta}_r}{\boldsymbol{\theta}_M^\top \nabla^2\mathcal{U}\,\boldsymbol{\theta}_M}. \tag{A.13}$$

The following lemma characterizes the objects in (A.13) and records how each depends on α. Throughout, the comparative-static experiment of Proposition 4 is in force: as α varies, productivity is $A(\alpha) = y^*/(\ell^*)^\alpha$ and the wage is $w = w^*(\alpha)$, so the constrained-efficient allocation is the same for every α.

Lemma 3. *Evaluated at $r = r^*$ and the constrained-efficient allocation:*

i) $\boldsymbol{\theta}^*$, λ^*, *and the allocation do not depend on* α, *while* w^* *is proportional to* α.

ii) $\boldsymbol{\theta}_M$ *does not depend on* α, *and* $\boldsymbol{\theta}_r = (0,\ 0,\ -\lambda^*/\mathcal{E})^\top$, *where* $\mathcal{E} > 0$ *is defined in* (A.6) *and does not depend on* α.

iii) The Hessian of $\mathcal{U}(\boldsymbol{\theta})$ is diagonal,

$$\nabla^2\mathcal{U} = \begin{pmatrix} \dfrac{g_c'' g_c - (g_c')^2}{g_c^2} & 0 & 0 \\ 0 & -\dfrac{f_c'\theta_c^2}{c^*}\dfrac{y^*}{\ell^*}G_\ell'' \times \alpha & 0 \\ 0 & 0 & \omega\,\dfrac{g_h'' g_h - (g_h')^2}{g_h^2} \end{pmatrix}.$$

The $(1,1)$ and $(3,3)$ entries are strictly negative and do not depend on α, and the $(2,2)$ entry is α times a strictly negative term that does not depend on α.

Proof. Part 1. θ_ℓ^* satisfies $G_\ell'(\theta_\ell^*) = 0$, so θ_ℓ^* depends only on the labor-market matching function and ρ_ℓ. It follows that $\ell^* = G_\ell(\theta_\ell^*)$ does not depend on α, while y^* is held fixed by the choice of $A(\alpha)$. The planner's goods-market condition (6a) can be written

$$g_c'(\theta_c^*) = \rho_c\, g_c(\theta_c^*)\, y^*,$$

which pins down θ_c^* from y^* alone, and the housing condition $\omega\, g_h'(\theta_h^*) = \rho_h\, \bar{h}\, g_h(\theta_h^*)$ pins down θ_h^* with no reference to α. The allocation then follows from Lemma 1. Evaluating (A.4) at the benchmark gives

$$w^* = \frac{g_c(\theta_c^*)}{g_\ell(\theta_\ell^*)}\,\alpha\, y^*,$$

which is proportional to α, and (A.2) gives $\lambda^* = \dfrac{1}{c^*} - \dfrac{\rho_c}{f_c(\theta_c^*)}$, which does not depend on α.

Part 2. As in Appendix A.4, we work with λ as the policy instrument with the knowledge from (A.1) that λ is inversely related to M. The system (A.2)-(A.4) is then

$$F(\boldsymbol{\theta}, \lambda) = \begin{pmatrix} \lambda + \dfrac{\rho_c}{f_c(\theta_c)} - \dfrac{1}{g_c(\theta_c)\, y} \\ g_\ell(\theta_\ell)\, w - g_c(\theta_c)\,\alpha\, y \\ \lambda r + \dfrac{\rho_h}{f_h(\theta_h)} - \dfrac{\omega}{\bar{h}\, g_h(\theta_h)} \end{pmatrix} = 0 \tag{A.14}$$

with the understanding that $y = AG_\ell(\theta_\ell)^\alpha$. Differentiating we have $F_\lambda = (1,\ 0,\ r)^\top$. F_θ is a 3×3 matrix that has zeros in the (1,3), (2,3), (3,1), and (3,2) locations: there are no feedback effects between the housing market and the other markets. Define

$$\begin{aligned}\mathcal{A} &\equiv -\frac{\rho_c f_c'}{f_c^2} + \frac{g_c' y}{c^2} \\ \mathcal{B} &\equiv \frac{g_c}{c^2}\frac{dy}{d\theta_\ell} \\ \mathcal{C} &\equiv -g_c' \alpha y \\ \mathcal{D} &\equiv g_\ell' w.\end{aligned}$$

Note that $\mathcal{A} > 0$, $\mathcal{D} > 0$, and $\mathcal{C} < 0$, while $\mathcal{B}$ has the sign of $dy/d\theta_\ell$, which is zero at the constrained-efficient allocation because

$$\left.\frac{dy}{d\theta_\ell}\right|_{\boldsymbol{\theta}=\boldsymbol{\theta}^*} = \alpha A G_\ell(\theta_\ell^*)^{\alpha-1} G_\ell'(\theta_\ell^*) = 0.$$

The remaining nonzero entry is $\mathcal{E} > 0$ from (A.6), which depends only on θ_h^*, ρ_h, ω, and $\bar{h}$ and therefore does not depend on α. We then have

$$F_\theta = \begin{pmatrix} \mathcal{A} & 0 & 0 \\ \mathcal{C} & \mathcal{D} & 0 \\ 0 & 0 & \mathcal{E} \end{pmatrix}$$

and by the implicit function theorem

$$\left.\frac{d\boldsymbol{\theta}}{d\lambda}\right|_{\boldsymbol{\theta}=\boldsymbol{\theta}^*} = -F_\theta^{-1} F_\lambda = \frac{-1}{\mathcal{A}\mathcal{D}} \begin{pmatrix} \mathcal{D} & 0 & 0 \\ -\mathcal{C} & \mathcal{A} & 0 \\ 0 & 0 & \mathcal{A}\mathcal{D}\mathcal{E}^{-1} \end{pmatrix} \begin{pmatrix} 1 \\ 0 \\ r \end{pmatrix}.$$

We then have $\frac{d\theta_c}{d\lambda} = -1/\mathcal{A}$, which does not depend on α, and $\frac{d\theta_\ell}{d\lambda} = \mathcal{C}/(\mathcal{A}\mathcal{D})$. As $\mathcal{C}$ and $\mathcal{D}$ are both proportional to α (recall that $w = w^*(\alpha)$ is proportional to α and $y = y^*$ at the benchmark), the quotient does not depend on α. In the housing market, $\frac{d\theta_h}{d\lambda} = -r/\mathcal{E}$, which does not depend on α. Finally, as $d\lambda/dM$ does not depend on α by (A.1), the same conclusions carry over to $\boldsymbol{\theta}_M$.

Turning to $\boldsymbol{\theta}_r$: holding M, and hence λ, fixed, the rent enters (A.14) only through the housing equation, with $F_r = (0,\, 0,\, \lambda)^\top$. Therefore $d\theta_c/dr = d\theta_\ell/dr = 0$ and $d\theta_h/dr = -\lambda^*/\mathcal{E}$ at the benchmark.

Part 3. The planner's objective evaluated along Lemma 1 separates as

$$\mathcal{U}(\boldsymbol{\theta}) = \log g_c(\theta_c) + \log y(\theta_\ell) + \omega \log\left[\bar{h}\, g_h(\theta_h)\right] - \rho_c\, \theta_c\, y(\theta_\ell) - \rho_h\, \bar{h}\, \theta_h,$$

where $y(\theta_\ell) = AG_\ell(\theta_\ell)^\alpha$. The only interaction between elements of θ is the search-cost term $\rho_c\theta_c\, y(\theta_\ell)$, whose cross-partial derivative is $-\rho_c\, y'(\theta_\ell)$. Since $y'(\theta_\ell^*) = \alpha AG_\ell(\theta_\ell^*)^{\alpha-1}G_\ell'(\theta_\ell^*) = 0$, the Hessian is diagonal at the benchmark.

The $(1,1)$ entry is $[g_c'' g_c - (g_c')^2]\,/g_c^2$, evaluated at θ_c^*. It is strictly negative because $(g_c')^2 > 0$ and $g_c'' < 0$ by Lemma 2(iii), and it does not depend on α because θ_c^* does not. The $(3,3)$ entry is $\omega\,[g_h'' g_h - (g_h')^2]\,/g_h^2 < 0$ by the same argument, and it likewise does not depend on α.

For the $(2,2)$ entry, differentiate $\mathcal{U}(\boldsymbol{\theta})$ twice with respect to θ_ℓ and evaluate at $y'(\theta_\ell^*) = 0$:

$$\frac{\partial^2 \mathcal{U}}{\partial \theta_\ell^2} = \left(\frac{1}{y^*} - \rho_c\theta_c^*\right) y''(\theta_\ell^*), \qquad y''(\theta_\ell^*) = \alpha AG_\ell(\theta_\ell^*)^{\alpha-1}G_\ell''(\theta_\ell^*) = \alpha\,\frac{y^*}{\ell^*}\,G_\ell''(\theta_\ell^*).$$

Using the planner's condition $\rho_c = g_c'(\theta_c^*)/c^*$ with $c^* = g_c(\theta_c^*)\, y^*$, together with the matching identity $g_c'\theta_c = g_c + f_c'\theta_c^2$,

$$\frac{1}{y^*} - \rho_c\theta_c^* = \frac{g_c - g_c'\theta_c}{g_c\, y^*} = -\frac{f_c'\theta_c^2}{c^*} > 0.$$

Hence the $(2,2)$ entry equals $-\frac{f_c'\theta_c^2}{c^*}\frac{y^*}{\ell^*}G_\ell'' \times \alpha$, which is α times a strictly negative term (as $f_c' < 0$ and $G_\ell'' = g_\ell'' < 0$) that does not depend on α. □

Proof of Proposition 4. By Lemma 3, $\nabla^2\mathcal{U}$ is diagonal and $\boldsymbol{\theta}_r$ has zeros in its first two components, so the numerator term in (A.13) reduces to

$$\boldsymbol{\theta}_M^\top\, \nabla^2\mathcal{U}\,\boldsymbol{\theta}_r = \frac{d\theta_h}{dM}\, K\, \frac{\lambda^*}{\mathcal{E}} \equiv Z > 0,$$

where $K > 0$ is -1 times the $(3,3)$ entry of $\nabla^2\mathcal{U}$ and $d\theta_h/dM > 0$ by Proposition 2. By Lemma 3, no factor in Z depends on α. For the denominator, the diagonal structure gives

$$\boldsymbol{\theta}_M^\top\, \nabla^2\mathcal{U}\,\boldsymbol{\theta}_M = -\left(X + \alpha Y\right),$$

where X collects the $(1,1)$ and $(3,3)$ contributions and αY the $(2,2)$ contribution; by Lemma 3, X and Y are positive and do not depend on α. Substituting into (A.13),

$$\left.\frac{\partial \mathcal{M}}{\partial r}\right|_{r=r^*} = \frac{Z}{X + \alpha Y} > 0 \qquad \text{and} \qquad \left.\frac{\partial^2 \mathcal{M}}{\partial r\,\partial \alpha}\right|_{r=r^*} = -\frac{ZY}{(X+\alpha Y)^2} < 0.$$

□

A.10 Proof of Proposition 5

Proof. The demand-determined economy has preferences

$$\log c + \omega \log h + \log m - \frac{\ell^{1+\sigma}}{1+\sigma} - \frac{n^{1+\sigma}}{1+\sigma},$$

with $\sigma > 0$ the inverse Frisch elasticity of labor supply. Substituting the labor requirements $\ell = (c/A)^{1/\alpha}$ and $n = h^{1/\kappa}$ gives the welfare function

$$\mathcal{W}^D(c,h) = \log c + \omega \log h - \frac{(c/A)^{(1+\sigma)/\alpha}}{1+\sigma} - \frac{h^{(1+\sigma)/\kappa}}{1+\sigma}. \tag{A.15}$$

Demand determination implies

$$c(M) = \frac{M}{P}, \qquad h(M,r) = \frac{\omega M}{rP}.$$

For given (r,α), define the optimal money supply directly as

$$\mathcal{M}_D(r,\alpha) \equiv \arg\max_{M>0} \mathcal{W}^D\left(\frac{M}{P}, \frac{\omega M}{rP}; \alpha\right).$$

Let $M^* \equiv Pc^*$ denote the money supply that implements efficient goods consumption, and define the efficient rent by $r^* \equiv \frac{\omega c^*}{h^*}$. Because c^* and h^* are independent of α, so are M^* and r^*.

Define

$$F(M,r;\alpha) \equiv \frac{\partial}{\partial M}\mathcal{W}^D\left(\frac{M}{P}, \frac{\omega M}{rP}; \alpha\right)$$

and note that the first-order condition of the policy problem is $F(M,r;\alpha) = 0$. By the chain rule,

$$F(M,r;\alpha) = \mathcal{W}^D_c c_M + \mathcal{W}^D_h h_M.$$

The optimal-policy function therefore satisfies

$$F\big(\mathcal{M}_D(r,\alpha), r; \alpha\big) = 0.$$

Differentiating this equation with respect to r gives

$$F_M \frac{\partial \mathcal{M}_D(r,\alpha)}{\partial r} + F_r = 0,$$

and hence

$$\frac{\partial \mathcal{M}_D(r,\alpha)}{\partial r} = -\frac{F_r}{F_M}.$$

To evaluate F_M, differentiate the policy first-order condition with respect to M:

$$\begin{aligned} F_M = \mathcal{W}^D_{cc} c_M^2 + 2\mathcal{W}^D_{ch} c_M h_M + \mathcal{W}^D_{hh} h_M^2 \\ + \mathcal{W}^D_c c_{MM} + \mathcal{W}^D_h h_{MM}. \end{aligned}$$

At $(M,r) = (M^*, r^*)$, efficiency implies

$$\mathcal{W}^D_c = \mathcal{W}^D_h = 0,$$

while additive separability implies $\mathcal{W}^D_{ch} = 0$. Therefore,

$$F_M = \mathcal{W}^D_{cc} c_M^2 + \mathcal{W}^D_{hh} h_M^2 < 0.$$

Similarly, differentiating the policy first-order condition with respect to r, holding M fixed, gives

$$F_r = \mathcal{W}^D_{ch} h_r c_M + \mathcal{W}^D_{hh} h_r h_M + \mathcal{W}^D_h h_{Mr},$$

where $c_r = c_{Mr} = 0$. At the efficient allocation, $\mathcal{W}^D_{ch} = \mathcal{W}^D_h = 0$, and hence

$$F_r = \mathcal{W}^D_{hh} h_M h_r.$$

At $(M,r) = (M^*, r^*)$,

$$c_M = \frac{1}{P} = \frac{c^*}{M^*}, \qquad h_M = \frac{\omega}{r^* P} = \frac{h^*}{M^*}, \qquad h_r = -\frac{\omega M^*}{(r^*)^2 P} = -\frac{h^*}{r^*}.$$

Using

$$-\mathcal{W}^D_{cc}(c^*)^2 = \frac{1+\sigma}{\alpha}, \qquad -\mathcal{W}^D_{hh}(h^*)^2 = \frac{\omega(1+\sigma)}{\kappa},$$

we obtain

$$F_M = -\frac{1+\sigma}{(M^*)^2}\left(\frac{1}{\alpha} + \frac{\omega}{\kappa}\right)$$

and

$$F_r = \frac{\omega(1+\sigma)}{\kappa\, M^* r^*}.$$

It follows that

$$\left.\frac{\partial \mathcal{M}_D}{\partial r}\right|_{r=r^*} = -\frac{F_r}{F_M} = \frac{M^*}{r^*}\frac{\omega\alpha}{\kappa+\omega\alpha} > 0.$$

Finally, because M^* and r^* do not depend on α,

$$\left.\frac{\partial^2 \mathcal{M}_D}{\partial r\,\partial\alpha}\right|_{r=r^*} = \frac{M^*}{r^*}\frac{\omega\kappa}{(\kappa+\omega\alpha)^2} > 0.$$

$\square$

A.11 Welfare loss function

This appendix derives the second-order approximations (12) and (13) to the welfare loss in our baseline search model and under demand-determined output.

Search rationing. At $w = w^*$, firm optimality and the resource constraints determine employment, production, and search from (c, h) through the allocation mapping used in Figure 3. In particular,

$$\theta_\ell(c) = g_\ell^{-1}(\alpha c/w^*), \qquad y(c) = A[G_\ell(\theta_\ell(c))]^\alpha,$$
$$\theta_c(c) = g_c^{-1}(c/y(c)), \quad \theta_h(h) = g_h^{-1}(h/\bar{h}).$$

Substituting into the policy objective $\mathcal{U}(\boldsymbol{\theta})$ defines the welfare function

$$\mathcal{W}(c,h) \equiv \log c + \omega \log h - \rho_c\theta_c(c)y(c) - \rho_h\bar{h}\,\theta_h(h),$$

so that the welfare loss is $\mathcal{L} \equiv \mathcal{W}(c^*, h^*) - \mathcal{W}(c, h)$.

Write $\eta_j^* \equiv \eta_j(\theta_j^*)$ and $\widehat{\theta}_j \equiv \log(\theta_j/\theta_j^*)$, $\widehat{c} \equiv \log(c/c^*)$, and $\widehat{h} \equiv \log(h/h^*)$, and collect the three log tightness gaps in $\widehat{\theta}$.

Let $\theta(c,h) \equiv (\theta_c(c), \theta_\ell(c), \theta_h(h))^\top$. By construction, $\mathcal{W}(c,h) = \mathcal{U}(\theta(c,h))$ and $\theta(c^*, h^*) =$

θ^*. Writing $\Delta\theta = \theta(c,h) - \theta^*$ and using $\nabla_\theta \mathcal{U}(\theta^*) = 0$, Taylor expansion gives

$$\begin{aligned}
\mathcal{L} &= \mathcal{W}(c^*, h^*) - \mathcal{W}(c,h) \\
&= \mathcal{U}(\theta^*) - \mathcal{U}(\theta(c,h)) \\
&= -\frac{1}{2}\Delta\theta^\top \nabla_\theta^2 \mathcal{U}(\theta^*)\Delta\theta + o(\|\Delta\theta\|^2).
\end{aligned}$$

where the first-order term vanishes at the efficient allocation. By Lemma 3(iii), the Hessian is diagonal, and passing to log gaps multiplies its jth diagonal entry by $(\theta_j^*)^2$. Lemma 2(iii)–(iv) give

$$\theta\eta_j'(\theta) = -\gamma\eta_j(\theta)[1-\eta_j(\theta)], \qquad -\frac{\theta^2 g_j''(\theta)}{g_j(\theta)} = (1+\gamma)\eta_j(\theta)[1-\eta_j(\theta)],$$

so the $(1,1)$ and $(3,3)$ entries in Lemma 3 equal $-\eta_c^*[1+\gamma(1-\eta_c^*)]/(\theta_c^*)^2$ and $-\omega\eta_h^*[1+\gamma(1-\eta_h^*)]/(\theta_h^*)^2$. For the $(2,2)$ entry, the planner's goods-market condition (6a) gives $\rho_c\theta_c^* = \eta_c^*/y^*$, so the entry equals $\alpha(1-\eta_c^*)G_\ell''(\theta_\ell^*)/\ell^*$; and $G_\ell'(\theta_\ell^*) = 0$ gives $\ell^* = g_\ell(\theta_\ell^*)(1-\eta_\ell^*)$, so $-(\theta_\ell^*)^2 G_\ell''(\theta_\ell^*)/\ell^* = (1+\gamma_\ell)\eta_\ell^*$. Substituting these entries into the quadratic form yields

$$\begin{aligned}
\mathcal{U}(\boldsymbol{\theta}^*) - \mathcal{U}(\boldsymbol{\theta}) = \frac{1}{2}\Big\{&\eta_c^*[1+\gamma(1-\eta_c^*)]\widehat{\theta}_c^2 + \alpha(1-\eta_c^*)(1+\gamma_\ell)\eta_\ell^*\widehat{\theta}_\ell^2 \\
&+ \omega\eta_h^*[1+\gamma(1-\eta_h^*)]\widehat{\theta}_h^2\Big\} + o(\|\widehat{\theta}\|^2). \qquad \text{(A.16)}
\end{aligned}$$

Next impose the allocation mapping underlying $\mathcal{W}(c,h)$, at $w = w^*$. Firm optimality gives $we = \alpha c$ and $w^*e^* = \alpha c^*$, so $e/e^* = c/c^*$ exactly within each economy. Also, $G_\ell'(\theta_\ell^*) = 0$ implies $\log(y/y^*) = O(\widehat{\theta}_\ell^2)$. Using $e = g_\ell(\theta_\ell)$, $c = g_c(\theta_c)y$, and $h = \bar{h}\, g_h(\theta_h)$, to first order, the tightness gaps are related to the consumption gaps by

$$\begin{aligned}
&\widehat{\theta}_c = \frac{\widehat{c}}{\eta_c^*} + O(\widehat{c}^2), \qquad \widehat{\theta}_\ell = \frac{\widehat{c}}{\eta_\ell^*} + O(\widehat{c}^2), \\
&\widehat{\theta}_h = \frac{\widehat{h}}{\eta_h^*} + O(\widehat{h}^2).
\end{aligned}$$

Substituting these linear approximations into (A.16) gives the expression (12) in the paper:

$$\mathcal{L} \approx \frac{1}{2}\left[(a_c + \alpha a_\ell)\widehat{c}^2 + a_h\widehat{h}^2\right]$$

with

$$a_c = \frac{1+\gamma_c(1-\eta_c^*)}{\eta_c^*}, \qquad a_\ell = \frac{(1-\eta_c^*)(1+\gamma_\ell)}{\eta_\ell^*}, \qquad a_h = \omega\,\frac{1+\gamma_h(1-\eta_h^*)}{\eta_h^*}. \qquad \text{(A.17)}$$

Note that since $\gamma > 0$, $\gamma_\ell > 0$, and $\eta_j^* \in (0,1)$ by Lemma 2(iv), all three coefficients are strictly positive.

Demand-determined output. The efficient allocation of the demand-determined economy satisfies $(\ell^*)^{1+\sigma} = \alpha$ and $(n^*)^{1+\sigma} = \omega\kappa$. Referring to the welfare function in (A.15), $\mathcal{W}_c^D(c^*, h^*) = \mathcal{W}_h^D(c^*, h^*) = \mathcal{W}_{ch}^D(c^*, h^*) = 0$. Direct differentiation at the efficient allocation gives

$$-\mathcal{W}_{cc}^D(c^*, h^*)(c^*)^2 = \frac{1+\sigma}{\alpha}, \qquad -\mathcal{W}_{hh}^D(c^*, h^*)(h^*)^2 = \frac{\omega(1+\sigma)}{\kappa}. \tag{A.18}$$

Define $\mathcal{L}^D \equiv \mathcal{W}^D(c^*, h^*; \alpha) - \mathcal{W}^D(c, h; \alpha)$, and let starred derivatives be evaluated at $(c^*, h^*; \alpha)$. Efficiency and additive separability imply $\mathcal{W}_c^{D,*} = \mathcal{W}_h^{D,*} = \mathcal{W}_{ch}^{D,*} = 0$. A second-order Taylor expansion in consumption levels therefore gives

$$\mathcal{L}^D = -\frac{1}{2}\left[\mathcal{W}_{cc}^{D,*}(c-c^*)^2 + \mathcal{W}_{hh}^{D,*}(h-h^*)^2\right] + o\big((c-c^*)^2 + (h-h^*)^2\big)\,.$$

Defining $\widehat{c} = \log(c/c^*)$ and $\widehat{h} = \log(h/h^*)$, we have

$$c - c^* = c^*\widehat{c} + O(\widehat{c}^2), \qquad h - h^* = h^*\widehat{h} + O(\widehat{h}^2).$$

Consequently,

$$(c-c^*)^2 = (c^*)^2\widehat{c}^2 + O(|\widehat{c}|^3), \qquad (h-h^*)^2 = (h^*)^2\widehat{h}^2 + O(|\widehat{h}|^3).$$

Substituting these expressions and (A.18),

$$\begin{aligned}\mathcal{L}^D &= -\frac{1}{2}\left[\mathcal{W}_{cc}^{D,*}(c^*)^2\widehat{c}^2 + \mathcal{W}_{hh}^{D,*}(h^*)^2\widehat{h}^2\right] + o(\widehat{c}^2 + \widehat{h}^2) \\ &\approx \frac{1+\sigma}{2}\left[\frac{\widehat{c}^2}{\alpha} + \frac{\omega\widehat{h}^2}{\kappa}\right].\end{aligned}$$

This is expression (13).

B Additional results for Section 4

B.1 Characterization of constrained efficient allocation and efficient prices

Let $u_t \equiv 1-(1-\delta_\ell)e_{t-1}$ and $h_t^v \equiv 1-(1-\delta_h)h_{t-1}$ denote the stocks of workers and housing units available for matching at date t. The first-order conditions of the planner's problem are

$$
\begin{aligned}
S_{c,t} &= \frac{1}{c_t} \\
\rho_c &= \frac{\partial \mathbb{M}_{c,t}}{\partial s_{c,t}}\, S_{c,t} \\
\rho_\ell\, A_t\, \frac{\partial \mathbb{M}_{c,t}}{\partial y_t}\, S_{c,t} &= \frac{\partial \mathbb{M}_{\ell,t}}{\partial v_t}\, S_{\ell,t} \\
S_{\ell,t} &= \frac{\partial \mathbb{M}_{c,t}}{\partial y_t}\, A_t\, S_{c,t} + \beta(1-\delta_\ell)\left[1 - \frac{\partial \mathbb{M}_{\ell,t+1}}{\partial u_{t+1}}\right] S_{\ell,t+1} \\
S_{h,t} &= \frac{\omega_t}{h^o + h_t} + \beta(1-\delta_h)\left[1 - \frac{\partial \mathbb{M}_{h,t+1}}{\partial h^v_{t+1}}\right] S_{h,t+1} \\
\rho_h &= \frac{\partial \mathbb{M}_{h,t}}{\partial s_{h,t}}\, S_{h,t},
\end{aligned}
$$

The derivatives are written explicitly with respect to the relevant matching-function argument. For the searching input $x_{j,t} \in \{s_{c,t}, v_t, s_{h,t}\}$, $\partial \mathbb{M}_{j,t}/\partial x_{j,t} = f_j(\theta_{j,t})\eta_j(\theta_{j,t})$, where η_j is the matching elasticity defined in Section 3.

As the matching functions are constant returns to scale, Euler's theorem implies

$$
\begin{aligned}
\frac{\partial \mathbb{M}_{c,t}}{\partial y_t}\, y_t + \frac{\partial \mathbb{M}_{c,t}}{\partial s_{c,t}}\, s_{c,t} &= \mathbb{M}_{c,t} \\
\frac{\partial \mathbb{M}_{c,t}}{\partial y_t} &= \frac{\mathbb{M}_{c,t}}{y_t} - \frac{\partial \mathbb{M}_{c,t}}{\partial s_{c,t}} \frac{s_{c,t}}{y_t} \\
&= g_c(\theta_{c,t}) - \frac{\partial \mathbb{M}_{c,t}}{\partial s_{c,t}}\, \theta_{c,t} \\
S_{c,t} \frac{\partial \mathbb{M}_{c,t}}{\partial y_t} &= S_{c,t} g_c(\theta_{c,t}) - S_{c,t} \frac{\partial \mathbb{M}_{c,t}}{\partial s_{c,t}}\, \theta_{c,t} \\
&= S_{c,t} g_c(\theta_{c,t}) - \rho_c \theta_{c,t}
\end{aligned}
$$

where the last line uses $S_{c,t} \frac{\partial \mathbb{M}_{c,t}}{\partial s_{c,t}} = \rho_c$ from the planner first-order conditions. A similar derivation for the housing market leads to

$$S_{h,t}\frac{\partial \mathbb{M}_{h,t}}{\partial h^v_t} = S_{h,t}g_h(\theta_{h,t}) - \rho_h\theta_{h,t}$$

For labor, we have

$$S_{\ell,t}\frac{\partial \mathbb{M}_{\ell,t}}{\partial u_t} = S_{\ell,t}g_\ell(\theta_{\ell,t}) - \rho_\ell A_t\theta_{\ell,t}\left(S_{c,t}g_c(\theta_{c,t}) - \rho_c\theta_{c,t}\right).$$

Rearranging the FOCs and using these Euler's theorem results yields

$$\begin{aligned}
S_{c,t} &= \frac{1}{c_t}\\
\frac{\partial \mathbb{M}_{c,t}}{\partial s_{c,t}}\frac{1}{c_t} &= \rho_c\\
\frac{\partial \mathbb{M}_{\ell,t}}{\partial v_t}S_{\ell,t} &= \rho_\ell A_t g_c(\theta_{c,t})\lambda_t\\
S_{\ell,t} &= A_t g_c(\theta_{c,t})\lambda_t + \beta(1-\delta_\ell)\left(1 - g_\ell(\theta_{\ell,t+1})\right)S_{\ell,t+1} + \beta(1-\delta_\ell)\rho_\ell A_{t+1}\theta_{\ell,t+1}g_c(\theta_{c,t+1})\lambda_{t+1}\\
S_{h,t} &= \frac{\omega_t}{h^o + h_t} + \beta(1-\delta_h)\left(1 - g_h(\theta_{h,t+1})\right)S_{h,t+1} + \beta(1-\delta_h)\rho_h\theta_{h,t+1}\\
\frac{\partial \mathbb{M}_{h,t}}{\partial s_{h,t}}S_{h,t} &= \rho_h,
\end{aligned}$$

where we have used the definition of λ_t from the household's FOC $\lambda_t = \frac{1}{c_t} - \frac{\rho_c}{f_c(\theta_{c,t})}$.

We now discuss how to define the efficient prices in order to implement the constrained-planner solution in the competitive equilibrium. The household's FOC for $s_{c,t}$ can be written

$$\left(\frac{1}{c_t} - \lambda_t p^*_t\right) f_c(\theta_{c,t}) = \rho_c,$$

where p^*_t is the efficient goods-price benchmark that would induce the efficient search effort. The incentives for search will match the planner's choice if

$$\left(\frac{1}{c_t} - \lambda_t p^*_t\right) f_c(\theta_{c,t}) = \rho_c = f_c(\theta_{c,t})\frac{\eta_c(\theta_{c,t})}{c_t}.$$

Solving this equation yields

$$p^*_t = \frac{1 - \eta_c(\theta_{c,t})}{\lambda_t c_t}.$$

The household's FOC for $s_{h,t}$ is

$$f_h(\theta_{h,t})\,(\mu_{h,t} - r_t\psi_t) = \rho_h$$

and efficiency requires

$$f_h(\theta_{h,t})\,(\mu_{h,t} - r_t^*\psi_t) = \rho_h = f_h(\theta_{h,t})\,\eta_h(\theta_{h,t})S_{h,t}.$$

Solving for the rent yields (28) in the main text.

The FOCs of the firm are

$$\begin{aligned}\zeta_{\ell,t} &= \lambda_t\left[g_c(\theta_{c,t})A_t - w_t\right] + \beta(1-\delta_\ell)\zeta_{\ell,t+1} \\ f_\ell(\theta_{\ell,t})\zeta_{\ell,t} &= \rho_\ell\lambda_t g_c(\theta_{c,t})A_t.\end{aligned}$$

In defining w_t^* we assume the firm pays $\{w_\tau^*\}_{\tau=t}^\infty$ for the life of the match

$$\zeta_{\ell,t}^* = \lambda_t\left(g_c(\theta_{c,t})A_t - w_t^*\right) + \beta(1-\delta_\ell)\zeta_{\ell,t+1}^*,$$

where $\zeta_{\ell,t}^*$ is the surplus to the firm when the wage follows $\{w_\tau^*\}_{\tau=t}^\infty$. Then w_t^* is defined by

$$f_\ell(\theta_{\ell,t})\zeta_{\ell,t}^* = \rho_\ell A_t g_c(\theta_{c,t})\lambda_t = f_\ell(\theta_{\ell,t})\,\eta_\ell(\theta_{\ell,t})S_{\ell,t}.$$

Substituting $\zeta_{\ell,t}^* = \eta_\ell(\theta_{\ell,t})\,S_{\ell,t}$ at dates t and $t+1$ into the recursion for $\zeta_{\ell,t}^*$ and solving for the wage yields (30) in the main text.

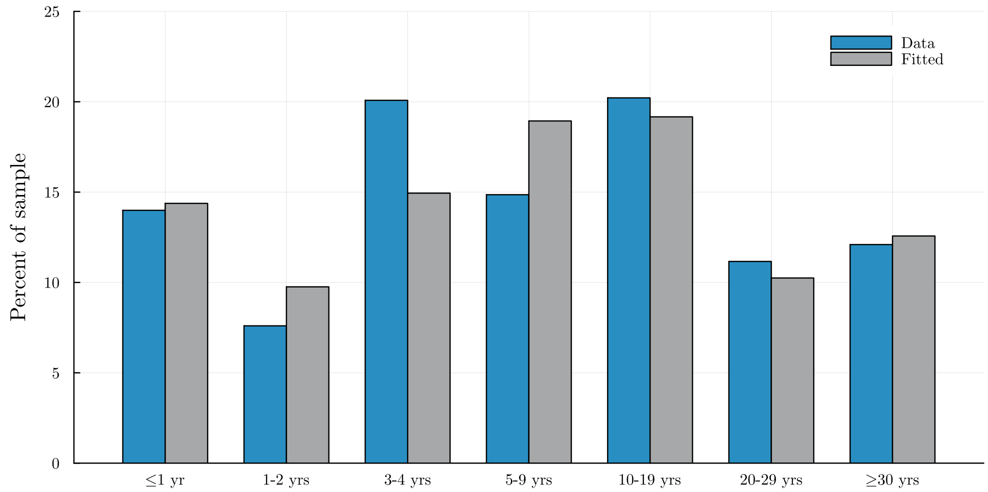

Figure C.1: Distribution of answers to "How long have you lived here?" The fitted values are from a two-component mixture of Poisson processes. Source: American Community Survey 2019.

C Additional data and results

C.1 Data on housing mobility

Figure C.1 plots the distribution of length of residence from the 2019 American Community Survey. We fit a simple model to this distribution. The model is a two-component mixture of Poisson processes in which a share p of households have a monthly moving probability of δ_{low} and $1-p$ have a monthly moving probability of δ_{high}. We fit p and the two δ's by maximum likelihood, yielding $p = 0.71$, $\delta_{\text{low}} = 0.005$, and $\delta_{\text{high}} = 0.035$.

C.2 Alternative calibration of χ_h

We calibrate the rigidity in new leases to be the same as the rigidity in goods prices with $\chi_h = \chi_c = 1 - 1/12$. Here we report results for a sensitivity analysis in which we raise χ_h to $1 - 1/36$. Figure C.2 repeats the main experiment reported in Figure 6 under this alternative calibration. Even in this extreme case, it remains optimal to place low weight on housing, which demonstrates that our results are not sensitive to the exact calibration of rent rigidity.

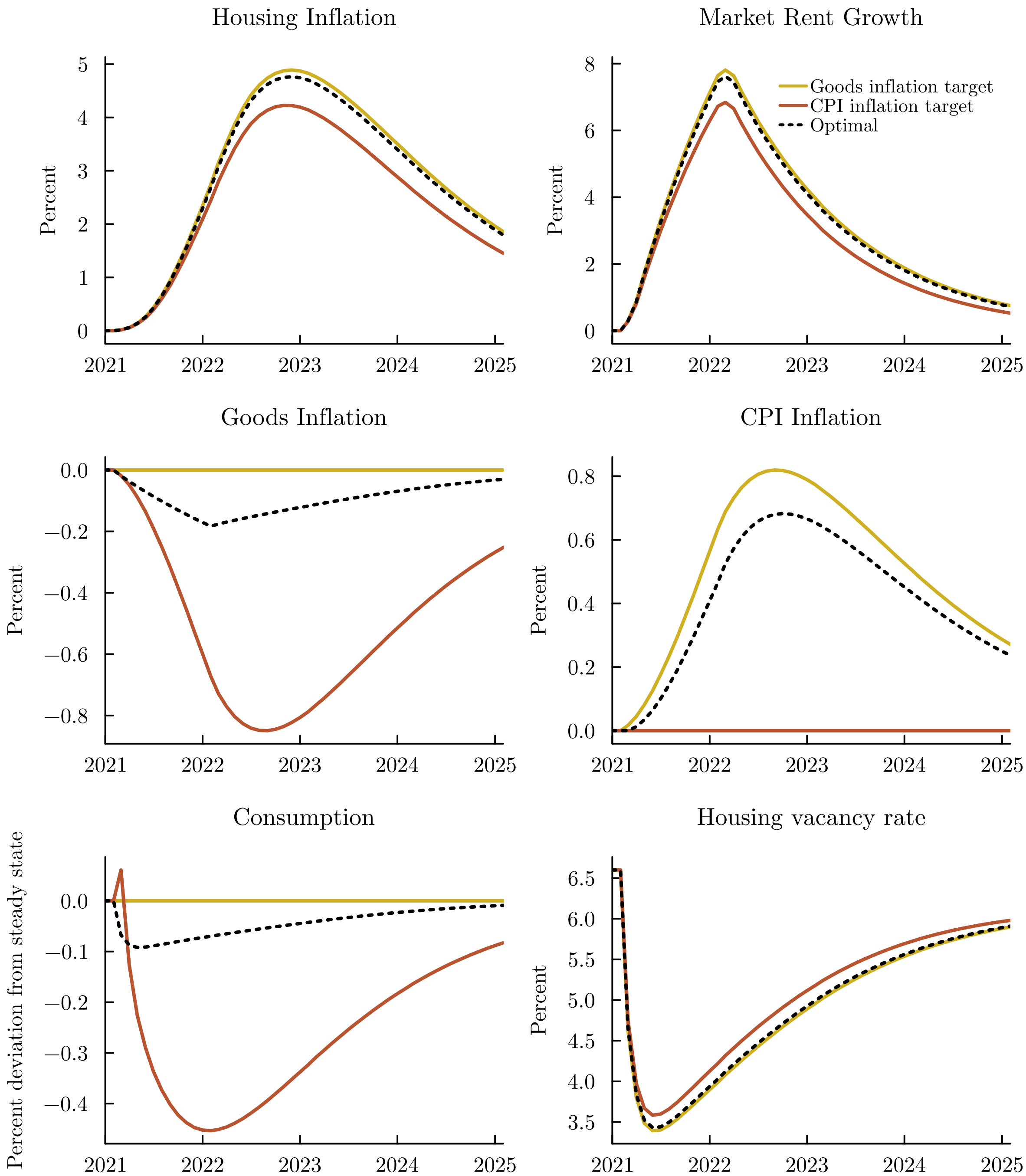

Figure C.2: Alternative monetary policy responses to a permanent increase in housing demand ω_t with $\chi_h = 1 - 1/36$.

Note: Inflation rates and market rent growth are expressed in percent at an annual rate. Goods consumption is expressed in percentage deviations from the initial steady state. The shock is assumed to occur in March of 2021.