University of Glasgow

Adam Smith Business School

WORKING PAPER SERIES

Searching for flexibility: The Joint Impact of Thatcher's Reforms of UK Labour and Housing Markets

Tatiana Kirsanova, Øyvind Masst and Charles Nolan

Paper No. 2025-13
December 2025

Searching for flexibility: The Joint Impact of Thatcher's Reforms of UK Labour and Housing Markets*

Tatiana Kirsanova † University of Glasgow
Øyvind Masst ‡ Oslo Economics
Charles Nolan § University of Glasgow

December 14, 2025

Abstract

This paper quantifies the macroeconomic effects of the major housing- and labour-market reforms of the 1980s in the United Kingdom under the Thatcher government. We estimate a small New Keynesian DSGE model with search frictions in both labour and housing markets to evaluate the collapse in public construction, the Right to Buy programme, the decline in trade union bargaining power, and the shift in monetary policy. We find strong cross-market spillovers: housing-market shocks account for roughly half of the volatility in unemployment and job search, and tight housing markets significantly dampen job creation. Counterfactual experiments imply that the observed fall in union bargaining power lowered the mid-1980s unemployment peak by about two percentage points relative to a no-reform path. The housing reforms tilt tenure sharply towards ownership and keep house-price-to-earnings ratios under sustained pressure, but, taken together, the reforms generate only modest changes in average affordability. In welfare terms, the negative effects of lower public construction are more than offset by the combination of lower unemployment and higher housing-service consumption, yielding a net welfare gain of around one percent in consumption-equivalent terms.

Key Words: Estimated New Keynesian DSGE Models; Monetary Policy; Search-and-Matching Frictions; Labour and Housing Markets; Bayesian Estimation

JEL Reference Number: E32, E24, E52, E65

*Acknowledgements to be added.

†Address: Economics, Adam Smith Business School, University of Glasgow, 2 Discovery Place, Glasgow G11 6EY; e-mail tatiana.kirsanova@glasgow.ac.uk

‡Address: Oslo Economics, Klingenberggata 7A, 0161 Oslo; e-mail orm@osloeconomics.no

§Address: Economics, Adam Smith Business School, University of Glasgow, 2 Discovery Place, Glasgow G11 6EY; e-mail charles.nolan@glasgow.ac.uk

1 Introduction

The motivation for our paper lies in far-reaching reforms introduced in the 1980s. Britain, like many other countries, faced serious economic challenges throughout the 1970s. The Thatcher government, which assumed office in 1979, proceeded over three terms to introduce fundamental reforms in many areas of economic and social life. The underlying philosophy was one of freeing up markets and deregulation. A centrepiece of these reforms was a sequence of five laws aimed at shifting the balance of power in the labour market away from trade unions to bolster management's 'right to manage'. This shift in the balance of power proved enduring, undoubtedly assisted by a changing industrial structure moving away from traditionally highly unionized sectors. Notably, the first piece of legislation introduced by the new government, The Employment Act 1980, coincided with the peak of union membership (just over 13 million), which then declined year after year for the next 11 years. By the time Labour returned to government in 1997, membership was under 8 million.

The Thatcher governments also introduced many tax and benefit reforms over the decade of the 1980s[1], aimed at increasing employment. Briefly, one might point to changes to income tax, increases in the relative importance of in-work benefits, and a decrease in out-of-work benefits. For example, in 1982, the Earnings-Related Supplement (ERS) to unemployment benefits was abolished. There were also initiatives to help the unemployed find work by reducing search costs and by initiatives to improve training.[2] In short, trade union legislation, welfare and tax reform and other innovations were aimed at increasing what one would now label search and match efficiency.

Equally striking were the privatisation programmes, especially the Housing Acts of 1980, which gave millions of council tenants the right to purchase their council houses on very favourable terms (see Jones and Murie, 2006). Interestingly, some economists had argued that the preponderance of council housing before the 1980's made the labour market less flexible as workers might be unwilling to move if that meant joining the end of the housing queue in a new locale. Later assessments on that issue uncovered a complex set of interactions.[3] In any event, housing reform also proved to be an enduring feature of Mrs. Thatcher's legacy. Owner-occupied tenure in 1980

[1]Some of the more significant changes did not come in until the late 1980's. See Mayhew (1991).

[2]See Johnson and Stark (1989) for a contemporary assessment of some of those reforms. Muellbauer and Soskice (2022) is a modern and wider perspective on many of those issues. A useful overview is in Mayhew (1991), while a detailed look at various tax and benefit changes are in Bowen and Mayhew (1990).

[3]See Muellbauer and Murphy (2008) for a detailed overview of that issue and many others related to housing and the economy.

was 55.5%; by 1990, it had risen to 67.1%. Over the same period, the proportion of publicly rented housing fell from 31.1% to 22.1%, and the private rented sector decreased from 12.7% to 7.5%.[4] Moreover, Jones and Murie (2006) note that sales of public sector dwellings under the Right to Buy policy had generated £36.8 billion by the end of the financial year 2002/03 and will amount to about £40 billion over the first 25 years.

Alongside labour and housing reforms were several others that complemented them. Liquidity restrictions on banks were removed and capital controls were lifted enabling banks to lend substantially more than before. Similarly, the building society sector was deregulated. By the late 1970s, building societies had accounted for over 95% of mortgages, protected from bank competition by the liquidity regulations just mentioned, among other tax and regulatory privileges. These mutual institutions, primarily funded by retail savings, were largely prohibited from accessing any form of wholesale funding source. Throughout the 1980s, building societies were permitted to expand their product range, diversify their funding sources, and demutualise. The result of these reforms on banks and building societies was a financial sector that decisively shifted toward mortgage and property finance. Net mortgage lending in 1980 was a little over £7 billion; by 1989, it had risen to over £34 billion (Boleat, 1994).

These structural reforms went ahead simultaneously with a 'paradigm shift' in macroeconomic policy, moving away from the Keynesian objective of full employment towards prioritising price stability in monetary policy, albeit without granting independence to the Bank of England. The Medium Term Financial Strategy, launched in March 1980, aimed for a gradually declining growth rate of the money supply. Over the ensuing four years, the growth rate of money supply (M3) was to be reduced from 7-11 percent in 1980-81 to 4-8 percent in 1983-84. This shift in the monetary policy framework was a crucial backdrop to structural reform since aggregate price stability was seen as central in allowing the price mechanism–the free market–to work efficiently.

The interplay between reforms to monetary policy and labour and housing markets forms the foundation of the complex legacy of Thatcher's economic policies. The central question for us is not merely how each reform performed in isolation but how, collectively, they influenced the dynamics between labour and housing markets and the broader economy. In seeking to contribute to a more robust and flexible economy, did these policies, in fact, operate in isolation? Or did they collectively enhance or mitigate the impact of one another?

To address these questions in a formal way, we build and estimate a small and stylized New Keynesian model with interconnected labour and housing markets. This allows us to study the

[4] The data are from the Department of the Environment, quoted in Stephens (1993).

joint determination of house prices and unemployment, controlling for monetary policy stance. We use a workhorse search and matching model (Mortensen and Pissarides, 1994) in a general equilibrium setting (see, e.g., Christiano, Eichenbaum, and Trabandt, 2016, and Lubik, 2009, for similar DSGE treatments), combined with a search and matching model of the housing sector, where the modelling approach is most similar to Head, Lloyd-Ellis, and Sun (2014). We introduce a linkage between the two markets, assuming that the matching efficiency and separation rate in one market are affected by the tightness of the other market. Specifically, we allow for the fact that a tight housing market may inhibit job search, resulting in fewer job quits and fewer job matches. As we mentioned earlier, when council housing was much more significant, some economists worried that the housing market was a significant impediment to labour market flexibility. On the other hand, a tight labour market might incentivise labour to move. In that case, we allow for homeowners receiving a mismatch signal such that they find a housing match more easily elsewhere. As we discuss later, we also allow the real interest rate to enter directly into the matching functions. This is to indicate if other channels related to issues such as stricter borrowing constraints at times of high interest rates are of significance. Similarly, we allow the separation rate in the labour market to be affected by a higher interest rate (to capture effects such as an increase in the number of bankruptcies which is more likely when interest rates are high). We model monetary policy in terms of simple rules, allowing coefficients to shift to reflect important changes in the monetary policy framework. We then use a Bayesian approach to estimate the model using quarterly UK data from 1971-2020.

We find that, compared with the previous decade, 1980 likely marked an important shift to a more strict monetary policy. However, the really decisive shift followed the UK's departure from the ERM (in September 1992) and the introduction of inflation targeting. Controlling for the monetary policy stance, we find that spillovers between the labour and housing markets are relatively strong. An increase in labour market activity tends to boost housing market activity, while a tight housing market can also impact negatively on the labour market. Moreover, matching efficiency shocks in the housing market explain a substantial part of employment volatility and the number of workers engaged in search. We find that housing market variables are driven predominantly by housing market shocks, but shocks to workers' bargaining power explain some of the volatility of house prices, and the number of buyers. Through a sequence of counterfactual experiments focussing on Thatcher's period in office, we show that halting the construction of council housing worsened housing affordability, but had only limited effects on labour-market outcomes. The Right to Buy privatisation programme further tilted tenure towards owner-occupation and contributed to sustained house-price pressures. Labour market reforms that reduced the bargaining power of trade unions, by contrast, generated a substantial reduction in unemployment and—on their own—also improve affordability in the model.

Three broad findings stand out. First, the estimated cross-market linkages are quantitatively important: shocks originating in the housing market account for roughly half of the volatility in unemployment and job search. Second, the reform package embodies a clear trade-off: jobs became easier to find and home-ownership more widespread, while housing-market pressures remained elevated. In particular, the decline in union bargaining power between 1979 and the mid-1980s lowers the unemployment peak by around two percentage points relative to a no-reform counterfactual, while housing reforms shift tenure sharply towards ownership and keep the house-price-to-earnings ratio under sustained pressure. Finally, aggregating the four reforms, the net welfare effect peaks at around one to two percent of steady-state consumption: losses from lower public construction and the early-1980s monetary stance are more than offset by gains from lower unemployment and higher housing-service consumption under the union and Right to Buy reforms.

Our paper contributes to the empirical literature on search and matching models of labour and housing markets in New Keynesian DSGE models. Empirical DSGE models of the labour market are common, predominantly using US data (see, e.g., Lubik, 2009; Krause, Lopez-Salido, and Lubik, 2009), with exceptions being Zanetti (2016) and Faccini, Millard, and Zanetti (2013), where the former work focuses on the same historical period as we do. Models with search and matching in the housing market are becoming more common (see seminal papers by Arnott, 1989, and Wheaton, 1990, Garriga and Hedlund, 2020, Head et al., 2014, Gabrovski and Ortego-Marti, 2021, to mention only a few). However, empirical work is limited. While some empirical evidence is used to build and evaluate heterogeneous agent models (Hedlund, 2016), we are unaware of research that employs long time series to estimate a search and matching model of the housing market. Similarly, while the joint treatment of labour and housing markets is growing, models are predominantly theoretical (see, e.g., Head and Lloyd-Ellis, 2012, and Branch et al., 2016). Models often become relatively complex and not suitable for Bayesian estimation in countries where not many long time series describing the housing sector are available.

The paper is organised as follows. Section 2 summarises the model. Section 3 describes the Bayesian estimation framework, outlining the calibration choices, estimated parameters, and prior settings, and summarises key estimation results. Section 4 examines the model's fit to the data and interprets the historical decompositions of key variables. Section 5 runs policy counterfactuals. Section 6 concludes.

2 The Model

We study a small New Keynesian model with search-and-matching frictions in both the labour and housing markets. The economy is populated by households whose members consume and supply hours to a “general industry” sector and to construction; they may be renters or owner-occupiers who derive utility from housing services. Labour-market activity in the general industry follows the standard search-and-matching framework à la Mortensen and Pissarides (1994), adapted for a general equilibrium setting (see e.g. Christiano et al. (2016) and Lubik (2009) for similar DSGE treatments), while their search and matching behaviour in the housing market parallels that in Head et al. (2014). Monopolistically competitive firms post vacancies and set prices à la Calvo, and competitive developers convert land into new dwellings using construction labour. We allow for a two-way linkage between labour- and housing-market tightness and let the strength of these linkages vary with credit conditions—proxied by the ex-ante real interest rate—so that higher real rates (tighter credit) dampen buyer–seller matching efficiency and increase separations in housing, even though credit frictions are not modelled explicitly. Monetary policy follows a simple interest-rate rule that can switch between dovish and hawkish regimes.

All variables are expressed in stationarised real terms. We remove the balanced-growth components associated with labour-augmenting technology (growth rate γ) and population (growth rate μ), applying the appropriate normalisation to each series. This transformation removes deterministic trends from the model and allows constant steady-state ratios to be defined.

Full details of optimisation problems, first-order conditions, aggregation, and equilibrium definitions are provided in the Online Appendix A.

2.1 Economic Agents

Households. A representative household pools income risk across employed and unemployed members, as well as across renters and owner-occupiers. Households derive utility from the habit-adjusted consumption composite x_t, utility from not working in the general industry ($(1 - h_{c,t})$, subscript c) and disutility from work in the construction sector($l_{h,t}$, subscript h); a share of owner-occupiers n_t also enjoy the flow of housing services. The expected lifetime utility is[5]

$$U^H = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[s_t^{\varrho} \frac{x_t^{1-\sigma} - 1}{1-\sigma} + \chi_c s_t^{\chi_c} l_{c,t} \frac{(1-h_{c,t})^{1-\nu} - 1}{1-\nu} - \chi_h l_{h,t} + z^H n_t \right]. \tag{1}$$

Here β is the subjective discount factor, coefficient χ_c weights the utility from leisure for those employed in the general industry, parameter χ_h weights the disutility from construction labour supply, and z^H weights the utility from housing services enjoyed by the share of owner-occupier. The curvature parameters σ and ν correspond to the inverse of the intertemporal elasticity of substitution and the inverse of the Frisch elasticity of labour supply, respectively. Stochastic processes s_t^{ϱ} and $s_t^{\chi_c}$ are taste ans labour supply shocks, respectively.

Households allocate expenditure between consumption, housing investment, and saving. Income arrives from sectoral labour earnings, benefits received while searching for work, transfers, and profits. The aggregate real, productivity-adjusted, per-capita budget constraint is

$$c_t + \omega_t + a_{t+1} = R_t a_t + w_{c,t} h_{c,t} l_{c,t} + w_{h,t} h_{h,t} l_{h,t} + b_c(1 - l_{c,t}) + \tau_t + \varphi_t - pr_t, \tag{2}$$

where c_t is consumption, ω_t net housing investment, a_t real bond holdings, R_t the gross return, $w_{j,t}$ is wage in sector $j \in \{c, h\}$, $h_{j,t}$ hours per employed worker in sector j, $l_{j,t}$ the employment share in sector j, τ_t lump-sum transfers received, φ_t profits rebated by firms, and pr_t privatisation payments. Parameter b_c is the unemployment benefit, fixed in real per-capita terms. Household optimisation yields the standard Euler equation for consumption and intratemporal labour-supply conditions.

Firms in general industry. A continuum of intermediate-goods producers combine employment and hours to produce differentiated goods, post costly vacancies, and face Calvo price rigidity. A perfectly competitive final-goods firm aggregates these intermediates into the composite consumption good. Appendix A.2 presents the firms' optimisation problem and the resulting New Keynesian Phillips curve.

Developers. Competitive developers hire construction labour and convert land into new dwellings. Free entry ensures that the real cost of construction equals the discounted value of a completed unit in the following period. Appendix A.3 describes their production technology and steady-state relationships.

[5]For exposition purpose we present the main-text summary equations in real per capita terms, adjusted for productivity growth rate. The details of the underlying optimisation problem, with exact transformations and normalisations, are in Appendix A.1.

2.2 Labour Market

Matching technology. Job creation in the general industry follows a standard search-and-matching mechanism. Let $v_{c,t}$ denote vacancies, $u_{c,t}$ be the pool of searching workers, $\omega_{c,t} \equiv v_{c,t}/u_t$ market tightness, and $\kappa_{c,t}$ is (endogenous) matching efficiency. The flow of successful matches $M_{c,t}$ is given by

$$M_{c,t} = \kappa_{c,t}\, u_t^{\delta_c}\, v_{c,t}^{1-\delta_c},$$

where $\delta_c \in (0,1)$ is the elasticity of matches with respect to searchers. This implies the job-filling and job-finding rates

$$\gamma_{c,t} = \kappa_{c,t}\, \omega_{c,t}^{-\delta_c}, \qquad \lambda_{c,t} = \omega_{c,t}\, \gamma_{c,t}. \tag{3}$$

A tighter market (higher $\omega_{c,t}$) increases the job-finding rate $\lambda_{c,t}$ but reduces the probability $\gamma_{c,t}$ of a firm filling a vacancy.

Stocks and flows. Employment evolves with surviving matches and new hires:

$$l_{c,t} = (1 - \vartheta_{c,t})\, l_{c,t-1} + v_{c,t}\, \gamma_{c,t}, \tag{4}$$

where $\vartheta_{c,t}$ is the (endogenous) separation rate. The pool of searching workers is the residual population share not in continuing employment:

$$u_t = 1 - (1 - \vartheta_{c,t})\, l_{c,t-1}. \tag{5}$$

Equations (4)–(5) jointly describe the employment and search dynamics of the labour market.

Wages and hours. Wages $w_{c,t}$ and hours $h_{c,t}$ are determined through Nash bargaining with stochastic worker share $\epsilon_c s_t^{\epsilon_c}$. The firm's surplus reflects the marginal revenue product and the continuation value of a filled vacancy, while the worker's outside option includes benefits b_c and the utility value of leisure scaled by $\chi_c s_t^{\chi_c}$ and the marginal utility of wealth λ_t. The vacancy cost ι_t and free-entry condition pin down tightness $\omega_{c,t}$ in equilibrium. Closed-form expressions for the wage rule, free-entry condition, and intratemporal hours choice are reported in Appendix A.2.

Prices. Under Calvo price rigidity, the aggregate price-setting block produces a standard New Keynesian Phillips curve linking inflation to expected inflation and real marginal cost. Thus, labour-market frictions affect inflation dynamics through their influence on marginal cost and wage mark-ups.

2.3 Housing Market

Matching technology. Housing transactions are governed by a search-and-matching process similar to that in the labour market. Let b_t denote the pool of searching buyers and s_t the per-capita stock of houses *for sale* (listings). Housing-market tightness is $\omega_{h,t} \equiv b_t/s_t$, The flow of new matches is

$$M_{h,t} = \kappa_{h,t}\, b_t^{\delta_h}\, s_t^{1-\delta_h},$$

with (endogenous) matching efficiency $\kappa_{h,t}$ and elasticity $\delta_h \in (0,1)$. This implies the *house finding rate* for buyers and the *house filling rate* for sellers are:

$$\lambda_{h,t} = \kappa_{h,t}\, \omega_{h,t}^{\delta_h - 1}, \qquad \gamma_{h,t} = \omega_{h,t}\, \lambda_{h,t}. \tag{6}$$

Higher tightness $\omega_{h,t}$ raises the probability that a buyer finds a property but lowers the probability that a seller completes a sale.

Tenure flows. Ownership evolves with (endogenous) separations $\vartheta_{h,t}$ and successful buyer matches:

$$n_t = (1 - \vartheta_{h,t})\, n_{t-1} + b_t\, \lambda_{h,t}. \tag{7}$$

The pool of active buyers consists of non-owners who choose to search in the housing market and those re-entering after separation.

$$b_t = 1 - f_t - (1 - \vartheta_{h,t})\, n_{t-1}, \tag{8}$$

where f_t denotes the share of permanent renters who never participate in the market. The population of permanent renters evolves with demographics and with the renter preference parameter ψ and shock to renters' preferences s_t^{ψ}:

$$f_t(1+\mu) = f_{t-1} + \left(1 - \psi s_{t-1}^{\psi}\right)\mu. \tag{9}$$

so that higher ψ implies a smaller inflow of new renters and, equivalently, a larger potential pool of future buyers. Equations (7)–(9) jointly describe tenure dynamics in the housing market.

Transaction chains. We allow for transaction chains: a fraction $\alpha_h \in [0,1)$ of all listings s_t are made by households who remain in their current home until completion (they "rent from themselves").

The effect of chain listings is to scale down the effective buyer pressure that can match to existing vacancies. In per-capita terms, effective housing-market tightness is therefore

$$\omega_{h,t} = \frac{(1 - \alpha_h s_t^{\alpha})\, b_t}{h_t - 1},$$

where α_h is the steady-state share of sellers who are in a chain, s_t^{α} is a chain listings shock, and we use that the number of vacant houses per capita is $h_t - 1 = (1 - \alpha_h s_t^{\alpha}) s_t$. Intuitively, a higher share of chain listings lowers effective tightness: each vacant unit is associated with more sellers, so there are more listings per buyer. Buyers therefore face less competition per usable home and find it easier to match, whereas individual sellers face tougher competition. Chain listings thus directly influence market liquidity by diluting buyer pressure without changing the stock of vacant units, which affects both matching rates and the propagation of housing shocks.

Housing supply. The per-capita housing stock evolves according to construction activity:

$$h_{t+1}(1 + \mu) - h_t = \phi s_t^{\phi} l_{h,t}, \tag{10}$$

where ϕs_t^{ϕ} is the stochastic productivity in the construction sector and $l_{h,t}$ construction employment. Equation (10) links the flow of new dwellings to labour input in construction.

Prices and user cost. Transaction prices p_t^h are determined by Nash bargaining over match surpluses between buyers and sellers with the seller's bargaining weight ϵ_h. User-cost conditions for developers and the value-function recursions are provided in Appendix A.3, and underlie our price-to-rent and sales objects in estimation.

2.4 Inter-market linkages

Frictions in the housing and labour markets are interconnected through workers' mobility and households' relocation decisions. When the housing market is tight—meaning a high relative number of buyers per property—moving becomes more difficult and costly. Workers may then be less willing to search for new jobs that require relocation, leading to fewer voluntary separations and fewer new job matches.

Conversely, when the labour market is tight and vacancies are abundant, households face stronger incentives to relocate, which raises housing turnover and search activity.

To capture these two-way linkages, we allow matching efficiency and separation rates in one market to depend on market tightness in the other, with additional sensitivity in the housing market to credit conditions proxied by the ex-ante real interest rate:

$$\kappa_{c,t} = \kappa_c s_t^{\kappa_c} \left(\frac{\omega_{h,t}}{\omega_h}\right)^{-\zeta_\kappa}, \qquad \vartheta_{c,t} = \vartheta_c \left(\frac{\omega_{h,t}}{\omega_h}\right)^{-\zeta_\vartheta}, \tag{11}$$

$$\kappa_{h,t} = \kappa_h s_t^{\kappa_h} \left(\frac{\omega_{c,t}}{\omega_c}\right)^{\eta_\kappa} \left(\frac{1+i_t}{1+\pi_{t+1}} R^{-1}\right)^{-\theta_\kappa}, \quad \vartheta_{h,t} = \vartheta_h \left(\frac{\omega_{c,t}}{\omega_c}\right)^{\eta_\vartheta} \left(\frac{1+i_t}{1+\pi_{t+1}} R^{-1}\right)^{\theta_\vartheta}. \tag{12}$$

Here ω_c and ω_h denote steady-state tightness in the labour and housing markets, respectively; and R is the steady-state real interest rate. Parameters $\zeta_{\{\kappa,\vartheta\}}$ and $\eta_{\{\kappa,\vartheta\}}$ are cross-market elasticities, so that tighter-than-normal housing (higher $\omega_{h,t}/\omega_h$) dampens job creation and quits, whereas tighter-than-normal labour (higher $\omega_{c,t}/\omega_c$) accelerates housing search and separations.

We allow housing-market activity to depend directly on household credit conditions. The elasticities $\theta_{\kappa,\vartheta}$ let the matching efficiency and separation rate respond to a reduced-form measure of credit tightness, proxied by the ex-ante real interest rate $\big((1+i_t)/(1+\pi_{t+1})\big)R^{-1}$. Higher-than-steady-state real rates reduce the effective matching efficiency and increase separations, capturing—albeit in a stylised way—the influence of credit frictions not modelled explicitly.

A large literature emphasises the importance of credit conditions for housing-market activity, see, e.g., Aoki et al. (2004), Iacoviello (2005), Cameron et al. (2006), Justiniano et al. (2019). For instance, Cameron et al. (2006) show that UK house prices co-move strongly with a broad credit-conditions index largely driven by loan-to-value ratios. Because our framework does not include mortgage contracts or borrower balance-sheet constraints, we introduce the real interest rate as a tractable, reduced-form proxy for credit availability. This device preserves the main transmission channels through which monetary policy affects the housing market and improves identification of the housing matching shocks.

The proxy is motivated by two considerations. First, with complete insurance households share income risk, so mortgage interest payments would have little direct effect on aggregate consumption even if included explicitly. Second, the extensive margin—first-time buyers accumulating savings to meet down-payment requirements—is absent from the model. Allowing the real interest rate to shift the matching and separation schedules, via elasticities θ_κ and θ_ϑ around the steady-state real rate R, provides a parsimonious way of capturing the empirical link between tighter credit conditions and weaker housing-market turnover. Higher real rates may also raise separations by increasing the financial stress and default risk of indebted households, a mechanism that the reduced form mimics.

2.5 Monetary Policy

Monetary policy follows a simple interest-rate rule:

$$\frac{1+i_t}{1+i_{ss}} = \left(\frac{1+i_{t-1}}{1+i_{ss}}\right)^{\alpha_i} \left(\left(\frac{1+\pi_t}{1+\pi_{ss}}\right)^{\alpha_\pi} \left(\frac{y_t}{y_{t-1}}\right)^{\alpha_y}\right)^{1-\alpha_r} s_t^m$$

where i_{ss} and π_{ss} are steady state values and s_t^a is a stationary technology shock.

The rule includes interest–rate smoothing and a response to deviation of output growth from the stochastic trend, as in An and Schorfheide (2007). Monetary policy shock s_t^m accounts for other targets.

3 Estimation Framework

We estimate the model using quarterly UK data covering real activity, prices, and housing-market variables. The observed series are linked to a set of structural shocks—governing productivity, demand, matching efficiency, separations, preferences, and monetary policy—whose volatilities and policy parameters may switch across regimes. Estimation follows a Bayesian approach implemented in the `RISE` toolbox (Maih, 2015), using methods discussed in Hashimzade, Kirsanov, Kirsanova, and Maih (2024) to integrate regime inference with parameter estimation.

3.1 Measurement and Shock Specification

Observables For the estimation period of 1971Q2-2020Q1, we use the following eleven data series: the growth rate of real output, the growth rate of real earnings, the unemployment rate, the growth rate of labour market tightness, hours of work, the growth rate of the house price-to-rent ratio, the growth rate of the housing stock, the growth rate of house sales, the home ownership rate, inflation rate and the nominal interest rate. Detailed descriptions of the data, data sources and data transformation can be found in Appendix C.1.

Structural shocks Although the full model presented in the appendix includes a large number of exogenous processes—such as unemployment benefit $b_{c,t}$, population growth rate μ_t , and others—we hold all of these constant (in normalised terms) and retain only eleven structural disturbances. This ensures identification of the empirical model with eleven observable variables. Each shock is modelled as a mean-one multiplicative process whose logarithm follows an AR(1) law of motion. The shocks are: stationary productivity s_t^z, taste s_t^ϱ, matching efficiency in the labour market $s_t^{\kappa_c}$ and in the housing market $s_t^{\kappa_h}$, labour bargaining power $s_t^{\epsilon_c}$, construction productivity s_t^{ϕ}, permanent renters s_t^{ψ}, labour supply $s_t^{\chi_c}$, housing chain listings s_t^{α}, cost-push s_t^{ε}, and monetary policy shock s_t^m.

Regime structure To accommodate medium-run changes in the policy framework and in shock variances, we allow two independent two-state Markov processes.

The monetary-policy Markov process, $\upsilon_{M,t} \in \{H, D\}$, governs the inflation-response coefficient in the Taylor rule, switching between a hawkish state H and a dovish state D with $\alpha_\pi^H > \alpha_\pi^D$.[6] The transition matrix contains elements $p_{ij} = P(\upsilon_{M,t+1} = j \,|\, \upsilon_{M,t} = i), i, j \in H, D$.

A separate volatility Markov process, $\upsilon_{S,t} \in \{T, V\}$, affects the standard deviations of all structural shocks, switching between a tranquil state T and a volatile state V (e.g. Sims and Zha, 2006), with transition matrix defined by elements $q_{ij} = P(\upsilon_{S,t+1} = j \,|\, \upsilon_{S,t} = i), i, j \in T, V$.

These states jointly determine the likelihood through their influence on the policy rule and the conditional variance–covariance structure of shocks, while leaving steady-state relationships unchanged.

3.2 Priors, Identification, and Estimation

Parameters of the model can be divided into three subsets. The first subset includes the structural parameters that can be calibrated using the observed long run ratios, sample averages. The second subset of parameters is calibrated because the simplicity of the model and the shortage of available data do not allow us to identify them. The third subset includes parameters that are estimated, including the persistence and standard deviations of structural shocks. We will discuss these sets in turn.

Observed ratios and implied parameters.

The model is relatively tightly parameterised: many steady-state ratios are fixed using sample averages from the estimation period, as summarised in Table 1 and documented in Appendix C.1.

The variables in Table 1, which provide steady-state ratios used for calibration, are derived from standard macroeconomic and sectoral data sources. The employment rate l_c equals one minus the mean unemployment rate. Average weekly hours h_c are computed from UK labour data under the convention of 16 available hours per day over six working days.

Unemployment duration of approximately 40 weeks implies a weekly job-finding probability

[6] Zanetti (2016) used a variable inflation target to capture similar shifts.

Table 1: Known Steady-State Ratios

Data ratio	**Notation**	**Value**
Employment rate	$\bar{l}_c$	0.93
Hours of work (normalised)	$\bar{h}_c$	0.3418
Average duration of unemployment (weeks)	$\bar{\tau}_c^w = 1/\lambda_c^w$	40
Daily job-filling rate	$\bar{\gamma}_c^d$	0.05
Share of employment in construction	$\bar{\ell} = l_h/l_c$	0.036
Earnings ratio (construction to industry)	$\bar{w}_h = w_h/(h_c w_c)$	1.18
Unemployment benefit to earnings ratio	$\bar{b}_c = b_c/(h_c w_c)$	0.19
Vacancy-posting cost to earnings ratio	$\bar{\iota} = \iota/(h_c w_c)$	0.50
Housing stock to occupied-housing ratio	$\bar{h}$	1.03
Share of rented dwellings (of occupied stock)	$\bar{s}^r = b + f$	0.34
Average time to find a house (weeks)	$\bar{\tau}_h^w = 1/\lambda_h^w$	20
Average time between house moves (years)	$\bar{\tau}_o^a = 1/(4\vartheta_h)$	13
Rent-to-earnings ratio	$\bar{r}^h = r^h/(h_c w_c)$	0.356
House-price-to-quarterly-earnings ratio	$\bar{p}^h = p^h/(h_c w_c)$	24.03

λ_c^w, and hence a quarterly rate

$$\lambda_c = 1 - \left(1 - \lambda_c^w\right)^{\frac{52}{4}} = 0.28,$$

consistent with Hobijn and Şahin (2009). Because matching flows occur at higher frequencies than a quarter, both finding and filling probabilities must be interpreted as probabilities bounded by one. Following Davis et al. (2013), we calibrate the *daily* filling rate to $\gamma_c^d = 0.05$, implying a quarterly rate

$$\gamma_c = 1 - \left(1 - \gamma_c^d\right)^{\frac{365}{4}} = 0.9907,$$

i.e., very close to one.

The construction-sector employment share l_h/l_c is the sample average. The earnings ratio $w_h/(h_c w_c)$ is computed as weekly construction earnings relative to economy-wide weekly earnings. Since construction accounts for less than 5% of employment, excluding it from the aggregate when forming the "rest of the economy" would have a negligible effect on this ratio.

The replacement ratio is calibrated from OECD data to $b_c/(h_c w_c) = 0.19$. The vacancy-posting cost $\iota/(h_c w_c)$ represents hiring costs; we set it to 0.50. Values in a reasonably large neighbourhood do not materially affect our findings.

Housing quantities—vacant, owner-occupied, and rented—are taken from the Ministry of

Housing, Communities & Local Government and used to construct the ratio of all housing units to occupied housing, and the share of rented dwellings $(b + f)$ among the occupied stock. We interpret the latter as reflecting the combined shares of searching buyers and permanent renters.

The average time between house moves is taken to be $\vartheta_h = 13$ years (circa 2000–2008, Savills). The time to find and complete a purchase is assumed to be about 20 weeks in total, decomposed into roughly 4.5 months of search and 1.5 months to complete.

The average rent to earnings ratio used the BoE weekly earnings data and the rescaled ONS rent index to match level data on average weekly rent provided by the Department for Communities and Local Government (UK) for selected years.

Finally, house price to earnings ratio is computed using the normalised house price to rent ratio, see Appendix C.1.

The steady-state ratios in Table 1 pin down the structural parameters

$$\mathcal{P}_1 = \{\xi, u, \vartheta_c, \epsilon_c, \chi_c, \vartheta_h, \chi_h, \psi, \phi\},$$

together with other steady-state objects detailed in Appendix B.2.

Calibrated but non-identified parameters.

Calibrated parameters are reported in Table 2. Several structural parameters in the model are only weakly identified by the available observables, a common feature of small-scale DSGE environments with habits, matching frictions, and bargaining. In such cases, estimation delivers limited additional information beyond what is already implied by steady-state restrictions, and calibrating these parameters to conventional values improves numerical stability and comparability with the literature.

For example, when matching efficiencies are stochastic, the elasticities of matches (δ_c, δ_h) are not separately identified from the efficiency shocks and are therefore treated as calibrated. Similarly, the presence of preference shocks significantly weakens identification of the habit parameter θ, and—in turn—of the intertemporal-substitution coefficient σ. For this reason, both σ and the inverse Frisch elasticity ν are set to standard values widely used in New Keynesian and search–and–matching models. These parameters mainly affect steady-state consumption smoothing and labour supply behaviour but have limited bearing on the cross-market interactions that the estimation seeks to discipline.

The bargaining power of housing-market buyers, ϵ_h, is also not identified from the data and is fixed at 0.5, a value consistent with the existing empirical and theoretical literature. Finally, the land-conversion parameters (Λ, s) governing the curvature and scale of the (unobserved) land input are calibrated because no reliable data series exist to discipline them directly.

Although calibrated, these parameters enter the steady state of several endogenous variables. To ensure internal consistency, we verified that the resulting steady-state objects—such as matching probabilities, bargaining weights, and implied transition rates—remain within economically meaningful ranges and behave appropriately under filtering.

Table 2: Calibrated Parameters

Parameter description	**Notation**	**Value**
Trend productivity growth rate (quarterly)	$\bar{\gamma}$	0.0025
Population growth rate (quarterly)	$\bar{\mu}$	0.0025
Household discount factor (quarterly)	$\bar{\beta}$	0.9975
Real interest rate (quarterly)	$R = \frac{1+\bar{\gamma}}{\bar{\beta}}$	1.0045
Steady-state inflation rate (quarterly)	$\bar{\pi}_{ss} = \frac{1+\bar{i}}{\bar{R}}$	1.005
Habit persistence	$\bar{\theta}$	0.80
Intertemporal elasticity of substitution	$\bar{\sigma}$	2
Inverse Frisch elasticity	$\bar{\nu}$	2
Elasticity of substitution (consumption varieties)	$\bar{\epsilon}$	6.00
Elasticity of matches, labour market	$\bar{\delta}_c$	0.70
Elasticity of matches, housing market	$\bar{\delta}_h$	0.70
Buyers' bargaining power (housing)	$\bar{\epsilon}_h$	0.50
Share of chain listings (housing market)	$\bar{\alpha}_h$	0.40
Production-function parameter	$\bar{\Lambda}$	0.025
Production-function parameter	$\bar{s}$	0.50

After calibrating the weakly identified elements, the dynamic part of the model consists of stochastic processes for matching efficiency, separation, chain listings, and bargaining power, each following a simple AR(1) law of motion. Their steady-state means, together with the time-invariant structural parameters, are collected in

$$\mathcal{P}_2 = \{\delta_c, \delta_h, \alpha_h, \vartheta_h, \epsilon_h, \xi, \epsilon, \Lambda, s\},$$

and calibrated as reported in Table 2. Together with the steady-state ratios in Table 1, these parameters determine the stationary equilibrium objects

$$\{u, w_c, y, c, x, \lambda, \lambda_c, \gamma_c, \omega_c, w_h, b_c, \iota, \kappa_c, p^h, l_h, \lambda_h, n, b, f, \omega_h, \gamma_h, \kappa_h, p^h, v, v^B, v^N, v^F, r^h, q_h, z^h\},$$

as described in Appendix B.2.

Priors for estimated parameters

The set of estimated parameters comprises $\mathcal{P}_{3P} = \{\zeta\kappa, \zeta_\vartheta, \eta_\kappa, \eta_\vartheta, \theta_\kappa, \theta_\vartheta\}$, capturing behavioural elasticities, and $\mathcal{P}_{3S} = \rho^j, \sigma j$, denoting the autoregressive coefficients and standard deviations of the jth structural shock. Priors for these parameters are standard and relatively uninformative. Details are reported in Table 3.

3.3 Posterior Estimates

Cross-market elasticities. Table 3 reports the estimated elasticities. The results indicate strong interdependence between the housing and labour markets in the United Kingdom.

An increase in labour-market activity stimulates housing-market activity. The estimate of η_κ suggests that a one-percent rise in labour-market tightness raises housing matches by about 6%. The effect of lower housing separations is smaller (around –0.5%), so the matching channel dominates in the housing market. This is consistent with the interpretation that many housing separations correspond to moves within the same quarter or to matches realised shortly after. Counterfactual analysis in Section 5 confirms that the estimated η-coefficients capture the imbalance between matching and separation during booms, a key factor behind the cyclical behaviour of house prices.

Conversely, a more active housing market tends to slow labour-market activity. A one-percent increase in housing-market tightness reduces labour-market matches and separations by roughly 4.5% and 6%, respectively. The matching effect again dominates: tighter housing conditions lead to slightly higher unemployment, although the quantitative impact is modest.

Monetary policy also affects housing-market dynamics through real interest rates. A one-percent increase in the real rate lowers housing-market matching efficiency by about 3% and raises the separation rate by roughly 1.5%, jointly reducing the home-ownership rate. As discussed below, this mechanism only partly offsets the absence of financial frictions and the presence of consumption risk sharing in the model.

Regime evidence. Table 3 also reports the estimated policy-rule coefficients. The posterior means confirm a statistically significant difference between hawkish and dovish policy states, with $\alpha_\pi^H \simeq 1.8$ and $\alpha_\pi^D \simeq 1.01$. The transition probabilities imply that each policy state is highly persistent, consistent with major policy-framework shifts rather than short-term changes in stance.

Table 3 also suggests that all shocks are relatively persistent and that there is a statistically significant difference between their standard deviations in the high and low volatility states at the 95% confidence level.

Table 3: Estimation Results, 1971Q2–2020Q1.

Parameters		Prior dist. Type (mean, std)	Posterior dist. Mean [95% conf. int.]
		Cross-market elasticities	
Elast. of HM matching eff-cy wrt. LM tightness	η_κ	$N(3.0, 1.0)$	5.1328 [5.0620,5.2238]
Elast. of HM matching eff-cy wrt. Interest rate	θ_κ	$N(2.0, 1.0)$	2.9702 [1.4903,4.2434]
Elast. of LM matching eff-cy wrt. HM tightness	ζ_κ	$N(3.0, 1.0)$	4.4792 [4.4355,4.5159]
Elast. of HM separation rate wrt. LM tightness	η_ϑ	$N(3.0, 1.0)$	0.4069 [0.3815,0.4358]
Elast. of HM separation rate wrt. Interest rate	θ_ϑ	$N(2.0, 1.0)$	1.6315 [0.6991,2.7304]
Elast. of LM separation rate wrt. HM tightness	ζ_ϑ	$N(3.0, 1.0)$	5.9529 [5.8998,5.9816]
		Policy Parameters	
Policy, inflation response (H)	α_π^H	$N(2, 0.5)$	1.7813 [1.7748,1.7864]
Policy, inflation response (D)	α_π^D	$N(2, 0.5)$	1.0067 [1.0004,1.0132]
Policy, output gap response	α_y	$N(1, 0.5)$	0.2899 [0.2738,0.3048]
Policy, interest smoothing	α_i	$B(0.5, 0.15)$	0.8398 [0.8337,0.8480]
		Shock Persistence	
AR(1), technology	ρ^z	$B(0.5, 0.10)$	0.9555 [0.9553,0.9556]
AR(1), taste	ρ^ϱ	$B(0.5, 0.10)$	0.7207 [0.7026,0.7377]
AR(1), housing tech.	ρ^ϕ	$B(0.5, 0.10)$	0.9528 [0.9489,0.9554]
AR(1), labour supply	ρ^{χ_c}	$B(0.5, 0.10)$	0.9448 [0.9369,0.9509]
AR(1), matching LM	ρ^{κ_c}	$B(0.5, 0.10)$	0.8979 [0.8943,0.9029]
AR(1), bargaining LM	ρ^{ϵ_c}	$B(0.5, 0.10)$	0.9527 [0.9465,0.9555]
AR(1), matching HM	ρ^{κ_h}	$B(0.5, 0.10)$	0.9552 [0.9540,0.9556]
AR(1), renters HM	ρ^ψ	$B(0.5, 0.10)$	0.9554 [0.9553,0.9556]
AR(1), sales HM	ρ^{α_h}	$B(0.5, 0.10)$	0.9534 [0.9480,0.9556]

continued on next page

Table 3 (continued)

Parameters		Prior dist. Type (mean, std)	Posterior dist. Mean [95% conf. int.]	
AR(1), elasticity of subst.	ρ^{ε}	$B(0.5, 0.10)$	0.9415 [0.9311,0.9526]	
		Shock Volatilities		
Std, technology	σ_z	$I(0.01, 0.02)$	$T:$ 0.0061 [0.0060,0.0062]	$V:$ 0.0159 [0.0153,0.0164]
Std, taste	σ_{ϱ}	$I(0.01, 0.02)$	$T:$ 0.0572 [0.0543,0.0602]	$V:$ 0.1614 [0.1550,0.1660]
Std, housing tech.	σ_{ϕ}	$I(0.01, 0.02)$	$T:$ 0.0950 [0.0914,0.0976]	$V:$ 0.1947 [0.1903,0.1983]
Std, labour supply	σ_{χ_c}	$I(0.01, 0.02)$	$T:$ 0.0222 [0.0218,0.0227]	$V:$ 0.0352 [0.0328,0.0373]
Std, matching LM	σ_{κ_c}	$I(0.01, 0.02)$	$T:$ 0.0548 [0.0540,0.0554]	$V:$ 0.0693 [0.0584,0.0809]
Std, bargaining LM	σ_{ϵ_c}	$I(0.01, 0.02)$	$T:$ 0.0989 [0.0882,0.1136]	$V:$ 0.2652 [0.2427,0.2914]
Std, matching HM	σ_{κ_h}	$I(0.01, 0.02)$	$T:$ 0.4264 [0.3785,0.4762]	$V:$ 1.3051 [1.2061,1.4067]
Std, renters HM	σ_{ψ}	$I(0.01, 0.02)$	$T:$ 0.3529 [0.3326,0.3664]	$V:$ 0.7256 [0.7155,0.7851]
Std, sales HM	σ_{α_h}	$I(0.01, 0.02)$	$T:$ 0.0822 [0.0735,0.0920]	$V:$ 0.2097 [0.1658,0.2560]
Std, elasticity	σ_{ε}	$I(0.01, 0.02)$	$T:$ 0.0014 [0.0013,0.0015]	$V:$ 0.0031 [0.0026,0.0040]
Std, policy	σ_m	$I(0.01, 0.02)$	0.0027 [0.0025,0.0029]	
		State Probabilities		
Prob. to move from H to D	p_{HD}	$B(0.05, 0.025)$	0.0022 [0.0011,0.0040]	
Prob. to move from D to H	p_{DH}	$B(0.05, 0.025)$	0.0030 [0.0014,0.0049]	
Prob. to move from T to V	q_{TV}	$B(0.05, 0.025)$	0.0555 [0.0360,0.0787]	
Prob. to move from V to T	q_{VT}	$B(0.05, 0.025)$	0.0595 [0.0161,0.1194]	

4 Model Fit and Historical Decomposition

This section evaluates the model's empirical performance and internal consistency. Using the estimated parameters and filtered states, we reconstruct key historical series and assess how well the model reproduces major macroeconomic episodes. The analysis proceeds in three steps. First, the historical narratives trace the evolution of estimated regimes and the role of shocks during salient periods such as the 1980s reforms and the 2008 crisis. Second, forecast-error variance decompositions summarise the relative importance of structural shocks in driving macroeconomic fluctuations. Finally, historical decompositions attribute movements in selected variables to their underlying shocks over time, providing a diagnostic check of the model's dynamic structure. Together, these exercises benchmark the model's implied dynamics against economic intuition and assess whether its small-scale structure delivers a credible account of the UK economy.

4.1 Historical Narrative

Figure 1 plots the estimated probabilities of being in a particular monetary policy and shock volatility state.

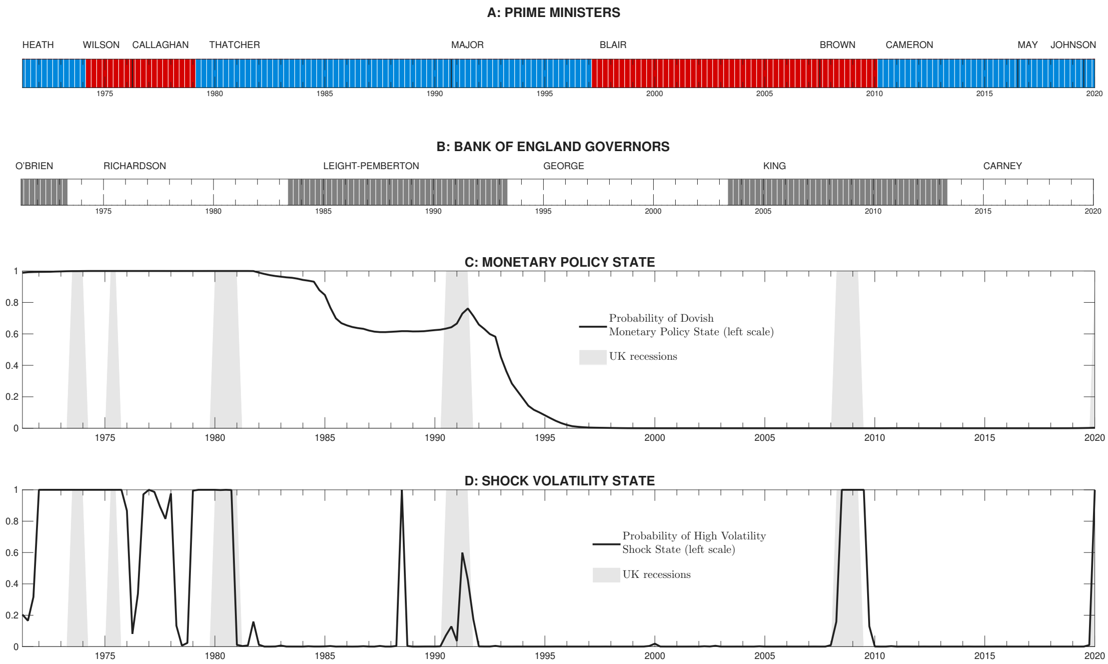

Figure 1: State Probabilities

Our sample starts in 1971, just as the Bretton Woods system of fixed exchange rates ended. For most of the five-year period following 1971, the UK had a floating exchange rate but lacked a monetary anchor, as detailed in the brief history of UK monetary policy frameworks by HM Treasury (2013) and King (1997).[7] Our model identifies this period as having large shock volatility and a virtually 100% certainty of dovish monetary policy.

While the formal targeting of monetary aggregates began in 1976 with published targets for M3, our model identifies a move towards a hawkish policy only after 1980, when Thatcher's

[7]See also Batini and Nelson (2005) for an interesting and wide ranging discussion of British monetary and macroeconomic policy frameworks.

government launched the Medium Term Financial Strategy designed to reduce inflation. The Bank of England faced many difficulties in meeting its M3 target between 1976-79: the targets were frequently overshot, and targets revised or abandoned. The Medium Term Financial Strategy proposed a gradual decline in M3 growth rates. In addition, starting from 1981, the M3 targets were complemented by M1 and later M0 targets, recognizing the destabilizing effect of financial innovations on the relationship between M3 and nominal income, as discussed by e.g. Mishkin, 2001. This strategy worked for some time; inflation was steadily falling until 1985 when M3 substantially overshot the target. The M3 target was suspended in 1985 and then dropped altogether in 1987. The steady increase in inflation in the late 1980s occurred during a period when, '...the framework for monetary policy was, at best, opaque', (King, 1997).

Consistent with this narrative, the model indicates a significant increase in dovish monetary policy during the late 1980s. It also highlights a period of high shock volatility in 1988, as shown in Figure 1. The Bank of England's base rate rose rapidly from 7.4% at the end of May 1988 to 12.9% in November 1988 and to 14.9% in October 1989, with mortgage rates following the same pattern. This likely contributed to a subsequent decline in real house prices by more than 40% over the following years. Our model — which correctly identifies all recessions — singles out this very distinct market crash as a shock, rather than a change in policy state.

The UK joined the European System of Exchange Rates in 1990 and left in 1992, with a 20% currency devaluation and the associated inflation spike. The first, perhaps implicit, inflation target of 1-4% per year was introduced in 1992, and the Bank of England gained instrument independence in 1997. Consistently, the model shows a quick reduction in the probability of dovish policy from 1992 to 1995. Moreover, the probability of hawkish policy remains close to 100% until the end of the sample: the Great Financial Crisis of 2008 and the associated quantitative easing are not identified as dovish policy.

Finally, Figure 1 shows that the high volatility regime was prevalent in the pre-1980s and then it virtually coincides with the Great Recession and the Covid recession.

4.2 Relative Importance of Shocks

Table 4 presents variance decomposition in the ergodic state. This table, together with the estimated elasticities, helps to understand the relative importance of shocks in the long run.

The quantity variables of the general industry are mostly driven by the labour market and demand shocks, but there are notable spillovers from the housing market. In particular, shocks to matching efficiency in the housing market explain a substantial part of the volatility in employment and the number of searching workers in the labour market.

The variables in the housing market are driven mostly by shocks in the housing market, although there are significant spillovers from the labor market. Shocks to workers' bargaining power explain a notable part of the long run volatility of house prices, and the number of buyers. In particular, the monetary policy shock explains little in the long run.

Table 4: Variance decomposition. Ergodic distribution.

		s_t^z	s_t^ϱ	$s_t^{\chi_c}$	$\kappa_{c,t}$	$\epsilon_{c,t}$	ε_t	$\kappa_{h,t}$	s_t^ϕ	s_t^α	s_t^ψ	s_t^m
Output	Y	5.7	24.3	8.9	0.3	14.1	24.1	18.2	0.7	2.8	0.4	0.5
Employment	l_c	0.0	1.0	0.5	2.0	33.0	9.2	44.5	1.6	6.7	0.9	0.2
Searching workers	u_c	0.0	0.9	0.4	0.4	26.1	7.5	54.2	2.1	6.8	1.1	0.2
Real wage rate	w_c	4.7	0.4	5.0	0.0	18.7	57.7	10.4	0.4	0.3	0.1	2.1
Work hours	h_c	7.0	28.1	9.5	2.1	14.3	14.4	19.7	0.7	3.0	0.4	0.4
Labour suppply	l_h	0.1	0.7	0.1	0.0	15.0	3.0	25.9	51.0	2.8	0.9	0.1
Earnings in construction	w_h	12.5	6.3	17.4	0.8	8.4	38.4	11.5	0.4	1.7	0.2	1.7
Housing stock	H	0.0	0.6	0.3	0.1	27.0	6.4	44.5	10.4	3.9	5.9	0.1
Rent rate	r^h	0.2	1.2	0.4	0.1	29.7	4.4	50.2	3.6	4.3	4.6	0.2
House price	P	0.7	1.6	0.4	0.1	29.7	4.4	50.2	3.6	4.3	4.6	0.2
Homeowners	N	0.0	0.1	0.0	0.0	2.8	0.7	4.4	0.2	0.4	91.2	0.0
Searching buyers	B	0.0	0.8	0.4	0.1	30.4	8.0	50.8	2.0	3.8	3.0	0.2
House sales	$\gamma_c B$	0.0	0.6	0.2	0.1	13.1	3.2	6.3	1.8	1.6	73.1	0.1

Note: The list of shocks: technology a_t^z, preference (demand) s_t^ϱ, labour supply $s_t^{\chi_c}$, matching efficiency in the labour market κ_c, bargaining power in the labour market ϵ_c, matching efficiency in the housing market κ_h, technology in construction sector ϕ, house sales α_h, renters ψ, elasticity of substitution (cost-push) ε, monetary policy m.

Variance decompositions imply that housing-market shocks—especially shocks to housing-market matching efficiency—account for around 50–60% of the volatility in unemployment and job search. Even in the long run, the labour market is therefore at least as exposed to disturbances originating in the housing sector as to 'pure' labour-market shocks.

To understand the role of shocks in the short run, consider the growth rate of the house price to rent ratio in the top panel of Figure 2, which covers the Thatcher period in office. It

Figure 2: Historical decomposition of selected variables

is apparent that shocks to bargaining power drove the large cyclical reduction in house prices in 1980-81 and explain the peak in 1988, the latter typically associated with relatively low interest rates. In both episodes, bargaining shocks also explain a substantial share of the growth rate of real earnings, consistent with the demand pressure on house prices. Another significant driver of the price to rent ratio—the housing matching efficiency shock—counterweighs the positive bargaining shocks to explain the relatively stable house prices in the second half of 1979 and is nearly completely responsible for the dramatic fall in house prices during 1988-91. This episode is often described in large measure as a consequence of a sharp increase in policy rates[8] and greater financial constraints[9]. As this feature is not in our model, stricter financial constraints are captured by a negative housing matching shock.

The bottom panel in Figure 2 shows that the main driver of the growth rate of house sales is the shock to renters. In this model, this shock captures the influx of first-time buyers. The figure shows a substantial effect of these shocks in the second half of 1979, which coincides with the start of the Right to Buy privatisation programme. This shock also explains the collapse in sales in 1988-1991, consistent with prohibitive borrowing constraints that disproportionately affect first-time buyers.

[8]See, for example, Boleat (1994).

[9]By greater financial constraints we are referring to factors such as those noted by Boleat (1994). He notes: 'Mortgage borrowing has itself become relatively less attractive as a consequence of government actions that have reduced both mortgage tax relief and tax rates and, therefore, the value of tax relief.' p.261.

5 Economic Implications

In this section, we consider the economic implications of four substantial changes in economic environment, that were introduced at the start of Mrs Thatcher's term in office. They are: A drastic reduction in housing construction and the large privatisation programme; labour market reforms aimed at, amongst other things, reducing the power of trade unions[10]; and a change in core monetary policy objectives.

5.1 Fall in Housing Construction

Panel A in Figure 3 shows the evolution of UK housing construction. By 1982, three years into the new government, the growth rate of Local Authority (LA) housing had fallen to below a quarter of a percent per year—around one-tenth of its 1972 rate—while the pickup in private construction was too small to offset the loss of LA activity.

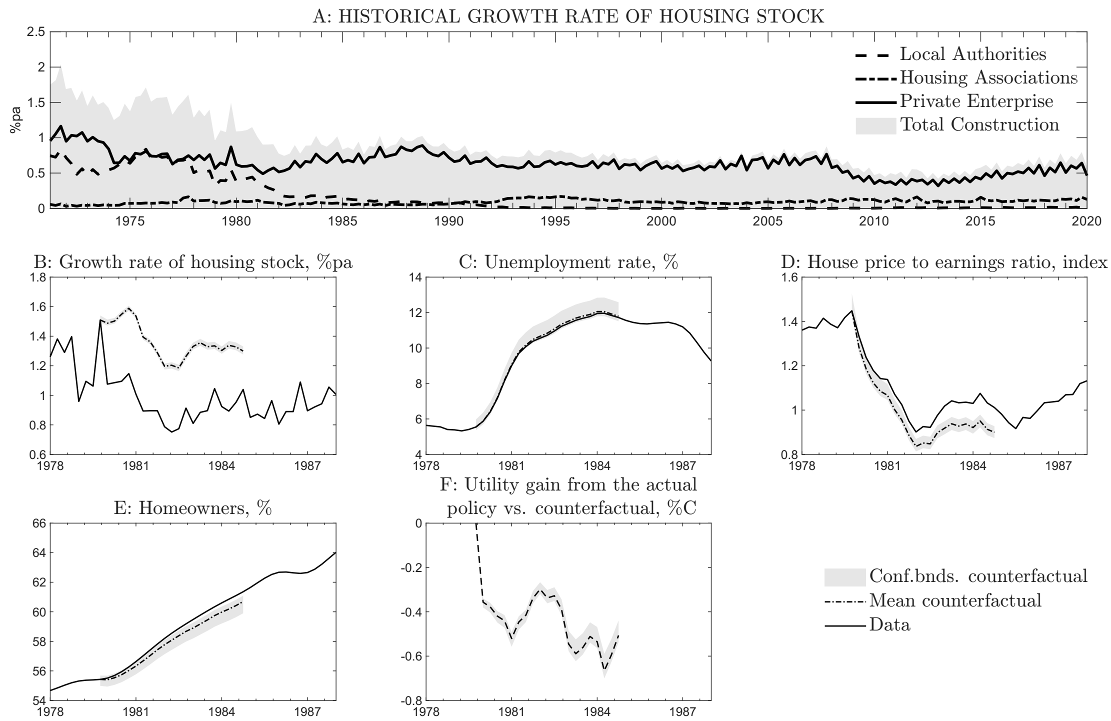

Figure 3: Collapse of Local Authorities Housing Construction

To quantify the effect of this contraction, we run a counterfactual that raises construction-sector technology shock so that the housing stock grows about 0.4 pp faster per year than observed

[10]For a different take on labour market reforms, related to the benefit system, see Zanetti (2016).

during 1979–84—bringing the total growth path into line with typical 1970s rates (Panel B). A larger flow of new dwellings relaxes housing market tightness and pushes house prices lower relative to earnings. In the data window we study, earnings move little, so the price-to-earnings ratio falls by more than 10% in the counterfactual (Panel D), while the home ownership share sits below its realized path (Panel E). These are precisely the patterns in Figure 3.

We report welfare as consumption-equivalent variation: the permanent percentage change in consumption services that makes households indifferent between the realized path and the counterfactual with continued LA building. In this experiment, Thatcher's actual policy (i.e., allowing LA construction to collapse) entails a welfare loss of about 0.4–0.5% of consumption (Panel F). Intuitively, with fewer dwellings the relative price of housing services is higher, so households obtain fewer housing services per unit of income, lowering utility. While realized policy coincided with a higher owner-occupation rate in this window (which tends to raise utility in our model through housing-services access and lower mobility frictions for owners/tenants), the deterioration in affordability dominates: the price-to-earnings increase under the realized policy more than offsets any utility gains from a higher ownership share, yielding a net welfare loss on the order of one-half percent.

These magnitudes are in line with the DSGE welfare literature once we recognize that this counterfactual exercise is a level/composition experiment operating through housing services, not a pure business-cycle stabilization exercise. In NK models with search-and-matching, welfare depends on more than inflation and aggregate consumption gap because search frictions create an efficient unemployment/tightness benchmark; deviations from that benchmark affect the welfare-based loss. Our result is consistent with work showing that non-standard wedges beyond inflation—such as resource costs tied to labour market frictions—affect welfare and can generate sub-1% to low-single-digit consumption-equivalent changes under plausible policy shifts. For orientation, in a DSGE model with search and matching frictions, Ravenna and Walsh (2011) report 1-1.5% welfare loss for suboptimal simple policy rules. Likewise, Walentin and Westermark (2022), in a search model with loss of knowledge on the job, find that the elimination of aggregate volatility increases welfare by 0.70-1.68% in steady-state consumption units, highlighting that channels beyond inflation and pure consumption volatility can move welfare by amounts of this order.

Note that in this experiment, we treat social housing tenants as homeowners rather than permanent renters. This is because permanent renters in this model do not have any frictions in moving a house. Homeowners have frictions, and so do social tenants, perhaps to a much greater extent. As we do not distinguish between private and social housing, we are likely to overstate the implied counterfactual effect on the labour market if the attachment to social housing imposes some restrictions on workers' mobility (Hughes and McCormick, 1987). This experiment quantifies the effect of a reduction in housing construction as a whole.

5.2 Right to Buy

The Right to Buy programme began in 1980, with sales of Local Authority dwellings peaking in 1982 at roughly 200,000. Panel A of Figure 4 shows that from 1979 to 1982, housing construction was shrinking, and the house price-to-earnings ratio was falling. To gauge the quantitative effects of privatisation, we consider a counterfactual in which the share of permanent renters remains higher: specifically, we impose a positive shock to permanent renters such that the rise in home ownership is about 50% slower than realised (Panel B). This counterfactual path is aligned with the more gradual increase observed in 1971–79.

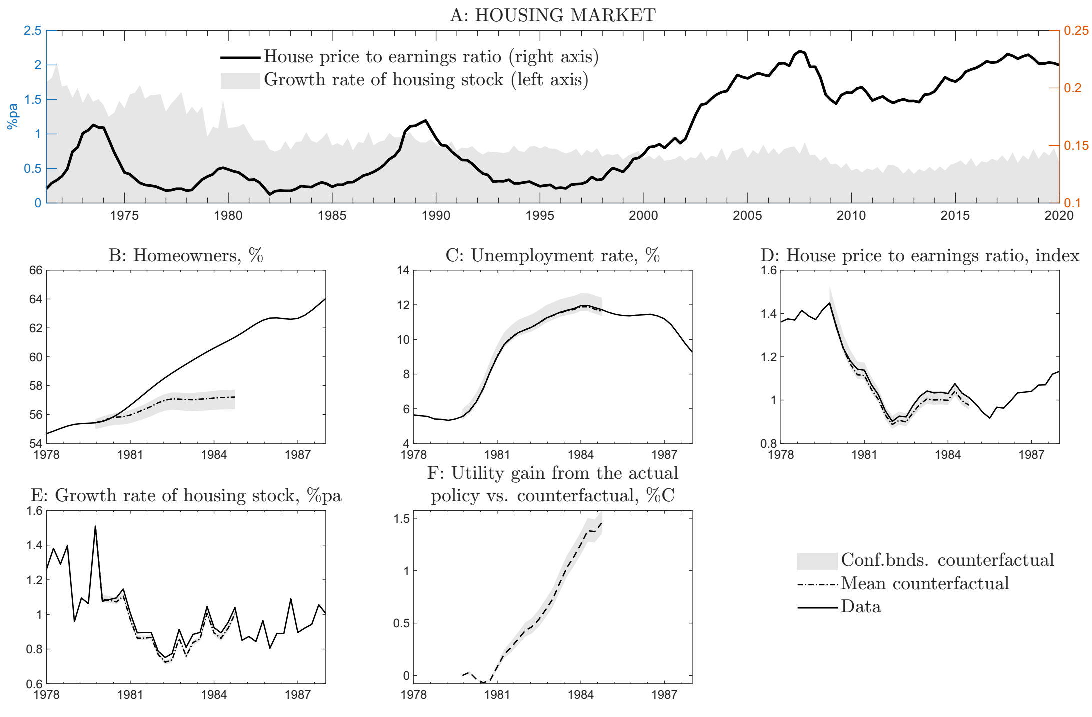

Figure 4: Right to Buy

The dynamics of the counterfactual experiment are shown in Panels B–E of Figure 4. By construction, the counterfactual restricts the pace of tenure change, maintaining a higher share of permanent renters and, consequently, a lower rate of home ownership than in the data (Panel

B). In the model, owner-occupiers derive direct utility from housing services, so the tenure composition of households affects welfare through the consumption of these services. With fewer transitions into ownership, the housing market becomes less active and market tightness declines; developers face weaker incentives to initiate new projects, leading to a modest reduction in construction growth relative to the realised path (Panels A and E).

A higher proportion of renters also reduces demand for owner-occupied dwellings, resulting in a lower house-price-to-earnings ratio in the counterfactual (Panel D), which may be interpreted as an improvement in affordability. In the realised path, the faster expansion of home ownership sustains stronger demand pressure and therefore higher prices, partially offsetting any stimulus to construction. Quantitatively, the difference between the price-to-earnings ratios in the data and in the counterfactual remains moderate, on the order of a few percentage points. The effect on unemployment is negligible (Panel C), confirming that the tenure composition shock operates primarily through the housing-services and price channels rather than through job creation or separation dynamics during this period.

Panel F reports the associated welfare implications, expressed in consumption-equivalent units. The realised path under the Right-to-Buy programme yields a welfare gain that peaks at approximately 1.5 per cent of steady-state consumption relative to the counterfactual with slower tenure change. Two mechanisms operate in opposite directions. On the one hand, a higher share of homeowners increases utility through enhanced access to housing services and improved risk-sharing within the household aggregator. On the other hand, higher house prices under the realised policy reduce affordability. In our calibration, the positive effect of increased housing-services consumption dominates, producing a net gain of around 1–1.5 per cent in consumption terms. The scale of this gain falls within the range of welfare effects typically reported in search-and-matching DSGE studies for level or composition experiments, as in Ravenna and Walsh (2011) and Walentin and Westermark (2022) as discussed in the previous subsection.

5.3 Trade Unions

Panel B of Figure C.1 shows that unemployment was relatively low at the end of the 1970s but rose sharply during the 1980–81 recession. Over the same period, trade union membership was at a historic peak and the number of labour disputes—and days lost—was elevated, most visibly in 1978–79 during the "Winter of Discontent," when widespread strike action sought to protect real wages against high inflation (see Panel A of Figure 5). In response to what was perceived as excessive union power and recurrent industrial disruption, the Thatcher administration introduced

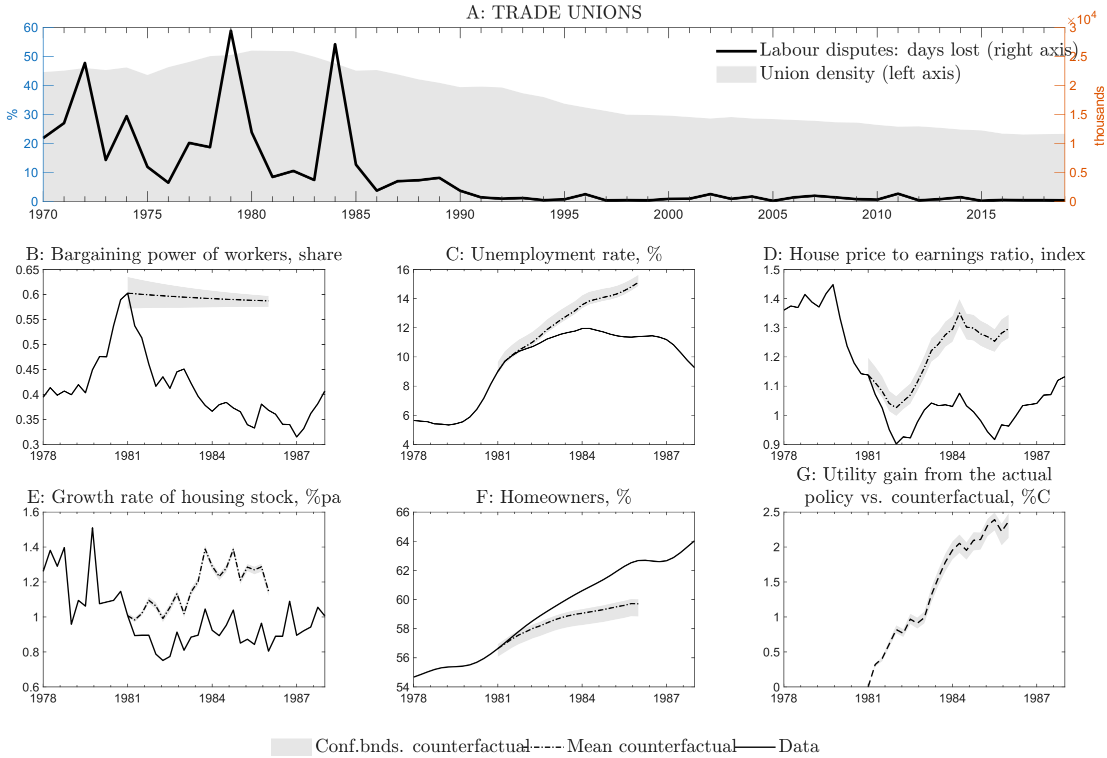

Figure 5: Trade Unions

a sequence of legislative measures intended to curtail union influence: the Employment Acts of 1980, 1982, and 1988, the Trade Union Act of 1984, and the Public Order Act of 1986. Confrontations with unions remained salient throughout the decade—the 1984–85 miners' strike being the most prominent episode—but our estimation indicates that workers' bargaining power declined after 1980 and remained comparatively low for the remainder of the administration. Panel B plots the smoothed latent bargaining power estimated in our model, alongside with a counterfactual path that removes the policy-driven decline, maintaining a higher level and a mild upward trend consistent with pre-1980 dynamics.

To quantify the economic consequences of these reforms, we use the estimated sequence of shocks to workers' bargaining power, denoted $s_t^{\epsilon_c}$, which our model identifies as negative during the early 1980s. We interpret these negative shocks as capturing the impact of the Thatcher labour-market reforms, which curtailed union power and shifted bargaining outcomes in favour of firms. In the counterfactual experiment, we remove these shocks—that is, we hold bargaining power at the level implied by its pre-1980 trajectory—to represent a scenario in which the reforms did not occur (see Panel B). The resulting higher bargaining power raises wages and earnings of employed workers but reduces the surplus available for job creation. Consequently, unemployment rises by nearly three percentage points by the end of the five-year horizon (Panel C), and labour-market tightness declines further. These are standard search-and-matching responses to a contraction in firms' hiring incentives. In our calibration, the decline in union bargaining power between 1979 and the mid-1980s reduces unemployment by around two percentage points relative to a no-reform counterfactual at the height of the early-1980s recession.

The housing market adjusts through two distinct channels. First, stronger bargaining power in the counterfactual worsens affordability—the house-price-to-earnings ratio is higher (Panel D)—which depresses effective demand for ownership and lowers the home ownership share (Panel F). Second, on the supply side, higher relative prices raise the marginal profitability of new construction (a Tobin-q–type condition in the model), so the growth rate of the housing stock is higher in the counterfactual (Panel E) even as fewer households transition into ownership. The combination of reduced affordability (demand) and stronger supply incentives (supply) implies more units being added but a smaller fraction owned by households, with the tenure margin shifting toward renting or unoccupied stock. Quantitatively, these differences accumulate gradually over the window—rather than appearing as one-off jumps—because stocks (matches, housing, and tenure) adjust endogenously over time.

Panel G reports welfare in consumption-equivalent terms, comparing the realised reform path with the no-reform counterfactual. The dash-dotted line (realised policy relative to the counterfactual) shows a welfare gain that rises to just above 2% of steady-state consumption by the end of the horizon. The mechanism is primarily a level effect: by curbing bargaining power, the reforms lower average unemployment and improve housing affordability relative to the counterfactual. These gains dominate smaller offsets from tenure composition, yielding a net welfare improvement of order two percentage points. As discussed in the previous counterfactual and in the broader search-DSGE literature, multi-percent consumption-equivalent effects are plausible when policies shift mean unemployment and alter the flow of housing services—in contrast to pure stabilisation exercises, whose welfare effects are typically sub-percent.

5.4 Monetary Policy

Monetary policy gradually shifted from dovish in the pre-1980 period to hawkish in the post-ERM period, as illustrated in Figure 1. This prompts the question of what the economic impact would have been if monetary policy had adopted a more hawkish stance from the start of the 1980s, similar to the shift observed in the US. Many researchers identify a decisive shift in the

US monetary policy framework around 1980 or shortly thereafter.[11]

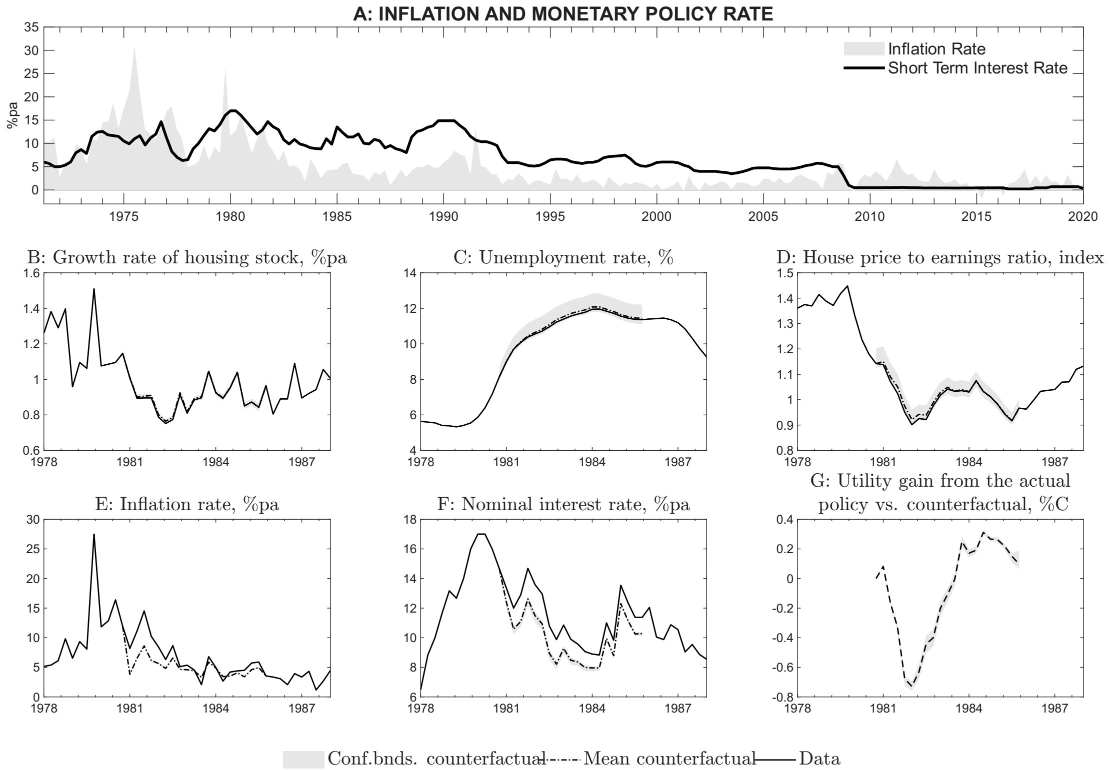

Figure 6: Effect of a switch to Hawkish policy

Figure 6 reports the counterfactual in which the policy regime is 100% hawkish from 1981Q1 for five years. The disinflation is material—inflation falls by roughly 2–4 percentage points (Panel E)—and, in our estimated rule, the reduction in the inflation gap dominates the rule's response so that the nominal policy rate is about 2 percentage points lower on average over the window (Panel F). The lower rate raises discounted housing demand, but the house-price effect is small, about 2%, and short-lived (Panel D). Real activity responds only modestly: the growth rate of the housing stock changes little (Panel B) and the effect on unemployment is negligible (Panel C).

Two model features explain these muted real effects. First, risk sharing at the aggregate level dampens the intertemporal-substitution channel, so a lower policy rate translates into only limited movements in aggregate consumption and housing demand. Second, in the absence of borrowing constraints or explicit financial frictions, the user-cost channel to first-time buyers is weak; we allow the real rate to feed directly into housing-market activity, but this reduced-form

[11]See for example, Goodfriend and King (2005).

margin is not strong enough to generate large, persistent house-price or construction responses. As discussed in Section 4.2, credit conditions and borrowing limits are likely subsumed in the estimated housing matching-efficiency disturbance rather than being captured by the monetary policy block.

Panel G shows the welfare implications in consumption-equivalent terms, comparing the realised policy path with the fully hawkish counterfactual. Early in the 1980s the realised (more dovish) stance entails a welfare loss of roughly 0.7% of steady-state consumption, which diminishes over time as the regime gradually shifts toward hawkishness and disinflation completes. The modest scale and transience of this loss are consistent with the model's limited real-side transmission (aggregate risk-sharing and the absence of credit frictions dampen the interest-rate channel). Quantitatively, the magnitude sits just below the 1% losses often reported for sub-optimal simple rules in NK search-and-matching model in Ravenna and Walsh (2011). This places our estimate well within the expected range.

5.5 Thatcher's Legacy: Combined Counterfactual

Figure 7 brings the four policy experiments together and contrasts the realised path with a joint no-reform counterfactual. Taken in combination, the reforms alter the level and composition of activity across housing and labour in ways that are muted in isolation but accumulate over time (Panels A–G), and these cumulative effects are what shape welfare (Panel H).

On the labour side, the decline in workers' bargaining power is the dominant driver. In the counterfactual where bargaining power follows its pre-1980 trend, firms' hiring incentives are weaker and unemployment is persistently higher, with the gap peaking during the mid-1980s recession (Panel A). The same mechanism also explains the tighter realised labour market in the early 1980s despite similar inflation disinflation dynamics: by raising the surplus available to job creation, the reforms supported vacancy posting and job finding, gradually widening the unemployment differential relative to the counterfactual.

On the housing side, the tenure and affordability margins move in nuanced, and partly offsetting, ways. The home ownership share is meaningfully lower in the no-reform counterfactual throughout the window (Panel D), a direct consequence of both slower transitions into ownership (the absence of Right-to-Buy) and weaker labour-market tightness. Affordability, measured by the house-price-to-earnings ratio, remains close to the realised path on average (Panel B): the counterfactual lacks the tenure-induced demand pressure from ownership, but it also misses the supply-side responses that higher relative prices and market activity would have induced under

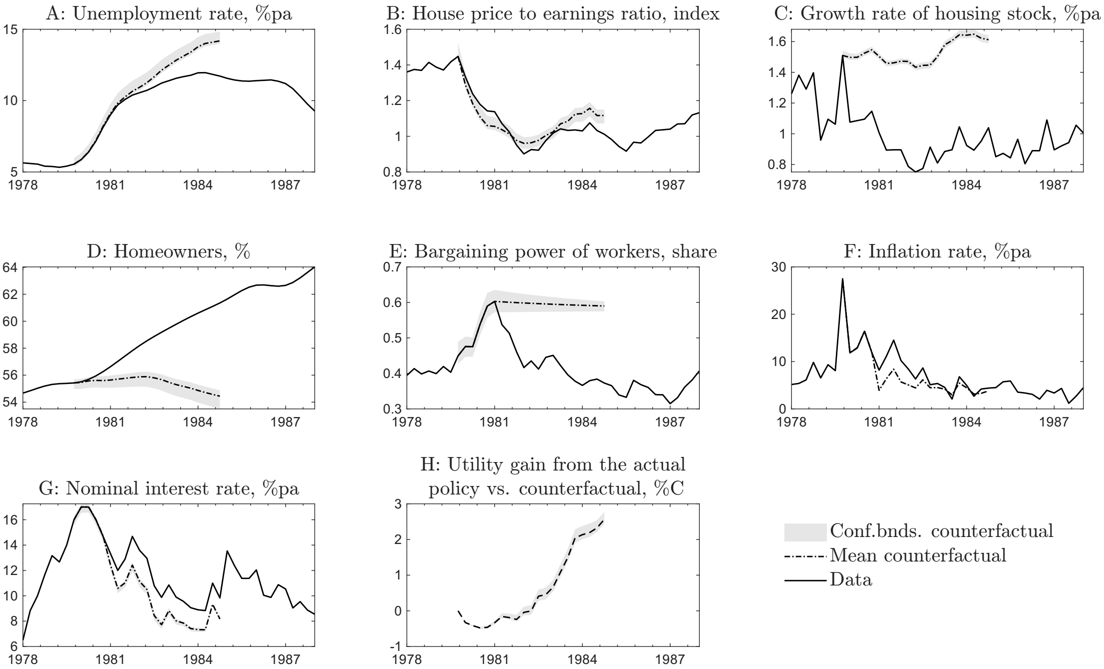

Figure 7: Combined effect of all four policies.

the reforms. The implication is that tenure composition rather than headline affordability carries the larger quantitative footprint in the combined experiment.

Panel H translates these joint movements into consumption-equivalent welfare. The realised policy path delivers little net welfare gain initially—hovering around zero during the early 1980s—because the transitional costs of disinflation and the gradual nature of housing and labour reallocation offset one another. As the decade progresses, the labour-market level effect (lower mean unemployment due to reduced bargaining power) and the tenure-composition effect (higher owner-occupation and associated housing-services consumption) accumulate, and the welfare gain rises into the low single digits by the mid-to-late 1980s.

Overall, the joint experiment provides a coherent quantitative account of the 1980s adjustment. The initial stagnation of welfare, followed by gradual gains, is consistent with historical assessments of the Thatcher reforms: early disinflation and restructuring entailed transitory costs, while labour-market liberalisation and housing privatisation yielded medium-term efficiency gains. The model's timing—welfare remaining near zero through the early 1980s and rising thereafter—mirrors the historical narrative that the benefits of reform materialised only gradually, once inflation was contained and job creation resumed. In this sense, the results reconcile the short-run political costs of reform with the long-run improvement in efficiency and welfare often highlighted in retrospective policy evaluations.

6 Concluding Remarks

This paper has examined the macroeconomic effects of four major policy shifts of the 1980s—housing construction policy, the Right-to-Buy programme, monetary policy, and labour-market reform—within a unified model linking the housing and labour markets. The analysis highlights how tenure composition and labour-market frictions—often originating in the housing sector—jointly shaped the transmission of these reforms.

Individually, each policy generated relatively modest effects, but taken together they produced a substantial reallocation of resources: lower unemployment, a lasting rise in home ownership, but only limited changes in average housing affordability. The model's aggregate welfare profile reflects these dynamics—near-zero gains in the early 1980s, as transitional costs from disinflation and restructuring offset one another, followed by a gradual rise in welfare as lower unemployment and higher housing-service consumption dominate.

From a broader historical perspective, the results imply that the Thatcher-era reforms should not be regarded as the primary cause of the long-term decline in housing affordability. In the model, the reforms reshaped the economy mainly through labour-market liberalisation and the expansion of owner-occupation, while affordability remained broadly stable once stronger employment and earnings effects were taken into account. This interpretation aligns with empirical evidence that attributes the sustained deterioration in affordability to later financial liberalisation and credit expansion, rather than to the early-1980s structural reforms themselves.

While the framework is deliberately stylised—it omits credit frictions, collateral constraints, and detailed financial channels—the results suggest that the interaction between housing and labour markets was a key mechanism of macroeconomic adjustment during the Thatcher era. Extending this analysis to settings with heterogeneous agents and explicit mortgage markets would enable a richer assessment of the distributional and financial consequences of these reforms.

Large changes to housing and labour markets are far from being of purely historical interest. Contemporary policy debates in the UK and other advanced economies involve both ambitious plans to expand housing supply and reforms that strengthen employment protections or raise minimum wages. Our results highlight a potential sequencing issue. In the model, labour-market reforms that increase workers' bargaining power operate quickly through job-creation margins, tending to raise unemployment and—absent an offsetting expansion in housing supply—put upward pressure on house-price-to-earnings ratios. By contrast, large-scale increases in housing construction relax market tightness and improve affordability, but do so only gradually. This suggests that reforms strengthening labour-market protections are more likely to be absorbed with limited adverse effects when they coincide with, or follow, credible and timely expansions in housing supply. When housing supply responses lag behind labour-market changes, short-run increases in unemployment and housing-market pressures may emerge before any relief materialises. While our analysis abstracts from credit frictions, heterogeneity, and distributional concerns, the central message is robust: labour-market policy moves fast, housing supply moves slowly, and the interaction between the two is central to both employment outcomes and housing affordability.

References

An, S. and F. Schorfheide (2007). Bayesian Analysis of DSGE Models. *Econometric Reviews 26*(2-4), 113–172.

Aoki, K., J. Proudman, and G. Vlieghe (2004). House prices, consumption, and monetary policy: a financial accelerator approach. *Journal of Financial Intermediation 13*(4), 414–435.

Arnott, R. (1989). Housing Vacancies, Thin Markets, and Idiosyncratic Tastes. *Journal of Real Estate Finance and Economics 2*, 5–30.

Batini, N. and E. Nelson (2005). The UK's Rocky Road to Stability. FRB St.Louis Working Paper 2005-020A.

Boleat, M. (1994). The 1985-1993 Housing Market in the United Kingdom: An Overview. *Housing Policy Debate 5*(3), 253–274.

Bowen, A. and K. Mayhew (Eds.) (1990). *Improving Incentives for the Low-Paid.* London: Palgrave Macmillan and National Economic Development Office.

Branch, W. A., N. Petrosky-Nadeau, and G. Rocheteau (2016). Financial frictions, the housing market, and unemployment. *Journal of Economic Theory, Elsevier 164*(C), 101–135.

Calvo, G. (1983). Staggered Prices in a Utility-Maximising Framework. *Journal of Monetary Economics 12*, 383–398.

Cameron, G., J. Muellbauer, and A. Murphy (2006). Was There a British House Price Bubble? Evidence from a Regional Panel. CEPR Discussion Paper 5619.

Christiano, L. J., M. S. Eichenbaum, and M. Trabandt (2016). Unemployment and Business Cycles. *Econometrica 84*(4), 1523–1569.

Davis, S. J., R. J. Faberman, and J. C. Haltiwanger (2013). The establishment-level behavior of vacancies and hiring. *The Quarterly Journal of Economics 128*(2), 581–622.

Faccini, R., S. Millard, and F. Zanetti (2013). Wage Rigidities in an Estimated Dynamic, Stochastic, General Equilibrium Model of the UK Labour Market. *The Manchester School 81*(S1), 66–99.

Gabrovski, M. and V. Ortego-Marti (2021). Search and credit frictions in the housing market. *European Economic Review 134*, 103699.

Garriga, C. and A. Hedlund (2020). Mortgage Debt, Consumption, and Illiquid Housing Markets in the Great Recession. *American Economic Review 110*(6), 1603–34.

Goodfriend, M. and R. G. King (2005). The incredible Volcker disinflation. *Journal of Monetary Economics 52*(5), 981–1015.

Hashimzade, N., O. Kirsanov, T. Kirsanova, and J. Maih (2024). On Bayesian Filtering for Markov Regime Switching Models. Norges Bank Working Paper 8/2024.

Head, A. and H. Lloyd-Ellis (2012). Housing Liquidity, Mobility, and the Labour Market. *The Review of Economic Studies 79*(4), 1559–1589.

Head, A., H. Lloyd-Ellis, and H. Sun (2014). Search, Liquidity, and the Dynamics of House Prices and Construction. *The American Economic Review 104*(4), 1172–1210.

Hedlund, A. (2016). The cyclical dynamics of illiquid housing, debt, and foreclosures. *Quantitative Economics 7*(1), 289–328.

HM Treasury (2013). Review of the monetary policy framework. Presented to Parliament, available at https://www.gov.uk/official-documents.

Hobijn, B. and A. Şahin (2009). Job-finding and separation rates in the OECD. *Economics Letters 104*(3), 107–111.

Hughes, G. and B. McCormick (1987). Housing markets, unemployment and labour market flexibility in the UK. *European Economic Review 31*(3), 615–641.

Iacoviello, M. (2005). House prices, borrowing constraints, and monetary policy in the business cycle. *American Economic Review 95*(3), 739–764.

Johnson, P. and G. Stark (1989). Ten Years of Mrs Thatcher: the Distributional Consequences. *Fiscal Studies 10*(2), 29–37.

Jones, C. and A. Murie (2006). *The Right to Buy.* Blackwell Publishing.

Justiniano, A., G. E. Primiceri, and A. Tambalotti (2019). Credit supply and the housing boom. *Journal of Political Economy 127*(3), 1317–1350.

Karaboga, D. and B. Basturk (2007). A powerful and efficient algorithm for numerical function optimization: artificial bee colony (abc) algorithm. *Journal of Global Optimization 39*, 459–471.

King, M. (1997). The Inflation Target five years on. Speech at the London School of Economics, available at www.bankofengland.co.uk/publications/Pages/speeches/default.aspx.

Krause, M. U., D. Lopez-Salido, and T. A. Lubik (2009). Inflation dynamics with search frictions: A structural econometric analysis. *Journal of Monetary Economics 55*(5), 892–916.

Lubik, T. A. (2009). Estimating a search and matching model of the aggregate labor market. *Economic Quarterly 95*(Spr), 101–120.

Maih, J. (2015). Efficient perturbation methods for solving regime-switching DSGE models. Working Paper 2015/01, Norges Bank.

Mayhew, K. (1991). The Assessment: The UK Labour Market in the 1980s. *Oxford Review of Economic Policy 7*(1), 1–17.

Mishkin, F. S. (2001). From Monetary Policy Targeting to Inflation Targeting: Lessons from the Industrialized Countries. World Bank Publications.

Mortensen, D. T. and C. A. Pissarides (1994). Job Creation and Job Destruction in the Theory of Unemployment. *The Review of Economic Studies 61*(3), 397–415.

Muellbauer, J. and D. Soskice (2022). The Thatcher legacy, Lessons for the future of the UK economy. *The Resolution Foundation.*

Ravenna, F. and C. E. Walsh (2011). Welfare-Based Optimal Monetary Policy with Unemployment and Sticky Prices: A Linear Quadratic Framework. *American Economic Journal: Macroeconomics 3*, 130–162.

Sims, C. A. and T. Zha (2006). Were There Regime Switches in US Monetary Policy. *American Economic Review 96*(1), 54–81.

Stephens, M. (1993). Finance for Owner Occupation in the UK: the sick man of Europe? *Policy and Politics 21*(4), 307–317.

Walentin, K. and A. Westermark (2022). Learning on the Job and the Cost of Business Cycles. *American Economic Journal: Macroeconomics 14*(4), 341–377.

Wheaton, W. C. (1990). Vacancy, Search, and Prices in a Housing Market Matching Model. *Journal of Political Economy 98*, 1270–1292.

Zanetti, F. (2016). Labour market and monetary policy reforms in the UK: a structural interpretation of the implications. In J. S. Chadha, A. Crystal, J. Pearlman, P. Smith, and S. Wright (Eds.), *The UK Economy in the Long Expansion and its Aftermath*, pp. 81–110. Cambridge, UK: Cambridge University Press.

Online Appendix
to
Searching for flexibility: The Joint Impact of Thatcher's Reforms of UK Labour and Housing Markets
by

Tatiana Kirsanova Øyvind Masst Charles Nolan

A The Model

This appendix provides the detailed formulation of households, labour and housing market setup, summarised in Section 2 of the main text. We present the optimisation problems, aggregation, and equilibrium conditions in terms of aggregate, trend-growing variables. Appendix B then derives a stationary, per-capita representation of this system; the equations reported in Section 2 correspond to a subset of those normalised equilibrium conditions and are presented there purely for exposition purposes.

A.1 Households

The economy is populated by households, with the population size denoted as Q_t, which grows at the exogenous net rate μ_t:

$$Q_{t+1} = (1 + \mu_t)Q_t. \tag{A1}$$

Within this population, which also serves as the labour force, all individuals are infinitely lived and discount time at a rate β. Each individual supplies labour elastically to the construction sector but can be either employed or unemployed in the general industry. Each individual is either a permanent renter or not. People who are not permanent renters are either homeowners who also occupy their own homes or they are 'moving homes', meaning they live in rented accommodations, searching for a home to buy, and may also have a house to sell. In contrast, permanent renters do not want to buy a house and do not have one to sell.

Each individual is a member of one of the households. There is a constant number of households, H, while the size of a household changes over time. When the population rises, people are assigned to existing households, and there is no mobility between households. Each household may have both employed and unemployed individuals in the general and construction industries. It may have homeowners, renters, and buyers. A household is the unit at which consumption risk-sharing occurs, so all members of one household have the same level of consumption.

All individuals derive utility from habit- and productivity-adjusted per-capita consumption:

$$X_{i,t} = \frac{C_{i,t}}{A_t} - \theta \frac{C_{t-1}}{Q_{t-1} A_{t-1}},$$

where A_t is the trending productivity level of the economy:

$$A_{t+1} = (1+\gamma)\, s_t^z A_t \tag{A2}$$

with a stationary technology shock s_t^z.

In the general industry, households face search frictions and unemployment. If employed, they provide $h_{c,i,t}$ labour hours to the general industry. In the construction industry, individuals derive disutility from supplying elastically $L_{h,i,t}$ units of labour, and this term enters the utility function trivially and additively. Owner-occupiers derive utility z^H from housing services of the owned house.

The total utility of a household can be expressed as:

$$U^H = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(s_t^{\varrho} \frac{(X_{i,t})^{1-\sigma} - 1}{1-\sigma} \frac{Q_t}{H} + \chi_c s_t^{\chi_c} \frac{L_{c,t}}{H} \frac{(1-h_{c,i,t})^{1-\nu} - 1}{1-\nu} - \chi_h L_{h,i,t} \frac{Q_t}{H} + z^H \frac{N_t}{H} \right).$$

In this equation, $L_{c,t}$ represents the number of employed individuals, and N_t is the number of owner-occupiers in the economy. The index i is associated with consumption, hours, and labour supply in the construction sector—these are all choice variables. All individuals within one household will make the same decisions.

When firms and households in the general industry match, they enter into contracts where the real wage rate $w_{c,t}$ is determined through a Nash bargaining process. Consequently, an employed individual receives a labour income $h_{c,i,t} w_{c,t}$. An unemployed person receives an unemployment benefit $b_{c,t}$ as a government transfer, financed through lump-sum taxes.

The budget constraint for household i states that consumption spending ($C_{i,t}$), investment in private bonds ($\mathcal{A}_{i,t+1}$), net investment in housing ($\Omega_{i,t}$) and any privatisation payments ($Pr_{i,t}$) must be financed through labour incomes ($w_{c,t} h_{c,i,t}$), unemployment benefits ($b_{c,t}$), bond returns ($R_t \mathcal{A}_{i,t}$) with gross real rate R_t, lump-sum transfers ($T_{i,t}$) and any profits earned by firms (Φ_t):

$$\begin{aligned} &C_{i,t}\frac{Q_t}{H} + \frac{Q_t}{H}\mathcal{A}_{i,t+1} + \frac{Q_t}{H}\Omega_{i,t} + Pr_{i,t} \\ &= \frac{Q_t}{H}\Phi_{i,t} + w_{c,t} h_{c,i,t} \frac{L_{c,t}}{H} + b_{c,t} \frac{(Q_t - L_{c,t})}{H} + w_{h,t} L_{h,i,t} \frac{Q_t}{H} + R_t \mathcal{A}_{i,t} \frac{Q_{t-1}}{H} - \frac{Q_t}{H} T_{i,t} \end{aligned}$$

Net household investment in housing accounts for the rent r_t^h that permanent renters $F_{i,t}$ pay to other households, maintenance m_t^h that homeowner $N_{i,t}$ pay to government repair agencies, and house purchases (at price P_t^h) minus house sales to other households:

$$\Omega_{i,t} = r_t^h F_{i,t} + N_{i,t} m_t^h + P_t^h \left(N_{i,t} - N_{i,t-1}\right) - P_t^h \left(N_{-i,t} - N_{-i,t-1}\right),$$

where index $-i$ denotes households other than the i-th household.

The Lagrangian for household's decision problem is

$$\mathcal{L} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\begin{array}{c} s_t^{\varrho} \frac{(X_{i,t})^{1-\sigma}}{1-\sigma} \frac{Q_t}{H} + \chi_c s_t^{\chi_c} \frac{L_{c,t}}{H} \frac{(1-h_{c,i,t})^{1-\nu}-1}{1-\nu} - \chi_h L_{h,i,t} \frac{Q_t}{H} + z^H \frac{N_t}{H} \\ +\upsilon_t \left(\frac{C_{i,t}}{A_t} - \theta \frac{C_{t-1}}{A_{t-1}} - X_{i,t} \right) - \lambda_t \left(C_{i,t} \frac{Q_t}{H} + \frac{Q_t}{H} \mathcal{A}_{i,t+1} + \frac{Q_t}{H} T_{i,t} + \frac{Q_t}{H} \Omega_{i,t} \right. \\ \left. - \frac{Q_t}{H} \Phi_{i,t} - w_{c,t} h_{c,i,t} \frac{L_{c,t}}{H} - b_{c,t} \frac{(Q_t - L_{c,t})}{H} - w_{h,t} L_{h,i,t} \frac{Q_t}{H} - R_t \mathcal{A}_{i,t} \frac{Q_t}{H} \right) \end{array} \right),$$

and the first order conditions are:

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial C_{i,t}} &\equiv 0 = \upsilon_t \frac{1}{A_t} - \lambda_t \frac{Q_t}{H} \\ \frac{\partial \mathcal{L}}{\partial X_{i,t}} &\equiv 0 = s_t^{\varrho} \left(X_{i,t}\right)^{-\sigma} \frac{Q_t}{H} - \upsilon_t \\ \frac{\partial \mathcal{L}}{\partial L_{h,i,t}} &\equiv 0 = -\chi_h \frac{Q_t}{H} + \lambda_t w_{h,t} \frac{Q_t}{H} \\ \frac{\partial L}{\partial \mathcal{A}_{i,t+1}} &\equiv 0 = -\lambda_t \frac{Q_t}{H} + \beta \lambda_{t+1} R_{t+1} \frac{Q_{t+1}}{H} \end{aligned}$$

Aggregation of these equations using $X_t = Q_t X_{i,t}$ yields:

$$\left(\frac{X_t}{Q_t}\right)^{-\sigma} s_t^{\varrho} = \beta \mathbb{E}_t R_{t+1} \frac{A_t}{A_{t+1}} \left(\frac{X_{t+1}}{Q_{t+1}}\right)^{-\sigma} \frac{Q_{t+1}}{A_{t+1}} s_{t+1}^{\varrho} \tag{A3}$$

$$\frac{X_t}{Q_t} = \frac{C_t}{Q_t A_t} - \theta \frac{C_{t-1}}{Q_{t-1} A_{t-1}} \tag{A4}$$

$$\chi_h = s_t^{\varrho} \left(\frac{X_t}{Q_t}\right)^{-\sigma} \frac{w_{h,t}}{A_t} \tag{A5}$$

$$A_t \lambda_t = s_t^{\varrho} \left(\frac{X_t}{Q_t}\right)^{-\sigma} \tag{A6}$$

$$\frac{X_t}{Q_t} = \frac{C_t}{Q_t A_t} - \theta \frac{C_{t-1}}{Q_{t-1} A_{t-1}} \tag{A7}$$

and the aggregated budget constraint can be written as:

$$C_t + \mathcal{A}_{t+1} + \Omega_t + Pr_t = \Phi_t + w_{c,t} h_{c,t} L_{c,t} + b_{c,t} \left(Q_t - L_{c,t}\right) + w_{h,t} L_{h,t} + R_t \mathcal{A}_t - T_t, \tag{A8}$$

where

$$\Omega_t = m_t^h N_t + \left(H_{t+1} - H_t\right) \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}}{\lambda_t} \tilde{\mathcal{V}}_{t+1}\right)$$

The term $\left(H_{t+1} - H_t\right) \beta \mathbb{E}_t \left(\frac{\lambda_{t+1}}{\lambda_t} \tilde{\mathcal{V}}_{t+1}\right)$ represents payment for newly constructed houses $\left(H_{t+1} - H_t\right)$, and its value today is equal to the discounted value when they will be occupied next period.

A.2 Production

We use a workhorse search and matching model (Mortensen and Pissarides, 1994) in a general equilibrium setting (see e.g. Christiano et al. (2016) and Lubik (2009) for similar DSGE treatments). There is a unit-continuum of firms that hire new workers in a matching market. Unemployed workers search for a job and fill a vacant position. Firms pay a fixed cost of posting a vacancy. Matches are destroyed with exogenous probability and workers become unemployed. Wages and hours worked are determined through a Nash bargaining process, that takes place between workers and firms. Firms sell goods in a monopolistically competitive market and choose their price subject to their demand curve. Prices are set with Calvo (1983) stickiness.

A.2.1 Labour Dynamics

The number of firms grows with population. The number of workers employed by the j'th firm, $j \in [0, 1]$, at the end of period $t-1$ is denoted $L_{c,t-1}(j)$. New jobs are created at the beginning of period t and some jobs are exogenously dissolved at the end of period t such that by the end of period t the j'th firm's employment level is:

$$L_{c,t}(j) = (1 - \vartheta_{c,t})(1 + \mu_{t-1})L_{c,t-1}(j) + M_{c,t}(j), \tag{A9}$$

where $\vartheta_{c,t} \in (0, 1)$ is separation rate and $M_{c,t}(j)$ represents the number of new jobs, or matches, formed between the pool of unemployed workers and firm j.

The total number of matches that occur economy-wide is governed by the constant-returns-to-scale matching technology:

$$M_{c,t} = \kappa_{c,t} U_{c,t}^{\delta_c} V_{c,t}^{1-\delta_c}, \tag{A10}$$

where $V_{c,t}$ denotes the the economy-wide number of vacancies, $U_{c,t}$ denotes the number of searching workers, $\delta_c \in (0, 1)$ represents the elasticity of matches with respect to the unemployment rate, and $\kappa_{c,t}$ denotes the matching efficiency.

We define the level of labour market tightness, $\omega_{c,t}$, by

$$\omega_{c,t} = \frac{V_{c,t}}{U_{c,t}}, \tag{A11}$$

so that the labour market is tight ($\omega_{c,t}$ is high) when the size of the unemployment pool is small relative to the number of vacancies. Given the matching technology and the definition of labour market tightness, the economy's job-filling rate is:

$$\gamma_{c,t} = \frac{M_{c,t}}{V_{c,t}} = \kappa_{c,t} \omega_{c,t}^{-\delta_c} \tag{A12}$$

and its job-finding rate is:

$$\lambda_{c,t} = \frac{M_{c,t}}{U_{c,t}} = \kappa_{c,t}\omega_{c,t}^{1-\delta_c} = \omega_{c,t}\gamma_{c,t}. \tag{A13}$$

We assume that all firms take $\omega_{c,t}$ (and hence $\gamma_{c,t}$ and $\lambda_{c,t}$) as given, and write equation (A9) as:

$$L_{c,t}(j) = (1-\vartheta_{c,t})(1+\mu_{t-1})L_{c,t-1}(j) + V_{c,t}(j)\gamma_{c,t}, \tag{A14}$$

where $V_{c,t}(j)$ is the number of vacancies posted by the j'th firm.

With economy-wide employment equalling $L_{c,t} = \int_0^1 L_{c,t}(j)\,dj$, the number of people that are unemployed and searching for work at the start of period t is:

$$U_{c,t} = Q_t - (1-\vartheta_{c,t})(1+\mu_{t-1})L_{c,t-1}. \tag{A15}$$

A.2.2 Firms

Firm j produces according to the production technology

$$Y_t(j) = A_t h_{c,t}(j)\, L_{c,t}(j), \tag{A16}$$

where A_t is an aggregate technology shock. To hire more workers, firms must post a vacancy and pay a fixed cost ι_t. Firms are monopolistically competitive, choosing the price they charge for their good subject to the demand curve:

$$Y_t(j) = \left(\frac{p_t(j)}{P_t}\right)^{-\epsilon} Y_t, \tag{A17}$$

where $\epsilon > 1$ is the stochastic elasticity of substitution among goods. In equation (A17), $p_t(j)$ denotes the price of the j'th firm's good, P_t denotes the aggregate price level, and Y_t denotes aggregate output.

Taking $\{P_t, w_t, Y_t, L_{c,t}(j)\}_{t=0}^{\infty}$ as given, the decision problem confronting the j'th firm is:

$$\max_{\{p_t(j),L_{c,t}(j),V_{c,t}(j)\}_{t=0}^{\infty}} \mathbb{E}_0 \left[\sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0}\left(\frac{p_t(j)}{P_t}\frac{Y_t(j)}{Q_t} - A_t w_{c,t} h_{c,t}(j)\frac{L_{c,t}(j)}{Q_t} - \iota_t \frac{V_{c,t}(j)}{Q_t}\right)\right], \tag{A18}$$

subject to the production technology (A16), the demand curve (A17), and the law-of-motion for employment (A14).

The Lagrangian for this decision problem is:

$$\mathcal{L} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{\lambda_t}{\lambda_0} \left(\begin{array}{c} \left(\frac{p_t(j)}{P_t}\right)^{1-\epsilon} \frac{Y_t}{Q_t} - A_t w_t h_{c,t}(j) \frac{L_{c,t}(j)}{Q_t} - \iota_t \frac{V_{c,t}(j)}{Q_t} \\ -\xi_t \left(\left(\frac{p_t(j)}{P_t}\right)^{-\epsilon} \frac{Y_t}{Q_t} - A_t h_{c,t} \frac{L_{c,t}(j)}{Q_t} \right) \\ -\eta_t \left(\frac{L_{c,t}(j)}{Q_t} - (1-\vartheta_{c,t})(1+\mu_{t-1}) \frac{L_{c,t-1}(j)}{Q_t} - \frac{V_{c,t}(j)}{Q_t}\gamma_{c,t} \right) \end{array} \right),$$

where we used the demand curve (equation A17) to substitute for firm-level output and introduced two Lagrange multipliers: ξ_t and η_t. The first of these Lagrange multipliers can be interpreted as the real marginal cost of production while the second represents the value of filling a vacancy.

We assume that firms set prices a la Calvo (1983), with α being probability to being unable to change price in the current quarter.

This, the Lagrangian for price optimisation can be written as:

$$L = E_t \sum_{k=0}^{\infty} \left(\frac{\lambda_{t+k}}{\lambda_t}\right) (\beta\alpha)^k \Bigg[\left(\frac{p_t(j)\,\pi^k}{P_{t+k}}\right)^{1-\varepsilon} \frac{Y_{t+k}}{Q_{t+k}} - w_{c,t+k}\, h_{c,t+k}(j)\, \frac{L_{c,t+k}(j)}{Q_{t+k}}$$
$$- \iota_{t+k} \frac{V_{c,t+k}(j)}{Q_{t+k}} - \xi_{t+k} \left(\left(\frac{p_t(j)\,\pi^k}{P_{t+k}}\right)^{-\varepsilon} \frac{Y_{t+k}}{Q_{t+k}} - A_{t+k} h_{c,t+k}(j) \frac{L_{c,t+k}(j)}{Q_{t+k}} \right)$$
$$- \eta_{t+k} \left(\frac{L_{c,t+k}(j)}{Q_{t+k}} - (1-\vartheta_{c,t+k})(1+\mu_{t+k-1}) \frac{L_{c,t+k-1}(j)}{Q_{t+k}} - \gamma_{c,t+k} \frac{V_{c,t+k}(j)}{Q_{t+k}} \right) \Bigg].$$

And its first order conditions are

$$\frac{\partial \mathcal{L}}{\partial L_{c,t}(j)} \equiv 0 = -w_t h_{c,t}(j) + A_t \xi_t h_{c,t}(j) - \eta_t + \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \eta_{t+1} (1 - \vartheta_{c,t+1})$$
$$\frac{\partial \mathcal{L}}{\partial V_{c,t}(j)} \equiv 0 = -\iota_t + \eta_t \gamma_{c,t}$$
$$\frac{\partial \mathcal{L}}{\partial p_t(j)} \equiv 0 = \mathbb{E}_t \sum_{k=0}^{\infty} (\beta\alpha)^k \left(\frac{\lambda_{t+k}}{\lambda_t}\right) \Bigg[(1-\varepsilon) \left(\frac{p_t(j)\,\pi^k}{P_{t+k}}\right)^{-\varepsilon} \left(\frac{\pi^k Y_{t+k}}{P_{t+k} Q_{t+k}}\right)$$
$$- \xi_{t+k} \left(-\varepsilon \left(\frac{p_t(j)\,\pi^k}{P_{t+k}}\right)^{-\varepsilon-1} \left(\frac{\pi^k Y_{t+k}}{P_{t+k} Q_{t+k}}\right) \right) \Bigg]$$

The aggregated version of the first two equations are:

$$0 = -w_t h_{c,t} + A_t \xi_t h_{c,t} - \eta_t + \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \eta_{t+1} (1 - \vartheta_{c,t+1}) \tag{A19}$$
$$0 = -\iota_t + \eta_t \gamma_{c,t} \tag{A20}$$

Equation (A19) is the job-posting condition that says that firms will post vacancies up to the point where the expected payoff from filling a position equals the cost of posting the vacancy. Lagrange multiplier η_t is associated with the law of motion for employment and represents the value of filling a vacancy (A14). Equation (A20) is the job creation condition which says that the value of a newly filled position should equal the current-period profit generated from the match plus the expected discounted value of a filled position next period. Here ξ_t is the Lagrange multiplier on the demand curve (A17) which can be interpreted as the real marginal cost of production.

The third equation yields the relative forward-looking price $p_t^f = \frac{p_t(j)}{P_t}$ at optimum:

$$p_t^f = \frac{\epsilon}{(\epsilon-1)} \frac{\mathbb{E}_t \sum_{k=0}^{\infty} (\alpha\beta)^k \frac{\lambda_{t+k}}{\lambda_t} \xi_{t+k} \left[\frac{P_t \pi^k}{P_{t+k}}\right]^{-\epsilon-1} \frac{Y_{t+k}}{Q_{t+k}}}{\mathbb{E}_t \sum_{k=0}^{\infty} (\alpha\beta)^k \frac{\lambda_{t+k}}{\lambda_t} \left[\frac{P_t \pi^k}{P_{t+k}}\right]^{-\epsilon} \frac{Y_{t+k}}{Q_{t+k}}} = \frac{\epsilon}{(\epsilon-1)} \frac{K_{1,t}}{K_{2,t}},$$

where the two helper variables evolve as

$$K_{1t} = \xi_t \frac{Y_t}{Q_t} + \alpha\beta\mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \Pi_{t+1}^{\epsilon} K_{1,t+1}, \tag{A21}$$

$$K_{2t} = \frac{Y_t}{Q_t} + \alpha\beta\mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \Pi_{t+1}^{\epsilon-1} K_{2,t+1}. \tag{A22}$$

and the gross inflation is

$$\Pi_t = \frac{P_t}{\pi P_{t-1}}. \tag{A23}$$

To introduce inflation inertia we allow some firms to follow simple rules of thumb when setting prices. Specifically, when a firm is given the opportunity to post a new price, we assume that rather than choosing the profit-maximising price (see **??**), a proportion ζ follow a simple rule of thumb:

$$p_t^b = p_{t-1}^* \Pi_{t-1}, \tag{A24}$$

so that they update their price in line with last period's rate of inflation. Here p_t^* denotes an index of the newly reset prices, given by

$$p_t^* = \left(p_t^f\right)^{1-\zeta} \left(p_t^b\right)^{\zeta}. \tag{A25}$$

The law of motion of the aggregate price index satisfies

$$1 = \alpha\Pi_t^{\epsilon-1} + (1-\alpha)\left(p_t^*\right)^{1-\epsilon}. \tag{A26}$$

Aggregation of firm-level production functions yields

$$\Delta_t Y_t = A_t h_{c,t} L_{c,t} \tag{A27}$$

where Δ_t is price dispersion, which evolves according to

$$\Delta_t = (1-\alpha)\left(p_t^*\right)^{-\epsilon} + \alpha\Pi_t^{\epsilon}\Delta_{t-1}. \tag{A28}$$

Finally, the aggregated profit of firms is

$$\Phi_t = Y_t - w_{c,t} h_{c,t} L_{c,t} - \iota_t V_{c,t}. \tag{A29}$$

A.2.3 Wages and Hours Worked

The real wage and the number of hours worked are determined through Nash bargaining between workers and firms. Expressed in terms of period-t final goods, we denote using $\mathcal{V}_t^E$ and $\mathcal{V}_t^U$ the value to the household of having a member employed and unemployed, respectively.

The value to a household of having a member employed is given by:

$$\begin{aligned}\mathcal{V}_t^E &= h_{c,t}w_{c,t} + \chi_c s_t^{\chi_c} \frac{(1-h_{c,t})^{1-\nu} - 1}{(1-\nu)\lambda_t} \\ &+ \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \left(\vartheta_{c,t+1} (1-\lambda_{c,t+1}) \mathcal{V}_{t+1}^U + (1-\vartheta_{c,t+1}(1-\lambda_{c,t+1})) \mathcal{V}_{t+1}^E \right) \right]. \end{aligned} \tag{A30}$$

Looking at the terms on the right hand side of equation (A30), the first term represents the extra goods that the household receives through the worker's labour income. The second term captures the value of the worker's leisure, expressed in terms of period-t final goods. The third term is a composite one that reflects the expected payoffs to being either unemployed or employed next period. For a worker that is employed today, the probability that they are unemployed next period is given by the separation rate, $\vartheta_{c,t+1}$, multiplied by the probability that they are unable to be matched to a new job in period $t+1$, which equals one minus the job-filling rate. The payoff to being unemployed next period in terms of next-period goods is $\mathcal{V}_{t+1}^U$. The next-period payoff to being employed equals $\mathcal{V}_{t+1}^E$, which is multiplied by the probability of being employed. These next-period payoffs are multiplied by the marginal rate of substitution and the discount factor in order to be expressed in terms of period-t final goods.

The value to the household of having a member unemployed is:

$$\mathcal{V}_t^U = b_{c,t} + \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} \left((1-\lambda_{c,t+1}) \mathcal{V}_{t+1}^U + \lambda_{c,t+1} \mathcal{V}_{t+1}^E \right) \right], \tag{A31}$$

where the first term on the right hand side reflects the real benefits that accrue to being unemployed today and the second term is a composite one reflecting the expected payoffs to being either unemployed or employed next period, which are then expressed in terms of period-t goods by multiplying by the marginal rate of substitution and the discount factor.

Given equations (A30) and (A31), the match surplus, $\mathcal{V}_t^S = \mathcal{V}_t^E - \mathcal{V}_t^U$, for the household equals:

$$\mathcal{V}_t^S = h_{c,t}w_{c,t} - b_{c,t} + \chi_c s_t^{\chi_c} \frac{(1-h_{c,t})^{1-\nu} - 1}{(1-\nu)\lambda_t} + \beta \mathbb{E}_t \left[\frac{\lambda_{t+1}}{\lambda_t} (1-\vartheta_{c,t+1})(1-\lambda_{c,t+1}) \mathcal{V}_{t+1}^S \right]. \tag{A32}$$

Turning to the representative firm, the value of an unfilled vacancy, $\mathcal{V}_t^V$, equals zero while the value of filling a vacancy, $\mathcal{V}_t^F$, is given by equation (**??**). Recognizing that $\mathcal{V}_t^F = \eta_t$ and making use of equation (A19), we have:

$$\mathcal{V}_t^F = h_{c,t}\left(\xi_t A_t - w_{c,t}\right) + \beta \mathbb{E}_t \left[\left(1-\vartheta_{c,t+1}\right) \frac{\lambda_{t+1}}{\lambda_t} \frac{\iota_{t+1}}{\gamma_{c,t+1}} \right]. \tag{A33}$$

The first term on the right hand side captures the real profits obtained from the goods produced from hiring an additional worker (filling a vacancy). The second term reflects the payoff that the firm receives when the match continues next period and the firm does not have to post a vacancy in order to fill a vacant position.

We assume that the real wages are set by Nash bargaining with the worker's share of the joint surplus equal to $\epsilon_{c,t}$, leading to the well-known sharing rule:

$$\mathcal{V}_t^S = \epsilon_{c,t}\left(\mathcal{V}_t^S + \mathcal{V}_t^F\right). \tag{A34}$$

Substituting equations (A32) and (A33) and the one-period lead of equation (A19) into equation (A34) yields:

$$\begin{aligned} h_{c,t} w_{c,t} = {} & \epsilon_{c,t} \left(\xi_t A_t h_{c,t} + \beta \mathbb{E}_t \left[\left(1-\vartheta_{c,t+1}\right) \frac{\lambda_{t+1}}{\lambda_t} \left(1 - \left(1-\lambda_{c,t+1}\right) \frac{\left(1-\epsilon_{c,t}\right)\epsilon_{c,t+1}}{\left(1-\epsilon_{c,t+1}\right)\epsilon_{c,t}} \right) \frac{\iota_{t+1}}{\gamma_{c,t+1}} \right] \right) \\ & + \left(1-\epsilon_{c,t}\right) \left(b_{c,t} - \frac{\chi_c s_t^{\chi_c}}{\lambda_t} \frac{\left(1-h_{c,t}\right)^{1-\nu} - 1}{(1-\nu)} \right). \end{aligned} \tag{A35}$$

which determines the real wage per worker as a weighted average of a terms equaling the marginal revenue product of the worker plus the value of not having to replace the worker and a term equaling the outside option of the worker.

Finally, hours worked are chosen to maximize the joint surplus of the match, $\mathcal{V}_t^S + \mathcal{V}_t^F$, which gives:

$$\xi_t A_t = \chi_c s_t^{\chi_c} \frac{\left(1-h_{c,t}\right)^{-\nu}}{\lambda_t}. \tag{A36}$$

A.3 Housing Sector

The housing sector model is largely built on Head et al. (2014), extended to general equilibrium setting.

A.3.1 Housing Dynamics

At time t the economy has H_t houses which are either occupied by the population Q_t, or vacant $V_{h,t}$, so that:

$$H_t = Q_t + V_{h,t}, \tag{A37}$$

where vacant houses $V_{h,t}$ are made up of a combination of newly constructed houses by property developers, and houses which have been vacated and listed for sale by homeowners.

At time t, homeowners can become mismatched with their house at an exogenous probability $\vartheta_{h,t} \in (0,1)$. If mismatched, homeowners become unhappy with their home and no longer receive utility z^H. These individuals stop being classified as homeowners. They can vacate their houses and either put them on the rental market, or list for sale, move to a rented accommodation and become searching buyers, trying to match with a new house.

The number of homeowners, therefore, is determined by the following equation:

$$N_t = (1 - \vartheta_{h,t})(1 + \mu_{t-1})N_{t-1} + M_{h,t} \tag{A38}$$

Matching in the housing market is determined by the matching function $M_{h,t}$, which depends on the matching technology $\kappa_{h,t}$, the number of searching buyers and houses for sale, S_t:

$$M_{h,t} = \kappa_{h,t} B_t^{\delta_h} S_t^{1-\delta_h}. \tag{A39}$$

We define the level of housing market tightness, $\omega_{h,t}$, by

$$\omega_{h,t} = \frac{B_t}{S_t} \tag{A40}$$

so that the labour market is tight ($\omega_{h,t}$ is high) when the number of buyers is large relative to the number of sellers. Given the matching technology, the house finding rate (matching probability of a searching buyer) is:

$$\lambda_{h,t} = \frac{M_{h,t}}{B_t} = \kappa_{h,t} \omega_{h,t}^{-1+\delta_h}, \tag{A41}$$

and the house filling rate (matching probability for vacant houses) is:

$$\gamma_{h,t} = \frac{M_{h,t}}{S_t} = \kappa_{h,t} \omega_{h,t}^{\delta_h} = \omega_{h,t} \lambda_{h,t} \tag{A42}$$

Therefore, the dynamics of homeowners can be written as

$$N_t = (1 - \vartheta_{h,t})(1 + \mu_{t-1})N_{t-1} + \lambda_{h,t} B_t. \tag{A43}$$

The $(1 - \psi s_t^{\psi})$ is a proportion of new born who are perpetual renters. That is:

$$F_t = F_{t-1}(1 + \mu_{t-1}) + (1 - \psi s_{t-1}^{\psi})\mu_{t-1} Q_{t-1}. \tag{A44}$$

Then, the number of searching buyers at the start of period t is:

$$B_t = Q_t - F_t - (1 - \vartheta_{h,t})(1 + \mu_{t-1})N_{t-1}. \tag{A45}$$

The number of houses for sale is the sum of vacant houses and those still occupied as the sellers are in a chain, the latter list their house for sale but remain in their house. In the context of our model they rent from themselves. Therefore,

$$S_t = V_{h,t} + C_{h,t}$$

where $C_{h,t}$ is the number of sellers that are in a chain.

We assume that the number of sellers who are in a chain is a proportion of all sellers:

$$C_{h,t} = \alpha_{h,t} S_t$$

Then, it follows that

$$\omega_{h,t} = \frac{(1-\alpha_{h,t})\,B_t}{H_t - Q_t}. \tag{A46}$$

A.3.2 Developers

There is land, K_t^L, which is made available at the growth rate $\varkappa_t > 0$, so that the law of motion for land is:

$$K_t^L = (1+\varkappa_t)\,K_{t-1}^L. \tag{A47}$$

We assume that steady state growth rate of land and population are the same, $\varkappa = q$.

Units of land can be converted into land for housing, $\hat{H}_t$, by paying a conversion cost $q_{h,t}$ per unit of land, with a non-linear cost function $\Lambda\left(\frac{q_{h,t}}{A_t}\right) < 1$:

$$\hat{H}_{t+1} - \hat{H}_t = \Lambda\left(\frac{q_{h,t}}{A_t}\right)\left(K_t^L - \hat{H}_t\right). \tag{A48}$$

As developers can only produce housing by combining developed land and labour, their production function is Leontief in nature:

$$H_{t+1} - H_t = \min(\hat{H}_{t+1} - \hat{H}_t, \phi s_t^\phi L_{h,t}), \tag{A49}$$

where ϕs_t^ϕ is the labour productivity in the construction industry.

The result of optimisation is

$$\hat{H}_{t+1} - \hat{H}_t = \phi s_t^\phi L_{h,t}, \tag{A50}$$

from where, using (A49) and $\hat{H}_t = H_t$, we get the housing law of motion:

$$H_{t+1} - H_t = \phi s_t^\phi L_{h,t}. \tag{A51}$$

It remains to determine labour demand in the housing construction sector. Under the assumption of free entry into the construction sector, developers produce housing so long as profitable. That is, in the competitive housing construction market, new units of housing is produced until the cost of production is equal to their benefit from production:

$$\frac{w_{h,t}}{\phi s_t^{\phi}} + q_{h,t} = \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \tilde{\mathcal{V}}_{t+1} \tag{A52}$$

Where: $\mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \tilde{\mathcal{V}}_{t+1}$ is the value of unit of a house constructed this period and available for sale in the next period. This equation determines wage that house producers are willing to pay.

Profit of developers can be written as:

$$\Pi_{h,t} = \left(\beta \mathbb{E}_t \left(\frac{\lambda_{t+1}}{\lambda_t} \tilde{V}_{t+1} \right) - q_{h,t} \right) (H_{t+1} - H_t) - w_{h,t} L_{h,t} = 0. \tag{A53}$$

A.3.3 Value Functions and the House Price

A permanent renter may move home, but remains a permanent renter. Her value function $\mathcal{V}_t^F$ satisfies the following equation:

$$\mathcal{V}_t^F = -r_t^h + \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \mathcal{V}_{t+1}^F \tag{A54}$$

where r_t^h is a rent rate.

When an owner-occupier receives a mismatch shock with probability $\vartheta_{h,t}$, it causes her to vacate the house, move out into a rented accommodation, and either list the house for sale or put it on the rental market. The value function of an owner-occupier takes the form:

$$\begin{aligned} \mathcal{V}_t^N \quad = \quad & -m_t^h + \frac{z^H}{\lambda_t} + \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \left(\left(1 - \vartheta_{h,t} \left(1 - \lambda_{h,t+1}\right)\right) \mathcal{V}_{t+1}^N \right. \\ & \left. + \vartheta_{h,t} \left(\tilde{\mathcal{V}}_{t+1} - \lambda_{h,t+1} P_{t+1}^h \right) + \vartheta_{h,t} \left(1 - \lambda_{h,t+1}\right) \mathcal{V}_{t+1}^B \right). \end{aligned} \tag{A55}$$

In the current period, the homeowner pays maintenance and receives utility from the house. The expected payoff is the following. If there is no mismatch shock then she remains an owner-occupier. When a mismatch shock arrives, the expected value of the vacant house is $\mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \tilde{\mathcal{V}}_{t+1}$as the sale or rent may only happen one period later. The homeowner expects to be a searching buyer with probability $(1 - \lambda_{h,t+1})$ when not matched with a suitable house next period, but she becomes a new owner-occupier if the next-period match realises. In the latter case, the price she pays for new house is P_{t+1}^h. Given the quarterly frequency of the model, it is not realistic to demand that the buyer searches for a house for more than one quarter.

A searching buyer pays rent rate r_t^h. Her value function can be described by the following equation:

$$\mathcal{V}_t^B = -r_t^h + \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \left((1 - \lambda_{h,t+1}) \mathcal{V}_{t+1}^B + \lambda_{h,t+1} \left(\mathcal{V}_{t+1}^N - P_{t+1}^h \right) \right) \tag{A56}$$

With probability $1 - \lambda_{h,t+1}$ the searching buyer remains a searching buyer, and with probability $\lambda_{h,t+1}$ there is a match so she becomes an owner-occupier, derives value from home ownership, facing price P_{t+1}^h for the house.

At the beginning of each period, an unoccupied house $\tilde{\mathcal{V}}_t$, can either be put on the rental market, or listed for sale. Such vacant houses move frictionlessly between sale and rental markets. Homeowners maximise profits and solve the following maximisation problem:

$$\tilde{\mathcal{V}}_t = \max[r_t^h - m_t^h + \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \tilde{\mathcal{V}}_{t+1}, \mathcal{V}_t] \tag{A57}$$

Where the first argument describes the value of a house listed on the rental market and where the house owner is responsible for maintenance payments. $\mathcal{V}_t$ is the value of house designated for sale. As houses move frictionlessly between the two markets, it follows that:

$$\tilde{\mathcal{V}}_t = r_t^h - m_t^h + \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \tilde{\mathcal{V}}_{t+1} = \mathcal{V}_t. \tag{A58}$$

As homeowners will look for a new house, they are likely to sell when conditions seem right, so we assume that they also do not want to wish to be locked into a long-term rental contract.

The value of an unsold house to a seller, $\mathcal{V}_t$, satisfies the following equation:

$$\mathcal{V}_t = \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \left(\gamma_{h,t+1} P_{t+1}^h + (1 - \gamma_{h,t+1}) \tilde{\mathcal{V}}_{t+1} \right). \tag{A59}$$

When a searching buyer meets with a vacant house for sale, the buyer and the seller determine the transaction price by engaging in Nash bargaining over the total surplus of a match in the same way as wages are determined in the general industry.

The match surplus for the searching buyer is:

$$\mathcal{V}_t^S = \mathcal{V}_t^N - \mathcal{V}_t^B - P_t^h, \tag{A60}$$

while the match surplus for the seller is:

$$\mathcal{V}_t^E = P_t^h - \mathcal{V}_t.$$

Maximisation of the Nash product yields

$$P_t^h = (1 - \epsilon_{h,t})(\mathcal{V}_t^N - \mathcal{V}_t^B) + \epsilon_h \mathcal{V}_t \tag{A61}$$

where ϵ_h is the bargaining power of the buyer.

A.4 Aggregation and Equilibrium

Aggregation of (A14) yields

$$L_{c,t} = (1 - \vartheta_{c,t})(1 + \mu_{t-1})L_{c,t-1} + V_{c,t}\gamma_{c,t} \tag{A62}$$

The aggregate production function is

$$Y_t = h_{c,t}L_{c,t} \tag{A63}$$

Households' budget constraint (A8), the developers' zero profit condition (A53), profit of monopolistic firms (A29), the government budget constraint

$$b_{c,t}(Q_t - L_{c,t}) + T_t = q_{h,t}(H_{t+1} - H_t) + (1 - \iota_{Mt})\, m_t^h N_t + Pr_t \tag{A64}$$

and the requirement that net private bonds have zero net supply $\mathcal{A}_t = 0$ yield the resource constraint:

$$Y_t = C_t + \iota V_{c,t}. \tag{A65}$$

A private sector equilibrium consists of stochastic processes of 26 aggregate endogenous variables $\{R_t, X_t, \lambda_t, w_{h,t}, C_t, \xi_t, L_{c,t}, U_{c,t}, \omega_{c,t}, w_{c,t}, h_{c,t}, Y_t, \omega_{h,t}, \mathcal{V}_t^F, \mathcal{V}_t^N, \mathcal{V}_t^B, \mathcal{V}_t, r_t^h, P_t^h,$ $B_t,$ $S_t,$ $N_t,$ $F_t,$ $L_{h,t}, H_t, q_{h,t}\}$ such that 26 equations (A3)-(A7), (A15), (A62)-(A63), (A19)-(**??**), (A65), (A35)-(A36), (A37), (A40), (A43)-(A45), (A51)-(A52), (A48), (A54)-(A56), (A58)-(A59), (A61) hold, given the system of exogenous processes.

B Model Transformation: Stationarizing and solving for Steady State

B.1 The System as a Whole

In the following system, the labour market equilibrium is described by this block of equations 1–19, the housing market equilibrium is described by the block of equations 20–32, where land and population follow exogenous processes in equations 33–34, and filling and finding rates are functions of the relevant tightness.

$$\text{Euler equation 1:} \quad \left(\frac{X_t}{Q_t}\right)^{-\sigma} s_t^{\varrho} = \beta \mathbb{E}_t \frac{1+i_t}{1+\pi_{t+1}} \left(\frac{X_{t+1}}{Q_{t+1}}\right)^{-\sigma} \frac{A_t}{A_{t+1}} s_{t+1}^{\varrho} \to 1 + i_t$$

$$\text{Habits 2:} \quad \frac{X_t}{Q_t} = \frac{C_t}{Q_t A_t} - \theta \frac{C_{t-1}}{Q_{t-1}A_{t-1}} \to \frac{X_t}{Q_t}$$

$$\text{Marginal utility 3:} \quad A_t \lambda_t = s_t^{\varrho} \left(\frac{X_t}{Q_t}\right)^{-\sigma} \to A_t \lambda_t$$

$$\text{Labour supply 4:} \quad \chi_h = s_t^{\varrho}\left(\frac{X_t}{Q_t}\right)^{-\sigma}\frac{w_{h,t}}{A_t} \rightarrow \frac{w_{h,t}}{A_t}$$

$$\text{National income 5:} \quad \frac{Y_t}{Q_t A_t} = \frac{C_t}{Q_t A_t} + \frac{\iota_t}{A_t}\frac{V_{c,t}}{Q_t} \rightarrow \frac{C_t}{Q_t A_t}$$

$$\text{Helper 6:} \quad \frac{K_{1,t}}{A_t} = \xi_t \frac{Y_t}{Q_t A_t} + \beta\alpha\,\mathbb{E}_t\left(\frac{\lambda_{t+1}A_{t+1}}{\lambda_t A_t}\right)\Pi_{t+1}^{\varepsilon}\frac{K_{1,t+1}}{A_{t+1}} \rightarrow \xi_t$$

$$\text{Helper 7:} \quad \frac{K_{2,t}}{A_t} = \frac{Y_t}{Q_t A_t} + \beta\alpha\,\mathbb{E}_t\left(\frac{\lambda_{t+1}A_{t+1}}{\lambda_t A_t}\right)\Pi_{t+1}^{\varepsilon-1}\frac{K_{2,t+1}}{A_{t+1}} \rightarrow \frac{K_{2,t}}{A_t}$$

$$\text{Backward price 8:} \quad p_t^b = p_{t-1}^*\Pi_{t-1} \rightarrow p_t^b$$

$$\text{Forward price 9:} \quad p_t^f = \frac{\varepsilon}{\varepsilon-1}\frac{K_{1,t}}{K_{2,t}} \rightarrow \frac{K_{1,t}}{A_t}$$

$$\text{Reset price 10:} \quad p_t^* = \left(p_t^f\right)^{1-\zeta}\left(p_t^b\right)^{\zeta} \rightarrow p_t^f$$

$$\text{Aggregate price 11:} \quad 1 = \alpha\Pi_t^{\varepsilon-1} + (1-\alpha)\left(p_t^*\right)^{1-\varepsilon} \rightarrow p_t^*$$

$$\text{Price dispersion 12:} \quad \Delta_t = (1-\alpha)\left(p_t^*\right)^{-\varepsilon} + \alpha\Pi_t^{\varepsilon}\Delta_{t-1} \rightarrow \Delta_t$$

$$\text{Labour dynamics 13:} \quad \frac{L_{c,t}}{Q_t} = (1-\vartheta_{c,t})\frac{L_{c,t-1}}{Q_{t-1}} + \frac{V_{c,t}}{Q_t}\gamma_{c,t} \rightarrow \frac{L_{c,t}}{Q_t}$$

$$\text{Searching workers 14:} \quad \frac{U_{c,t}}{Q_t} = 1 - (1-\vartheta_{c,t})\frac{L_{c,t-1}}{Q_{t-1}} \rightarrow \frac{U_{c,t}}{Q_t}$$

$$\text{Job creation 15:} \quad \frac{\iota_t}{A_t}\frac{1}{\gamma_{c,t}} = h_{c,t}\left(\xi_t - \frac{w_{c,t}}{A_t}\right) + \beta(1-\vartheta_c)\mathbb{E}_t\left[\frac{\lambda_{t+1}A_{t+1}}{\lambda_t A_t}\frac{1}{\gamma_{c,t+1}}\frac{\iota_{t+1}}{A_{t+1}}\right] \rightarrow \omega_{c,t}$$

$$\text{Wage bargaining 16:} \quad h_{c,t}\frac{w_{c,t}}{A_t} = \epsilon_{c,t}\Bigg(h_{c,t}\,\xi_t + \beta(1-\vartheta_c)\mathbb{E}_t\Bigg[\frac{\lambda_{t+1}A_{t+1}}{\lambda_t A_t}\frac{\iota_{t+1}}{A_{t+1}}\frac{1}{\gamma_{c,t+1}} \longrightarrow \frac{w_{c,t}}{A_t}$$

$$\times\left(1 - (1-\lambda_{c,t+1})\frac{(1-\epsilon_{c,t})\,\epsilon_{c,t+1}}{(1-\epsilon_{c,t+1})\,\epsilon_{c,t}}\right)\Bigg]\Bigg)$$

$$+ (1-\epsilon_{c,t})\left(\frac{b_{c,t}}{A_t} - \frac{\chi_{c,t}}{A_t\lambda_t}\frac{(1-h_{c,t})^{1-\nu}-1}{1-\nu}\right)$$

$$\text{Hours worked 17:} \quad \xi_t = \chi_c s_t^{\chi_c}\frac{(1-h_{c,t})^{-\nu}}{A_t\lambda_t} \rightarrow h_{c,t}$$

$$\text{Production function 18:} \quad \frac{Y_t}{Q_t A_t} = h_{c,t}\frac{L_{c,t}}{Q_t}$$

$$\text{Policy rule 19:} \quad \frac{1+i_t}{1+i_{ss}} = \left(\frac{1+i_{t-1}}{1+i_{ss}}\right)^{\alpha_i}\left(\left(\frac{\pi_t}{\pi_{\text{targ}}}\right)^{\alpha_\pi}\left(\frac{Y_t}{Q_t A_t}\frac{Q_{t-1}A_{t-1}}{Y_{t-1}}\right)^{\alpha_y}\right)^{1-\alpha_r} s_t^m$$

$$\text{Market tightness 20:} \quad \omega_{h,t} = (1-\alpha_{h,t})\frac{B_t/Q_t}{H_t/Q_t - 1} \rightarrow \omega_{h,t}$$

$$\text{Value of a renter 21:} \quad \frac{\mathcal{V}_t^F}{A_t} = -\frac{r_t^h}{A_t} + \beta\mathbb{E}_t\frac{\lambda_{t+1}A_{t+1}}{\lambda_t A_t}\frac{\mathcal{V}_{t+1}^F}{A_{t+1}} \rightarrow \frac{\mathcal{V}_t^F}{A_t}$$

$$\text{Value of a homeowner 22:} \quad \frac{\mathcal{V}_t^N}{A_t} = -\frac{m_t^h}{A_t} + \frac{z^H}{A_t\lambda_t} + \beta\mathbb{E}_t\frac{\lambda_{t+1}A_{t+1}}{\lambda_t A_t}\Bigg[(1-\vartheta_{h,t}(1-\lambda_{h,t+1}))\frac{\mathcal{V}_{t+1}^N}{A_{t+1}} \rightarrow \frac{\mathcal{V}_t^N}{A_t}$$

$$+ \vartheta_{h,t}\left(\frac{\mathcal{V}_{t+1}}{A_{t+1}} - \lambda_{h,t+1}\frac{P_{t+1}^h}{A_{t+1}}\right) + \vartheta_{h,t}(1-\lambda_{h,t+1})\frac{\mathcal{V}_{t+1}^B}{A_{t+1}}\Bigg]$$

$$\text{Value of a buyer 23:} \quad \frac{\mathcal{V}^B_t}{A_t} = -\frac{r^h_t}{A_t} + \beta\mathbb{E}_t\frac{\lambda_{t+1}A_{t+1}}{\lambda_t A_t}\left[(1-\lambda_{h,t+1})\frac{\mathcal{V}^B_{t+1}}{A_{t+1}} \rightarrow \frac{\mathcal{V}^B_t}{A_t}\right.$$
$$\left. + \lambda_{h,t+1}\left(\frac{\mathcal{V}^N_{t+1}}{A_{t+1}} - \frac{P^h_{t+1}}{A_{t+1}}\right)\right]$$

$$\text{Value of a house 24:} \quad \frac{\mathcal{V}_t}{A_t} = \frac{r^h_t - m^h_t}{A_t} + \beta\mathbb{E}_t\frac{\lambda_{t+1}A_{t+1}}{\lambda_t A_t}\frac{\mathcal{V}_{t+1}}{A_{t+1}} \rightarrow \frac{r^h_t - m^h_t}{A_t}$$

$$\text{Value of unsold house 25:} \quad \frac{\mathcal{V}_t}{A_t} = \beta\mathbb{E}_t\frac{\lambda_{t+1}A_{t+1}}{\lambda_t A_t}\left(\gamma_{h,t+1}\frac{P^h_{t+1}}{A_{t+1}} + (1-\gamma_{h,t+1})\frac{\mathcal{V}_{t+1}}{A_{t+1}}\right) \rightarrow \frac{\mathcal{V}_t}{A_t}$$

$$\text{House price bargaining 26:} \quad \frac{P^h_t}{A_t} = (1-\epsilon_{h,t})\left(\frac{\mathcal{V}^N_t}{A_t} - \frac{\mathcal{V}^B_t}{A_t}\right) + \epsilon_{h,t}\frac{\mathcal{V}_t}{A_t} \rightarrow \frac{P^h_t}{A_t}$$

$$\text{Buyers dynamics 27:} \quad \frac{B_t}{Q_t} = 1 - \frac{F_t}{Q_t} - (1-\vartheta_{h,t})\frac{N_{t-1}}{Q_{t-1}} \rightarrow \frac{B_t}{Q_t}$$

$$\text{Homeowners dynamics 28:} \quad \frac{N_t}{Q_t} = (1-\vartheta_{h,t})\frac{N_{t-1}}{Q_{t-1}} + \frac{B_t}{Q_t}\lambda_{h,t} \rightarrow \frac{N_t}{Q_t}$$

$$\text{Renters dynamics 29:} \quad \frac{F_t}{Q_t} = \frac{F_{t-1}}{Q_{t-1}}\frac{Q_{t-1}}{Q_t} + (1-\psi s^{\psi}_{t-1})\mu_{t-1}\frac{Q_{t-1}}{Q_t} \rightarrow \frac{F_t}{Q_t}$$

$$\text{Production function 30:} \quad \frac{H_{t+1}}{Q_{t+1}}\frac{Q_{t+1}}{Q_t} - \frac{H_t}{Q_t} = \phi s^{\phi}_t\frac{L_{h,t}}{Q_t} \rightarrow \frac{L_{h,t}}{Q_t}$$

$$\text{Land conversion 31:} \quad \frac{H_{t+1}}{Q_{t+1}}\frac{Q_{t+1}}{Q_t} - \frac{H_t}{Q_t} = \Lambda\left(\frac{q_{h,t}}{A_t}\right)\left(\frac{K^L_t}{Q_t} - \frac{H_t}{Q_t}\right) \rightarrow \frac{H_t}{Q_t}$$

$$\text{Labour demand 32:} \quad \frac{w_{h,t}}{A_t}\frac{1}{\phi s^{\phi}_t} + \frac{q_{h,t}}{A_t} = \beta\mathbb{E}_t\frac{\lambda_{t+1}A_{t+1}}{A_t\lambda_t}\frac{\mathcal{V}_{\sqcup+\infty}}{A_{t+1}} \rightarrow \frac{q_{h,t}}{A_t}$$

$$\text{Land dynamics 33:} \quad \frac{K^L_{t+1}}{Q_{t+1}}\frac{Q_{t+1}}{Q_t} = (1+\varkappa_t)\frac{K^L_t}{Q_t} \rightarrow \frac{K^L_t}{Q_t}$$

$$\text{Population dynamics 34:} \quad \frac{Q_{t+1}}{Q_t} = (1+\mu_t) \rightarrow \frac{Q_{t+1}}{Q_t}$$

Denote normalised variables:
$x_t = \frac{X_t}{Q_t}$; $c_t = \frac{C_t}{Q_t A_t}$; $y_t = \frac{Y_t}{Q_t A_t}$; $v_{c,t} = \frac{V_{c,t}}{Q_t}$; $l_{c,t} = \frac{L_{c,t}}{Q_t}$; $l_{h,t} = \frac{L_{h,t}}{Q_t}$; $u_t = \frac{U_{c,t}}{Q_t}$; $b_t = \frac{B_t}{Q_t}$; $h_t = \frac{H_t}{Q_t}$; $n_t = \frac{N_t}{Q_t}$; $f_t = \frac{F_t}{Q_t}$; $k_t = \frac{K^L_t}{Q_t}$; $p^h_t = \frac{P^h_t}{A_t}$; $k_{1,t} = \frac{K_{1,t}}{A_t}$; $k_{2,t} = \frac{K_{2,t}}{A_t}$
value functions:
$v^F_t = \frac{\mathcal{V}^F_t}{A_t}$; $v^N_t = \frac{\mathcal{V}^N_t}{A_t}$; $v^B_t = \frac{\mathcal{V}^B_t}{A_t}$; $v_t = \frac{\mathcal{V}_t}{A_t}$
and recycle notation for prices:
$\frac{w_{h,t}}{A_t}$; $\frac{\iota_t}{A_t}$; $\frac{w_{c,t}}{A_t}$; $\frac{q_{h,t}}{A_t}$; $\lambda_t A_t$; $\frac{m^h_t}{A_t}$; $\frac{r^h_t}{A_t}$; $\frac{b_c}{A_t}$
The system becomes

$$\text{Euler equation 1:} \quad x^{-\sigma}_t s^{\varrho}_t = \beta\mathbb{E}_t\frac{1+i_t}{1+\pi_{t+1}}x^{-\sigma}_{t+1}\frac{A_t}{(1+\gamma)s^z_t}s^{\varrho}_{t+1} \rightarrow 1+i_t$$

$$\text{Habits 2:} \quad x_t = c_t - \theta c_{t-1} \rightarrow x_t$$

$$\text{Marginal utility 3:} \quad \lambda_t = s^{\varrho}_t x^{-\sigma}_t \rightarrow \lambda_t$$

$$\text{Labour supply 4:} \quad \chi_h = s^{\varrho}_t x^{-\sigma}_t w_{h,t} \rightarrow w_{h,t}$$

National income 5: $y_t = c_t + \iota_t v_t \to c_t$

Helper 6: $k_{1,t} = \xi_t y_t + \beta\alpha\,\mathbb{E}_t\left(\frac{\lambda_{t+1}}{\lambda_t}\right)\Pi_{t+1}^{\varepsilon} k_{1,t+1} \to \xi_t$

Helper 7: $k_{2,t} = y_t + \beta\alpha\,\mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t}\Pi_{t+1}^{\varepsilon-1} k_{2,t+1} \to k_{2,t}$

Backward price 8: $p_t^b = p_{t-1}^* \Pi_{t-1} \to p_t^b$

Forward price 9: $p_t^f = \frac{\varepsilon}{\varepsilon-1}\frac{k_{1,t}}{k_{2,t}} \to k_{1,t}$

Reset price 10: $p_t^* = \left(p_t^f\right)^{1-\zeta}\left(p_t^b\right)^{\zeta} \to p_t^f$

Aggregate price 11: $1 = \alpha\Pi_t^{\varepsilon-1} + (1-\alpha)\left(p_t^*\right)^{1-\varepsilon} \to p_t^*$

Price dispersion 12: $\Delta_t = (1-\alpha)\left(p_t^*\right)^{-\varepsilon} + \alpha\Pi_t^{\varepsilon}\Delta_{t-1} \to \Delta_t$

Labour dynamics 13: $l_{c,t} = (1-\vartheta_{c,t})\, l_{c,t-1}\frac{1}{1+\mu_{t-1}} + v_{c,t}\gamma_{c,t} \to l_{c,t}$

Searching workers 14: $u_{c,t} = 1 - (1-\vartheta_{c,t})\, l_{c,t-1}\frac{1}{1-\mu_{t-1}} \to u_{c,t}$

Job creation 15: $\iota_t \frac{1}{\gamma_{c,t}} = h_{c,t}\big(\xi_t - w_{c,t}\big) + \beta(1-\vartheta_{c,t})\mathbb{E}_t\left[\frac{\lambda_{t+1}}{\lambda_t}\frac{1}{\gamma_{c,t+1}}\iota_{t+1}\right] \to \omega_{c,t}$

Wage bargaining 16:
$$h_{c,t}w_{c,t} = \epsilon_{c,t}\Bigg(h_{c,t}\,\xi_t + \beta(1-\vartheta_c)E_t\Bigg[\frac{\lambda_{t+1}}{\lambda_t}\frac{\iota_{t+1}}{\gamma_{c,t+1}} \longrightarrow w_{c,t}$$
$$\times\left(1-(1-\lambda_{c,t+1})\frac{(1-\epsilon_{c,t})\,\epsilon_{c,t+1}}{(1-\epsilon_{c,t+1})\,\epsilon_{c,t}}\right)\Bigg]\Bigg)$$
$$+ (1-\epsilon_{c,t})\left(b_{c,t} - \frac{\chi_{c,t}}{\lambda_t}\frac{(1-h_{c,t})^{1-\nu}-1}{1-\nu}\right)$$

Hours worked 17: $\xi_t = \chi_c s_t^{\chi_c}\frac{(1-h_{c,t})^{-\nu}}{\lambda_t} \to h_{c,t}$

Production function 18: $y_t = h_{c,t} l_{c,t}$

Policy rule 19: $\frac{1+i_t}{1+i_{ss}} = \left(\frac{1+i_{t-1}}{1+i_{ss}}\right)^{\alpha_i}\left(\left(\frac{\pi_t}{\pi_{\text{targ}}}\right)^{\alpha_\pi}\left(\frac{y_t}{y_{t-1}}\right)^{\alpha_y}\right)^{1-\alpha_r} s_t^m$

Market tightness 20: $\omega_{h,t} = (1-\alpha_{h,t})\frac{b_t}{h_t-1} \to \omega_{h,t}$

Value of a renter 21: $v_t^F = -r_t^h + \beta\mathbb{E}_t\frac{\lambda_{t+1}}{\lambda_t}v_{t+1}^F \to v_t^F$

Value of a homeowner 22:
$$v_t^N = -m_t^h + \frac{z^H}{\lambda_t} + \beta\mathbb{E}_t\frac{\lambda_{t+1}}{\lambda_t}\Bigg[(1-\vartheta_{h,t}(1-\lambda_{h,t+1}))\,v_{t+1}^N \quad \to v_t^N$$
$$+ \vartheta_{h,t}\left(v_{t+1} - \lambda_{h,t+1}p_{t+1}^h\right) + \vartheta_{h,t}(1-\lambda_{h,t+1})v_{t+1}^B\Bigg]$$

$$\text{Value of a buyer 23:} \quad v_t^B = -r_t^h + \beta \mathbb{E}_t \frac{\lambda_{t+1}}{\lambda_t} \Bigg[(1-\lambda_{h,t+1}) v_{t+1}^B \rightarrow v_t^B$$
$$+ \lambda_{h,t+1} \left(v_{t+1}^N - p_{t+1}^h \right) \Bigg]$$
$$\text{Value of a house 24:} \quad v_t = r_t^h - m_t^h + \beta \mathbb{E}_t \tfrac{\lambda_{t+1}}{\lambda_t} v_{t+1} \rightarrow r_t^h - m_t^h$$
$$\text{Value of unsold house 25:} \quad v_t = \beta \mathbb{E}_t \tfrac{\lambda_{t+1}}{\lambda_t} \left(\gamma_{h,t+1} p_{t+1}^h + (1-\gamma_{h,t+1})\, v_{t+1} \right) \rightarrow v_t$$
$$\text{House price bargaining 26:} \quad p_t^h = (1-\epsilon_{h,t}) \left(v_t^N - v_t^B \right) + \epsilon_{h,t} v_t \rightarrow p_t^h$$
$$\text{Buyers dynamics 27:} \quad b_t = 1 - f_t - (1-\vartheta_{h,t}) n_{t-1} \rightarrow b_t$$
$$\text{Homeowners dynamics 28:} \quad n_t = (1-\vartheta_{h,t}) n_{t-1} + b_t \lambda_{h,t} \rightarrow n_t$$
$$\text{Renters dynamics 29:} \quad f_t = \tfrac{f_{t-1}}{1+\mu_{t-1}} + (1-\psi s_{t-1}^{\psi}) \tfrac{\mu_{t-1}}{1+\mu_{t-1}} \rightarrow f_t$$
$$\text{Production function 30:} \quad h_{t+1}(1+\mu_t) - h_t = \phi s_t^{\phi} l_{h,t} \rightarrow l_{h,t}$$
$$\text{Land conversion 31:} \quad h_{t+1}(1+\mu_t) - h_t = \Lambda\left(q_{h,t}\right) \left(k_t^L - h_t \right) \rightarrow h_t$$
$$\text{Labour demand 32:} \quad w_{h,t} \tfrac{1}{\phi s_t^{\phi}} + q_{h,t} = \beta \mathbb{E}_t \tfrac{\lambda_{t+1}}{\lambda_t} v_{t+1} \rightarrow q_{h,t}$$

where filling and finding rates are functions of the relevant tightness.

B.2 Steady State and Parameter Values

The steady state of the dynamic system is well defined. We remove time indices and the arrows show that all variables can be found from the system, as functions of parameters. Note that the land-to-population ratio is a parameter.

However, practically, it is difficult to assign parameter values first and then solve for the steady state values as in many cases the sample averages—interpreted as steady state values—are known. Table 1 reports steady state empirical ratios that are assumed to be known. So we solve the steady state system recursively, assigning values to parameters to be consistent with known steady state values. The recursion is as follows.

1. $\lambda_c^w = \dfrac{1}{\bar{\tau}_u^w}$
2. $\lambda_c = 1 - (1-\lambda_c^w)^{\frac{52}{4}}$
3. $\gamma_c = 1 - \left(1 - \bar{\gamma}_c^d\right)^{\frac{365}{4}}$
4. $\gamma_c^w = 1 - (1-\gamma_c)^{\frac{4}{52}}$
5. $\xi = \dfrac{\bar{\epsilon} - 1}{\bar{\epsilon}}$
6. $u_c = \dfrac{1 - \bar{l}_c}{1 - \lambda_c}$
7. $\vartheta_c = 1 - \dfrac{(1-u)}{\bar{l}_c}$
8. $\omega_c = \dfrac{\lambda_c}{\gamma_c}$

9. $w_c = \dfrac{\xi\gamma_c}{\bar{\iota}(1-\beta(1-\vartheta_c))+\gamma_c}$ 10. $y = \bar{h}_c\bar{l}_c$

11. $c = y - \bar{\iota}w_c\bar{h}_c\omega_c u_c$ 12. $x = (1-\theta)c$

13. $\lambda = x^{-\sigma}$ 14. $\chi_c = \xi\lambda(1-\bar{h}_c)^{\bar{\nu}}$

15. $\chi_h = x^{-\sigma}\bar{w}_h w_c\bar{h}_c$ 16. $\Gamma_1 = (1-\bar{b}_c)\bar{h}_c w_c + \dfrac{\chi_c}{\lambda}\dfrac{(1-\bar{h}_c)^{1-\bar{\nu}}-1}{1-\bar{\nu}}$

17. $\Gamma_2 = \bar{h}_c\xi + \dfrac{\chi_c}{\lambda}\dfrac{(1-\bar{h}_c)^{1-\bar{\nu}}-1}{1-\bar{\nu}} + \left(\bar{\beta}(1-\vartheta_c)\lambda_c\dfrac{\bar{\iota}}{\gamma_c} - \bar{b}_c\right)\bar{h}_c w_c$

18. $\epsilon_c = \dfrac{\Gamma_1}{\Gamma_2}$ 19. $w_h = \bar{w}_h\bar{h}_c w_c$

20. $b_c = \bar{b}_c\bar{h}_c w_c$ 21. $\kappa_c = \lambda_c\omega_c^{-1+\bar{\delta}_c}$

22. $\iota = \bar{\iota}\bar{h}_c w_c$ 23. $k_1 = \left(1-\bar{\beta}\bar{\alpha}\right)^{-1}\xi y$

24. $k_2 = \left(1-\bar{\beta}\bar{\alpha}\right)^{-1}y$ 25. $p^h = \bar{p}^h\bar{h}_c w_c$

26. $r^h = \bar{r}_h h_c w_c$ 27. $l_h = \bar{\ell}\, l_c$

28. $\lambda_h = 1-(1-\bar{\lambda}_h^w)^{52/4}$ 29. $n = \dfrac{(1-\bar{s}^r)}{1-\bar{\vartheta}_h}$

30. $b = \dfrac{\bar{\vartheta}_h(1-\bar{s}^r)}{(1-\bar{\vartheta}_h)\lambda_h}$ 31. $\psi = b+1-\bar{s}^r$

32. $f = 1-\psi$ 33. $\omega_h = \dfrac{(1-\bar{\alpha}_h)b}{\bar{h}-1}$

34. $\gamma_h = \omega_h\lambda_h$ 35. $\kappa_h = \lambda_h\omega_h^{1-\bar{\delta}_h}$

36. $\phi = \dfrac{\bar{h}\bar{\mu}}{l_h}$ 37. $v = \dfrac{\bar{\beta}\gamma_h}{1-\bar{\beta}(1-\gamma_h)}p^h$

38. $q_h = \bar{\beta}v - \dfrac{w_h}{\bar{\phi}}$ 39. $k = \dfrac{\bar{\mu}+\bar{\Lambda}q_h^{\bar{s}}}{\bar{\Lambda}q_h^{\bar{s}}}\bar{h}$

40. $m^h = r^h - (1-\bar{\beta})v$ 41. $(v^N - v^B) = \dfrac{1}{1-\bar{\epsilon}_h}\left(1-\dfrac{\bar{\epsilon}_h\bar{\beta}\bar{\gamma}_h}{1-\bar{\beta}(1-\bar{\gamma}_h)}\right)p^h$

42. $v^B = \dfrac{1}{1-\bar{\beta}}\left(-r^h + \beta\lambda_h(v^N - v^B) - \bar{\beta}\lambda_h p^h\right)$

43. $v^N = (v^N - v^B) + v^B$ 44. $D = \dfrac{1-\bar{\beta}((1-\vartheta_h) - \bar{\epsilon}_h\lambda_h(1-\vartheta_h) - (1-\epsilon_h)\gamma_h)}{1-\bar{\beta}(1-\gamma_h) - \bar{\epsilon}_h\bar{\beta}\gamma_h}$

45. $\dfrac{z^h}{\lambda} = (1-\bar{\beta})D(v^N - v^B) - r^h + m^h$

C Data, and numerical implementation

C.1 Data

C.1.1 Data used in estimation

The estimation period is 1978Q1 - 2020Q1, determined by the availability of statistics on the housing stock in the UK. Where relevant, monthly data are converted to quarterly by averaging.

Unless specifically described, all growth rates are calculated with respect to the previous quarter and are seasonally adjusted using additive methods available in E-views. All growth rates are per quarter and are not multiplied by 100. This only affects the units of the estimated standard deviations of shocks. All data were demeaned prior to the estimation and measurement equations reported below were adjusted accordingly.

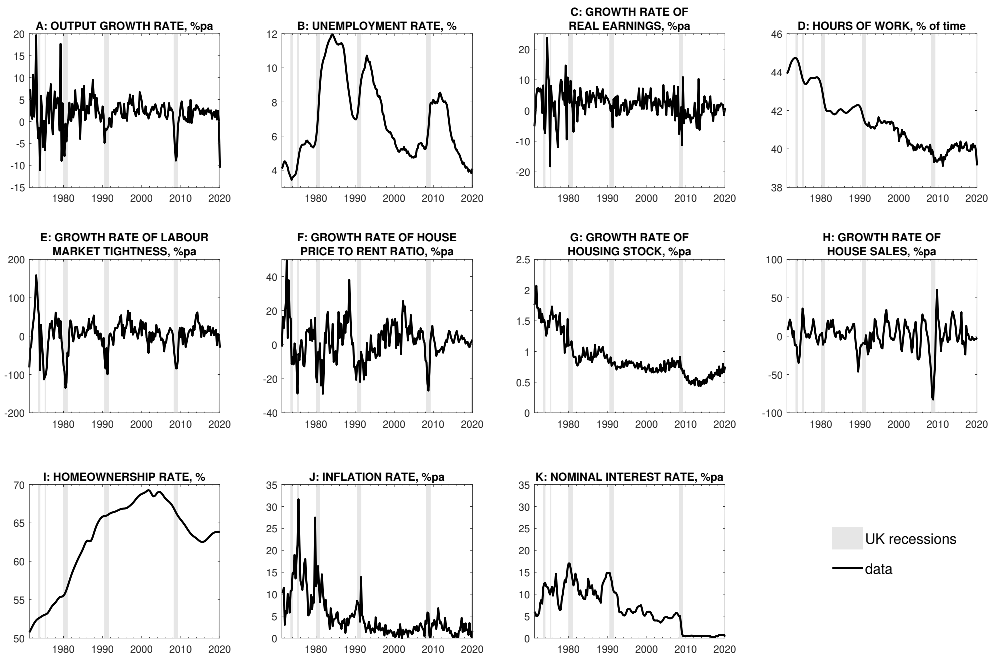

Figure C.1: Historical data

Growth Rate of Real Output. As a measure of real Gross Domestic Product (GDP), we use the Office for National Statistics (ONS) data series ABNI (`https://shorturl.at/aluO9`). The measurement equation is $data_t = \log\left(\left(1+\mu\right)\left(1+\gamma\right) s_t^z \frac{y_t}{y_{t-1}}\right)$.

Growth Rate of Real Earnings. We use 'Spliced Average Weekly Earnings, 1919-2015' from the Bank of England (BoE) publication 'A millennium of macroeconomic data' (KAB9, `https://shorturl.at/hjoJK`). To update this series until 2020Q1, we use the time-series for 'Average Weekly Earnings' of total pay for the whole economy from the ONS dataset EARN01 (`https://shorturl.at/CGRS9`).

To construct a real measure of earnings, we use the Organization for Economic Co-operation and Development (OECD) dataset for the Consumer Price Index for all items (OECD Descriptor ID: CPALTT01, OECD unit ID: IDX, OECD country ID: GBR, `https://shorturl.at/xzCPY`).

The measurement equation is $data_t = \log\left((1+\gamma)\, s_t^z \frac{w_{c,t}h_{c,t}}{w_{c,t-1}h_{c,t-1}}\right)$.

Unemployment Rate. We use the ONS dataset MGSX, which is part of the labour market statistics (LMS) time-series (`https://shorturl.at/sJPR5`). The time-series tracks the unemployment rate of all persons in the UK aged 16 and over.

The measurement equation is $data_t = 1 - l_{c,t}$

Growth Rate of Labour Market Tightness. For the period 1978Q1 - 2001Q1, we use the spliced time-series on *unfilled vacancies* from the BoE publication 'A millennium of macroeconomic data.' To update this series until 2020Q1, we use the ONS time series AP2Y(`https://tinyurl.com/muw85j4n`).

For statistics on the *number of unemployed persons*, we use the ONS time series MGSG (`https://tinyurl.com/yytmbjud`). This time series estimates the number of unemployed persons aged 16 and over, based on the data from the Labour Force Survey.

labour market tightness is computed as the ratio of the number of vacancies to the number of unemployed.

The measurement equation is $data_t = \log\left(\frac{\omega_{c,t}u_{c,t}(1-l_{c,t-1})}{\omega_{c,t-1}u_{c,t-1}(1-l_{c,t})}\right)$

Growth Rate of House Price to Rent Ratio. The UK Land Registry provides a GBR measure of nominal average transaction prices in the UK (`https://landregistry.data.gov.uk/app/ukhpi`). OECD provides long data series of a seasonally adjusted nominal rent index, which covers a longer period than the UK ONS series D7CE.

These two series are used to compute an index of the House Price to Rent Ratio.

To calibrate the steady state of this ratio, we renormalize the Rent Index to match recent annual observations of the average nominal rent in the UK. We use survey results published by Lloyds banking group, developed together with the ONS, BM solutions, and Halifax building society (`https://tinyurl.com/yc2jnka4`), which provide estimates of average monthly home ownership costs and average rental payments on an annual basis from 2012-2020. Then, the nominal house price series is divided by this nominal rent data series. We take its average over the period of estimation and use it to calibrate the steady state house price to rent ratio in the UK.

The measurement equation is $data_t = \log\left(\frac{P_t r_t^h}{P_{t-1} r_{t-1}^h}\right)$

Growth Rate of Housing Stock. The ONS publishes the number of permanent dwellings started and completed within a quarter (`https://tinyurl.com/mrxr7skw`). This represents a gross increase in the housing stock.

To compute the growth rate of the housing stock, we use annual data on the total housing stock in the UK (Table 101, `https://tinyurl.com/5d8svnh5`). Using data from Northern Ireland (`https://tinyurl.com/4j5p8b4k`) to reconstruct the missing observations, we convert them into quarterly frequency by assuming the same value in each quarter and then performing a seasonal adjustment. We then divide the gross increase by the seasonally adjusted total stock of houses. Note that the stock of houses series is heavily rounded, and the number of completed new dwellings is relatively small, so the growth rates are not heavily affected by using the annual data as the base for calculating the growth rate.

The measurement equation is $data_t = \log\left((1+\mu)\frac{H_t}{H_{t-1}}\right)$

Hours To obtain the data on average weekly hours worked, we divided 'Total actually hours worked' (ONS series id: YBUS) by 'The number of people in employment' (ONS series id: MGRS).

The measurement equation is $data_t = h_{c,t}$.

Growth Rate of House Sales. Quarterly data on the number of residential property transaction in England and Wales are available from the Land Registry for the period 1995-2023. We take quarter-to-quarter growth rate of these values as a proxy for the whole country. Annual data on the number of residential property transaction are available since 1981. For the period 1981-1994 we assume the quarterly growth rate is a quarter of the annual growth rate and extend the Land Registry data series to the earlier period.

The measurement equation is $data_t = \log\left((1+\mu)\frac{s_t}{s_{t-1}}\right)$ where $s_t = B_t \gamma_{h,t}$ is house sales.

Share of homeowners. The annual data on the share of homeowners is available from Statista for the period 1980 to 2022. These data were made quarterly (assuming the home ownership did not change within a year) and seasonally adjusted. This series helps to identify the long-run dynamics of the shock to renters, ψ_t. These data would include people who are in a chain to sell the house so the measurement equation is $data_t = n_t + \alpha_{h,t} b_t \omega_{h,t}^{-1}$.

C.1.2 Other data used to calibrate parameters and the steady state

To calibrate the steady state output growth rate we take the average of the real output growth rate over the sample (ONS series id: ABMI).

To calibrate the population growth rate we used the annual data on number of households (https://www.statista.com/statistics/295545/number-of-households-in-the-uk/), which gives an estimate of the average growth rate $\mu = 0.002$.

The average duration of unemployment was approximated using the ONS data table UNEM01.

The Ministry of Housing, Communities & Local Government data were used to compute the proportion of owner-occupied housing units (https://www.statista.com/statistics/804446/property-tenure-distribution-in-the-united-kingdom/) and the data from Department for Communities and Local Government were used to find the proportion of vacant housing units (https://www.statista.com

/statistics/755383/all-vacant-dwellings-england-by-type/). The average time to find a house is taken from research done by the estate agent Savills as reported in https://www.housebeautiful.com/uk

/lifestyle/property/a26866167/moving-house-lifetime-homeowners/

Relative earnings in construction is computed by dividing 'average weekly earnings in construction' (ONS id K5CD) by 'Average weekly earnings in the whole economy' (ONS id KAB9) and taking average over the period 2000-2020.

The replacement ratio is set to about 0.2, which is consistent with OECD data on individual replacement ratio based on 'after 6 months' benefits (https://data.oecd.org/benwage/benefits-in-unemployment-share-of-previous-income.htm) and consistent with Figure 9 in The Living Standards Outlook 2021 by Resolution Foundation, https://www.resolutionfoundation.org

/publications/the-living-standards-outlook-2021/

C.2 Numerical Implementation

We use RISE toolbox (Maih, 2015) for MATLAB to perform all parts of the numerical implementation.[12] We code the model in a symbolic form and then solve with perturbation methods. In our estimation we impose relatively wide priors and use the *Artificial Bee Colony* algorithm by Karaboga and Basturk (2007) for global optimisation. We use the IMM filter and recover latent variables using the associated regime-switching smoother developed in Hashimzade et al. (2024). Variance and historical decompositions are computed using the standard routines in RISE.

[12]RISE stands for 'Rationality in Switching Environments'. The codes and documentation are available at https://github.com/jmaih/RISE_toolbox