On-the-Job Search and Inflation Under the Microscope

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Abstract

We develop a model where heterogeneous agents choose whether to engage in on-the-job search (OJS) to improve labor income. The model accounts for untargeted microdata patterns: fiscal incentives affect job-to-job mobility and wage growth of stayers—but not leavers—across the income distribution, pointing to OJS as a key driver of labor costs. Calibrated to micro and macro moments, the model shows that OJS cost shocks significantly affect real activity and inflation. The permanent decline in OJS costs—driven by ICT and AI-based tools—offers a novel explanation for the weakening of the unemployment-inflation relationship documented in empirical studies.

JEL Codes: E31, J64, E12.

Keywords: Job ladder models; inflation; Danish microdata, wages; bargaining, tax incentives.

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1 Introduction

Workers may decide to search for better job opportunities while still employed—a behavior known as on-the-job search (OJS). These decisions can be driven by a variety of factors, including wage prospects, job security, working conditions, career advancement opportunities, and broader economic conditions such as inflation expectations or fiscal incentives. OJS is widely regarded as a key driver of workers' career progression, wage growth, productivity, and welfare, yet its broader macroeconomic implications are not fully understood.

We develop a heterogeneous-agent model with endogenous OJS to show its key role in shaping job mobility and wage dynamics across the income distribution. To this end, we use matched employer-employee microdata from Danish administrative records, exploiting a 2013 income tax reform that raised one of the income thresholds. The reform increased the returns to searching while employed for workers whose earnings were near the affected threshold, providing a natural experiment to analyze individual search behavior and wage outcomes. The model explains the estimated causal effects of the reform on job-to-job transitions and wage growth, which we treat as untargeted moments to match. We also use the model to assess the macroeconomic effects of exogenous changes in OJS costs, including the impact of the secular decline in these costs—driven by advances in ICT and, more recently, AI—on the apparently weakening link between the unemployment rate and nominal variables, such as inflation.

In the model, agents optimally engage in OJS to increase their labor income. In every period, employed workers face individual stochastic OJS costs and decide to search if the expected benefits outweigh the cost. OJS costs capture both pecuniary expenses and non-pecuniary factors, such as psychological costs and time commitments. Employers compete à la Bertrand to hire or retain workers, allowing employees to negotiate higher wages when presented with outside offers. As a result, income processes evolve endogenously, driven by individual reallocation decisions that lead to better matches, wage renegotiations, and a higher rate of inflation.

A difference-in-differences research design is used to analyze the causal impact of the tax reform-induced changes in job search incentives on EE transition rates and wage growth across the income distribution. We find that the empirical responses closely align with the model's predictions. In both the data and the model, EE transitions and wage growth for job stayers exhibit a distinct inverse-V-shaped pattern centered around the old tax threshold, with no corresponding change in the wage growth of job switchers.

The model explains the estimated effects of the 2013 Danish income-tax reform, even though we did not target these moments in the calibration. Workers earning well below the old threshold or well above the new one face unchanged marginal tax rates, so their incentives to search remain unaffected. In contrast, workers near the old threshold now face lower taxes on wages, making job search more attractive. This concentrated change in incentives generates a spike in OJS and job-to-job transitions near the threshold.

The model further explains why wage growth rises for stayers but not for movers. Since higher OJS increases the number of outside offers, incumbent employers must raise wages to retain staff—benefiting stayers indirectly. However, the wage gain from switching jobs remains determined by the productivity difference between firms and is largely unaffected by the reform. As a result, conditional wage growth for job switchers remains stable, consistent with the data.

Matching these patterns lends empirical credibility to the model by validating its ability to capture how on-the-job search and wage growth respond to exogenous incentive changes across the income distribution. More importantly, the model also performs well quantitatively: in both the model and the data, wage growth for job stayers increases by up to 10 percent for the most affected income groups. Since the majority of workers remain with their employer in any given year, and since the magnitude of their wage response is substantial, these findings imply that OJS is a quantitatively important force shaping marginal labor costs. As such, fiscal policy—or any other policy or shock that triggers changes in OJS, whether by altering expected returns or search costs—can meaningfully affect inflation dynamics by altering how individual workers and firms respond in equilibrium.

We then use the model to investigate the macroeconomic implications of changes in the frictions associated with OJS. We interpret variations in these OJS costs as the time, stress, informational barriers, or even collective fads, which may lower subjective search costs by reshaping social norms—making it feel less burdensome or risky for workers to explore new job opportunities. For example, during the DotCom bubble of the late 1990s, excitement around tech made it easier for workers to justify switching into rapidly-developing sectors. Similarly, during the Great Resignation in 2021, shifting expectations around work made it more psychologically acceptable—even expected—for workers to reconsider their jobs, seek better work-life balance, or greater flexibility.

A temporary decrease in OJS costs leads to a simultaneous rise in both unemployment and inflation. Inflation increases as wage competition among firms to hire or retain workers intensifies, raising expected wage costs for new hires and, in turn, pushing up marginal costs. At the same time, the larger share of employed job seekers elevates expected wage pressures, discouraging vacancy posting, reducing labor market tightness, and thereby increasing unemployment. The resulting fall in employment more than offsets the rise in labor productivity, ultimately leading to a contraction in output. Overall, this shock to OJS has sizable effects on both nominal and real variables. Specifically, following a shock calibrated to produce a one-standard-deviation increase in the EE transition rate (at the peak), inflation rises by about 20 basis points, while unemployment climbs by roughly 0.4 percentage points.

Finally, we use the model to examine the effects of lower OJS costs—driven, for instance, by the diffusion of ICT and AI-based search technologies. As OJS costs decline, the model predicts that an expansionary demand shock leads to a smaller rise in inflation and a larger fall in unemployment. This suggests that new technologies lowering search costs have contributed to the weakening of the unemployment-inflation relationship documented in several empirical studies (e.g., Stock and Watson, 2008). Although lower OJS costs lead more employed workers to search for new jobs following a positive demand shock, the percentage increase in on-the-job search is smaller, as more workers were already engaged in on-the-job search before the shock. This more muted rise in the *share* of employed job seekers leads to weaker inflationary pressures from the labor market. At the same time, unemployment falls more under low OJS costs because the relatively modest increase in expensive-to-hire employed job seekers encourages firms to create more vacancies.

It is worth noting that our model features complete markets. When we incorporate an additional dimension to the model's heterogeneity—households' wealth—in the spirit of the HANK literature, we find that the responses of OJS are fully preserved. This indicates that including wealth heterogeneity is not essential to illustrate the mechanism of the paper and its quantitative implications.

Literature review. Our work belongs to the recent literature that examines inflation dynamics through job ladder models of the labor market. Seminal work by Moscarini and Postel-Vinay (2023), for instance, shows how cyclical labor misallocation affects the transmission of shocks to inflation. However, their model assumes a constant OJS rate, omitting the channel central to this paper.

Faccini and Melosi (2023) examine the relationship between OJS, the employment-to-employment (EE) rate, and inflation, estimating *exogenous* OJS fluctuations using a fully macro approach that leverages joint movements in aggregate EE and unemployment-to-employment (UE) flows. In contrast, we use matched employer-employee microdata to discipline a richer heterogeneous-agent model featuring multiple match types, *endogenous* OJS decisions, and progressive income taxation. We draw on moments from the microdata to discipline the model and show that it can account for untargeted, causal evidence—based on individual-level responses to a fiscal shock—on the role OJS plays in shaping wage growth for job stayers and leavers. We then use the model to study the broader macroeconomic role of OJS, extending beyond inflation to its effects on business cycle dynamics and real variables.

Our work focuses on a novel source of heterogeneity arising from workers' decisions to search while employed. As such, we contribute to the expanding literature that examines the role of heterogeneity in macroeconomics (e.g., Huggett, 1993; Aiyagari, 1994; Krusell and Smith, 1998; Castañeda, Díaz-Giménez, and Ríos-Rull, 2003; Ahn, Kaplan, Moll, Winberry, and Wolf, 2018). Within this body of work, HANK models have emerged as a new paradigm for macroeconomic modeling and analysis. They have been used, for instance, to investigate the transmission of monetary policy, the role of fiscal policy in economies with heterogeneous agents, and the distributional consequences of aggregate shocks—e.g., Ravn and Sterk (2017); Kaplan and Violante (2018); Kaplan, Moll, and Violante (2018); Auclert (2019); Auclert, Rognlie, and Straub (2020); Bilbiie (2020); Ravn and Sterk (2020); Auclert, Bardóczy, Rognlie, and Straub (2021); Luetticke (2021); Auclert, Rognlie, and Straub (2023); Bayer, Born, and Luetticke (2024); and Kase, Melosi, and Rottner (2024).

A key departure of our model from the baseline HANK framework is the role of search behavior in shaping workers' income dynamics. In this setting, workers may decide to search on the job either to transition to better-paying positions or to renegotiate wages in response to outside offers. As a result, individual labor productivity evolves endogenously, driven by past and current search decisions, and influences income trajectories over multiple periods.

Our modeling framework builds on the HANK models with a job ladder developed by Alves (2020) and Birinci, Karahan, Mercan, and See (2023), but deviates from these approaches in a critical way. Unlike those papers, we allow agents to optimally decide whether to search on the job. These strategic decisions vary across the income distribution, introducing a novel and quantitatively important source of heterogeneity in the model. We show that our main results are driven by this form of heterogeneity, rather than by differences in wealth. To avoid unnecessary complexity that could obscure the model's predictions and core intuition, we assume full consumption insurance in the baseline specification.

Bagga, Mann, Şahin, and Violante (2025) build a general equilibrium model to study how the decline in job values associated with the absence of a remote work option triggers job-to-job mobility. Afrouzi, Blanco, Drenik, and Hurst (2024) develop a model to explain why periods of high inflation can lead the vacancy-to-unemployment ratio to rise alongside a decline in aggregate real wages. Both papers are closely connected to ours, as they rely on models in which the erosion of the value of existing matches triggers job-to-job mobility and wage renegotiation. In this sense, their findings nicely complement our analysis of the effects of OJS decisions at both the micro and macro levels. A key difference is that in our model agents treat OJS and wage renegotiation as connected, strategic decisions. To our knowledge, we are the first to model these interactions, which are essential for making endogenous on-the-job search a key driver of marginal costs and inflation through wage competition. Combined with the sequential auction bargaining protocol, this feature also helps explain micro evidence that would otherwise be puzzling—such as the fact that changes in fiscal incentives to search on the job do not affect the wage growth of leavers.

A growing literature using surveys to study inflation expectations as a potential trigger for OJS is rapidly emerging. This research is perfectly complementary to ours, which, by contrast, relies on micro data and structural macroeconomic modeling to examine the role of OJS in the propagation of shocks and, more broadly, in shaping aggregate dynamics. We highlight three recent contributions from this literature. First, Pilossoph and Ryngaert (2024) provide evidence that workers expecting higher inflation are more likely to engage in OJS and experience EE transitions in the short term. Their model connects inflation expectations with search behavior, generating potential wage-price spirals. Second, using large-scale survey data, Hajdini, Knotek II, Leer, Pedemonte, Rich, and Schoenle (2022) show that increased inflation expectations cause households to report a higher probability of seeking better-paying jobs. This connection between expected inflation and OJS is also present in our model. However, unlike their work, our general equilibrium framework allows OJS to feed back into price setting, capturing broader economic interactions. Third, Raposo (2024) design a survey of U.S. workers to study the causal effect of higher inflation expectations on job search behavior, finding that while higher expected inflation encourages search for better-paying jobs, this effect is offset by concerns about rising unemployment, rendering the overall impact ex-ante ambiguous. In our general equilibrium model, workers take into account both expected inflation and the job-finding rate when making OJS decisions.

In a different but related strand, Lorenzoni and Werning (2023) interpret inflation as a manifestation of conflict over relative prices—particularly between workers' aspirations for real wages and firms' desired markups. Our model offers one way to formalize this conflict within a general equilibrium framework. In particular, workers in our model respond to changing incentives—including, but not limited to, their expectations of future inflation—by engaging in on-the-job search to solicit outside offers and renegotiate their current wage. This behavior generates endogenous wage dynamics that influence labor costs for price-setting firms. In turn, to avoid a contraction in their markups, firms raise prices to pass higher production costs on to households. All else equal, this fuels further on-the-job search by workers, reinforcing the "conflict" loop. In this sense, our mechanism captures the type of conflict emphasized by Lorenzoni and Werning.

Guerreiro, Hazell, Lian, and Patterson (2024) develop a menu-cost model where inflation compels workers to take costly actions—such as requesting raises or soliciting outside offers—in order to maintain purchasing power. While they treat these behaviors as reduced-form “conflict costs” in a wage bargaining framework, our model provides a micro-founded mechanism that maps one such form of conflict, i.e., outside-offer-driven renegotiation, into a search-theoretic setting. In this sense, our framework provides a structural interpretation of how conflict can emerge through on-the-job search and wage bargaining dynamics.

Finally, our analysis is connected with Bagger, Moen, and Vejlin (2021), who examine the effects of income taxes within a job ladder model featuring endogenous OJS, using Danish microdata for estimation. Like ours, their study finds that income taxation reduces the returns to OJS. However, their focus is on the impact of taxes on labor allocation and the elasticity of taxable income, whereas we examine how taxes affect job mobility and wage dynamics across the income distribution, along with their macroeconomic implications.

The paper is organized as follows. Section 2 presents the baseline model with endogenous on-the-job search and progressive taxation. Section 3 describes the datasets used in the empirical analysis, while Section 4 covers the calibration of the model. Section 5 examines the effects of a shift in the high-income tax threshold on EE rates and wages across the income distribution. Section 6 examines the general equilibrium effects of policies that influence the cost of on-the-job search, on macroeconomic aggregates. In Section 7, we relax the assumption of complete markets and construct a HANK model with endogenous OJS decisions, showing that the responses in OJS are not materially affected by wealth heterogeneity. Finally, in Section 8 we conclude.

2 The model

We develop a New Keynesian model with heterogeneous agents that incorporates a job ladder, endogenous on-the-job search, and progressive income taxation. The model is designed to be taken to Danish micro data to study the effects of a tax reform that changes the incentives for on-the-job search among certain groups of workers.

To focus on the core mechanism, the baseline model in this section assumes full consumption insurance, abstracting from complications that are unessential for our objectives. In Section 7, we relax this assumption by introducing incomplete markets to examine the robustness of our results in a framework also featuring wealth heterogeneity.

2.1 The environment

The economy comprises a unit measure of ex-ante identical individuals facing a discrete and infinite time horizon. All of them participate to the labor market until they retire. While active in the labor market, workers can be either employed or unemployed. The pool of job seekers comprises the entire measure of the unemployed, and an endogenous share of the employed. Every period, an employed worker draws a psychological cost of search from a distribution and optimally decides to search provided that the expected return is larger than the cost. By searching on the job, the workers can move up the ladder to more productive matches. Employers compete *à la* Bertrand to hire or retain workers, which implies that workers have the opportunity to renegotiate their wages upwards with the arrival of outside offers. As a result, workers' labor productivity evolves endogenously—affecting workers' income prospects— in the sense that they originate from individual search and reallocation decisions, which may lead to better matches and wage renegotiations. At the end of the period, all workers pool their income together and the consumption-savings decision is taken at the level of the representative household. The household saves by investing in one-period government bonds and receives lump-sum profits from all the firms in the economy.

We assume the economy consists of two types of firms: labor-service firms and price setters. Labor-service firms decide whether to post vacancies to form matches with job seekers. Once a match is formed, the firm produces a homogeneous labor service good, which is sold to price setters at the competitive price, p^l. Price setters differentiate the homogeneous good purchased from labor-service firms and sell it to households. Price setters are monopolistically competitive and choose the price of their differentiated good given a downward-sloping demand function and nominal price rigidities *à la* Rotemberg. Importantly, the price of homogeneous good is the real marginal costs of producing the differentiated good for price setters. Finally, a monetary authority is in charge of setting the nominal interest-rate policy, while the fiscal authority levies taxes with tax rates varying across labor-income brackets and administers lump-sum transfers.

2.2 Labor market and wage negotiations

The labor market is governed by a standard meeting function that brings together vacancies and job seekers. This implies that the rates at which job seekers meet a vacant job, $f(\theta)$, and the rate at which vacant jobs meet a job seekers, $q(\theta)$, only depends on labor market tightness θ, defined as the ratio of the aggregate measure of vacancies, v, and job seekers, S, i.e., $\theta = \frac{v}{S}$. Note that the pool of job seekers includes both unemployed workers and employed job seekers. Homotheticity of the meeting function implies that $df(\theta)/d\theta > 0$ and $dq(\theta)/d\theta < 0$.

Consider a worker employed in a job with productivity x. When meeting a vacancy, the worker draws a new match productivity at the poaching firm, given by $x' = x(1+\epsilon)$, where ϵ follows a normal distribution with mean ω_x and standard deviation σ_x. The worker then receives a wage offer (details below) and decides whether to accept or reject it. Similarly, unemployed workers who meet a vacancy draw a productivity $x' = \underline{x}(1+\epsilon)$, where $\underline{x} > 0$ is a fixed parameter. We express the CDF of the productivity draw, x' as G^x, where x denotes the productivity of the worker in the current match. We assume that this CDF is a truncated normal with bounds $(\underline{x}, \overline{x})$. Each period, matches may dissolve for three reasons: an exogenous shock occurring with probability δ, a retirement shock, ψ^R, or voluntary worker reallocation to other firms.

The bargaining protocol follows Bagger, Fontaine, Postel-Vinay, and Robin (2014) and assumes that firms compete *à la* Bertrand on the share of output they are willing to pay as wages. Workers hired from unemployment cannot spark wage competition between employers, and are assumed to receive a wage equal to $\zeta\underline{x}$, where $\underline{x}$ is the production of the least productive match, and $\zeta \in (0,1)$ represents the maximum share of output that a worker can capture as wage, ensuring that the value of the match for the firm is always positive.[1]

To understand wage determination for the employed workers who receive an outside wage offer, it is useful to distinguish between two different cases. Let the wage schedule be denoted by $w(x,\alpha) = \alpha\zeta x$, where $\alpha \in (0,1)$ is the wage piece rate determining the fraction of the maximum share of output obtained by the worker.

Consider first the case of a worker employed with productivity x, who meets with a firm with productivity $x' > x$. This is the case where the poaching firm is more productive than the incumbent. The maximum wage that the incumbent can offer is $w(x,1)$. This offer can be outbid by the poacher, by offering $w(x,1)+\varepsilon$, where $\varepsilon \approx 0$ is an arbitrarily small value. Bertrand competition implies that the worker will switch employer, and receive the wage schedule $w(x', x/x') = \zeta x$, where $\alpha' = x/x'$ is the updated piece rate.

Now consider the case where a worker employed in a match with productivity x and piece rate α meets with a firm with productivity $x' < x$. In this case the poacher is less productive than the incumbent. The worker therefore stays with the incumbent, but the wage is still renegotiated upwards if the maximum wage that the poacher is willing to pay is higher than the pay the worker is currently receiving. That is, the outcome of the auction is a wage that satisfies $\max\{w(x,\alpha), w(x, x'/x)\}$.

2.3 Time and shocks

The timing of events is as follows: first, the aggregate tax shock hits the economy. Then both the unemployed and the employed workers search for jobs. Subsequently, reallocation takes place: some unemployed find jobs and some employed move to a different employer. Next,

[1] A value of ζ lower than the steady-state price of the homogeneous labor service good, p_l, is necessary to ensure that the expected value of all existing matches is non-negative for firms.

production takes place, wages, interests on government bonds, dividends, and government transfers are paid, taxes are levied and consumption decisions are taken. At the end of the period, idiosyncratic separation, retirement, and death shocks occur.

Henceforth, we use the time subscript 0 to indicate the value of a variable at the beginning of the period, specifically at the stage when the search decision is made. The subscript 1 denotes the value of the variable at the production stage, i.e., just before the shocks to separation, retirement and death take place.

Aggregate states. There are three aggregate endogenous state variables: household government bond holdings, B; the price of the homogeneous labor service, p^l; and labor market tightness, θ (since the labor market is frictional).

We consider two types of aggregate shocks. The first is a shock to the household discount factor, β. The second is a shock to the *average* OJS cost, modeled as an exogenous change in the upper bound of the support of the distribution of individual OJS costs—which we denote by ϑ^u.

We collect the aggregate endogenous and exogenous state variables in the vector $\Lambda \equiv \{B, p^l, \theta; \beta, \vartheta^u\}$. In a stationary equilibrium, this vector does not evolve over time. Following an aggregate shock, however, the vector changes dynamically. To keep the model tractable, we abstract from agents' uncertainty about the future evolution of aggregate states. In what follows, for simplicity, we omit the aggregate state vector from the notation of value functions that also depend on idiosyncratic states.

2.4 The consumption-savings decision

At the end of each period, after reallocation has occurred, the representative household pools the incomes of all its members—employed, unemployed, and retired. Specifically, employed workers earn a wage $w(x, \alpha)$, unemployed individuals receive benefits b, and retirees collect pensions T^R. The household aggregates the differentiated goods sold by price setters using a CES technology that produces the consumption bundle, C. The household derives utility from consuming this bundle, C, as described by the utility function $u(C)$. The price of the consumption good, which serves as the *numeraire* in this economy, is denoted by P. The household buys a one-period government bond, B, with net return i. It receives lump-sum dividend payments, D, from price setters and labor service firms. For each worker, labor market income is taxed at a rate τ, which depends on income and will be specified later. Additionally, all workers receive the same government transfer T. Let a prime ($'$) indicate next-period values. The household's optimization problem is expressed through the following value function:

$$\Upsilon(B)=\max_{C} \ \{u(C)+\beta E\Upsilon(B')\} \tag{1}$$

subject to

$$\begin{aligned} PC+\frac{B}{1+i} &= P(1-\tau(b))\,bu_1+P\int(1-\tau(w))\,w(x,\alpha)d\mu_1^E(x,\alpha) \\ &+\left[1-\tau\left(T^R\right)\right]T^R\varpi_1+B_{-1}+D+T, \end{aligned} \tag{2}$$

where u_1 and ϖ_1 denote the measure of workers unemployed and retired at the end of the period, respectively.

2.5 Workers

We let U, V and Γ denote the value functions associated with the states of unemployment, employment, and retirement, respectively. Consider an unemployed worker who did not manage to find a job within a given time period. At the end of the period, the value of unemployment is

$$U=[1-\tau(b)]\,b+\left(1-\psi^R\right)E\lambda\left[f(\theta')\,V_1\left(x,\frac{\underline{x}}{x}\right)+(1-f(\theta'))\,U'\right]+\psi^R E\lambda\Gamma' \tag{3}$$

where λ denotes the household's stochastic discount factor, E represents the expectation operator, and ψ^R is the probability that a worker retires at the end of the period. This expression illustrates that the value of unemployment is a weighted average of three possible future contingencies. If the worker does not retire (with probability $1-\psi^R$), they will either be employed or remain unemployed in the next period, with probabilities $f(\theta)$—the probability of meeting a vacancy—and $1-f(\theta)$, respectively. If they meet a vacancy, the worker enters a match with productivity x, earning the lowest salary, $\zeta\underline{x}$. This corresponds to a piece rate $\alpha=\underline{x}/x$.

The value of retirement is defined as follows:

$$\Gamma=\left[1-\tau\left(T^R\right)\right]T^R+E\lambda\left(1-\psi^D\right)\Gamma', \tag{4}$$

where ψ^D is the probability that a retired worker dies, and T^R denotes pension income.

Turning to the employed workers, the end-of-period value of employment is:

$$V_1(x_1,\alpha)=(1-\tau(w))w_1(x_1,\alpha)+E\lambda\left\{\left(1-\psi^R\right)\left[(1-\delta)\,V_0(x_1,\alpha)+\delta U'\right]+\psi^R\Gamma'\right\}, \tag{5}$$

where the wage schedule $w_1(x_1,\alpha)=\alpha\zeta x_1$ and $V_0(x,\alpha)$ is the value function of employment at the beginning of the period, i.e., before the search cost is drawn from the i.i.d. stochastic distribution G^ϕ, i.e.:

$$V_0(x_0,\alpha)=\int_\phi \widetilde{V}_0(x_0,\alpha,\phi)\,G^\phi(d\phi). \tag{6}$$

After observing the individual search cost for the current period, ϕ, the value of the option of searching on the job for an employed worker with productivity x_0 and piece rate α is given by

$$\widetilde{V}_0 \left(x_0, \alpha, \phi\right) = \max \left\{-\phi + V_0^S \left(x_0, \alpha\right), V_0^{NS} \left(x_0, \alpha\right)\right\}, \tag{7}$$

and where V^S and V^{NS} denote the value of an employed worker searching and not searching, respectively. The value of not searching is equal to the value of having the same wage at the end of the period:

$$V^{NS} \left(x_0, \alpha\right) = V_1 \left(x_0, \alpha\right). \tag{8}$$

The value of searching on the job is given by

$$\begin{aligned} V^S \left(x_0, \alpha\right) = f\left(\theta\right) \int_{\underline{x}}^{\overline{x}} \max \left\{V_1 \left(\widetilde{x}, \frac{x_0}{\widetilde{x}}\right), V_1 \left(x_0, \max \left\{\alpha, \frac{\widetilde{x}}{x_0}\right\}\right)\right\} dG^{x_0} \left(\widetilde{x}\right) \\ + \left(1 - f\left(\theta\right)\right) V_1 \left(x_0, \alpha\right). \end{aligned} \tag{9}$$

The first term inside the curly brackets represents the value of a worker who, with probability $f(\theta)$, meets another firm and transitions to a new job with higher productivity $\widetilde{x} > x_0$. The second term captures the case where the worker, again with probability $f(\theta)$, meets another firm but chooses to renegotiate their wage with their current employer rather than switching jobs. This situation arises when the incumbent firm's productivity exceeds that of the poaching firm, i.e., $x_0 > \widetilde{x}$. The new wage is given by

$$\max \left\{\alpha, \frac{\widetilde{x}}{x_0}\right\} \zeta x_0,$$

which implies that a renegotiation occurs only if the poaching firm's productivity—though lower than the incumbent's—would justify a higher wage offer than the worker's current wage. With probability $1 - f(\theta)$, the worker does not encounter a vacancy and remains in the current job without any change in value.

Expanding the expectation operator, the above equation can be rewritten as follows:

$$\begin{aligned} V^S \left(x_0, \alpha\right) = f\left(\theta\right) \Bigg\{ \int_{x_0}^{\overline{x}} V_1 \left(\widetilde{x}, \frac{x_0}{\widetilde{x}}\right) G^{x_0} \left(d\widetilde{x}\right) \\ + \int_{\underline{x}}^{x_0} V_1 \left(x_0, \max \left\{\alpha, \frac{\widetilde{x}}{x_0}\right\}\right) G^{x_0} \left(d\widetilde{x}\right) \Bigg\} + \left(1 - f\left(\theta\right)\right) V_1 \left(x_0, \alpha\right). \end{aligned}$$

We can define a threshold search cost $\phi^T(x_0, \alpha)$ such that the employed worker employed in a match with productivity x_0 and with piece rate α is indifferent between searching and not searching:

$$\phi^T(x_0,\alpha) = V^S(x_0,\alpha) - V^{NS}(x_0,\alpha). \tag{10}$$

It then follows that the share of workers searching on the job in every bin (x_0, α) is defined as

$$\xi(x_0,\alpha) \equiv \int_{\vartheta^l}^{\phi^T(x_0,\alpha)} G^{\phi}(d\phi), \tag{11}$$

where $G^{\phi}(d\phi)$ denotes the cumulative density function of the OJS cost, ϕ, and ϑ^l denotes the lower bound of the density.

Finally, the measure of workers looking for jobs at the beginning of a period is given by:

$$S = u_0 + \int \xi(x_0,\alpha)\, d\mu_0^E(x_0,\alpha), \tag{12}$$

where u_0 denotes the measure of unemployed workers, $\mu_0^E(x,\alpha)$ stands for the distribution of the employed workers, where the 0 subscript indicates beginning-of-period values, and $\xi(x,\alpha)$ denotes the share of employed workers in the state space defined by the vector (x,α) who optimally decides to search.

2.6 Price setting firms

Price setters purchase one unit of the homogeneous labor service and transform it into one unit of a differentiated good, subject to the demand function of the household. Under the standard assumption that the household minimizes the expenditure required to consume a CES bundle of differentiated products, the demand for an individual variety is given by

$$y_i = p_i^{-\eta} Y, \tag{13}$$

where η is the elasticity of substitution across varieties, p_i is the relative price set by the price setter i, and Y denotes the aggregate production of the goods consumed by households.

The problem of the price setters is to maximize current and expected profits subject to the demand constraint in equation (13) and quadratic price adjustment costs *à la* Rotemberg. The value function of the price setters solves:

$$\Omega(p_{i,-1}) = \max_{p_i} (p_i - p^l) y_i - \frac{\eta}{2\varrho} \log\left(\frac{p_i}{p_{i,-1}}(1+\pi)\right)^2 Y + \lambda E \Omega(p_i), \tag{14}$$

where ϱ is a price adjustment cost parameter.

The solution of the maximization problem yields the Phillips curve:

$$\frac{\log(1+\pi)(1+\pi)}{1+\pi} = \vartheta\left(p^l - \frac{\eta-1}{\eta}\right) + \lambda E \frac{\log(1+\pi')(1+\pi')}{1+\pi'}\frac{Y'}{Y}.$$

Formally, this Phillips curve corresponds to the standard one derived in nonlinear New Keynesian models. However, the definition of real marginal costs differs from that in standard frameworks. In our setting, real marginal costs are given by the relative price of the homogeneous labor service, p^l.

An important implication of this distinction is that the relevant measure of labor market slack depends on the share of employed job seekers. We return to this critical point at the end of the next section and when we discuss the implications of a permanent decline in OJS costs on the slope of unemployment-inflation relation.

2.7 Labor service firms

The value for a labor service firm of a filled job is given by:

$$\begin{aligned} J(x,\alpha) = {} & p^l x - w(x,\alpha) + \lambda (1-\delta)\left(1-\psi^R\right) \\ & \times E\left\{\left[(1-\xi(x,a)) + \xi(x,a)(1-f(\theta'))\right] J(x,\alpha) \right. \\ & \left. + \xi(x,a) f(\theta') \int_{\underline{x}}^{x} J\left(x, \max\left\{\alpha, \frac{\widetilde{x}}{x}\right\}\right) dG^x(\widetilde{x})\right\}. \end{aligned} \tag{15}$$

The above expression relates the present value of a match to current period profits and expected future values. Current profits are given by the value of production x, measured in terms of the consumption good, p^l, minus the real wage, $w(x,\alpha)$. If the match is not dissolved at the end of the period at rate δ, and if the worker does not retire at rate ψ^R, the firm gets the continuation value of the relationship. This value depends on whether the worker will search or not, in the following period. In turn, the probability of searching depends on current productivity and the piece rate the worker is able to command. If the worker does not search, with probability $1-\xi(x,a)$, or if the worker searches but does not meet a vacancy, with probability $\xi(x,a)(1-f(\theta'))$, the match will continue with the same productivity x and piece rate α.

If the worker instead searches and finds a job, with probability $\xi(x,a)f(\theta')$, the match continues only if the worker meets a firm with lower productivity than the incumbent—that is, for any $\tilde{x} < x$, where $\tilde{x}$ denotes the poacher's productivity drawn from the CDF G^x. In this case, the wage will be renegotiated upwards with the incumbent whenever the worker can use the outside offer to raise it piece rate; that is, whenever $\tilde{x}/x > \alpha$.

Vacancies are opened at the beginning of the period at a flow cost κ. An additional fixed cost κ^f is paid if a match is formed. We assume that vacancies are matched at random with the workers in the pool of job seekers, who are either employed or unemployed.

The free entry condition. In equilibrium, labor service firms are ex-ante indifferent between posting a vacancy to search for a worker and staying out of the market. The free entry condition equates the expected costs on the left hand side and returns from posting a vacancy on the right hand side

$$\kappa^f + \frac{\kappa}{q(\theta)} = \frac{1}{S}\left[u\int_{\underline{x}}^{\overline{x}} J\left(\widetilde{x}, \frac{\underline{x}}{\widetilde{x}}\right) dG^{\underline{x}}(\widetilde{x}) + \int_{x,\alpha}\int_{x}^{\overline{x}} J\left(\widetilde{x}, \frac{x}{\widetilde{x}}\right) dG^{x}(\widetilde{x})\,\xi(x,\alpha)\,d\mu_0^E(x,\alpha)\right]. \tag{16}$$

On the left hand side, the expected cost is given by the flow cost κ times the number of periods that a vacancy is expected to remain open before a match is found, $1/q(\theta)$, plus the fixed cost, κ^f. On the right-hand side, we have a weighted average of the expected gains from two possible types of matches: the first term corresponds to the expected gain conditional on meeting an unemployed worker, while the second term corresponds to the expected gain conditional on meeting an employed job seeker. The weights are given by the probabilities of each event, namely, u/S for an unemployed worker and $\left(\int_{x,\alpha}\xi(x,\alpha)d\mu_0^E(x,\alpha)\right)/S$ for an employed job seeker, where $\mu_0^E(x,\alpha)$ denotes the population distribution density for the employed across all productivity levels and piece rates.

The value of a match with an unemployed depends on the stochastic productivity draw, and reflects the assumption that all unemployed workers start at the bottom of the wage ladder. The value of meeting with a worker employed depends not only on the productivity draw, but also on the productivity of their employer, the piece rate of their current wage contract, as well as the distribution of on-the-job search across productivity and wage-piece rates.

In principle, the expected value to the firm of matching with an unemployed worker, $\int_{\underline{x}}^{\overline{x}} J\left(\widetilde{x}, \frac{\underline{x}}{\widetilde{x}}\right) dG^{\underline{x}}(\widetilde{x})$, is not necessarily higher than the expected value of matching with an employed worker, $\int_{x}^{\overline{x}} J\left(\widetilde{x}, \frac{x}{\widetilde{x}}\right) dG^{x}(\widetilde{x})$. This ambiguity arises because unemployed workers are more likely to draw lower productivity levels than employed job seekers, as the distribution $G^{x}(\widetilde{x})$ stochastically dominates $G^{\underline{x}}(\widetilde{x})$.

However, matches with unemployed workers tend to generate a larger surplus for the firm. For any given productivity draw $\widetilde{x}$, the associated piece rate is lower when hiring an unemployed worker, since they cannot induce wage competition across firms. As a result, the firm can offer a wage based on the lowest productivity level, $\zeta\underline{x}$.

In addition, when meeting an employed job seeker, the firm may derive zero value from the match if the draw $\widetilde{x}$ is below the worker's current productivity x. This risk is captured by the narrower integration domain, $(x, \overline{x})$ on the right-hand-side of free entry condition, which excludes low-productivity matches that would be rejected.

Together, the last two considerations imply that, for any state pair (x, α), employed job seekers are more expensive to hire. While this conclusion holds in our calibrated model, it is not a general result.

Mechanism linking OJS to inflation. The free entry condition (16) is central to understanding the drivers of inflation in the model. A decline in the share of employed job seekers increases the likelihood that firms meet an unemployed worker. Since unemployed workers do not trigger wage competition, the expected surplus of a match rises.

A higher expected match surplus drives down the price of labor services, p^l, in order to reduce the value of matches $J(x, \alpha)$, which curbs vacancy creation and restores the zero-profit condition. As price setters now pay less for the homogeneous labor service, their marginal costs decline, prompting them to reduce prices (see Section 2.6). Consequently, marginal costs—and ultimately inflation—are shaped by the composition of the job-seeker pool: they are positively related to the *share* of employed job seekers and negatively related to the mass of unemployed individuals, who do not contribute to wage competition.

2.8 Fiscal and monetary authorities

The fiscal authority levies income taxes with varying tax rates across brackets and administers lump sum transfers to ensure that the budget balances period-by-period. Define two income brackets w_L and w_H, with $w_L < w_H$. The tax schedule is such that the marginal tax rate is equal to: (i) τ_0 for any income below w_L; (ii) $\tau_L > \tau_0$ for any share of income above w_L and below w_H; $\tau_H > \tau_L$ for any share of income above w_H. The government budget constraint is given by:

$$\begin{aligned} B_{-1} + T + P \cdot b \cdot u_1 + P \cdot T^R \cdot \varpi_1 \quad = \quad & \frac{B}{1+i} \\ & + P \cdot u_1 \cdot b \cdot \tau\left(b\right) \\ & + P \int w\left(x, \alpha\right) \tau\left(w\left(x, \alpha\right)\right) d\mu_1^E\left(x, \alpha\right) \\ & + P T^R \tau\left(T^R\right) \varpi_1, \end{aligned} \tag{17}$$

where the left- and right-hand side denote the allocation and funding of the government, respectively. Namely, the government revenues on the right-hand side are given by the new emissions of public debt, $B/(1+i)$, and by the taxes levied on the income earned by the unemployed, the employed, and the retirees. These funds can be used to repay outstanding government debt, transfers, unemployment benefits and pensions. In equilibrium, it is assumed that government bonds are in zero net supply, i.e. $B = 0$.

The monetary authority is assumed to set the nominal interest rate i of the one-period government bond following the Taylor rule:

$$i = i^* + \Phi_\pi (\pi - \pi^*) + \Phi_U (u_1 - u^*), \tag{18}$$

where starred variables indicate variables at their steady-state value.

2.9 Market clearing and equilibrium

The goods market-clearing condition requires that the aggregate demand of labor services from the price setters equals supply

$$\int_0^1 y_i di \equiv Y = \int x d\mu_1 (x, \alpha). \tag{19}$$

Finally, labor-market clearing requires that the sum of the employed, unemployed, and retirees equals unity, both at the beginning and at the end of a period:

$$\int d\mu_j^E (x, \alpha) + u_j + \varpi_j = 1, \quad \text{for} \quad j \in \{0, 1\}. \tag{20}$$

2.10 Global solution of the model

We solve both the stationary equilibrium and the transitional dynamics non-linearly using global methods. A detailed description of both algorithms can be found in Appendix C.1.1 and C.1.2, respectively.

3 Data

We combine various administrative records provided by Statistics Denmark. At the heart of our analysis are three data sets, which are described below. They will be used both to calibrate the model and to validate its performance at the micro level.

Wage payment data. The *Beskæftigelse for Lønmodtagere* (BFL) registry contains the universe of wage payments. We use these to create employment spells. Each record contains the hours registered for a period and the gross paid earnings, together with a firm and worker identifier.

Social security data. *Ikke Lønmodtagerdata fra E-Indkomst* (ILME) contains the universe of social security payments. We use these to create unemployment spells, and to compute unemployment and pension benefits. Each record contains a person identifier, a period, a benefit-type code and the corresponding payments. Individuals might receive multiple payments simultaneously.

Education data. *Uddanelser* (UDDA) contains for each individual and year the highest obtained degree. We exclude workers from our analysis that have not yet reached their highest obtained degree.

Job spells and job-to-job transitions. Consecutive wage payments within a worker-firm pair define a job spell, while unemployment spells are identified using unemployment benefit payments.[2] Both employment and unemployment spells are constructed following the detailed methodology outlined in Bunzel and Hejlesen (2016) for Danish administrative data. This approach has been widely applied in the study of Danish labor market dynamics—see, for instance, Bagger, Fontaine, Postel-Vinay, and Robin (2014), Bertheau, Bunzel, and Vejlin (2020), and Bagger, Moen, and Vejlin (2021).

We measure job-to-job transitions as follows. Let t denote the month in which a worker-firm spell ends. If the worker starts another job spell within the interval $[t-1, t+1]$, we classify it as a job-to-job transition, provided that (i) the worker physically changes workplaces, and (ii) the worker does not receive unemployment benefits during $[t-1, t+1]$. This definition includes both overlapping transitions, where the next job begins before the previous one ends, and transitions with up to a one-month gap between spells. In the context of our model, overlapping transitions indicate that the subsequent job was secured while the worker was still employed, meaning the previous job's earnings influenced the acceptance decision. Separated transitions, on the other hand, may represent two distinct scenarios: (1) spells where the worker experienced unemployment or nonemployment, during which the worker's outside option was considerably lower; or (2) cases where the worker secured the new job while still employed (and with a higher outside option) but deliberately timed the start of the new job to allow for additional leisure between the two spells.[3] We count these transitions as job-to-job transitions, as long as the worker receives no unemployment benefits between the two spells (restriction (ii)). Restriction (i) ensures that firm restructuring, mergers, and similar events are not falsely measured as job-to-job transitions.

Calibration			
Parameters	Description	Value	Target/source
β	Discount factor	0.9875	Faccini et al. (2024)
η	Elasticity of substitution	6.0000	25% markup
ξ	Elasticity of CES matching function	1.6000	Schaal (2017)
ψ^D	Death probability	0.0125	40 years of work life
ψ^R	Retirement probability	0.00625	20 years of retirement
τ^H	High marginal tax rate	0.5606	Danish data
τ^L	Low marginal tax rate	0.4226	Danish data
τ^0	Labor-market contributions tax rate	0.0800	Danish data
w^L	Low income tax threshold	0.0667	Calibrated
w^H	High income tax threshold	0.7200	Danish data
δ	Job separation rate	0.0400	Calibrated
b	Unemployment benefits	0.2	Calibrated
T^R	Pension income	0.4923	Calibrated
ζ	Max share negotiable with workers	0.727	Calibrated
κ	Flow cost of vacancy	0.0468	Calibrated
κ^f	Fixed cost of hiring	0.7729	Calibrated
ω_x	Mean productivity growth dist.	0	Normalization
σ_x	Std. productivity growth dist.	0.0548	Calibrated
ϑ^l	Lower bound cost-search distribution	0.0000	Normalization
ϑ^u	Upper bound cost-search distribution	0.7890	Calibrated
ς	Slope of Phillips Curve	0.0525	Hansen and Hansen (2007)
ϕ_π	Taylor rule response to inflation	1.5	Conventional
Variable	Description	Model	Target
	Steady-state calibration targets		
$\frac{\kappa}{q(\theta)}/\kappa^f$	Ratio of variable to fixed cost	0.0777	0.0780
$\frac{\kappa^f+\kappa/q(\theta)}{p^l}$	Total hiring costs over wages	0.9995	1.0000
$E[\xi(x,\alpha)]$	EE transition rate	0.0356	0.0365
u	Unemployment rate	0.0586	0.0550
$\sqrt{E\{[\log w(x,\alpha) - E(\log w(x,\alpha))]^2\}}$	Std. log wages	0.0552	0.0660
$(1-\tau)b/E[w(x,\alpha)]$	Average unempl.- over empl.-income	0.2167	0.2966
$(1-\tau)T^R/E[w(x,\alpha)]$	Average pension- over empl.-income	0.4811	0.4900
b/w^L	Benefits over low tax threshold	3.0000	2.5200
$\int w d\mu_1^E/Y$	Labor share of income	0.7135	0.6300

Table 1: Calibrated values for model parameters. Notes: EE stands for employment-to-employment.

4 Calibration

We calibrate the stationary equilibrium of the model to the Danish economy at quarterly frequencies. Some parameters are assigned using conventional values in the literature, others

[2] A job spell is considered to end if there is a gap of one year or more between payments. Single wage payments occurring more than three months after the previous payment are treated as "clearing payments", which may include residual benefits or holiday payments. These are removed from the data to avoid artificially extending the duration of the job spell.

[3] For a fuller discussion, we refer to Caplin, Gregory, Lee, Leth-Petersen, and Sæverud (2023), who show that Danish workers expect time off after a voluntary separation, consistent with the notion that households plan additional leisure between job-to-job transitions.

are fitted directly from the data while the remaining ones are calibrated to match a number of moments from the Danish micro data.

With regards to functional forms, we assume a CES matching function, which ensures that the contact rates of both workers and vacancies do not exceed unity, i.e. $f(\theta) = \theta(1+\theta^{\xi})^{(-1/\xi)}$ and $q(\theta) = (1+\theta^{\xi})^{(-1/\xi)}$, where ξ is an elasticity parameter. The utility function is assumed to be logarithmic in consumption. The distribution of idiosyncratic productivity shocks is assumed to be normal, and defined by the mean and standard deviation parameters ω_x and σ_x, respectively, where the mean parameter is normalized to zero. Upon meeting a vacancy, a worker's potential match productivity is given by $x' = x(1+\epsilon)$, where x is the productivity of the current match and ϵ is the exogenous shock. The distribution of search costs is assumed to be uniform over the support $\left[\vartheta^l, \vartheta^u\right]$, where the lower bound ϑ^l is normalized to zero. The parameters governing the probability of dying and moving to the retirement state, ψ^D and ψ^R respectively, are chosen in order to match an expected duration of retirement of twenty years and an expected duration of work life of forty, as in Birinci, Karahan, Mercan, and See (2023).

The elasticity of substitution between goods, η, is set to 6, which implies a markup of 25%, as estimated by Adam, Renkin, and Zullig (2024) for the Danish economy. In the stationary equilibrium, the discount factor, β, is set to 0.9875, as in Faccini, Lee, Luetticke, Ravn, and Renkin (2024). The marginal tax rates τ_0, τ_L and τ_H are set to 0.08, 0.4226 and 0.5606, which are the income tax rates in force in Denmark in 2012. The threshold earnings at which the high income tax rates apply, w^H, is set to be 10.8 times higher than the low threshold w^L, as in the data. The elasticity of the matching function, ξ, is set to 1.6, in line with estimates by Schaal (2017) for the US economy.

This leaves us with nine parameters to calibrate: δ, b, ζ, T^R, κ, κ^f, ϑ^u, σ_x, and w^L. The calibration process involves simultaneously solving a system of equations to ensure that the model matches specific empirical moments. While all parameters contribute to achieving the targets, certain moments are particularly sensitive to specific parameters. In this context, each parameter is explicitly linked to the moment it is intended to match.

The job separation rate, δ, is adjusted to match an unemployment rate of 5.5%. The unemployment benefits parameter, b, is calibrated to reproduce a ratio of net unemployment income to average gross employment income of around 30 percent.[4] The maximum share of

[4] We compute the ratio of unemployment-to-employment income as follows: we compute for each worker the ratio of their average monthly net unemployment benefit payments over their average monthly gross earnings. The reported statistic is the average across the Danish labor force for the year 2012. Denmark has a high unemployment benefit replacement rate of approximately 90%. However, benefits are capped at a relatively low ceiling, meaning the replacement rate declines for higher earnings, and is in fact quite low for high-income earners (see https://www.hk.dk/akasse/dagpenge/dagpengesatser).

output firms are willing to negotiate with workers, ζ, is set to match the labor share of income in Denmark. The transfer to retired workers, T^R, is calibrated to match a ratio of average net pension payments to average gross employment income of 49%. The variable cost of posting vacancies, κ, is adjusted to match the ratio of total variable costs of hiring to fixed costs, $\frac{\kappa/q(\theta)}{\kappa^f}$, at 0.078, consistent with estimates from Silva and Toledo (2009).[5] The fixed cost of posting vacancies, κ^f, is calibrated to ensure that total hiring costs, including both variable and fixed costs, equal one quarter of wage payments, in line with the accounting estimates in Faccini and Yashiv (2022). Wage payments are computed in the model using the real marginal costs of price-setting firms, p^l, i.e., the cost of labor. In the stationary equilibrium, the upper bound of the uniform search-cost distribution, ϑ^u, is calibrated to match the EE transition rate of 3.65 percent. Finally, the dispersion parameter of the idiosyncratic productivity shock process, σ_x, is set to reproduce a standard deviation of residualized log wages of about 6.6%.[6] The low tax threshold is set so to be about 2.5 times larger than the unemployment benefit, as implied by the microdata.

As for the parameters that do not affect the stationary equilibrium of the model, we set the parameter governing the response to inflation in the Taylor rule to 1.5. The slope of the Phillips curve is set to 0.0525, in line with micro estimates by Hansen and Hansen (2007) on Danish data.

5 Fiscal incentives and OJS in the micro data

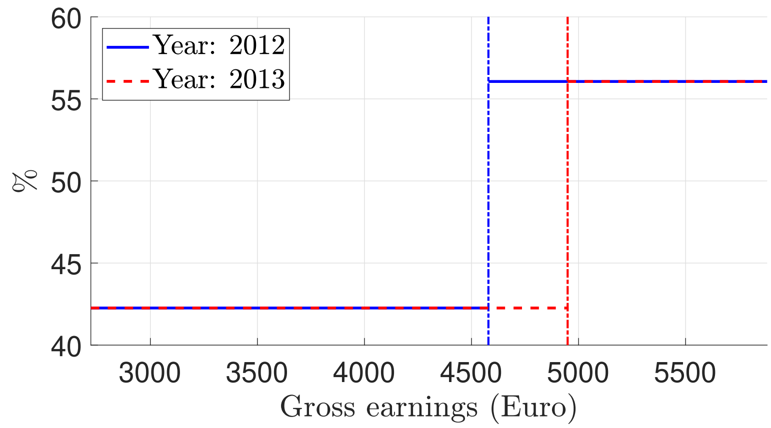
In this section, we examine the implications of changes in on-the-job search incentives. Specifically, we analyze how adjustments to the income tax schedule influence individuals' decisions to search while employed. Our analysis focuses on a sizable shift in an income tax bracket implying a fall in the tax rate for workers whose income lies within 423,804 DKK to 457,609 DKK.[7] This threshold remained unchanged in the three years leading up to and including 2012. For the tax year 2013, the higher tax threshold experienced a substantial

[5] This value is the ratio of pre-match recruiting, screening, and interviewing costs to post-match training costs in the U.S.

[6] We estimate the average EE rate and the dispersion of log wages using Danish workers aged 25-65 in the year 2012. Unlike the model, the data suffers from measurement error and uncaptured firm- and worker-level heterogeneity. To compute the model-equivalent of the data, we measure worker-firm level hourly wages as the annual earnings of a worker-firm pair, divided by the corresponding annual hours worked, exclude outliers and focus on workers that work full-time hours. Finally, we residualize log wages using worker-fixed and firm-fixed effects, since our model abstracts from any worker or firm-level heterogeneity.

[7] The nominal increase in the gross marginal tax rate for high-income earners is 15 percentage points, which effectively becomes 13.8 percentage points after accounting for labor market contributions.

Figure 1: Marginal Tax Rates in Denmark, 2012 vs. 2013



Notes: Earnings are monthly. The vertical blue and orange lines represent the thresholds for the high marginal tax rate in 2012 and 2013, respectively.

shift, namely from 423,804 DKK to 457,609 DKK, representing an 8% increase.[8] Figure 1 illustrates this shift, with earnings denominated in monthly Euros.

In the remainder of this section, we first provide more details about the 2013 Danish tax reform. We then use a difference-in-differences research design to identify the causal impact of the reform-induced change in search incentives on employer-to-employer (EE) transition rates and wage growth, across different income levels and worker types (stayers vs. leavers). We then assess whether the calibrated model from the previous section can explain these causal effects of the 2013 Danish tax reform.

Analysis of tax brackets. Through the lenses of our model, reducing the marginal tax rate strengthens on-the-job search incentives by increasing the expected after-tax return to search, i.e., net wage growth. Changes in tax thresholds can substantially modify marginal tax rates for specific workers while maintaining them constant for others, ensuring that threshold adjustments primarily affect a distinct subset of the population without raising concerns about general equilibrium effects.

Job search behavior exhibits substantial variation across income levels in the data. To isolate the effects of tax bracket changes, it is not sufficient to compare workers near the threshold to those further away, as differences in search behavior may stem from income variation rather than differences in effective marginal tax rates. Since the tax threshold affects all workers uniformly within a given year, we identify causal effects by comparing workers before and after the reform.

[8] Data on tax rates and thresholds are available at: https://skm.dk/tal-og-metode/satser/tidsserier/centrale-beloebsgraenser-i-skattelovgivningen-2018-2024.

The 2013 reform of Danish tax brackets provides an ideal setting for studying job search behavior for several reasons. First, the threshold had remained stable in the years leading up to this fiscal change, creating a clean baseline for comparison. Second, the substantial magnitude of the shift ensured high salience among workers, making them more likely to adjust their behavior in the labor market, while also generating meaningful increases in job-search returns—defined as the potential wage improvements associated with successful job search. Third, the Danish economy experienced moderate but stable growth in the years surrounding that adjustment. The combination of salience and magnitude is crucial; low awareness of tax changes would diminish behavioral responses, while small changes in returns might be indistinguishable from normal variation in the data. Furthermore, the threshold stability in previous years allowed workers to fully adjust to the existing tax structure, enabling us to compare "after" workers with "before" workers whose search behavior and income patterns had already normalized to the previous tax regime. This addresses potential confounds that might arise if workers were still adapting to recent policy changes during our pre-treatment period. Finally, because both the broader economy and tax brackets remained relatively stable for several years before and after the reform, we can pool several years of pre- and post-reform data to enhance statistical power.

Data and empirical framework. We examine year-on-year changes in job-to-job transitions and annual wage growth around the tax threshold that was modified using job spells and transitions as described in Section 3. Our analysis compares workers in the three years before and after the reform, averaging outcomes across these periods. Given that wage data are particularly noisy, pooling observations helps enhance statistical power. We limit the window to three years on either side, as the tax threshold changed prior to that period. This choice is also consistent with the approach used in Kleven, Kreiner, Larsen, and Søgaard (2025).[9] The sample includes workers aged 25 to 65. We restrict attention to full-time employed workers in each period.[10] For each worker, we compute annual labor earnings as total labor income across all job spells, including both wages and bonuses. We derive annual hourly wages by dividing annual labor earnings by annual hours worked.

According to our model, a change in the tax threshold influences not only workers whose earnings are at the threshold but also those in a broader range above and below it, an effect we will examine in the next section. To capture this, we analyze the empirical outcomes of

[9] When restricting the analysis to a one-year window around the reform, the results remain qualitatively similar, though estimated with less statistical precision. See Figures B1 and B2.

[10] We require annual hours worked within 5% of 1,927, consistent with Statistics Denmark's definition of full-time employment (160.6 monthly hours). This restriction effectively addresses extreme fluctuations in annual wage growth that arise even from single-month non-employment spells.

workers whose earnings fall within 20% of the threshold, grouping them into equally sized income bins, each containing approximately 50,000 workers.

We employ a simple difference-in-difference framework where we compare changes in outcome variables at the income-bin level, after the tax reform relative to before. We estimate

$$y_{i,t} = \text{after}_t + \sum_g \beta_g \mathbf{1}_{(income_{i,t-1} \in g)} + \gamma_g \mathbf{1}_{(income_{i,t-1} \in g)} \times \text{after}_t + X_{i,t} + \epsilon_{i,t}, \tag{21}$$

where $y_{i,t}$ represents an outcome variable for individual i, measured for $t \in \{2010 - 2015\}$. For example, the subsequent analysis will first consider job-to-job transitions rates, in which case $y_{i,t}$ is a binary variable reflecting whether worker i experienced a job-to-job transition in year t. The dummy variable $after_t$ equals one in the three-year period following the reform. The variable $\mathbf{1}_{(income_{i,t-1} \in g)}$ is another dummy variable assigning individuals i in calendar year t to income bins g according to their labor earnings in the previous calendar year $t-1$. That is, a worker might be assigned to different income bins g across the six years of our study. The main parameter of interest γ_g then captures the effect of the 2013 tax reform on the outcome variable y across the income distribution while β_g controls for the average outcome y observed in bin g across the whole sample. Finally, the vector $X_{i,t}$ represents individual-specific control variables including gender, age, education, occupation, and industry. In the subsequent analysis, we will also consider as outcome variables the wage growth of workers that are job movers or job stayers in a given year. There, the outcome variable $y_{i,t}$ is defined as the growth rate of individual i's wages from period $t-1$ to period t.

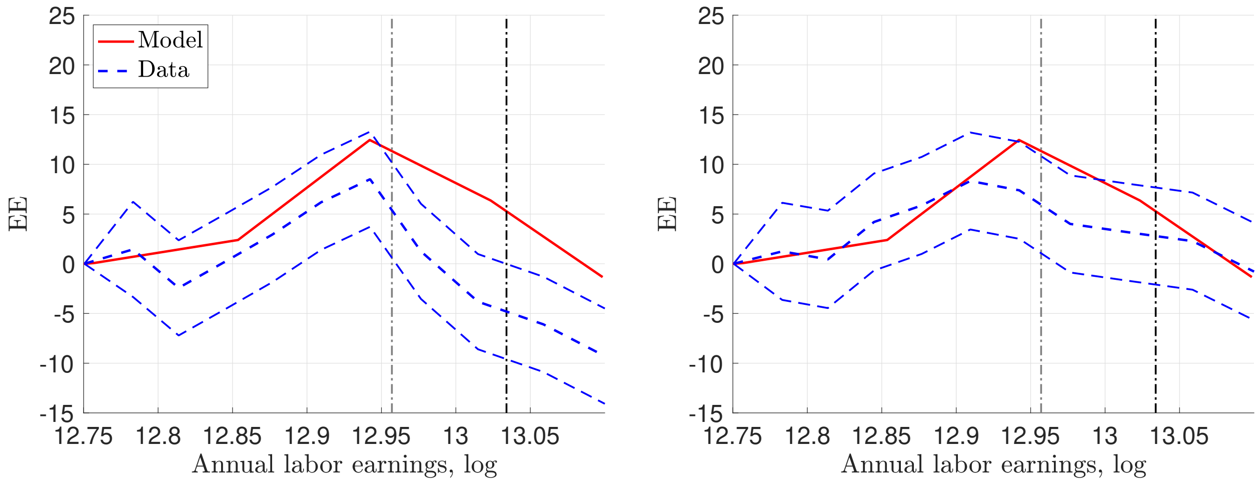
We report our estimates for γ_g together with the 95% confidence bands in Figures (2)-(5). In these figures, the coefficients are scaled by the sample average of the outcome variable y and can thus be understood as percent changes of y relative to the sample mean.

Model-analogue coefficients. We study the 2013 threshold adjustment also in our model, to compare our model predictions to that of the data. Here, we first solve for the steady state based on our model calibration for the year 2012. We then introduce an unanticipated change in the top-tax threshold according to the tax reform, and compute the transition of the model to the new steady state. We use distributions and policy functions 12 quarters after the change combined with the distributions and policy functions of the steady state, to compute the model-analogue of the coefficients γ_g estimated in the empirical regressions.

5.1 Job search response to the tax threshold shift

We begin our analysis by examining how EE rates respond to the change in the tax threshold. The red solid line in Figure 2 displays the model-implied effect of the tax change on EE rates, calculated for each income bin by comparing the 2013–2015 period to 2010–2012. The blue

Figure 2: Effects of Shifting the High-Income Tax Threshold on EE Rates



(a) Raw data (b) Full controls

Notes: Untargeted moments—employment-to-employment (EE) rates: The figure displays the percentage change in EE rates across income bins before and after the tax reform in the microdata and in the model. The light gray and dark gray vertical bars indicate the high-income tax thresholds for 2012 and 2013, respectively. The dashed blue lines show the estimated parameters γ_g together with the 95% confidence intervals (with standard errors clustered by earnings bin) obtained by running the regressions defined in equation (21) for the time window (2010-2012 vs. 2013-2015). The red solid line shows the model analogue of estimated parameters γ_g. Income bins are constructed to include approximately 50,000 workers per year during 2010–2015. Full controls include education, gender, age, occupation, and industry.

lines instead, report the empirical estimates of the coefficients γ_g estimated in eq.(21) along with their 95% confidence intervals. The figure contains two panels: Panel (a) excludes control variables $X_{i,t}$ from the regressions, while Panel (b) includes them. The figure shows that the model predicts a sharp increase in EE rates as earnings approach the 2012 tax threshold, followed by a rapid decline beyond it.

These findings follow economic intuition. Any change in the high-income threshold would be irrelevant for workers with earnings far below it, since the higher earnings associated with a job-to-job transition would likely be taxed at the same marginal rate; hence workers in lower income bins should not exhibit differential on-the-job search behavior before and after the reform. Similarly, workers who already in the pre-reform period had incomes above the 2013 threshold would face the same high-income-tax rate both before and after: so for workers in these high income bins, there should be no differential effect of the reform on job search behavior.[11] The income group most strongly affected by the tax reform lies between

[11]There is a secondary effect for workers in income bins above the 2013 threshold: while their net wage *increase* from on-the-job search is the same, their base net income is different. The increase of the tax threshold lowers the effective tax rate of these workers, leaving them with a higher net consumption than pre-2013 workers with the same income. Under our concave utility function specification, the marginal utility from additional consumption is thus lower for the post-2013 workers, decreasing their returns to search in

these two polar cases and, specifically, around the old income-tax threshold. For the workers at the threshold, the entire additional wage growth from a transition is taxed at a lower marginal rate after the reform, compared to the period that precedes it. These differential effects of the tax reform on the returns to on-the-job search across the income distribution lead to an inverse-V shape response in the share of employed job seekers.

In the empirical analysis, we let our outcome variable $y_{i,t}$ indicate whether worker i experienced a job-to-job transition in year t and estimate (21). The blue lines in Figure 2 present our main empirical results. A first takeaway from the figure is the striking stability of the estimated coefficients despite the inclusion of a large set of control variables. This robustness suggests that treatment and control groups are well balanced within income bins.

Most importantly, the empirical patterns align closely with our model predictions, even though not directly targeted in the calibration. EE transition rates exhibit an inverse-V shape that peaks near the 2012 threshold. Consistent with the model, we observe point estimates trending negative beyond the 2013 threshold.

The results provide strong evidence that reduced marginal tax rates stimulate on-the-job search and job-to-job transitions. The magnitude is economically significant: in the most affected income bin, EE transition rates increase by 11%, i.e., from 4.7% to 5.2% annually.

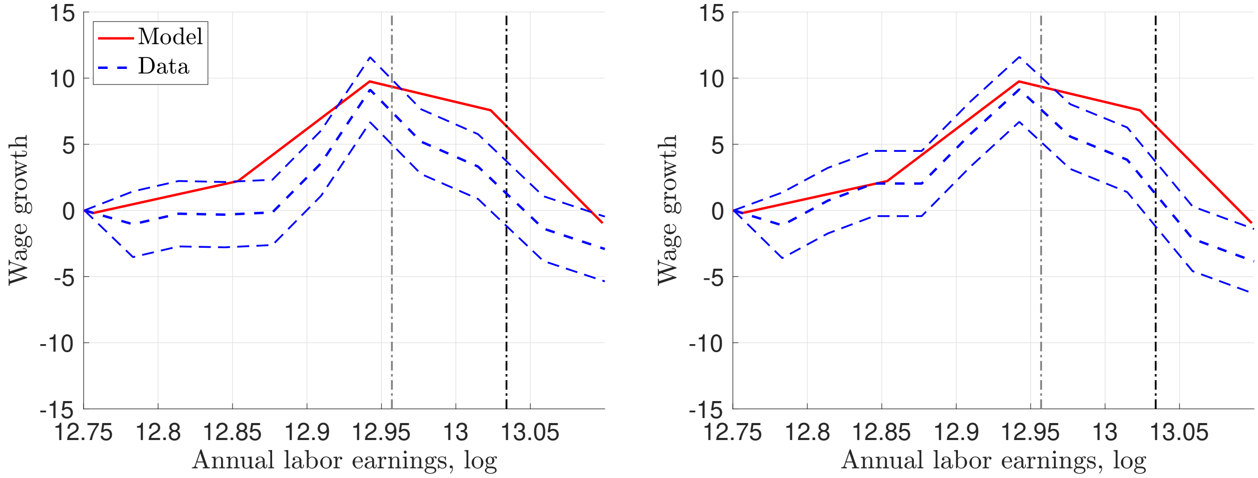
5.2 Wage growth of stayers

The tax threshold shift generates wage growth effects through two distinct mechanisms. First, a mechanical composition effect arises as increased EE transitions (see Figure 2) generate a larger share of workers transitioning to higher-wage employment. Second, the reform affects incumbent workers through a bargaining channel: intensified on-the-job search increases the number of outside offers that incumbent employers must match to retain workers. The red solid lines in Figure 3 demonstrate that the threshold adjustment generates in the model an inverse-V shaped wage growth response among job stayers, mirroring the pattern observed for EE transitions in Figure 2. This response peaks near the 2012 threshold before turning negative beyond the 2013 threshold.

Turning to the empirical results, we again observe that the estimates are remarkably stable across the two panels, despite the inclusion of an extensive set of controls for potential confounders. Our empirical analysis of hourly wage growth among job stayers—represented by the dashed blue lines in Figure 3—closely aligns with the model's predictions. The estimated response exhibits significant increases near the 2012 threshold. The magnitude is economically significant: peak wage growth effects reach 10%, representing an increase

terms of utility. This effect is quantitatively small, but explains why the relative change in the EE rate eventually falls into negative territory to the right of the tax threshold.

Figure 3: Effects of Shifting the High-Income Tax Threshold on the Wage Growth of Job Stayers



(a) Raw data (b) Full controls

Notes: Untargeted moments—wage growth of stayers: The figure displays the percentage change in wage growth for workers remaining with the same employer across income bins before and after the tax reform in the microdata and in the model. The light gray and dark gray vertical bars indicate the high-income tax thresholds for 2012 and 2013, respectively. The dashed blue lines show the estimated parameters γ_g together with the 95% confidence intervals (with standard errors clustered by earnings bin) obtained by running the regressions defined in equation (21) for the time window (2010-2012 vs. 2013-2015). The red solid line shows the model analogue of estimated parameters γ_g. Full controls include education, gender, age, occupation, and industry.

from 2.68% to 3.11% in annual terms. This wage effect is particularly notable as it applies to job stayers, who constitute the vast majority of the workforce. In the model, these workers do not experience changes in match productivity as they stay in the same job. So an increase in wages for the stayers is akin to a pure cost-push shock, except that it arises endogenously. Thus, our estimation reveals that the threshold adjustment generated substantial wage pressure through the bargaining channel alone.

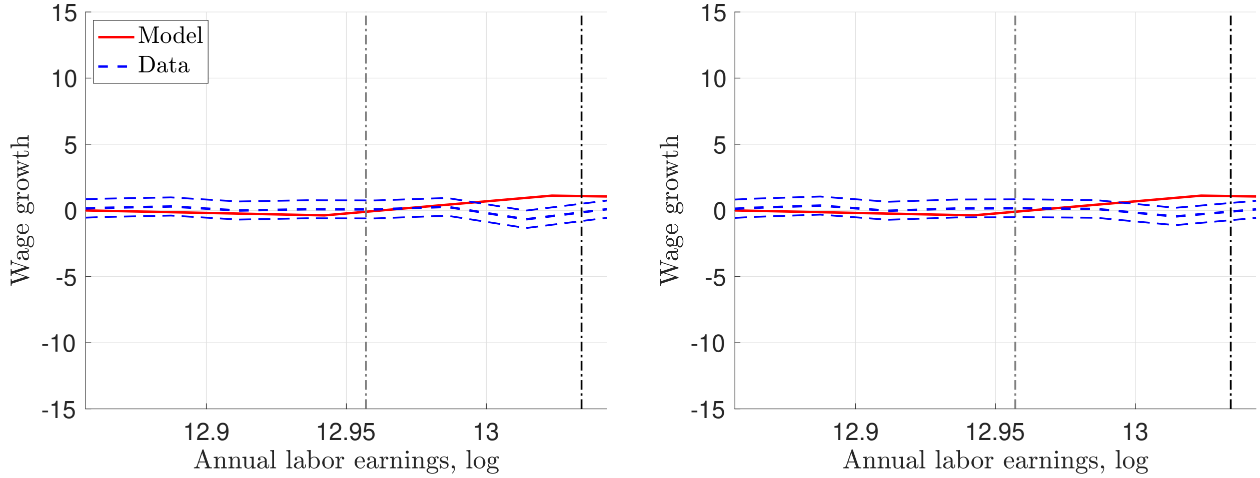
Note that the observed inverse-V pattern in stayer wages provides evidence supporting the sequential auction bargaining protocol used in the model. Under Nash bargaining, instead, the tax reduction would increase match surplus, requiring gross wages to decline to maintain constant surplus shares—yielding the opposite wage response.[12]

5.3 Wage growth of leavers

Does the tax change affect the wage growth of workers who experience a job-to-job transition? The answer to this question is no. As shown by the red solid lines in Figure 4, the change in

[12]We provide the proof in Appendix D.

Figure 4: Effects of Shifting the High-Income Tax Threshold on Wage Growth of Job Changers



(a) Raw data (b) Full controls

Notes: Untargeted moments—wage growth of leavers: The figure displays the percentage change in wage growth for workers changing employer across income bins before and after the tax reform in the microdata and in the model. The light gray and dark gray vertical bars indicate the high-income tax thresholds for 2012 and 2013, respectively. The dashed blue lines show the estimated parameters γ_g together with the 95% confidence intervals (with standard errors clustered by earnings bin) obtained by running the regressions defined in equation (21) for the time window (2010-2012 vs. 2013-2015). The red solid line shows the model analogue of estimated parameters γ_g. Full controls include education, gender, age, occupation, and industry.

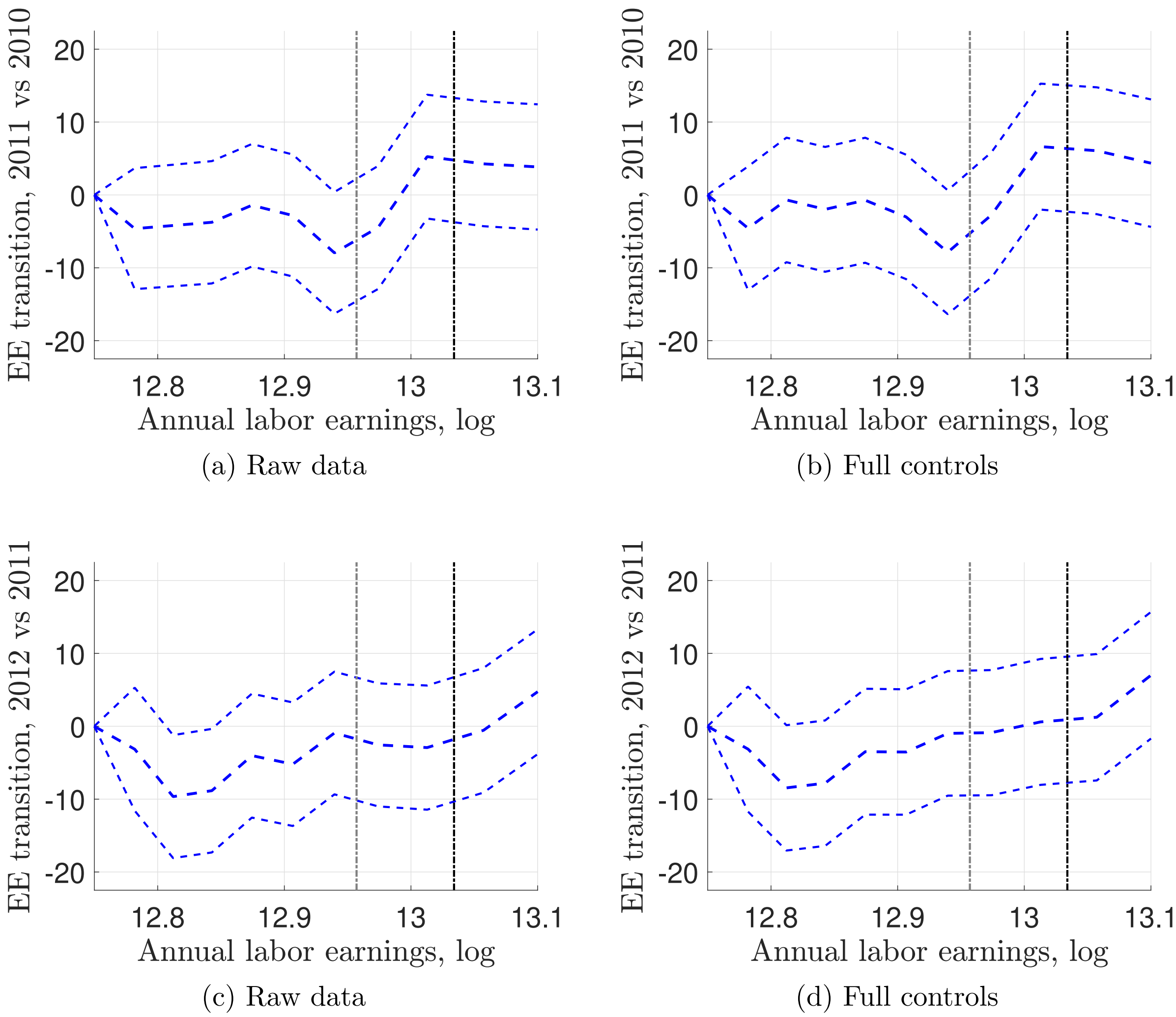
wage growth before and after the reform is nearly zero for any bin of the income distribution. We note that wage growth conditional on changing jobs is still positive, as implied by the calibration. It is the differential effect before and after the reform, that is close to zero.

This is because in this model, the wage change conditional on a job change only depends on the productivity difference between the two firms, and the extent to which the worker was already extracting surplus from the previous match. A higher job-search intensity increases the likelihood of changing jobs, but not the wage change conditional on a job change.

The blue dashed lines in Figure 4 show the empirical counterpart to the model-generated patterns. In line with our model, there is no difference between the wage growth of job changers in the years before and after the change of the tax schedule.

Note that a model with Nash Bargaining would predict lower gross wage growth for job leavers following the tax reform compared to the period before it—that is, a negative wage gap in Figure 4. Intuitively, this is because the same transition from a less productive to a more productive firm now yields a larger surplus increase. This higher surplus increase would be split among the worker and the new firm, leading to a larger growth in after-tax

Figure 5: Placebo experiment: Empirical Responses of EE rates in Years of No Tax Reforms



(a) Raw data (b) Full controls

(c) Raw data (d) Full controls

Notes: Placebo experiment: difference-in-difference effect of a shift in the tax threshold on EE transition rates. The vertical bars represent the high-income tax thresholds for the years 2012 and 2013. Panels (a) and (b) compare EE transition rates in 2011 relative to 2010, while panels (c) and (d) compare 2012 relative to 2011. Within each comparison, panels (a) and (c) display results using raw EE data, whereas panels (b) and (d) show results using residualized data. Full controls include education, gender, age, occupation, and industry.

wages, but a smaller growth of before-tax wages.[13]

5.4 Placebo exercise

To ensure that our results are indeed due to the 2013 change in the tax threshold and not to other factors that may correlate with the income distribution, we create placebo experiments

[13]We provide the proof in Appendix D.

on neighboring years. Here we expect no significant findings around the tax threshold since it remained constant throughout these placebo periods.

Figure 5 presents the results of these placebo experiments. Panels (a) and (b) compare EE transition rates in 2011 relative to 2010, while panels (c) and (d) compare 2012 relative to 2011. Within each comparison, panels (a) and (c) display results using raw EE data, whereas panels (b) and (d) show results using residualized data. Because the threshold tax rate for high income earners remained unchanged over the 2010-2012 period, the difference-in-difference results should show no differential outcomes across the treatment and control periods, which is precisely what the figure illustrates.

5.5 Anticipation effects

The computation of the effects of a change in the tax threshold on EE rates and wages that we have examined so far in the model, implicitly assumes that changes in the tax threshold affects workers' incentives to search for jobs only in 2013 and not already in 2012, i.e., that responses to the change in threshold were not anticipated. However, the tax reform was already announced at the end of May 2012, so it is indeed possible that workers responded to the announcement well before the beginning of 2013. To the extent that that is the case, our estimated increase of earnings for the stayers is biased downwards, and hence should be regarded as conservative.

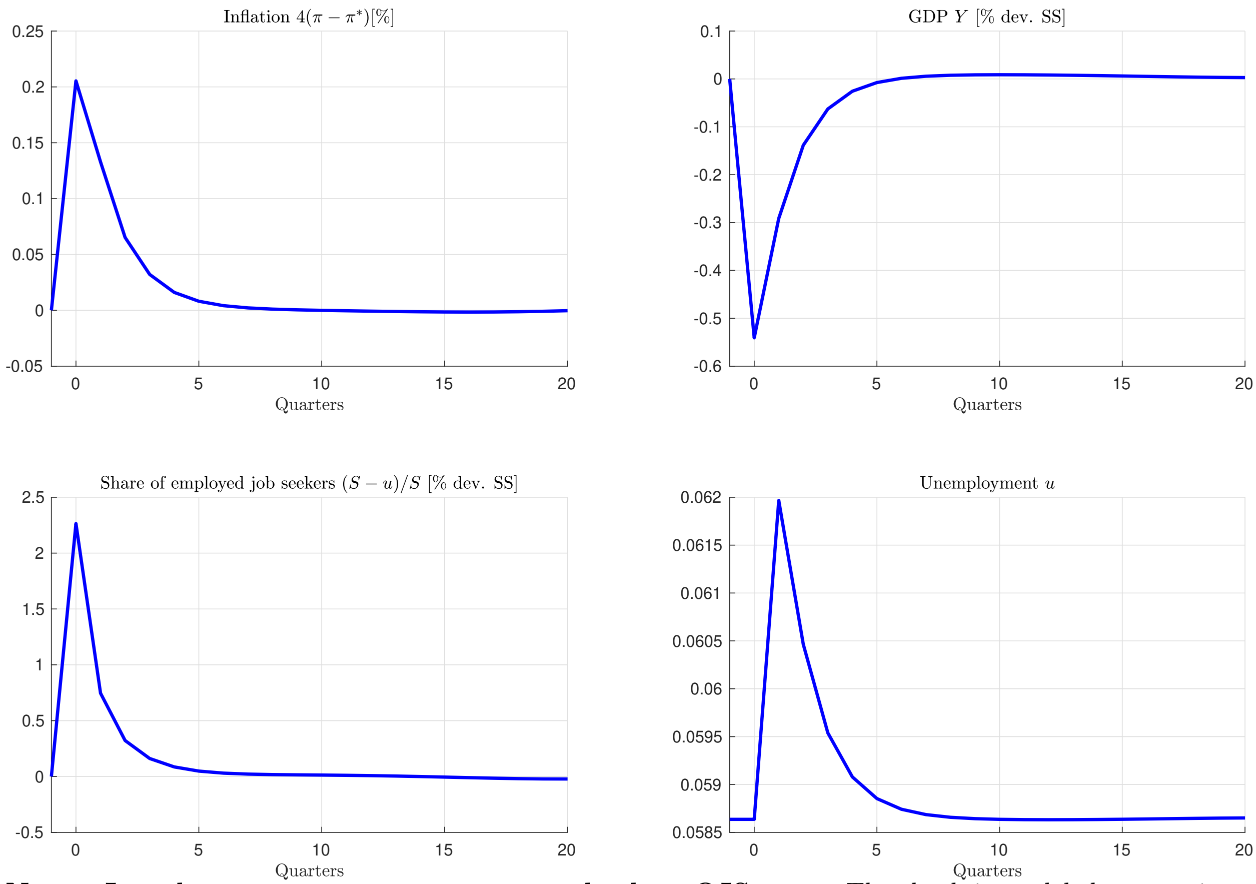
6 The effects of changes in OJS costs

The previous section showed that the model's core mechanism—where endogenous changes in OJS behavior in response to economic incentives drive wage inflation—generates quantitative effects across the income distribution that are both meaningful and realistic. In this section, we turn to the macroeconomic implications of shocks to OJS costs.

We interpret variations in OJS costs as encompassing time constraints, stress, informational barriers, or even collective shifts in attitudes that lower perceived search costs by reshaping social norms—making it feel less burdensome or risky for workers to explore new opportunities. For instance, during the DotCom boom of the late 1990s, enthusiasm for the tech sector made it easier for workers to justify moving into fast-growing industries. Similarly, the Great Resignation of 2021 reflected changing expectations around work, making it more socially acceptable—even expected—for individuals to reconsider their jobs, prioritize work-life balance, or seek greater flexibility.

Later, we study how a persistent change in OJS costs—possibly driven by the diffusion of

Figure 6: Macroeconomic effects of a Shock to the Cost of Searching on the Job



Notes: Impulse responses to a temporary shock to OJS costs. The shock is modeled as transitory decrease in the upper-bound parameter of the search-cost distribution by -0.13, necessary to match a one-standard deviation increase of the EE rate. The time series of EE transition rates is constructed following Fujita, Moscarini, and Postel-Vinay (2024). The standard deviation estimated from January 1996 to April 2025 is about 25 basis points. On the x-axis, period -1 represents the period before the shock, i.e., the steady state.

ICT technologies and AI-based search tools—can reduce the pass-through from unemployment to inflation.

6.1 Shocks to OJS costs

We study the effects of a temporary negative shock to the cost of searching on the job, affecting all workers at any rung of the job ladder and at any point of the income distribution. We keep the lower bound of the cost-shock distribution $\vartheta^l = 0$ and assume that the upper bound follows the process $\vartheta^u_t = \rho_\vartheta \vartheta^u_{t-1} + \epsilon_t$, where we set the autocorrelation coefficient $\rho_\vartheta = 0.5$ and the shock on impact produces a one-standard-deviation increase in the EE transition rate (at the peak).[14]

The impulse responses to a negative OJS cost shock are reported in Figure 6. The lower search cost produces a simultaneous increase in unemployment and inflation. Inflation increases, reflecting the rise in the expected wage costs of new hires, and hence a more expensive labor service. At the same time, the increase in the share of job seekers, by increasing the expected wage-cost of new hires, lowers labor market tightness, and increases unemployment. The increase in OJS increases the rate at which workers move up the ladder, thereby boosting aggregate productivity. However, the resulting decrease in employment, more than compensates for the increase in productivity, leading to a decrease in output.

Although the increase in the share of employed job seekers is short-lived, its impact on inflation and unemployment is significant. As a result, inflation increases by just over 20 basis points, GDP declines by slightly more than 50 basis points, and the unemployment rate increases by approximately a third of a percentage point.

6.2 The role of OJS in the propagation of demand shocks

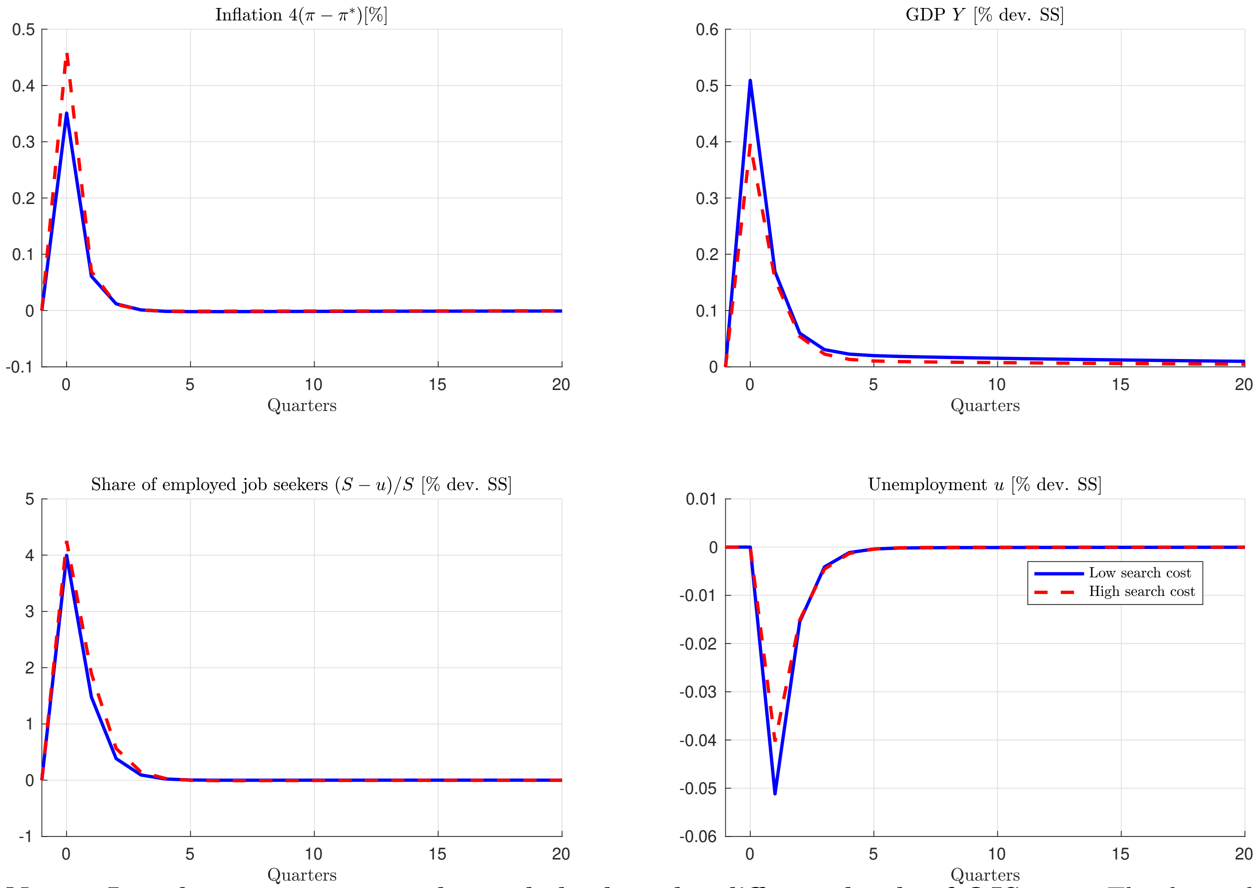
Search costs, or the time and effort required to find information and applying for jobs, have evolved significantly due to technological advancements. Over the past thirty years, as information and communication technologies (ICT) have become more widespread, the process of applying for jobs has shifted from traditional mail to email. At the same time, the time and effort required to gather information about available job opportunities has decreased dramatically. This is largely due to the increasing efficiency of internet search engines and platforms like LinkedIn, which allow job seekers to discover relevant vacancies with minimal effort and cost. Search engines, in particular, have become much more sophisticated, enabling individuals to quickly access and filter job listings based on specific criteria.

For individuals who are already employed, reducing time spent on job search is especially valuable, as their time outside of work is limited. Looking ahead, the continued diffusion of artificial intelligence (AI) is expected to further lower the time-costs associated with preparing job application materials, making the process even more streamlined. In this section, we examine how reducing search costs affects the transmission of demand shocks.

Figure 7 illustrates the effects of an expansionary demand shock, triggered by a 25-basis-point drop in the discount factor β, induced by a shock with a serial correlation of 0.25. The figure compares two scenarios: the low-search cost scenario, calibrated as in Table 4 (solid

[14] We set the shock to be equal to -0.13. The standard deviation is estimated using the time series of EE transition rates constructed by Fujita, Moscarini, and Postel-Vinay (2024) over a sample period ranging from January 1996 to February 2025. Computing the standard deviation using only data from before the COVID period would not materially change our results.

Figure 7: Demand Shock



Notes: Impulse responses to a demand shock under different levels of OJS cost: The demand shock is modeled as a shock to the household's discount factor, β. The low search case scenario corresponds to the calibration shown in Table 4. The high search cost case is obtained by increasing the upper bound of the support of the distribution of OJS cost, ϑ^u, by 50 basis points.

blue line), and the high-search cost case where the parameter ϑ^u setting the upper bound of the support of the OJS cost is increased by 50 basis points (dashed red line), implying a 60% permanent increase in average search costs.

The shock raises aggregate demand. With price rigidities, firms supply all demanded consumption goods, increasing labor services. Higher labor demand raises the relative price of labor, p^l, fueling price inflation. As labor's marginal revenue product rises, firms post more vacancies, boosting employment and reducing unemployment. In turn, the increase in vacancies combined with the effects of rising inflation on real wages entices more workers to search on the job.[15] The higher share of employed job seekers puts additional upward pressure on the prices of homogeneous goods, further contributing to inflation.

The model with low search costs generates a weaker inflation response and a stronger

[15] The increase in vacancies following an inflationary demand shock is consistent with the findings of Afrouzi, Blanco, Drenik, and Hurst (2024) on labor market flows.

unemployment response compared to the high search cost case. Although the absolute increase in on-the-job search is larger under low search costs, its percentage increase is smaller because the share of employed job seekers is larger in steady state than in the high search cost case. As a result, labor cost pressures are more contained, which helps explain the more muted increase in inflation and the stronger decline in unemployment.

Our analysis shows that, in a model with endogenous OJS, a permanent decline in search costs weakens the unemployment-inflation relationship—consistent with empirical evidence on the flattening of the *traditional* Phillips curve (e.g., Stock and Watson, 2008; Del Negro, Lenza, Primiceri, and Tambalotti, 2020). Notably, this relationship is inherently unstable in our model, where marginal costs depend on the share of employed workers actively engaged in search, as discussed in Section 2.7.

7 Incomplete market structure

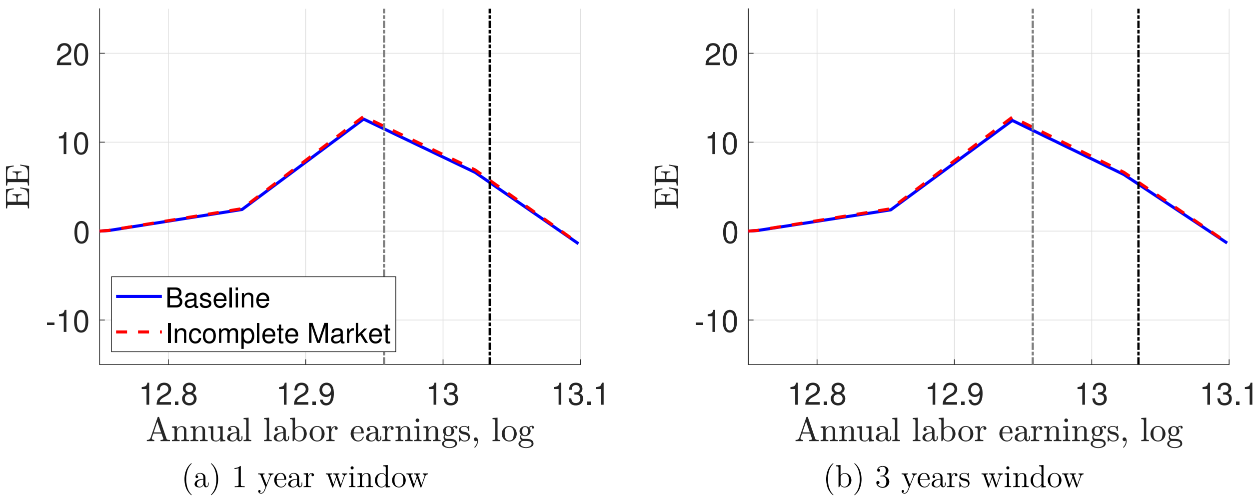
In this section, we introduce an incomplete market structure into the baseline model presented in Section 2 to show that the propagation mechanism highlighted in this paper is robust to allowing for heterogeneity in marginal propensities to consume. The only difference in assumptions between the HANK job ladder model presented here and the baseline of Section 2 is that the consumption-savings decision is now made at the individual worker level, rather than at the household level. Households hold shares, e, of mutual funds that own all the firms of the economy and government bonds. The profits of the mutual funds are rebated to the households lump sum.

These changes introduce wealth heterogeneity as an additional state variable, leading to differences in the marginal propensity to consume across workers. As a result, the optimal decision rules for OJS, $\xi(e, x, \alpha)$, now also depend on asset holding e. The full description of this extended model is provided in Appendix E. We extend the baseline algorithms to solve both the stationary equilibrium and the transitional dynamics to include the wealth distribution as third dimension of heterogeneity. The extended algorithms are described in detail in Appendix C.2.1 and C.2.2, respectively.

A key departure of this model—with endogenous OJS and wealth heterogeneity—from the baseline HANK framework is the role of search behavior in shaping workers' income dynamics. In this setting, workers search on the job either to transition to better-paying positions or to renegotiate wages in response to outside offers. As a result, individual labor productivity evolves endogenously, driven by past and current search decisions, and influences income trajectories over multiple periods.

Figure 8 illustrates that the differential response of EE rates to the change in the income

Figure 8: Effects of Shifting the High-Income Tax Threshold on EE Rates: Complete- vs. Incomplete-Market model



Notes: The figure compares the percentage change in employment-to-employment (EE) rates across income bins before and after the tax reform, as produced by the baseline model with complete markets (solid blue line) and the HANK model with incomplete-markets (dashed red line). The two panels depict the percent changes in EE rates in the model, relative to the 2012 steady-state distribution, after 1 and 3 years of transition to the new steady-state equilibrium characterized by the 2013 tax thresholds. The light gray and dark gray vertical bars indicate the high-income tax thresholds for 2012 and 2013, respectively.

threshold ensuing the 2013 Danish tax reform are very similar in the baseline model and in the HANK model. Similar results are obtained when looking at the wage growth of job stayers and leavers, as reported in Figures (B4) and (B5), respectively, in the appendix. So we conclude that the propagation mechanism highlighted in this paper, which works through the endogeneity of OJS, is best illustrated in the simpler, baseline model. The discussion of the policy functions for the OJS decisions in the HANK model is, therefore, relegated to Appendix F.

Introducing wealth heterogeneity in Sections 6.1 and 6.2 alters the quantitative results but leaves the qualitative responses unchanged, reaffirming the central role of the endogenous OJS mechanism in propagating OJS costs and aggregate demand shocks. The HANK variant of the model shows that this propagation is influenced quantitatively by how transfers and taxes across income groups adjust after the shocks. While these redistributive issues are, in principle, important, in practice such adjustments are not directly observable in the data, which limits the model's ability to deliver disciplined predictions. We therefore abstract from wealth heterogeneity in the baseline model to maintain clarity and keep the focus on our core mechanism based on endogenous adjustments in OJS.

8 Conclusions

We developed a New Keynesian job-ladder model incorporating endogenous OJS to examine how workers' OJS decisions influence wage and price inflation. We generated impulse responses to a change in the high-income tax threshold to study the model's quantitative implications for EE rates and wage inflation across the income distribution. Separately, we estimated the empirical responses to the same tax reform using Danish matched employer-employee microdata. The close alignment between the model's predictions and the empirical patterns provides support for the mechanism.

Our findings that higher OJS increases negotiated wages not just for the leavers but also for the stayers provides evidence in favor of the sequential auction bargaining protocol. Moreover, the strong response of EE rates and wage growth for the stayers, both in the model and in the microdata, suggests that the search behavior of the employed matters for inflation dynamics. The general equilibrium dynamics generated by the model suggest that changes in incentives to search on the job can materially affect real activity and price dynamics. Moreover, the long-term decline in search costs, can offer an explanation for the observed decoupling between unemployment and inflation.

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APPENDIX

On-the-Job Search and Inflation under the Microscope

by Saman Darougheh, Renato Faccini, Leonardo Melosi, and Alessandro T. Villa

A Laws of motion

Labor force constraint

$$\int d\mu_1^E(x,\alpha) + u + \varpi = 1.$$

Intertemporal law of motion for the employed

$$\mu_{0,t+1}^E(x',\alpha') = \left(1-\psi^R\right)(1-\delta)\,\mu_{1,t}^E(x',\alpha') \tag{22}$$

Intratemporal law of motion for the employed

$$\begin{aligned}\mu_{1,t}^E(x',\alpha') \quad = \quad & \mu_{0,t}^E(x',\alpha')\left[\left[1-\xi(x',\alpha')f(\theta)\right] + \xi(x',\alpha')f(\theta)\sum_{\widetilde{x}<x'\alpha'} G^x(\widetilde{x})\right] \\ & + \sum_{\alpha}\mu_{0,t}^E(x',\alpha)\,\xi(x',\alpha)f(\theta)G^x(x'\alpha')\,\mathbf{1}_{x'\alpha'>x'\alpha} \\ & + \sum_{\alpha}\mu_{0,t}^E\left(\underbrace{\alpha'x'}_{x},\alpha\right)\xi(\alpha'x',\alpha)f(\theta)G^x(x') \\ & + uf(\theta)G^x(x')\,\mathbf{1}_{\alpha'=\frac{\underline{x}}{x'}}\end{aligned} \tag{23}$$

The first row in the above expression refers to employed workers who either do not search for jobs at all or, if they do search and receive a job offer, the offer is too low to justify renegotiating their wage with their current employer.

The second row refers to employed workers who find a new job offer that leads them to renegotiate their wage with their current employer, allowing them to extract a share α' of the incumbent's productivity x'.

The third row refers to workers who are employed in a job with productivity x, search for a new job, and find an offer that leads them to switch to a different employer with productivity x'. In this case, they manage to extract exactly a share α' of the poacher's productivity.

The fourth row refers to unemployed workers who find a job with productivity x', and in this case, the share of output paid as wages is exactly $\alpha' = \underline{x}/x'$.

Intertemporal law of motion for the unemployed:

$$u_{0,t+1} = \left(1-\psi^R\right)u_{1,t} + \left(1-\psi^R\right)\delta\sum_{\alpha}\sum_{x}\mu_{1,t}^E(x,\alpha) + \psi^D\varpi_{1,t} \tag{24}$$

Intratemporal law of motion for the unemployed:

$$u_{1,t} = u_{0,t}\left[1 - f\left(\theta\right)\right] \tag{25}$$

Intertemporal law of motion for the retirees:

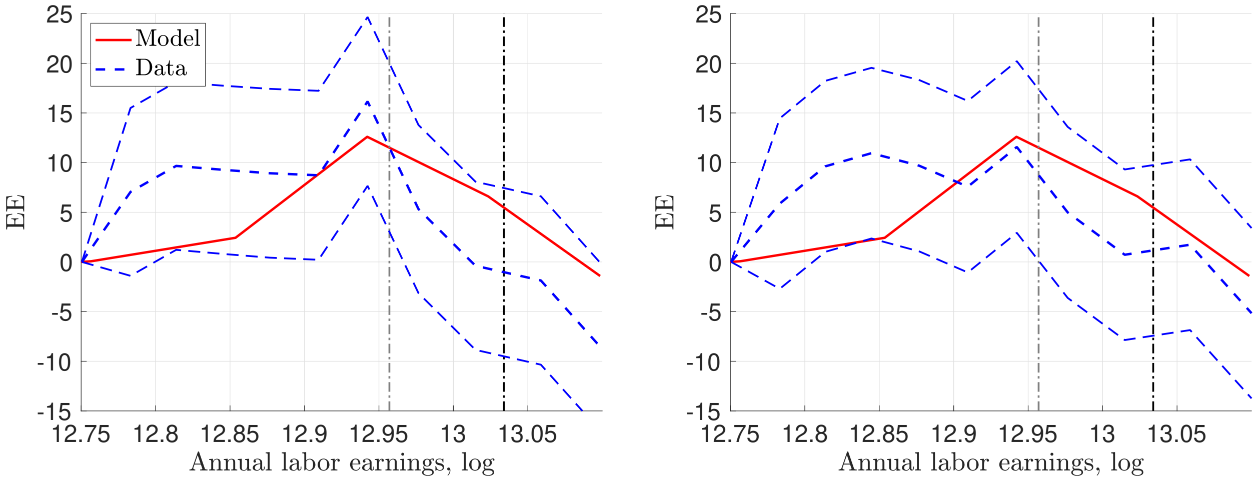
$$\varpi_{0,t+1} = \left(1 - \psi^{D}\right)\varpi_{1,t} + \psi^{R} u_{1,t} + \psi^{R} \sum_{x,\alpha} \mu^{E}_{1,t}\left(x, \alpha\right) \tag{26}$$

Intratemporal law of motion for the retirees:

$$\varpi_{1,t} = \varpi_{0,t} \tag{27}$$

B Additional figures

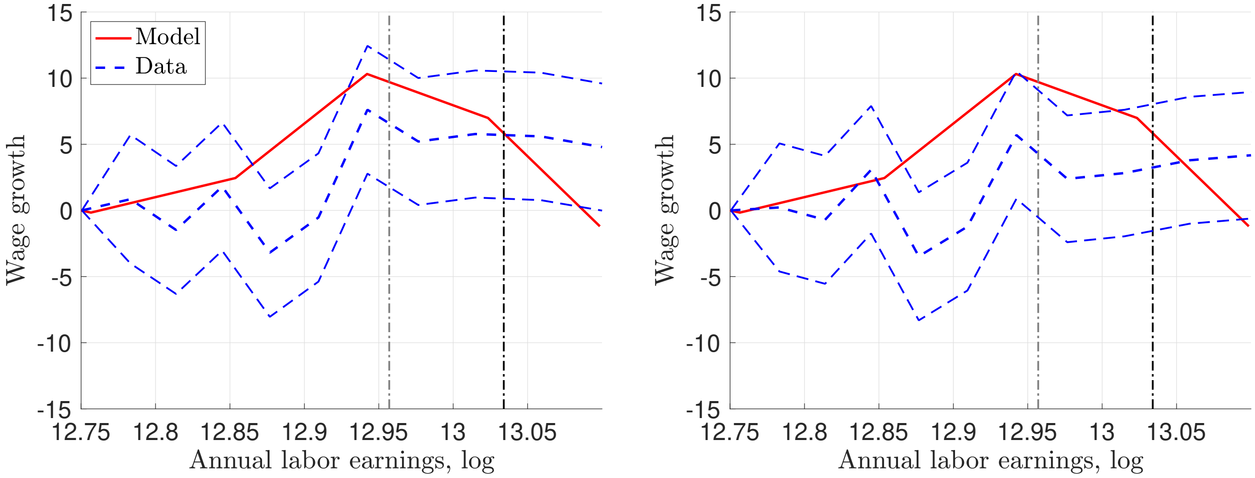
Figure B1: Effects of Shifting the High-Income Tax Threshold on EE Rates



(a) Raw data (b) Full controls

Notes: Untargeted moments—employment-to-employment (EE) rates: The figure displays the percentage change in EE rates across income bins before and after the tax reform in the microdata and in the model. The light gray and dark gray vertical bars indicate the high-income tax thresholds for 2012 and 2013, respectively. The dashed blue lines show the estimated parameters γ_g together with the 95% confidence intervals (with standard errors clustered by earnings bin) obtained by running the regressions defined in equation (21) for the time window (2012 vs. 2013). The red solid line shows the model analogue of estimated parameters γ_g. Income bins are constructed to include approximately 50,000 workers per year during 2010–2015. Full controls include education, gender, age, occupation, and industry.

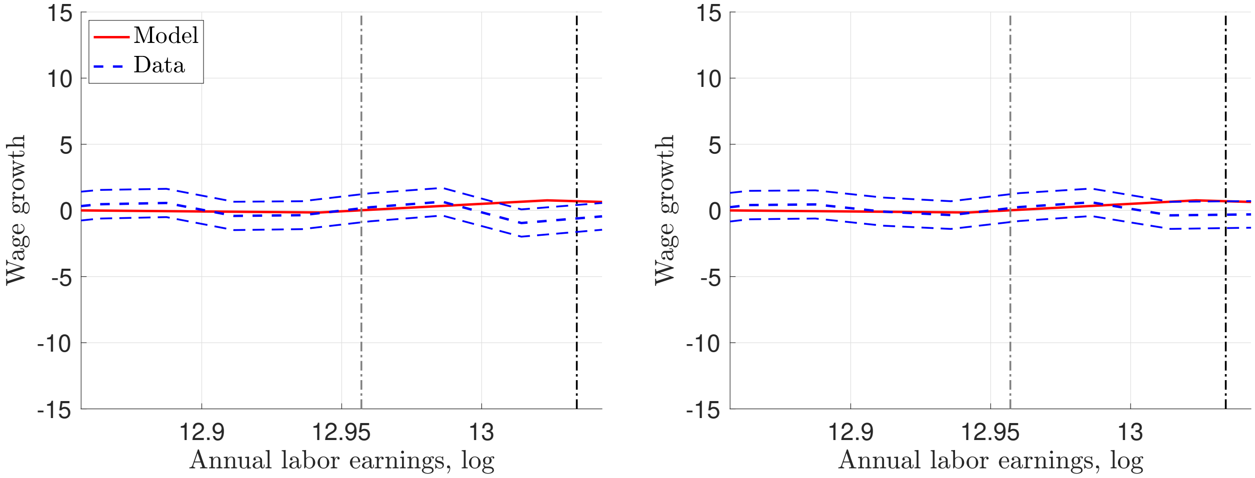
Figure B2: Effects of Shifting the High-Income Tax Threshold on the Wage Growth of Job Stayers



(a) Raw data (b) Full controls

Notes: Untargeted moments—wage growth of stayers: The figure displays the percentage change in wage growth for workers remaining with the same employer across income bins before and after the tax reform in the microdata and in the model. The light gray and dark gray vertical bars indicate the high-income tax thresholds for 2012 and 2013, respectively. The dashed blue lines show the estimated parameters γ_g together with the 95% confidence intervals (with standard errors clustered by earnings bin) obtained by running the regressions defined in equation (21) for the time window (2012 vs. 2013). The red solid line shows the model analogue of estimated parameters γ_g. Full controls include education, gender, age, occupation, and industry.

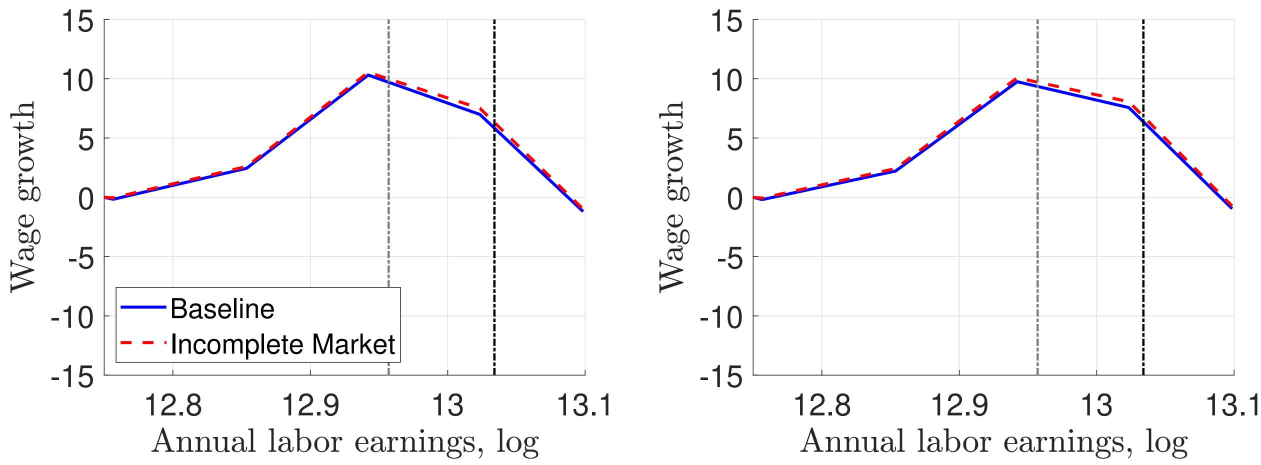
Figure B3: Effects of Shifting the High-Income Tax Threshold on Wage Growth of Job Changers



(a) Raw data (b) Full controls

Notes: Untargeted moments—wage growth of leavers: The figure displays the percentage change in wage growth for workers changing employer across income bins before and after the tax reform in the microdata and in the model. The light gray and dark gray vertical bars indicate the high-income tax thresholds for 2012 and 2013, respectively. The dashed blue lines show the estimated parameters γ_g together with the 95% confidence intervals (with standard errors clustered by earnings bin) obtained by running the regressions defined in equation (21) for the time window (2012 vs. 2013). The red solid line shows the model analogue of estimated parameters γ_g. Full controls include education, gender, age, occupation, and industry.

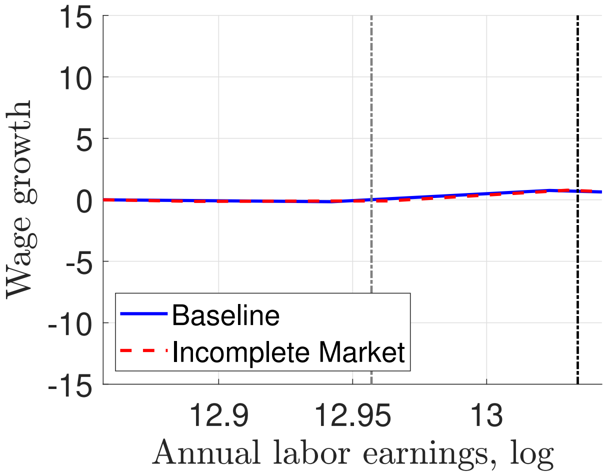
Figure B4: Effects of Shifting the High-Income Tax Threshold on the Wage Growth of Job Stayers: Complete- vs. Incomplete-Market model



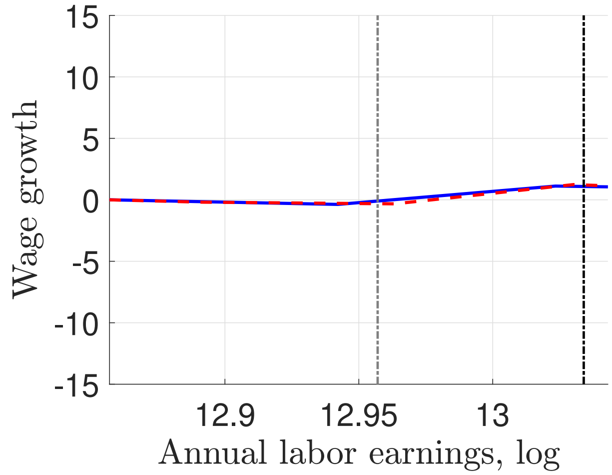
(a) 1 year window (b) 3 years window

Notes: The figure compares the percentage change in the wage growth of job stayers across income bins before and after the tax reform, as produced by the baseline model with complete markets (solid blue line) and the HANK model with incomplete-markets (dashed red line). The two panels depict the percent difference in wage growth, relative to the 2012 steady-state distribution, after 1 and 3 years of transition to the new steady-state equilibrium characterized by the 2013 tax thresholds. The light gray and dark gray vertical bars indicate the high-income tax thresholds for 2012 and 2013, respectively.

Figure B5: Effects of Shifting the High-Income Tax Threshold on Wage Growth of Job Changers: Complete- vs. Incomplete-Market model



(a) 1 year window



(b) 3 years window

Notes: The figure compares the percentage change in the wage growth of job changers across income bins before and after the tax reform, as produced by the baseline model with complete markets (solid blue line) and the HANK model with incomplete-markets (dashed red line). The two panels depict the percent difference in wage growth, relative to the 2012 steady-state distribution, after 1 and 3 years of transition to the new steady-state equilibrium characterized by the 2013 tax thresholds. The light gray and dark gray vertical bars indicate the high-income tax thresholds for 2012 and 2013, respectively.

C Computational appendix

In this section, we describe the algorithms we use to solve for the stationary equilibrium and the transitional dynamics both for the baseline and the model with incomplete market. We solve the baseline model incorporating the trading of firm shares—representing price-setting and labor-service firms—into a single asset, which also includes bonds B. This ensures consistency with the incomplete markets solution method. As a result, households do not receive dividend payments directly but instead trade shares whose returns, in the absence of aggregate uncertainty, must equal the bond return. This setup is equivalent to distributing firm profits as lump-sum transfers, as presented in the main text.

C.1 Computational appendix for the baseline model

In this section, we describe the algorithms we use to solve for the stationary equilibrium and the transitional dynamics for representative agents.

C.1.1 Solution algorithm for the stationary equilibrium

We create the following two grids. Namely, the log-normally distributed productivity grid $\mathcal{X} = [\underline{x}, x_1, ..., \bar{x}]$ and the linearly scaled piece rate grid $P = [\underline{\alpha}, \alpha_1, ..., 1]$, where $\underline{\alpha}$ is the minimum possible piece rate $\underline{x}/\bar{x}$. The population density distributions are $\mu^U_{p,t}, \mu^R_{p,t}$, and $\mu^E_{p,t}(x, \alpha)$ for period $p \in \{0, 1\}$. We use 21 nodes on productivity and 17 nodes for the piece rate, for a total of 357 nodes. We use piece-wise linear interpolation to evaluate both policy and value functions outside of the nodes of the grids. The distribution of search costs is assumed to be uniform over the support $\left[\vartheta^l, \vartheta^u\right]$, where the lower bound ϑ^l is normalized to zero.

We also employ normally distributed shocks to worker productivity, $\Delta = [\underline{\epsilon}, \epsilon_1, ..., \bar{\epsilon}]$. Shocks are applied intertemporally in the form $x' = \min(\max(\underline{x}, x \cdot (1 + \epsilon)), \bar{x})$.

We compute a wage grid $w = \zeta \cdot P \times \mathcal{X}$, where ζ is the maximum share of output as wages and $\times$ indicates the Cartesian product. We use the three taxation brackets τ_0, τ_L, and τ_H to create a measure of average taxation in function of income w:

$$\tau = \begin{cases} \tau_0, & \text{if } w \leq w_L \\ \dfrac{w_L \cdot \tau_0 + (w - w_L) \cdot \tau_L}{w}, & \text{if } w_L \leq w \leq w_H \\ \dfrac{w_L \cdot \tau_0 + (w_H - w_L) \cdot \tau_L + (w - w_H) \cdot \tau_H}{w}, & \text{otherwise.} \end{cases} \tag{28}$$

The algorithm works as follows.

1. Create an iterator j and set $j = 0$. Guess the initial transfer T^j.

- Create a second iterator w and set $w = 0$.
  (a) We initialize constant values for retired, Γ, and the unemployed, U. For the employed, their start-of-period value of employment is $V_0^w(x,\alpha)$ and end-of-period is $V_1^w(x,\alpha)$. Thus, we look to solve the associated optimization problems (5) and (7) and find $V_0^{w+1}(x,\alpha)$, and $V_1^{w+1}(x,\alpha)$.
  (b) Update the job search policy function for the employed population, $I_{\phi<\phi^T}^{w+1}(x,\alpha)$ using equations (9) and (10) and evaluate the job search probability $\xi^{w+1}(x,\alpha)$ based on the job search decisions for the employed.
  (c) Using $r = \pi^*/\beta$ and $\xi^{w+1}(e,x,\alpha)$, calculate the value of a filled job $J^{w+1}(x,\alpha)$ using equation (15).
  (d) If all value functions converged (i.e. $\max(\sup|V^{w+1}(x,\alpha)-V^w(x,\alpha)|, \sup|J^{w+1}(x,\alpha)-J^w(x,\alpha)|) < \epsilon$), exit the loop. Otherwise, set $w = w+1$ and restart from step (a).
- Create an iterator t and set $t = 0$. This step uses the policy functions to solve for the asymptotic distributions. We simulate using the Young (2010) lottery method when the policy functions contains value outside of the nodes of the grids.
  (a) Use the intratemporal laws of motion, calculate the population distribution density for the employed $\mu_{1,t}^E(x^{'},\alpha^{'}), \mu_{1,t}^U$, and $\mu_{1,t}^R$ in period $p = 1$, from the guess for period $p = 0$, $\mu_{0,t}^E(x^{'},\alpha^{'}), \mu_{0,t}^U$, and $\mu_{0,t}^R$ using equations (24), (25), and (27).
  (b) Using the results from step (a), $\mu_{1,t}^E(x,\alpha), \mu_{1,t}^U$, and $\mu_{1,t}^R$ and the intertemporal laws of motion, calculate the population distribution function for period 0 for $t+1$, $\mu_{0,t+1}^E(x^{'},\alpha^{'}), \mu_{0,t+1}^U$, and $\mu_{0,t+1}^R$ using equations (22), (24), and (26).
  (c) If the population distributions converge (i.e. $\max(\sup|\mu_{0,t+1}^E-\mu_{0,t}^E|, \sup|\mu_{1,t+1}^E-\mu_{1,t}^E|, \sup|\mu_{0,t+1}^U-\mu_{0,t}^U|, \sup|\mu_{1,t+1}^U-\mu_{1,t}^U|, \sup|\mu_{0,t+1}^R-\mu_{0,t}^R|, \sup|\mu_{1,t+1}^R-\mu_{1,t}^R|) < \epsilon^T$), exit the loop. Otherwise, set $t = t+1$ and restart from step (a).
- Calculate the implied transfer T^{j+1} using the values for wages w and the population density distribution $\mu_1^E(x',\alpha'), \mu_1^U$, and μ_1^R using the government budget constraint (17). If transfers converged (i.e. $|T^{j+1} - T^j| < \epsilon$), then exit the loop. Otherwise, set $j = j+1$, update the value of T^j towards T^{j+1} using a dampening parameter and restart. We use a dampening parameter of 0.9, i.e. $T^{j+1} \leftarrow 0.9 \cdot T^{j+1} + (1-0.9) \cdot T^j$. If the transfer clearing condition is satisfied, we can exit the loop. Otherwise, restart with the new j.

C.1.2 Solution algorithm for the dynamic equilibrium

The economy is initially in a stationary equilibrium when all agents experience a sudden tax shock in the form of change of tax brackets. For the baseline case, the highest tax slab starts at the stationary equilibrium associated with the calibrated wage w^H. Here, we introduce a shock in the form of a change of this tax slab such that, $w^H_{high} = w^H \cdot 1.08$. We solve for both stationary equilibria first. Then, we solve for the transition numerically, allowing a sufficiently high number of periods $\bar{t}$ for the masses to adjust and the economy to converge to the stationary equilibrium associated with w^H_{high}. In particular, we use $\bar{t} = 100$. We run an identical procedure for the search cost shock except that instead of changing the tax bracket we introduce a shock to ϑ^u allowing it to dynamically change. In particular, on impact it increases by 50% and then reverts back to its calibrated value following an AR(1) with persistence 0.5. In order to calculate the equilibrium dynamics, we need to find sequences of: (i) government transfer, $\{T_t\}_{t=0}^{\bar{t}}$, (ii) market tightness parameter, $\{\theta_t\}_{t=0}^{\bar{t}}$, (iii) price of one share of the mutual fund, $\{P^e_t\}_{t=0}^{\bar{t}}$, and (iv) real interest rates, $\{r_t\}_{t=0}^{\bar{t}}$.

1. Create an iterator j and set $j = 0$. Guess an interest rate path $\{r^j_t\}_{t=0}^{\bar{t}}$. Using the Taylor Rule (18), calculate the associated inflation path $\{\pi^j_t\}_{t=0}^{\bar{t}}$.

2. Create an iterator t and set $t = \bar{t} - 1$. Hence, use projection with backward time iteration from $t = \bar{t} - 1$ to $t = 0$. The policy functions at $t = \bar{t}$ are the ones associated with the ending stationary equilibrium as previously calculated. At each time $t = 0$, we proceed similarly as before in the case of stationary equilibrium. Start from guessed paths $\{T^j_t\}_{t=0}^{\bar{t}}$ and $\{\theta^j_t\}_{t=0}^{\bar{t}}$ using the stationary equilibrium values do the following two steps.

   - Calculate consumption for unemployed, employed, and retired population, C^U_t, C^R_t, and $C^E_t(x, \alpha)$ after having update the average taxation level generated by equation (28).
   - Start from the stationary equilibrium value functions and iterate backward on the optimization problems (3), (5), (7), and (4) to find $\{V^t_0(x, \alpha)\}_{t=0}^{\bar{t}}$ for start-of-period and $\{V^t_1(x, \alpha)\}_{t=0}^{\bar{t}}$ for end-of-period value of employment.

3. Now, start from $t = 0$ and iterate forward up to $t = \bar{t}$. Start at $t = 0$ from the $p = 0$ distributions of the initial stationary equilibrium $\mu^E_{0,0}(x, \alpha), \mu^U_{0,0}$, and $\mu^R_{0,0}$.

   (a) Use the intratemporal laws of motion to calculate the population distribution density for period $p = 1$, $\mu^E_{1,t}(x, \alpha), \mu^U_{1,t}$, and $\mu^R_{1,t}$ from the $p = 0$, $\mu^E_{0,t}(x, \alpha), \mu^U_{0,t}$, and $\mu^R_{0,t}$ using equations (24), (25), and (27).

(b) Use the results from step (a), $\mu^E_{1,t}(x,\alpha), \mu^E_{1,t}$, and $\mu^R_{1,t}$ and the intertemporal laws of motion to calculate the population distribution functions for $p = 0$ for $t+1$, $\mu^E_{0,t+1}(x,\alpha), \mu^U_{0,t+1}$, and $\mu^R_{0,t+1}$ using equations (22), (24), and (26).

4. Iterate backward again from $t = \bar{t} - 1$ to $t = 0$.

   - Retrieve stored policy decisions and population distributions generated in the previous steps to calculate the value of filled job $\{J^t(x,\alpha)\}_{t=0}^{\bar{t}}$ at each time t using equation (15).

5. Iterate forward again from $t = 0$ to $t = \bar{t}$.

   - Calculate transfers $\{T_t^{j+1}\}_{t=0}^{\bar{t}}$ from wages and the population density distributions using equation (17).
   - Evaluate the market clearing condition (51) at each time t. Update $\{r_t^j\}_{t=0}^{\bar{t}}$ to get $\{r_t^{j+1}\}_{t=0}^{\bar{t}}$ using the residuals on all asset market clearing conditions.
   - Calculate the market tightness path $\{\theta_t^{j+1}\}_{t=0}^{\bar{t}}$ using equation (16).
   - Calculate the prices $\{P_t^{e,j+1}\}_{t=0}^{\bar{t}}$ using

$$\frac{P^{e\prime} + D'}{P^e} = 1 + i. \tag{29}$$

.

6. If all market clearing conditions are satisfied and the government transfer and market tightness paths converged, and real interest rates (i.e. $\max(\sup|\{r_t^{j+1}\}_{t=0}^{\bar{t}} - \{r_t^j\}_{t=0}^{\bar{t}}|, \sup|\{T_t^{j+1}\}_{t=0}^{\bar{t}} - \{T_t^j\}_{t=0}^{\bar{t}}|, \sup|\{\theta_t^{j+1}\}_{t=0}^{\bar{t}} - \{\theta_t^j\}_{t=0}^{\bar{t}}|, \sup|\{P_t^{e,j+1}\}_{t=0}^{\bar{t}} - \{P_t^{e,j}\}_{t=0}^{\bar{t}}| < \epsilon^T$), stop. Otherwise, set $j = j+1$, shift the values for $\{r_t^{j+1}\}_{t=0}^{\bar{t}}$, $\{T_t^{j+1}\}_{t=0}^{\bar{t}}$, $\{\theta_t^{j+1}\}_{t=0}^{\bar{t}}$, and $\{P_t^{e,j+1}\}_{t=0}^{\bar{t}}$ using a dampening parameter and restart from step (2).

C.2 Computational appendix for the model with incomplete markets

C.2.1 Solution algorithm for the stationary equilibrium

We create the following three grids. Namely, the exponentially scaled assets grid $A = [\underline{e}, e_1, ..., \bar{e}]$, the log-normally distributed productivity grid $\mathcal{X} = [\underline{x}, x_1, ..., \bar{x}]$, and the linearly scaled piece rate grid $P = [\underline{\alpha}, \alpha_1, ..., 1]$, where $\underline{\alpha}$ is the minimum possible piece rate $\underline{x}/\bar{x}$. The population density distributions are $\mu^U_{p,t}(e), \mu^R_{p,t}(e)$, and $\mu^E_{p,t}(e,x,\alpha)$ for period $p \in \{0,1\}$. We use 21 nodes on both assets and productivity grids, and 17 nodes for the piece rates, for a total of $21 \cdot 21 \cdot 17$ nodes. We use piece-wise linear interpolation to evaluate both policy and value functions outside of the nodes of the grids.. The distribution of search costs is assumed to be uniform over the support $\left[\vartheta^l, \vartheta^u\right]$, where the lower bound ϑ^l is normalized to zero.

We also employ normally distributed shocks to worker productivity, $\Delta = [\underline{\epsilon}, \epsilon_1, ..., \bar{\epsilon}]$. Shocks are applied intertemporally in the form $x' = \min(\max(\underline{x}, x \cdot (1+\epsilon)), \bar{x})$.

We compute a wage grid $w = \zeta \cdot P \times \mathcal{X}$, where ζ is the maximum share of output as wages and $\times$ indicates the Cartesian product. We use the three taxation brackets τ_0, τ_L, and τ_H to create a measure of average taxation in function of income w using equation (28).

The algorithm works as follows.

1. Create an iterator z and set $z = 0$. Guess initial values for the real rate of interest r^z.

2. Create a second iterator j and set $j = 0$. Guess the initial transfer T^j.

   - Create a third iterator w and set $w = 0$.

     (a) Use guesses for all value functions: $\Gamma^w(e)$ for retired, $U^w(e)$ for the unemployed, $V_0^w(e, x, \alpha)$ for start-of-period, and $V_1^w(e, x, \alpha)$ for end-of-period value of employment to solve the associated optimization problems (38), (39), (40), and (44) and find $\Gamma^{w+1}(e), U^{w+1}(e), V_0^{w+1}(e, x, \alpha)$, and $V_1^{w+1}(e, x, \alpha)$.

     (b) Update the job search policy function for the employed population, $I^{w+1}_{\phi<\phi^T}(e, x, \alpha)$ using equations (42) and (43) and evaluate the job search probability $\xi^{w+1}(e, x, \alpha)$ based on the job search decisions for the employed.

     (c) Using $e^{'}_E(e, x, \alpha), r^z$, and $\xi^{w+1}(e, x, \alpha)$, calculate the value of a filled job $J^{w+1}(e, x, \alpha)$ using equation (45).

     (d) If all value functions converged (i.e. $\max(\sup|\Gamma^{w+1}(e) - \Gamma^w(e)|, \sup|U^{w+1}(e) - U^w(e)|, \sup|V^{w+1}(e, x, \alpha) - V^w(e, x, \alpha)|, \sup|J^{w+1}(e, x, \alpha) - J^w(e, x, \alpha)|) < \epsilon$), exit the loop. Otherwise, set $w = w + 1$ and restart from step (a).

   - Create an iterator t and set $t = 0$. This step uses the policy functions to solve for the asymptotic distributions. We simulate using the Young (2010) lottery method when the policy functions contains value outside of the nodes of the grids.

     (a) Use the intratemporal laws of motion, calculate the population distribution density for period $p = 1$, $\mu^E_{1,t}(e^{'}, x^{'}, \alpha^{'}), \mu^U_{1,t}(e^{'})$, and $\mu^R_{1,t}(e^{'})$ from the guess for period $p = 0$, $\mu^E_{0,t}(e, x^{'}, \alpha^{'}), \mu^U_{0,t}(e)$, and $\mu^R_{0,t}(e)$ using equations (54), (56), and (58).

     (b) Using the results from step (a), $\mu^E_{1,t}(e, x, \alpha), \mu^U_{1,t}(e)$, and $\mu^R_{1,t}(e)$ and the intertemporal laws of motion, calculate the population distribution function for period 0 for $t+1$, $\mu^E_{0,t+1}(e^{'}, x^{'}, \alpha^{'}), \mu^U_{0,t+1}(e^{'})$, and $\mu^R_{0,t+1}(e^{'})$ using equations (53), (55), and (57).

(c) If the population distributions converge (i.e. $\max(\sup|\mu^U_{0,t+1} - \mu^U_{0,t}|, \sup|\mu^R_{0,t+1} - \mu^R_{0,t}|, \sup|\mu^E_{0,t+1} - \mu^E_{0,t}|, \sup|\mu^U_{1,t+1} - \mu^U_{1,t}|, \sup|\mu^R_{1,t+1} - \mu^R_{1,t}|, \sup|\mu^E_{1,t+1} - \mu^E_{1,t}|) < \epsilon^T$), exit the loop. Otherwise, set $t = t + 1$ and restart from step (a).

- Calculate transfer T^{j+1} using the values for wages w and the population density distributions $\mu^U_1(e'), \mu^R_1(e')$, and $\mu^E_1(e', x', \alpha')$ using the government budget constraint (47). If transfers converged (i.e. $|T^{j+1} - T^j| < \epsilon^T$), then exit the loop. Otherwise, set $j = j + 1$, update the value of T^j towards T^{j+1} using a dampening parameter and restart. We use a dampening parameter of 0.9, i.e. $T^{j+1} \leftarrow 0.9 \cdot T^{j+1} + (1 - 0.9) \cdot T^j$.

3. Calculate the savings aggregated across all workers and evaluate the asset market clearing condition (51). If the asset market clearing condition is satisfied then exit the loop. Otherwise, set $z = z + 1$ and restart from step (2). Use a bisection algorithm to find the value of real interest rate r that clears the asset market.

C.2.2 Solution algorithm for the dynamic equilibrium

The economy is initially in a stationary equilibrium when all agents experience a sudden tax shock in the form of change of tax brackets. For the baseline case, the highest tax slab starts at the stationary equilibrium associated with the calibrated wage w^H. Here, we introduce a shock in the form of a change of this tax slab such that, $w^H_{high} = w^H \cdot 1.08$. We solve for both stationary equilibria first. Then, we solve for the transition numerically, allowing a sufficiently high number of periods $\bar{t}$ for the masses to adjust and the economy to converge to the stationary equilibrium associated with w^H_{high}. In particular, we use $\bar{t} = 100$. In order to calculate the equilibrium dynamics, we need to find sequences of: (i) government transfer, $\{T_t\}^{\bar{t}}_{t=0}$, (ii) market tightness parameter, $\{\theta_t\}^{\bar{t}}_{t=0}$, and (iii) real interest rates, $\{r_t\}^{\bar{t}}_{t=0}$.

1. Create an iterator j and set $j = 0$. Guess an interest rate path $\{r^j_t\}^{\bar{t}}_{t=0}$. Using the Taylor Rule (18), calculate the associated inflation path $\{\pi^j_t\}^{\bar{t}}_{t=0}$.

2. Create an iterator t and set $t = \bar{t} - 1$. Hence, use projection with backward time iteration from $t = \bar{t} - 1$ to $t = 0$. The policy functions at $t = \bar{t}$ are the ones associated with the ending stationary equilibrium as previously calculated. At each time $t = 0$, we proceed similarly as before in the case of stationary equilibrium. Start from guessed paths $\{T^j_t\}^{\bar{t}}_{t=0}$ and $\{\theta^j_t\}^{\bar{t}}_{t=0}$ using the stationary equilibrium values.

   - Calculate consumption for unemployed, employed, and retired population, $C^U_t(e), C^E_t(e, x, \alpha)$, and $C^R_t(e)$ after having update the average taxation level generated by the tax shock $\Delta\tau_t$ calculated, at each time t, from equation (28).

- Start from the stationary equilibrium value functions and iterate backward on the optimization problems (38), (39), (40), and (44) to find $\{\gamma^t(e)\}_{t=0}^{\bar{t}}$ for retired, $\{U^t(e)\}_{t=0}^{\bar{t}}$ for the unemployed, $\{V_0^t(e,x,\alpha)\}_{t=0}^{\bar{t}}$ for start-of-period, and $\{V_1^t(e,x,\alpha)\}_{t=0}^{\bar{t}}$ for end-of-period value of employment.

3. Now, start from $t=0$ and iterate forward up to $t=\bar{t}$. Start at $t=0$ from the $p=0$ distributions of the initial stationary equilibrium $\mu_{0,0}^E(e,x,\alpha)$, $\mu_{0,0}^U(e)$, and $\mu_{0,0}^R(e)$.

   (a) Use the intratemporal laws of motion to calculate the population distribution density for period $p=1$, $\mu_{1,t}^E(e,x,\alpha)$, $\mu_{1,t}^U(e)$, and $\mu_{1,t}^R(e)$ from the $p=0$, $\mu_{0,t}^E(e,x,\alpha)$, $\mu_{0,t}^U(e)$, and $\mu_{0,t}^R(e)$ using equations (54), (56), and (58).

   (b) Use the results from step (a), $\mu_{1,t}^E(e,x,\alpha)$, $\mu_{1,t}^U(e)$, and $\mu_{1,t}^R(e)$ and the intertemporal laws of motion to calculate the population distribution functions for $p=0$ for $t+1$, $\mu_{0,t+1}^E(e,x,\alpha)$, $\mu_{0,t+1}^U(e)$, and $\mu_{0,t+1}^R(e)$ using equations (53), (55), and (57).

4. Iterate backward again from $t=\bar{t}-1$ to $t=0$.

   - Retrieve stored policy decisions and population distributions generated in the previous steps to calculate the value of filled job $\{J^t(a,x,\alpha)\}_{t=0}^{\bar{t}}$ at each time t using equation (15).

5. Iterate forward again from $t=0$ to $t=\bar{t}$.

   - Calculate transfers $\{T_t^{j+1}\}_{t=0}^{\bar{t}}$ from wages and the population density distributions using equation (47).
   - Evaluate the market clearing condition (51) at each time t. Update $\{r_t^j\}_{t=0}^{\bar{t}}$ to get $\{r_t^{j+1}\}_{t=0}^{\bar{t}}$ using the residuals on all asset market clearing conditions.
   - Calculate the market tightness path $\{\theta_t^{j+1}\}_{t=0}^{\bar{t}}$ using equation (46).

6. If all market clearing conditions are satisfied and the government transfer and market tightness paths converged, and real interest rates (i.e. $\max(\sup|\{r_t^{j+1}\}_{t=0}^{\bar{t}}-\{r_t^j\}_{t=0}^{\bar{t}}|, \sup|\{T_t^{j+1}\}_{t=0}^{\bar{t}}-\{T_t^j\}_{t=0}^{\bar{t}}|, \sup|\{\theta_t^{j+1}\}_{t=0}^{\bar{t}}-\{\theta_t^j\}_{t=0}^{\bar{t}}) < \epsilon$), stop. Otherwise, set $j=j+1$, shift the values for $\{r_t^{j+1}\}_{t=0}^{\bar{t}}$, $\{T_t^{j+1}\}_{t=0}^{\bar{t}}$, and $\{\theta_t^{j+1}\}_{t=0}^{\bar{t}}$ using a dampening parameter and restart from step (2).

D Wages and taxes under Nash bargaining

In this section, we briefly study the effects of a change in the labor tax rate on wages set according to generalized Nash bargaining. Let w be the wage rate, y be worker productivity,

b be unemployment benefits or value of leisure, θ be labor market tightness, r be the discount rate, λ be the job separation rate, $q(\theta)$ be the probability of a firm filling a vacancy, $f(\theta)$ be the probability of a worker finding a job, β be the worker's bargaining power, c be the cost of posting a vacancy, and τ be the tax wedge representing the difference between the gross wage that firms pay $w(1+\tau)$ and the net wage that workers receive w.

The value functions for workers and firms are given by

For workers:

$$rE = w - \lambda(E - U) \tag{30}$$

$$rU = b + f(\theta)(E - U) \tag{31}$$

$$rJ = y - w(1+\tau) - \lambda(J - V) \tag{32}$$

$$rV = -c + q(\theta)(J - V) \tag{33}$$

Wages are given by

$$\beta(J - V) = (1-\beta)(E - U) \tag{34}$$

In equilibrium, market tightness θ is such that $V = 0$.

Proposition 1 *In this environment, and for $\beta \in (0,1)$, a decrease in taxes τ lowers gross wages*

$$\frac{\partial w(1+\tau)}{\partial \tau} < 0.$$

Furthermore, a transition from a firm with productivity $\underline{y}$ to a firm with $\overline{y}$ with $\overline{y} > \underline{y}$ leads to a smaller wage increase when taxes are lower.

$$\frac{\partial^2 w(y)(1+\tau)}{\partial y \partial \tau} < 0.$$

Proof. With free entry, $V = 0$, therefore:

$$J = \frac{c}{q(\theta)}$$

it is possible to rewrite (30) and (32) respectively as

$$E - U = \frac{w - rU}{r + \lambda} \tag{35}$$

$$J - V = \frac{y - w(1+\tau)}{r + \lambda} \tag{36}$$

Substituting surplus expressions:

$$\beta\left[\frac{y-w(1+\tau)}{r+\lambda}\right]=(1-\beta)\left[\frac{w-rU}{r+\lambda}\right]$$
$$\leftrightarrow w=\frac{\beta y+(1-\beta)rU}{1+\beta\tau}$$

The value of unemployment can be written as:

$$rU=b+f(\theta)\frac{\beta}{1-\beta}\frac{c}{q(\theta)}$$

Which allows us to write wages as

$$w=\frac{\beta(y+c\theta)+(1-\beta)b}{1+\beta\tau}$$

Where $\theta=\frac{v}{u}$ is market tightness.

For $\tau=0$, we recover the standard wage equation for Nash-bargained wages. For $\beta\to 0$, the worker receives exactly their outside option. For $\beta\to 1$, the worker's net wage is given by $(y+c\theta)/(1+\tau)$. In this case, the workers gross wage is given by $y+c\theta$—the worker receives the entire surplus of the match as gross payment, but has to pay taxes on it.

Note that gross wages are given by

$$w(1+\tau)=[\beta(y+c\theta)+(1-\beta)b]\cdot\frac{1+\tau}{1+\beta\tau}$$

And the derivative w.r.t. τ is given by

$$\frac{d}{d\tau}[w(1+\tau)]=[\beta(y+c\theta)+(1-\beta)b]\cdot\frac{1-\beta}{(1+\beta\tau)^2},$$

which is strictly positive for $\beta<1$.

To address the second part of the proposition, we note that

$$\frac{\partial^2[w(1+\tau)]}{\partial y\partial\tau}=\beta\cdot\frac{1-\beta}{(1+\beta\tau)^2},$$

which is also strictly positive for $\beta\in(0,1)$.

E The HANK job-ladder model

Below, we focus only on the aspects of the model that differ from the baseline presented in the main text.

E.1 The labor market

Let $\mu_0^U(e)$ and $\mu_0^E(e,x,\alpha)$ denote the beginning-of-period distribution of the unemployed and the employed workers, respectively. Let $\xi\left(e,x,\alpha\right)$ denote the share of workers in the state space defined by the vector (e, x, α) who optimally decides to search. Then the measure of workers looking for jobs at the beginning of a period is given by:

$$S = \int d\mu_0^U(e) + \int \xi(e, x_0, \alpha)\, d\mu_0^E(e, x_0, \alpha). \tag{37}$$

Tightness θ is the ratio of vacancies to job seekers:

$$\theta = \frac{v}{S}.$$

E.2 Workers

We assume that all workers receive the same amount of transfers T from the government independently of their employment state. Consider an unemployed worker who did not manage to find a job within a given time period. At the end of the period, the value of unemployment is

$$U(e)=u(c) + \left(1-\psi^R\right)\beta\left[f(\theta')\, E_x V_1\left(e', x, \frac{x}{\underline{x}}\right) + (1 - f(\theta'))\, U(e')\right] + \beta\psi^R\Gamma(e'), \tag{38}$$

subject to the budget constraint

$$Pc + P^e e' = P(1 - \tau(b))\, b + (P^e + D)e + T,$$

The above maximization problem shows that an unemployed workers chooses current consumption and savings e' taking into account the probabilities associated with being in the three different labor market states next period.

The problem of an employed worker is separated in two parts. First, she choose whether to search. Next, after reallocation has taken place and wages have been rebargained, she choose consumption and savings. So the problem of search is solved at the beginning of the period (intra-time 0), while the consumption-savings problem is solved at the end (intra-time 1). Let's proceed by backward induction and start from the end-of-period problem. The end-of-period value of employment is:

$$V_1(e, x_1, \alpha) = \max_{e' \geq 0, c}\left\{u(c) + \beta\left(1-\psi^R\right)\left[(1-\delta)\, V_0(e', x_1, \alpha) + \delta U(e')\right] + \psi^R\Gamma(e')\right\} \tag{39}$$

subject to

$$Pc + P^e e' = P\left[1 - \tau(w)\right] w_1(x_1, \alpha) + (P^e + D)e + T$$

where $V_0(e, x_0, \alpha)$ is the value function of employment at the beginning of the period, i.e., before the search cost is drawn from the i.i.d. stochastic distribution G^ϕ. The solution to this problem is a policy function that characterizes the optimal savings decision: $e' = g^E(e, x, \alpha)$.

The search decision maximizes the expected value:

$$V_0(e, x_0, \alpha) = \int_\phi \widetilde{V}_0(e, x_0, \alpha, \phi)\, G^\phi(d\phi), \tag{40}$$

where

$$\widetilde{V}_0\left(e, x_0, \alpha, \phi\right) = \max\left\{-\phi + V_0^S\left(e, x_0, \alpha\right), V_0^{NS}\left(e, x_0, \alpha\right)\right\}, \tag{41}$$

and where V^S and V^{NS} denote the value of an employed worker searching and not searching, respectively. In turn, these are given by:

$$V^{NS}\left(e, x_0, \alpha\right) = V_1\left(e, x_0, \alpha\right)$$

$$\begin{aligned} V^S\left(e, x_0, \alpha\right) = &f\left(\theta\right) E_{\widetilde{x}} \max\left\{V_1\left(e, \widetilde{x}, \frac{x_0}{\widetilde{x}}\right), V_1\left(e, x_0, \max\left\{\alpha, \frac{\widetilde{x}}{x_0}\right\}\right)\right\} \\ &+ \left(1 - f\left(\theta\right)\right) V_1\left(e, x_0, \alpha\right). \end{aligned} \tag{42}$$

Opening the expectation operator, the above equation can be rewritten

$$\begin{aligned} V^S\left(e, x_0, \alpha\right) = f\left(\theta\right) &\left\{ \int_{\widetilde{x}=x_0}^{\overline{x}} V_1\left(e, \widetilde{x}, \frac{x_0}{\widetilde{x}}\right) G^x\left(d\widetilde{x}\right) \right. \\ &\left. + \int_{\widetilde{x}=\underline{x}}^{x_0} V_1\left(e, x_0, \max\left\{\alpha, \frac{\widetilde{x}}{x_0}\right\}\right) G^x\left(d\widetilde{x}\right) \right\} + \left(1 - f\left(\theta\right)\right) V_1\left(e, x_0, \alpha\right). \end{aligned}$$

We can define a threshold search cost $\phi^T\left(e, x_0, \alpha\right)$ such that the employed worker is indifferent between searching and not searching:

$$-\phi^T + V^S\left(e, x_0, \alpha\right) = V^{NS}\left(e, x_0, \alpha\right). \tag{43}$$

The solution to this problem is a rule, which can be expressed by the indicator function $I_{\phi<\phi^T}\left(e, x_0, \alpha\right) = 1$, which means that the worker searches if and only if $\phi < \phi^T$. For future convenience, it is helpful to denote by $\xi\left(e, x, \alpha\right)$ the ex-ante probability (i.e. before the fixed cost of search is drawn) that a worker defined by the state vector $\{e, x_0, \alpha\}$ ends up searching. By the law of large numbers, this will be given by the share of workers searching in every bin over $\{e, x, \alpha\}$.

The value of retirement is

$$\Gamma\left(e\right) = \max u\left(c\right) + \beta\left(1 - \psi^D\right)\Gamma\left(e'\right) \tag{44}$$

s.t

$$Pc + P^e e' = \left[1 - \tau\left(T^R\right)\right] T^R + (P^e + D)e + T,$$

where ψ^D is the probability that a retired worker dies, and T^R denotes pension income.

E.3 Labor service firms

The end-of-period value of a filled job is given by:

$$
\begin{aligned}
J(e,x,\alpha) = p^l x - w(x,\alpha) + \frac{1}{1+r}\left(1-\psi^R\right)(1-\delta) \\
\times \left\{ \left[(1-\xi(e',x,a)) + \xi(e',x,a)(1-f(\theta'))\right] J(e',x,\alpha) \right. \\
\left. + \xi(e',x,a) f(\theta') \int_{\underline{x}}^{x} J\left(e', x, \max\left\{\alpha, \frac{\widetilde{x}}{x}\right\} dG^x(\widetilde{x})\right) \right\},
\end{aligned} \tag{45}
$$

where e' satisfies the savings policy function of the workers, i.e., $e' = g^E(e,x,\alpha)$.

The free entry condition, which equates the expected costs and returns from a match, is:

$$
\begin{aligned}
\kappa^f + \frac{\kappa}{q(\theta)} = \frac{1}{S_t}\Bigg[\int_e \int_{\widetilde{x}} J\left(e, \widetilde{x}, \frac{\underline{x}}{\widetilde{x}}\right) dG^x(\widetilde{x})\, d\mu_0^U(e) \\
+ \int_{e,x,\alpha} \int_{x}^{\overline{x}} J\left(e, \widetilde{x}, \frac{x}{\widetilde{x}}\right) dG^x(\widetilde{x})\, \xi(e,x,\alpha)\, d\mu_0^E(e,x,\alpha) \Bigg]
\end{aligned} \tag{46}
$$

E.4 Fiscal and monetary authorities

The government budget constraint is given by:

$$
\begin{aligned}
B_{-1} + T + P\int b\, d\mu_1^U(e) + P\int T^R d\mu_1^R(e) = \frac{B}{1+i} \\
+ P\int b\tau(b)\, d\mu_1^U(e) \\
+ P\int w(e,x,\alpha)\,\tau(w(e,x,\alpha))\, d\mu_1^E(e,x,\alpha) \\
+ P\int T^R \tau\left(T^R\right) d\mu_1^R(e),
\end{aligned} \tag{47}
$$

where the left hand side and right hand side denote the allocation and funding of the public administration, respectively.

The monetary authority is assumed to set the nominal interest rate i following the Taylor rule:

$$
i = i^* + \Phi_\pi(\pi - \pi^*) + \Phi_U(u - u^*), \tag{48}
$$

where an asterisk superscript over a variable denotes its the steady-state value. The link between nominal and real interest rates is governed by the Fisher equation:

$$
1 + i \equiv E(1+\pi')(1+r). \tag{49}
$$

E.5 Market clearing and equilibrium

The goods market clearing condition requires that the aggregate demand of labor services from the price setters equals supply

$$\int_0^1 y_i di \equiv Y = \int x d\mu_1(e, x, \alpha). \tag{50}$$

Moreover, the total demand for shares of the mutual fund, which is obtained by aggregating the optimal savings decisions across the workers distribution, must equal supply:

$$\int g^U(e)\, d\mu_1^U(e) + \int g^E(e, x, \alpha)\, d\mu_1^E(e, x, \alpha) + \int g^R d\mu_1^R(e) = P^e S^e, \tag{51}$$

where the total amount of shares of the mutual fund S^e is chosen such that $P^e S^e$ is normalized to unity in the stationary equilibrium, g denotes the saving policy functions, i.e., the optimal choice of e' for every combination of $\{e, x, \alpha\}$ defined for each of the three labor market states, unemployment, employment and participation, respectively.

Finally, labor market clearing requires that the sum of the employed, unemployed and retirees equals unity, both at the beginning and at the end of a period:

$$\int d\mu_j^E(e, x, \alpha) + \int d\mu_j^U(e) + \int d\mu_j^R(e) = 1, \quad \text{for} j \in \{0, 1\}. \tag{52}$$

E.6 Laws of motion

Define $\mathcal{E}_t^E(e'; e, x, \alpha) = \left\{e \in \mathcal{E} : g^E(e, x, \alpha) = e'\right\}$, $\mathcal{E}_t^U(e'; e) = \left\{e \in \mathcal{E} : g^U(e) = e'\right\}$ and $\mathcal{E}_t^R(e'; e) = \left\{e \in \mathcal{E} : g^R(e) = e'\right\}$ denote the set of period-t share holdings e that map into a given level of next-period share holdings e' by employment status, through the policy functions g.

Intertemporal law of motion for the employed

$$\mu_{0,t+1}^E(e', x', \alpha') = \left(1 - \psi^R\right)(1 - \delta)\, \mu_{1,t}^E(e', x', \alpha'), \tag{53}$$

Intratemporal law of motion for the employed

$$\begin{aligned}
\mu_{1,t}^E(e', x', \alpha') = &\sum_{e \in \mathcal{E}_t^E} \mu_{0,t}^E(e, x', \alpha') \left[\left[1 - \xi(e, x', \alpha') f(\theta)\right] + \xi(e, x', \alpha') f(\theta) \sum_{\widetilde{x} < x'\alpha'} G^x(\widetilde{x})\right] \\
&+ \sum_{\alpha} \sum_{e \in \mathcal{E}_t^E} \mu_{0,t}^E(e, x', \alpha)\, \xi(e, x', a) f(\theta) G^x(x'\alpha')\, \mathbf{1}_{x'\alpha' > x'\alpha} \\
&+ \sum_{\alpha} \sum_{e \in \mathcal{E}_t^E} \mu_{0,t}^E\left(e, \underbrace{\alpha' x'}_{x}, \alpha\right) \xi(e, \alpha' x', a) f(\theta) G^x(x') \\
&+ \sum_{e \in \mathcal{E}_t^U} \mu_{0,t}^U(e) f(\theta) G^x(x')\, \mathbf{1}_{\alpha' = \frac{x}{x'}}
\end{aligned} \tag{54}$$

The first raw in the above expression refers to the employed workers who do not search for jobs, or, if they search and find a job, they get an outside offer that is too low to renegotiate the wage with the current employer.

The second row refers to the employed workers who find a job leading to renegotiate their wage at the current employer such that they extract a share α' of the incumbent's productivity x.

The third row refers to workers who are employed in some job with productivity x, search for a job and find one that leads them to shift to a different employer of productivity x', and such that they extract exactly a share α' of the poacher's productivity.

The fourth row refers to the unemployed workers who match with a job with productivity x', and such that the share of output paid as wages is exactly $\alpha' = \underline{x}/x'$.

Intertemporal law of motion for the unemployed

$$\mu^U_{0,t+1}(e') = \left(1-\psi^R\right)\mu^U_{1,t}(e') + \left(1-\psi^R\right)\delta\sum_{\alpha}\sum_{x}\sum_{e\in\mathcal{E}^U_t}\mu^E_{1,t}(e,x,\alpha) + \psi^D\sum_{e\in\mathcal{E}^R_t}\mu^R_{1,t}(e) \tag{55}$$

Intratemporal law of motion for the unemployed

$$\mu^U_{1,t}(e') = \sum_{e\in\mathcal{E}^U_t}\mu^U_{0,t}(e)\left[1-f(\theta)\right] \tag{56}$$

Intertemporal law of motion for the retirees

$$\mu^R_{0,t+1}(e') = \left(1-\psi^D\right)\sum_{e\in\mathcal{E}^R_t}\mu^R_{1,t}(e) + \psi^R\sum_{e\in\mathcal{E}^U_t}\mu^U_{1,t}(e) + \psi^R\sum_{x,\alpha,e\in\mathcal{E}^E_t}\mu^E_{1,t}(e,x,\alpha) \tag{57}$$

Intratemporal law of motion for the retirees

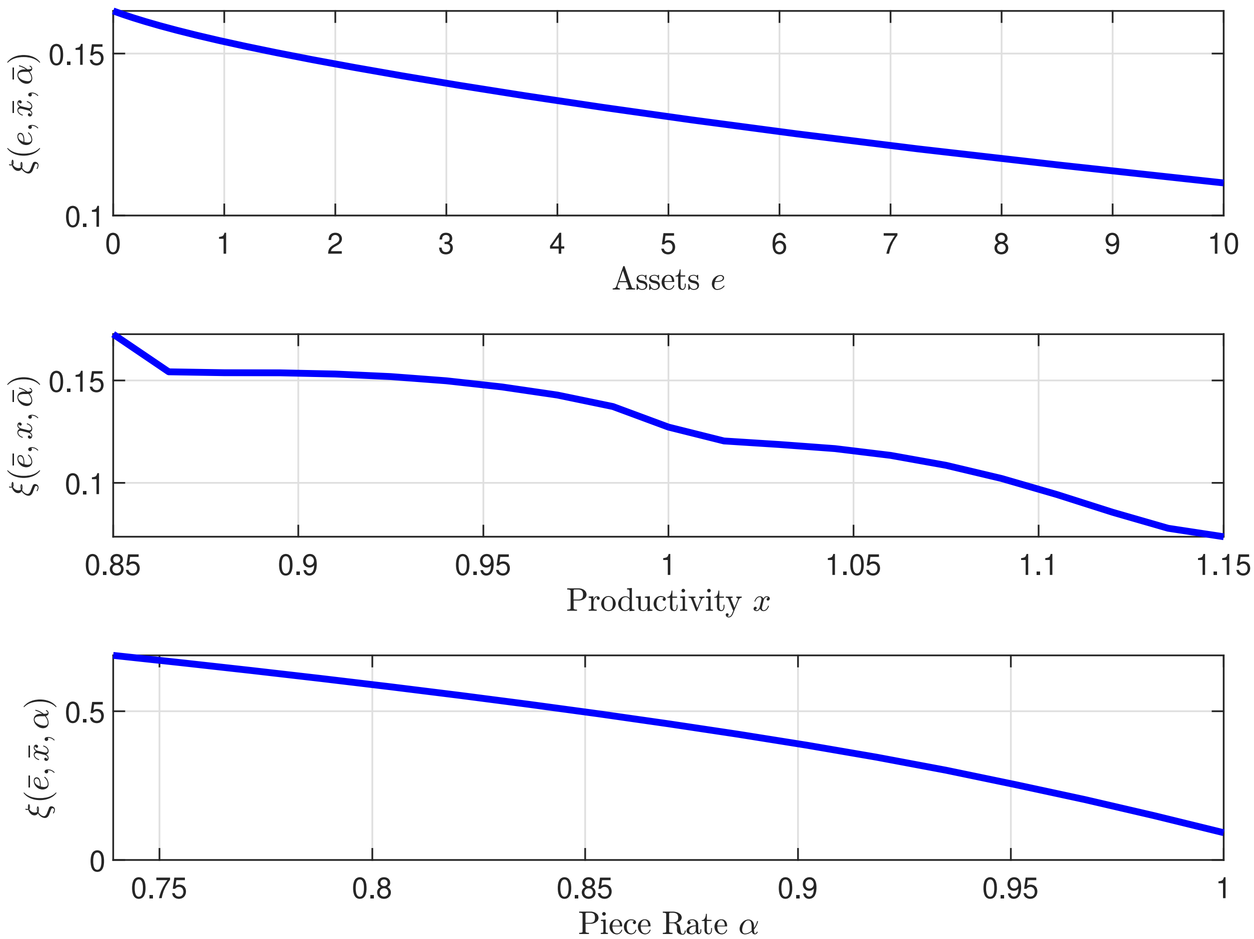
$$\mu^R_{1,t}(e') = \mu^R_{0,t}(e') \tag{58}$$

F Model determinants of OJS decisions in HANK

In the HANK model, workers decide to search on the job in any given period provided that, given the draw of a stochastic search cost, the value of searching exceeds the value of not searching. The share of workers searching on the job, $\xi(e,x,\alpha)$ depends on wealth, e, productivity, x, and the share of output paid as wages, α. Figure F6 shows how $\xi(e,x,\alpha)$ depends on each of its arguments, by changing one variable at the time, and keeping the other two fixed at their median value.

As shown in the top panel, OJS decreases with increasing wealth, all else being equal. This is intuitive, as the marginal propensity to consume declines with wealth, reducing the utility gains from higher earnings. Quantitatively, the impact of wealth on the optimal decision to search on the job is small, as can be noticed by comparing the range of changes in OJS induced by wealth relative to the other two determinants, especially wage piece rates.

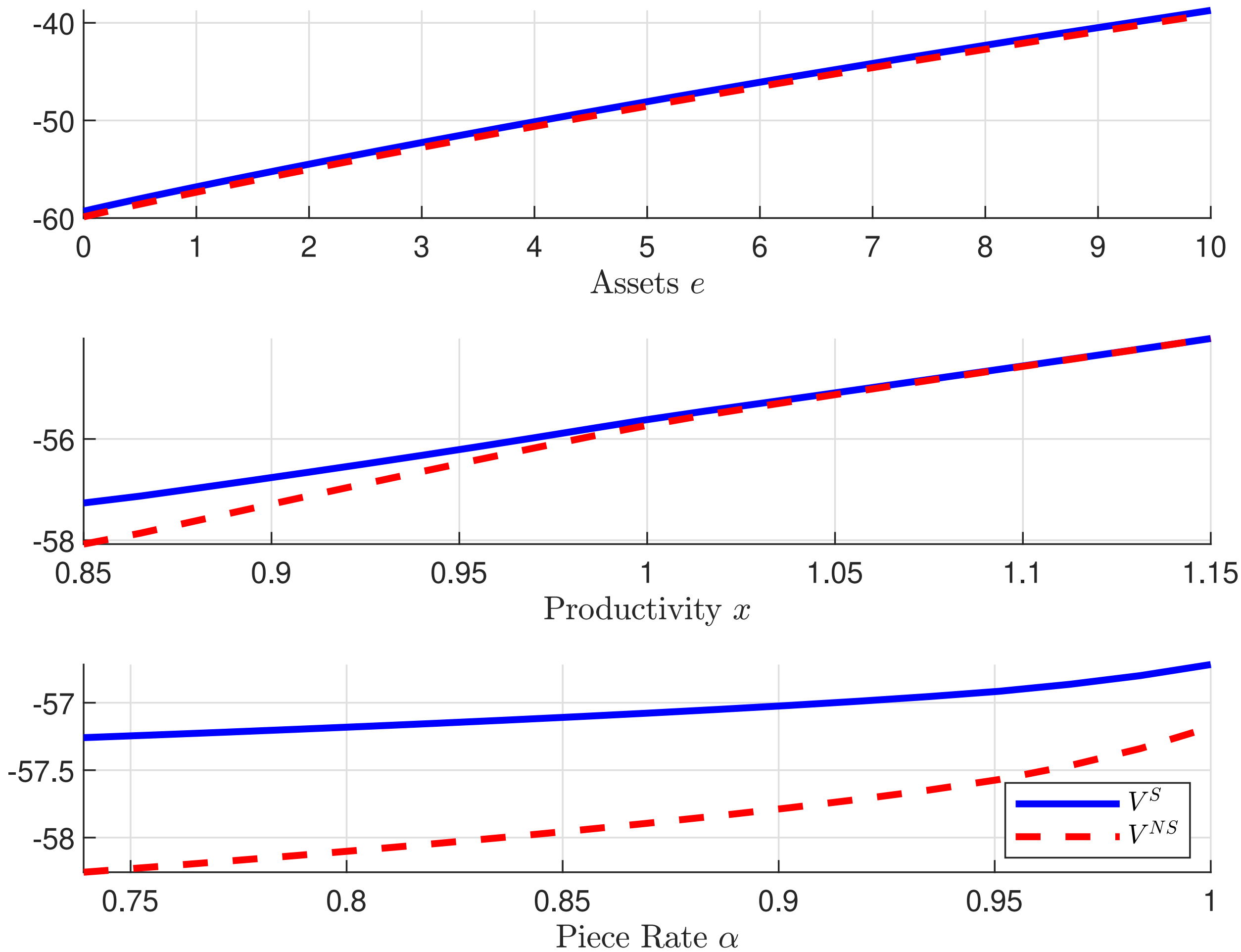
Figure F6: The determinants of on-the-Job Search



Notes: This figure shows how the share of workers searching on the job, $\xi(e, x, \alpha)$, depends on its three arguments. In the panels above we change one variable at the time, holding the other two arguments fixed at their median values.

The middle panel shows that the incidence of OJS decreases with higher match productivity. This result arises from the difference between the value of searching and the value of not searching. While both values increase with productivity, the value of not searching grows faster due to the concavity of the utility function. This relationship is illustrated in Figure F7 below. Finally, the share of workers engaging in OJS decreases as the share of output received as wages increases. Intuitively, workers who already receive the maximum possible share of output have no incentive to search for alternative employment.

Figure F7: Value Functions of searching and not searching



Notes: The blue solid line and red dashed line show the value of searching and not searching, respectively.