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On-the-Job Search and Inflation under the Microscope*

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Abstract

We develop a Heterogeneous Agents New Keynesian (HANK) model with a job ladder and endogenous on-the-job search (OJS) that challenges the traditional view of a negative relationship between unemployment and inflation. On the one hand, OJS is inflationary, sparking wage competition among firms to attract or retain workers. On the other hand, OJS strengthens workers' bargaining power, reducing firms' incentives to post vacancies and thereby increasing unemployment. The model explains the effects of the 2012 Danish tax reform, which influenced OJS differentially across the income distribution, on the employment transitions and wage growth observed in the microdata.

JEL Codes:

Keywords: Job ladder models; inflation; Danish microdata

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1 Introduction

A large body of research highlights an increasing disconnect between inflation and the labor market (e.g. Stock and Watson, 2008; Coibion and Gorodnichenko, 2015; Stock and Watson, 2020). The empirical fit of the Phillips curve—first proposed by A.W. Phillips in 1958 as an inverse relationship between unemployment and wage growth, later expanded to connect price inflation and unemployment—has steadily eroded, epitomizing this disconnect. This paper argues that the inflation-labor market relationship extends beyond the traditional link between unemployment and wages. Specifically, workers' on-the-job search (OJS) decisions significantly influence wage dynamics. Increased OJS heightens competition among employers, spurring wage growth via new job offers or counteroffers to retain employees.

We investigate the positive relationship between OJS and wage dynamics on both theoretical and empirical grounds. We start by constructing a Heterogeneous Agents New Keynesian (HANK) model featuring endogenous decisions to search on the job, a job ladder, and sequential auction bargaining in the spirit of Postel-Vinay and Robin (2002). In each period, employed workers face a stochastic search cost and optimally choose whether to search based on whether the expected benefits outweigh the cost. OJS enables workers to climb the job ladder by transitioning to more productive matches. 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 in this model, driven by individual reallocation decisions that result in better matches and wage renegotiations. This heterogeneous-agents framework enables us to analyze how exogenous changes in OJS incentives affect the composition of the job seekers' pool and the wage distribution within a microfounded general equilibrium model.

The next step is to empirically validate the model. To this end, we evaluate its ability to explain the cross-sectional effects of the 2012 income-tax reform in Denmark on OJS and wage dynamics in the microdata. The 2012 Danish reform raised the income threshold for the highest tax rate, effectively reducing the marginal tax rate for high-income workers. This policy change differentially impacted workers' incentives to search across the income distribution, providing a compelling natural experiment to test the predictions of our HANK model.

In the model, the effect of a change in the tax threshold on incentives for on-the-job search—and consequently on wage inflation—varies across the income distribution. For workers earning well below the original threshold, a job-to-job transition would still be taxed at the lower marginal rate, so their on-the-job search behavior remains largely unchanged before and after the reform. Similarly, workers earning above the new threshold continue to face the same high marginal tax rate, meaning the reform has no impact on their search incentives either. The group most affected lies between these extremes, particularly near the old income-tax threshold. For these workers, all post-reform wage gains from job transitions are taxed at a lower marginal rate than before. This differential impact of the reform on search incentives across income levels creates an inverse-V-shaped response in the share of employed job seekers.

The inverse V-shaped response in the share of employed job seekers leads to an inverse V-shaped pattern in employment-to-employment (EE) transition rates. This pattern also appears in the differential wage growth rates before and after the tax change but only among stayers, not leavers. For job changers, gross wage growth remains unaffected by the tax schedule change, as their wage offers still come from the same underlying distribution. However, the share of employed workers able to renegotiate their wages upward with their current employers increases with the share of employed workers who receive valuable outside offers. Since this response across the income distribution is proportional to the share of employed job seekers, the wage growth for stayers also exhibits an inverse V-shaped pattern.

We employ a difference-in-differences research design using Danish microdata to analyze the causal impact of tax reform-induced changes in job search incentives on EE transition rates and wage growth across different income levels. The results reveal an inverse V-shaped response in both EE transition rates and wage inflation for stayers, with no response in wage inflation for leavers, supporting the predictions of the HANK model. Quantitatively, the results are significant: EE transition rates and wage growth for stayers increase by approximately 10 percentage points near the 2012 threshold. Notably, the vast majority of the workforce consists of stayers, who remain in the same job within a year, and therefore do not experience the change in match-specific productivity that is typically associated with job changes. Moreover, the wage growth of job-movers is unaffected by the tax change: the change in the tax threshold incentivizes OJS, which increases the rate at which workers change jobs, but not the wage growth conditional on a transition.

We use our validated HANK model to study the general equilibrium effects of lowering OJS, and find that policies that reduce aggregate OJS would simultaneously decrease unemployment and wage inflation. In the model, a lower marginal tax rate raises the incentive to search on the job to secure a higher salary. Workers receiving external offers can leverage them to negotiate a better salary with their current employer, or choose to switch to a different job. Since not all workers receiving the salary raise move up the job ladder to start a more productive job, the distribution of unit labor costs shifts persistently to the right, leading firms to raise their prices. Concurrently, the stronger bargaining position of the employed workers reduces firms' incentives to post new vacancies, leading to an increase in unemployment and further increases in wages and prices. Therefore, in the model, exogenous shocks or policy changes that affect workers' incentives to search while employed create a positive comovement between unemployment and wages. This dynamic weakens the negative relationship between unemployment and wage growth predicted by the Phillips curve.

The mechanism underlying the model's predictions hinges on competition among firms to either poach or retain workers. Anecdotal and survey evidence indicates wage competition for staff retention, highlighting the role of wage bidding in recent inflationary dynamics and its divergence from traditional indicators of labor market slack. According to Financial Times (2023), a survey by the Chartered Institute for Personnel and Development (CIPD) found that bidding wars are becoming increasingly prevalent in the UK labor market, with 40% of surveyed firms reporting the use of counteroffers to retain employees as of August 2023. CIPD (2023) suggests that this trend may help explain the unexpectedly high wage growth observed despite signs of a cooling labor market. Our finding that changes in OJS incentives across the income distribution produces consistent patterns in both EE transitions and the wage growth of stayers further supports this narrative and the bargaining protocol that formalizes this mechanism.

Our work is directly related to the recent literature that explores inflation dynamics through job ladder models of the labor market. For example, seminal work by Moscarini and Postel-Vinay (2023) demonstrates how cyclical labor misallocation influences the transmission of shocks to inflation; their model holds the OJS rate constant, abstracting from the channel central to this paper. Faccini and Melosi (2023) develop a model-based indicator of labor market slack that allows for shocks to the rate of OJS, explaining both the "missing inflation" before the pandemic and some of the wage growth observed during the Great Resignation. Similarly, Alves (2020) and Birinci et al. (2023) find comparable results, using a theoretical framework that pioneers the nesting of job ladder models into a setup with heterogeneous households. Relative to their work, our framework endogenizes OJS decisions and adds income taxes, two crucial elements we require to bring the model to the Danish microdata. 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. 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.

Compared to this literature, we contribute both theoretically and empirically. On the theoretical side, we demonstrate how, when wage and price inflation are influenced by the search behavior of the employed, economic policies can potentially reduce inflation without necessarily increasing unemployment. Empirically, we examine the effects of taxes on EE transitions and wages using Danish microdata. By specifically analyzing the wages of stayers, we provide causal evidence that supports the foundational assumptions of this class of models.

Our paper closely relates to the literature on fiscal and monetary policy interactions. Over the past decade, significant policy and academic interest has centered on whether—and how—alternative policy tools can replicate monetary stimulus when nominal interest rates are constrained by the effective lower bound (Wolf, 2024). More broadly, Blanchard (2024) argues that fiscal policy should complement monetary policy in stabilizing both output and inflation, even outside periods when the lower bound is binding, due to the lack of ”divine coincidence.” Building on this literature, our paper presents a novel mechanism for fiscal policy transmission that influences incentives for job mobility, potentially circumventing the trade-offs typically faced by monetary authorities.

Our paper also relates to a broad literature on the impact of income taxes on labor market outcomes. Traditionally, this research has focused on how taxes affect the intensive and extensive margins of labor supply (see Keane, 2011, and Chetty et al., 2013, for reviews). Our model departs from these channels to highlight a different mechanism, which depends on the response of on-the-job search—a relatively underexplored aspect of labor supply decisions. Closely related to our work is Bagger et al. (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, while we investigate how taxes influence inflation.

The paper is organized as follows. Section 2 introduces a HANK job-ladder model with endogenous on-the-job search and taxation. Section 3 describes the datasets used in the empirical analysis, while Section 4 covers the calibration of the HANK model. Section 5 examines the effects of a shift in the high-income tax threshold on EE rates and wages across the income distribution, both theoretically and empirically. Section 6 examines the general equilibrium effects of this policy, along with other policies that influence the cost of on-the-job search, on macroeconomic aggregates. Finally, Section 7 concludes the paper.

2 The Model

We present a HANK model extended to include a job ladder, endogenous on-the-job search and taxes. This setup allows us to investigate how tax shocks affect macroeconomic dynamics when on-the-job search responds to incentives. In Section 5, we show that in this model, a change in the income threshold for the marginal tax rate produces differential responses in the rate of on-the-job search, EE transitions and wage growth across the income distribution. These theoretical predictions highlight a key mechanism, whereby income taxes affect wage inflation through the impact on on-the-job search.We then test for these results making use of administrative Danish microdata.

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 cost of search from a stochastic 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, income processes evolve endogenously in this model, in the sense that they originate from individual search and reallocation decisions, which lead to better matches and wage renegotiations. This marks a difference with respect to the standard HANK setup, where income processes are assumed to evolve exogenously.

Each period, households decide how much to consume and save. The savings decision takes into account the income risk that arises from the existence of frictions in the labor market. In the asset market, the individuals trade shares of a mutual fund, which owns all government bonds and firms in the economy, redistributing all profits as dividends.

We assume the economy consists of two types of firms. Service-sector firms decide whether to post a vacancy to form a match with a job seeker. Once a match is formed, the firm produces a homogeneous good, which is sold to monopolistically competitive price setters. Price setters differentiate the homogeneous good purchased from service-sector firms and sell it to households. Price setters choose the price of the differentiated good given a downward-sloping demand function and nominal price rigidities *à la* Rotemberg. Finally, a monetary authority is in charge of setting the nominal interest-rate policy, while the fiscal authority levies income taxes 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, $\phi(\theta)$, 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 and job seekers, i.e. $\theta = \frac{v}{S}$. Homotheticity of the meeting function implies that $d\phi(\theta)/d\theta > 0$ and $dq(\theta)/d\theta < 0$. Upon contact, the worker draws match productivity from a distribution G^x, defined over the support $[\underline{x}, \overline{x}]$ and receives a wage offer (details below) that can be accepted or rejected. Every period, matches can be terminated either because of an exogenous shock that hits with probability δ, or because workers endogenously reallocate to other firms.

The bargaining protocol follows Bagger et al. (2014) and assumes that firms Bertrand compete 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 the full production of the least productive firm in the economy, $\underline{x}$.

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 $\zeta \in (0, 1)$ represents the maximum share of output that a worker with piece-rate $\alpha = 1$ can capture as wage. 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 $w(x, 1) + \epsilon$, where $\epsilon \approx 0$ is an arbitrarily small value. Bertrand competition implies that the worker will switch employer, and receive the wage schedule $w(x', x/x')$, 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. In this case, the worker 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 $max\{w(x, \alpha), w(x, x'/x)\}$.

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 $\xi(e, x, \alpha)$ 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:

$$S = \int d\mu_0^U(e) + \int \xi(e, x_0, \alpha)\, d\mu_0^E(e, x_0, \alpha)\,. \tag{1}$$

2.3 Timing of events

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, production takes place, wages, interest rates, dividends and government transfers are paid, taxes are levied and consumption decisions are taken. At the end of the period, idiosyncratic, retirement, and death shocks take place.

In what follows, we denote by the time subscript 0 the value of a variable defined at the beginning of the period, i.e. at the stage where the search decision is taken. We denote by the subscript 1 the value at the end of a period, i.e. when the consumption/savings decision is taken.

2.4 Workers

We let U, V and Γ denote the value function associated with the states of unemployment, employment and retirement, respectively. All individuals derive utility from the consumption of a homogeneous good c as dictated by the function $u(c)$. The price of the consumption good, which is the *numeraire* in this economy, is denoted by P. Workers receive an amount D of dividend payments for each share they hold of the mutual fund. Shares are noted by e, and their unit price by P^e. They also receive wage payment $w(x, \alpha)$ if employed, unemployment benefits b if unemployed and pensions T^R if retired. All income from the labor market is taxed at the rate τ, where τ is a function of income, which we specify below. Finally, all workers receive the same amount of transfers T from the government.

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

$$U(e) = u(c) + \left(1 - \psi^R\right) \beta \left[f(\theta') E_x V_1 \left(e', x, \frac{x}{x}\right) + (1 - f(\theta')) U(e') \right] + \beta \psi^R \Gamma(e'), \qquad (2)$$

subject to the budget constraint

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

where $\beta \in (0, 1)$ is the discount factor, E denotes the expectation operator, ψ^R is the probability that at the end of a period a worker retires and a $'$ superscript denotes next period values. 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. Specifically, if the worker does not retire at the end of the period with probability ψ^R, she will be either employed or unemployed at the end of the following period with probabilities $f(\theta)$ and $1 - f(\theta)$, respectively. And if the worker ends-up employed in a match with productivity x, she will only be able to make a first step on the wage ladder, starting with a salary equal to $\underline{x}\zeta$, which correspond to a piece-rate $\alpha = \underline{x}/x$.

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:

$$V_1(e, x_1, \alpha) = \max_{e' \geq 0, c} \left\{ u(c) + \beta \left(1 - \psi^R\right) \left[(1-\delta) V_0(e', x_1, \alpha) + \delta U(e')\right] + \psi^R \Gamma(e') \right\} \tag{3}$$

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:

$$V_0(e, x_0, \alpha) = \int_\phi \widetilde{V}_0(e, x_0, \alpha, \phi) G^\phi(d\phi), \tag{4}$$

where

$$\widetilde{V}_0(e, x_0, \alpha, \phi) = \max\left\{-\phi + V_0^S(e, x_0, \alpha), V_0^{NS}(e, x_0, \alpha)\right\}, \tag{5}$$

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:

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

$$\begin{aligned} V^S(e, x_0, \alpha) = {} & f(\theta) E_{\widetilde{x}} \max\left\{ V_1\left(e, \widetilde{x}, \frac{x_0}{\widetilde{x}}\right), V_1\left(e, x_0, \max\left\{\alpha, \frac{\widetilde{x}}{x_0}\right\}\right)\right\} \\ & + (1 - f(\theta)) V_1(e, x_0, \alpha). \end{aligned} \tag{6}$$

The first term inside the curly brackets is the value of a worker who has met with another firm with probability $f(\theta)$, and will be employed next period in another firm at productivity $\widetilde{x} > x$; the second term is the value of a worker who has got in touch with another firm with probability $f(\theta)$, and has re-bargained his wage with the current employer at the new wage: $\max\left\{\alpha, \frac{\widetilde{x}}{x}\right\} \zeta F x_0$. This case occurs whenever the productivity of the incumbent firm is greater than the productivity of the poacher, i.e. $x > \widetilde{x}$. With probability $(1 - f(\theta))$ the worker does not meet with any vacancy and therefore gets the same value she would have got without searching. Opening the expectation operator, the above equation can be rewritten

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

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

$$-\phi^T + V^S(e, x_0, \alpha) = V^{NS}(e, x_0, \alpha). \tag{7}$$

The solution to this problem is a rule, which can be expressed by the indicator function $I_{\phi<\phi^T}(e, x_0, \alpha) = 1$, which means that the worker searches if and only if $\phi < \phi^T$. For future convenience, it is helpful to denote by $\xi(e, x, \alpha)$ 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

$$\Gamma(e) = \max u(c) + \beta\left(1 - \psi^D\right)\Gamma(e') \tag{8}$$

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.

2.5 Labor service firms

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

$$J(e, x, \alpha) = p^l x - w(x, \alpha) + \frac{1}{1+r}\left(1 - \psi^R\right)(1 - \delta)$$
$$\times \{[(1 - \xi(e', x, a)) + \xi(e', x, a)(1 - f(\theta'))] J(e', x, \alpha)$$
$$\left. + \xi(e', x, a) f(\theta') \int_{\underline{x}}^{x} J\left(e', x, \max\left\{\alpha, \frac{\widetilde{x}}{x}\right\} dG^x(\widetilde{x})\right) \right\}, \tag{9}$$

where e' satisfies the savings policy function of the workers, i.e., $e' = g^E(e, x, \alpha)$. The above expression relates the present value of a match to current period profits and expected future values. The profits are given by the value of production x, measured in terms of the consumption good, p^l, minus the real wage. 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 the assets of the worker, its current productivity and the piece-rate wage that he is able to command. If the worker does not search, with probability $1 - \xi(e', x, a)$, or if the worker searches but does not meet a vacancy, with probability $\xi(e', x, a)(1 - f(\theta'))$, the match will continue with the same productivity x and piece-rate α. If the worker instead searches and finds a job, with probability $\xi(e', x, a) f(\theta')$, the match will continue only if the worker meets with a firm with lower productivity than the incumbent, i.e. for any $\tilde{x} < x$, where $\tilde{x}$ is the poacher's productivity. In this case, the wage will be renegotiated upwards with the incumbent 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 seeker, who are either employed or unemployed. The free entry condition, which equates the expected costs and returns from a match, is:

$$\kappa^f + \frac{\kappa}{q(\theta)} = \frac{1}{S_t} \left[\int_e \int_{\widetilde{x}} J\left(e, \widetilde{x}, \frac{\underline{x}}{\widetilde{x}}\right) dG^x(\widetilde{x})\, d\mu_0^U(e) \right. \\ \left. + \int_{e,x,\alpha} \int_x^{\overline{x}} J\left(e, \widetilde{x}, \frac{x}{\widetilde{x}}\right) dG^x(\widetilde{x})\, \xi(e, x, \alpha)\, d\mu_0^E(e, x, \alpha) \right] \tag{10}$$

On the LHS, 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.

On the RHS, the expected return is broken down into two terms: the first (second) integral expression inside the squared brackets characterizes the expected return of meeting with an unemployed (employed) worker. The value of a match with an unemployed depends on the stochastic productivity draw, and assumes 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 her employer, the piece rate of her current wage contract, as well as the distribution of on-the-job search across the state-space.

The free entry equation (10) is key to understand the mechanism. The value to the firm of meeting with a worker unemployed is higher, everything else equal, than the value of meeting with a worker employed, because unemployed workers are cheaper to hire, given that they are not able to elicit wage competition between employers. A fall in the share of job seekers that are employed will increase the chances of meeting with an unemployed worker, reducing in expectation the wage payments of a new hire and increasing the surplus of a match on the RHS. With flexible prices, labor market tightness is the only variable that adjusts to restore the equilibrium in the labor market. Namely, tightness would increase, reducing the vacancy filling rate and increasing the expected vacancy costs required to meet a worker on the LHS.

With nominal price rigidities though, there is a second variable that can adjust to restore the equilibrium: it is the relative price of the labor service p^l, which appears inside the expression for the value function J in equation (9). Namely, when the share of employed job seekers falls, the value of the labor service also falls, reducing the value of the expression on the RHS, which compensates for the expected increase in match surplus. Intuitively, lower expected wage payments in the service sector are passed through as a lower cost of the homogeneous service that is provided to the intermediate fringe of producers. Hence, in this model, the current and future path of real marginal costs p^l is directly affected by the composition of the pool of job seekers; specifically, it is related positively to how many employed workers decide to search on the job and negatively to the rate of unemployment.

2.6 Price setting firms

Intermediate goods producers purchase one unit of the homogeneous labor service and transform it into one unit of a differentiated good, subject to the demand function from the workers. Under the standard assumption that workers minimize the expenditure required to consume a CES bundle of differentiated products, the demand for an individual variety is given by

$$y_i = \frac{p_i}{P}^{-\eta}, \tag{11}$$

where η is the elasticity of substitution across varieties.

The problem of the price setters is to maximize current and expected profits subject to the demand constraint in equation (11) and quadratic price adjustment costs *à la* Rotemberg. The value function of the price setters solves:

$$\Omega(p_{i,-1}) = \max_{p_i}(p_i - p^l)y_i - \frac{\eta}{2\vartheta}log\left(\frac{p_i}{p_{i,-1}}(1+\pi)\right)^2 Y + \frac{1}{1+r}\Omega(p_i), \tag{12}$$

where ϑ is a price adjustment cost parameter.

The solution of the maximization problem is the standard Phillips curve:

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

2.7 Fiscal and monetary authorities

The fiscal authority levies income taxes and administers lump sum transfers to ensure that the budget balances period-by-period. Define two threshold levels of real income 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:

$$\begin{aligned} B_{-1} + T + P\int b d\mu_1^U(e) + P\int T^R d\mu_1^R(e) = & \frac{B}{1+i} \\ & + P\int b\tau(b)\, d\mu_1^U(e) \\ & + P\int w(e,x,\alpha)\,\tau(w(e,x,\alpha))\, d\mu_1^E(e,x,\alpha) \\ & + P\int T^R\tau\left(T^R\right) d\mu_1^R(e), \end{aligned} \tag{13}$$

where the LHS and RHS denote the allocation and funding of the public administration, respectively. Namely, the government revenues on the RHS are given by the new emissions of public debt in present value, $B/(1+i)$, and by the taxes levied on the unemployed, the employed and the retirees. These funds can be used to repay outstanding government debt, transfers, unemployment benefits and pensions. It is assumed that Transfers T are distributed equally across the entire population of workers, including the employed, the unemployed, and the retirees. 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 following the Taylor rule:

$$i = i^* + \Phi_\pi(\pi - \pi^*) + \Phi_U(u - u^*), \tag{14}$$

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:

$$1 + i \equiv E(1 + \pi')(1 + r). \tag{15}$$

2.8 Mutual fund

The mutual fund owns all government bonds and firms in the economy. The no arbitrage condition across these two assets implies that the returns on investing in bonds and ownership of firms are equalized:

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

It is assumed that all balances are redistributed as dividends to the shareholder, including profits and changes in the value of bond holdings i.e.,

$$D = B_{-1} - \frac{B}{1+i} + P\Pi^I + P\Pi^S,$$

where Π^I and Π^S denote the profits of the price setters and the firms operating in the service sector, respectively. Specifically, the profits of the intermediate producers are given by:

$$\Pi^I = \left(1 - p^l - \frac{\eta}{2\vartheta} \log\left(1 + \pi - \pi^*\right)^2\right) Y,$$

where $1 - p^l$ is the real marginal profit obtained from selling one unit of the differentiated product purchased at the relative price p^l, net of the Rotemberg costs of price adjustment. The profits of service sector are given by the period profits integrated across the employment distribution:

$$\Pi^S = \int \left[p^l x - w\left(x, \alpha\right)\right] d\mu_1^E\left(e, x, \alpha\right).$$

2.9 Market clearing and equilibrium

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

$$\int_0^1 y_i di \equiv Y = \int x d\mu_1\left(e, x, \alpha\right). \tag{16}$$

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, which is normalized to unity:

$$\int g^U\left(e\right) d\mu_1^U\left(e\right) + \int g^E\left(e, x, \alpha\right) d\mu_1^E\left(e, x, \alpha\right) + \int g^R d\mu_1^R\left(e\right) = 1, \tag{17}$$

where 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:

$$\int d\mu_j^E\left(e, x, \alpha\right) + \int d\mu_j^U\left(e\right) + \int d\mu_j^R\left(e\right) = 1, \quad \text{for} j \in \{0, 1\}. \tag{18}$$

2.10 Computational strategy

In Appendix D, we describe in details the algorithms we use to solve for both the stationary equilibrium and the transitional dynamics.

3 Data

We combine various administrative records provided by Statistics Denmark. At the heart of our analysis are three data sets.

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.[1] 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, as demonstrated by Bagger et al. (2014), Bertheau et al. (2020), and Bagger et al. (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

[1] 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.

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.[2] 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.

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 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 lognormal, and defined by the mean and dispersion parameters ω_x and σ_x, with the restriction $\omega_x = -\sigma_x^2/2$, which implies that the mean of the distribution is normalized to one. 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 chose in order to match an expected duration of retirement of twenty years and an expected duration of work life of forty, as in Birinci et al. (2023).

The elasticity of substitution between goods, η, is set to 6, which implies a markup of 25%, as estimated by Adam et al. (2024) for the Danish economy. The discount factor is set to .9875, as in Faccini et al. (2024). The marginal tax rates τ_L and τ_H are set to 0.4226 and 0.5606, which are the income tax rates in force in Denmark in 2012. The elasticity of the matching function, ξ, is set to 1.6, in line with estimates by Schaal (2017) on the US economy.

[2]For a fuller discussion, we refer to Caplin et al. (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.

Calibration			
Parameters	Description	Value	Target/source
β	Discount factor	0.9875	Faccini et al. (2024)
χ	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	Low marginal tax rate	0.0800	Danish data
ζ	Scale parameter wage function	0.6850	Calibrated
δ	Job separation rate	0.0400	Calibrated
w^H	High income tax threshold	0.7200	Calibrated
b	Unemployment benefits	0.1500	Calibrated
T^R	Pension income	0.3000	Calibrated
κ	Flow cost of vacancy	0.0769	Calibrated
κ^f	Fixed cost of hiring	1.2800	Calibrated
ω_x	Mean parameter productivity dist.	−0.011	Normalization
σ_x	Dispersion parameter productivity dist.	0.1500	Calibrated
ϑ^l	Lower bound cost-search distribution	0.0000	Normalization
ϑ^u	Upper bound cost-search distribution	0.5000	Calibrated
φ	Slope of Phillips Curve	0.05	Hansen and Hansen (2007)
ϕ_π	Taylor rule response to inflation	1.8000	Conventional
Variable	Description	Model	Target
	Steady-state calibration targets		
$\frac{c}{q(\theta)}/c^f$	Ratio of variable to fixed cost	0.0771	0.0780
$EE \equiv \frac{\int \xi(e,x,\alpha) f(\theta) d\mu_0^E(e,x,\alpha)}{\int \mu_0^E(e,x,\alpha)}$	EE transition rate	0.0300	0.0300
$\int w(x,\alpha) d\mu_1^E(e,x,\alpha)/Y$	Labor share of income	0.6123	0.6300
$\int \mathcal{I}_{w(x,\alpha)<w^H} d\mu_1^E(e,x,\alpha)$	Share of workers earning less than w^H	0.5358	0.5300
$f(\theta)$	UE transition rate	0.4978	0.4800
$\int \frac{w(x',\alpha')-w(x,\alpha)}{w(x,\alpha)} \mathcal{I}_{EE=1} d\mu_1(e,x,\alpha)$	Wage growth for leavers	0.0809	0.0800
$(1-\tau)b/\int w(x,\alpha) d\mu_1^E(e,x,\alpha)$	Average unempl.- over empl.-income	0.2912	0.2966
$(1-\tau)T^R/\int w(x,\alpha) d\mu_1^E(e,x,\alpha)$	Average pension- over empl.-income	0.4900	0.4900
$\int w(x,\alpha) d\mu_1^E(e,x,\alpha)/w^H$	Average empl. income over w^H	0.9649	1.1000

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

This leaves us with nine parameters to calibrate: ζ, δ, w^H, b, T^R, κ, κ^f, ϑ^u, and σ_x. 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 associated with the moment it is designed to match.

The maximum share of output paid as wages, ζ, is calibrated to replicate a labor-income share of 63 percent. The job separation rate, δ, is adjusted to match a quarterly unemployment-to-employment (UE) transition rate of 48 percent. The high-income tax threshold, w^H, is set to ensure that the share of employed workers earning below this threshold equals 53 percent. The unemployment benefits parameter, b, is calibrated to reproduce a ratio of net unemployment income to average gross employment income of around 30 percent.[3]

The transfer to retired workers, T^R, is calibrated to match a ratio of average net pension payments to average gross employment income of 0.67. The variable cost of posting vacancies, κ, is adjusted to match the ratio of total variable costs of hiring to fixed costs, $\frac{c/q(\theta)}{c^f}$, at 0.078, consistent with estimates from Silva and Toledo (2009).[4] The fixed cost of posting vacancies, κ^f, which in turn affects the strength of labor demand, is calibrated to ensure that average employment income equals 110 percent of the high-income tax threshold, w^H. The upper bound of the uniform search-cost distribution, ϑ^u, is calibrated to match the EE transition rate of 2.5 percent.

Finally, the dispersion parameter of the idiosyncratic productivity shock process, σ_x, is set to reproduce an average wage increase of 8 percent for workers experiencing an EE transition.[5]

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 The Effects of a Danish Tax Reform: Model vs. Data

This section examines how changes in job search incentives, driven by tax reforms, affect wage negotiations and inflation, comparing model outcomes with empirical estimates. We implement a change in the high-income-tax threshold in our model that mirrors the 2012 Danish tax reform and analyze its implications for employment-to-employment (EE) transition rates and wage growth across the income distribution. By comparing these untargeted model predictions with estimates from Danish microdata, we test the model's core mechanism: whether intensified on-the-job search generates increased wage pressure.

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

[3]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.

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

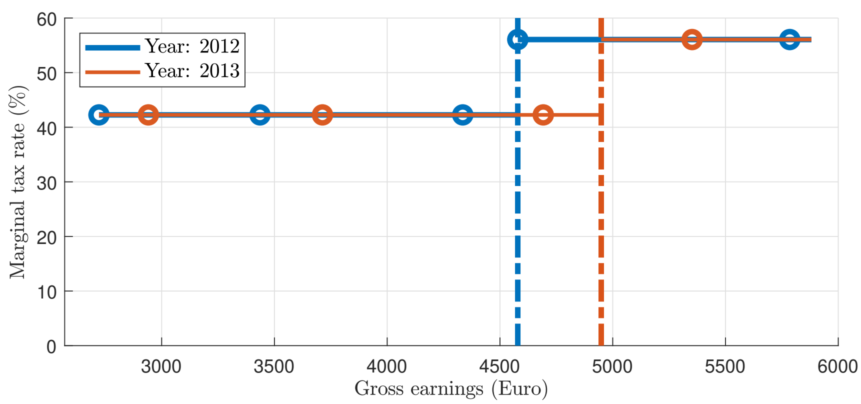
[5]Because in our model transitions are only up the ladder, we condition on workers experiencing an increase in wage upon changing job when computing this moment.

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.[6]

Job search behavior exhibits substantial variation across income levels. To isolate the effects of tax bracket changes, we cannot simply 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.

Danish Tax Schedule Structure Denmark maintained two income-tax thresholds from 2009 to 2012. Our analysis focuses on the top tax threshold, which increases the marginal tax rate by 13.8 percentage points, from around 42.2% to approximately 56%.[7] This threshold remained unchanged in the three years leading up to and including 2012. For the tax year 2013, the top tax threshold experienced a substantial 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.

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 top marginal tax rate in 2012 and 2013, respectively.

The 2013 threshold adjustment presents three advantageous features for studying job search behavior. First, the threshold's stability in the years leading up to the fiscal change

[6]We will use the model to study the general equilibrium effects in the subsequent section. These GE effects are qualitatively in line with what we would expect, but quantitatively irrelevant for our empirical findings.

[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.

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

suggests stationarity in the joint distribution of search intensity and annual income. Second, the substantial magnitude of the shift ensured high salience and meaningful increases in job-search returns. Third, the timing proves favorable for identification. Our strategy compares workers before and after the reform: differential behavior due to unrelated aggregate conditions would threaten identification. The Danish economy experienced moderate growth from 2011 to 2015, enabling confident comparison of outcomes before and after the reform. The economic stability allows us to pool multiple years of pre- and post-reform data to enhance statistical power. Our analysis presents results across various time horizons.

Data Construction We examine year-on-year changes in job-to-job transitions and annual wage growth around the top tax threshold using job spells and transitions as described in Section 3. Our analysis compares workers in pre- and post-reform periods, over one-, two-, and three-year windows. The sample includes workers aged 25 to 65. We restrict attention to full-time employed workers in each period.[9] For each worker, we compute annual labor earnings as total labor income across all job spells, including both wages and bonuses. We derive annual wages by dividing annual earnings by annual hours worked.

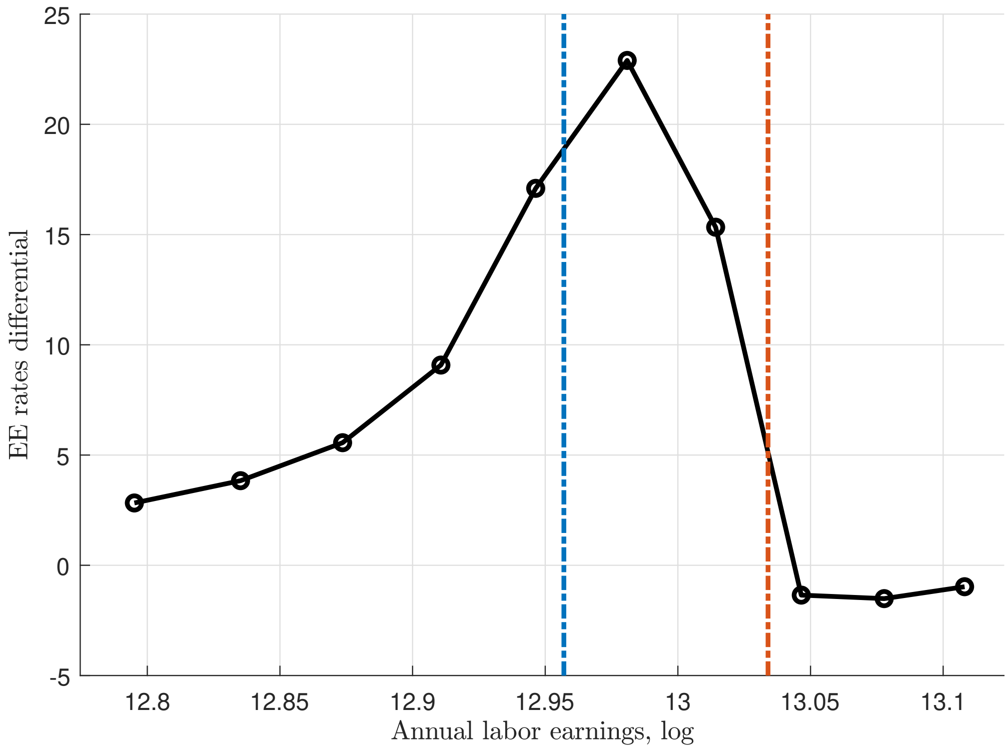
5.1 Job Search Response to Tax Threshold Shift

What changes in job search behavior should we expect in response to the shift in the tax threshold? We have used our model to compute two steady states, one for the economy in 2012 and one for 2013, where the only difference in the calibration stems from the value assigned to the high income-tax threshold. Figure 2 displays the effect of the tax change on EE rates across the two years. That is, for each income bin, we plot the percentage change in EE rates in the year 2013 relative to 2012. In our model, the change in EE rates increases in earnings as we approach the 2012 tax threshold, and falls rapidly thereafter.

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 still be taxed at the lower 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 2012 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. The income group most strongly affected by the tax reform lies between these two polar cases and,

[9] 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.

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



Notes: The figure shows the percentage difference by income bin in EE rates in a steady state with 2013 tax thresholds, relative to a steady state with 2012 tax thresholds. The high-income tax thresholds for 2012 and 2013 are represented by the blue and orange vertical bars, respectively.

specifically, around the old income-tax threshold. For these workers, 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.

To compute the empirical equivalent, we estimate

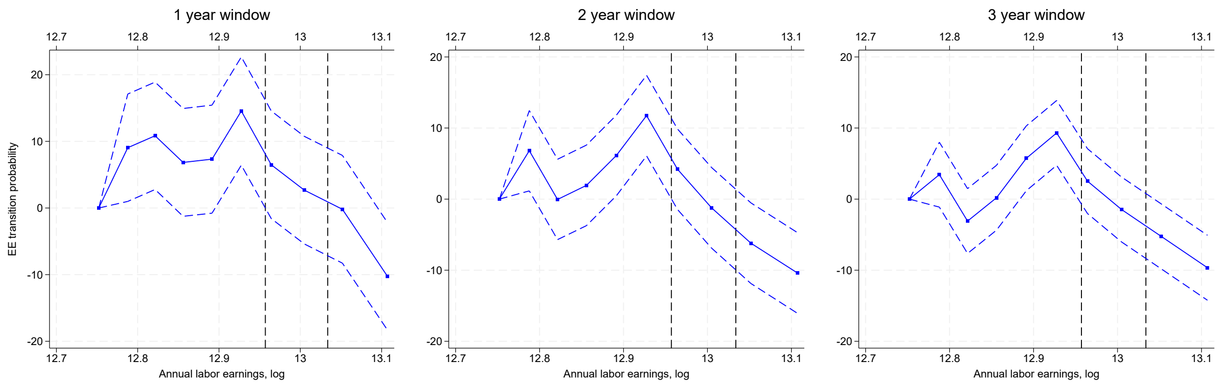
$$y_{i,t} = \text{after}_t + \sum_g \beta_g \mathbf{1}_{(\text{income } = \, g),i,t} + \gamma_g \mathbf{1}_{(\text{income } = \, g),i,t} \times \text{after}_t + X_{i,t} + \epsilon_{i,t}, \tag{19}$$

where $y_{i,t}$ represents an outcome variable for individual i, *after* is a dummy variable equaling one in the period following the threshold change of January 1, 2013, $\mathbf{1}_{income=g}$ indicates the income bin g and X represents potential control variables. Let $y_{i,t}$ indicate whether worker i experienced a job-to-job transition in year t.[10]

Figure 3 presents our main empirical results. We estimate effects across symmetric windows around January 1, 2013, when the tax threshold changed. The one-year specification

[10]The monthly job-to-job transition rate in our sample is 0.009%. As few workers experience multiple transitions within a year, we use an indicator rather than count to reduce the influence of outliers.

Figure 3: Empirical Responses of EE Rates to Shifts in the Tax Threshold



Notes: This figure shows changes in employment-to-employment transition rates estimated in the microdata. The first column compares outcomes between 2013 and 2012. Second (third) column compares 2013-2014 (2013-2015) versus 2011-2012 (2010-2012). Shaded areas represent 95% confidence intervals, with standard errors clustered by earnings bin. Income bins are constructed to contain approximately 50,000 workers per year between 2010-2016.

compares outcomes between 2013 and 2012, while the two- and three-year specifications compare 2013-2014 and 2013-2015 against their pre-reform counterparts, respectively. We focus on workers with log-income within 10% of the 2012 threshold, with each bin containing approximately 50,000 workers.

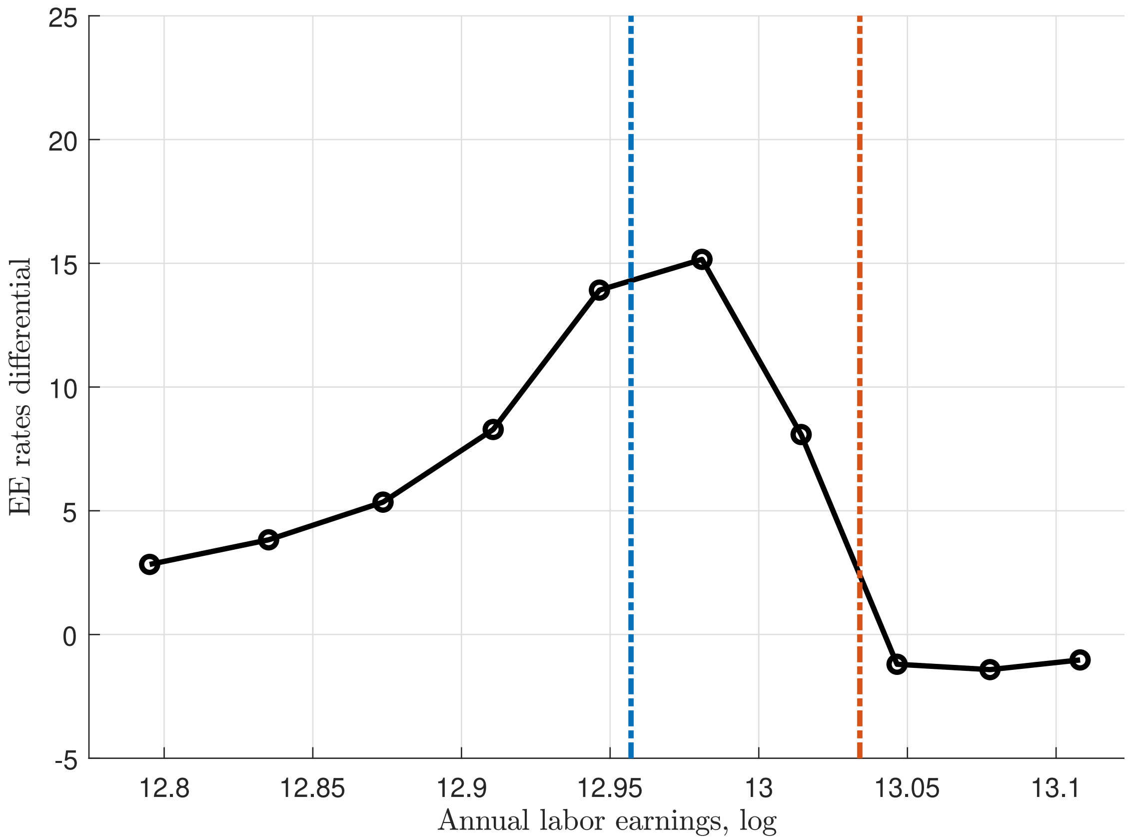
The empirical patterns align closely with our model predictions. EE transition rates exhibit an inverse-V shape that peaks near the 2012 threshold, with the pattern becoming more pronounced as we expand the estimation window and exploit larger samples. The increases in transition rates are statistically significant across all specifications. Consistent with the model, we observe 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 10%, i.e., from 4.0% to 4.4% 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 arrival rate of outside offers that incumbent employers must match to retain workers. Figure 4 demonstrates that the threshold adjustment generates an inverse-V shaped wage growth response among job stayers, mirroring the pattern observed for EE transitions

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



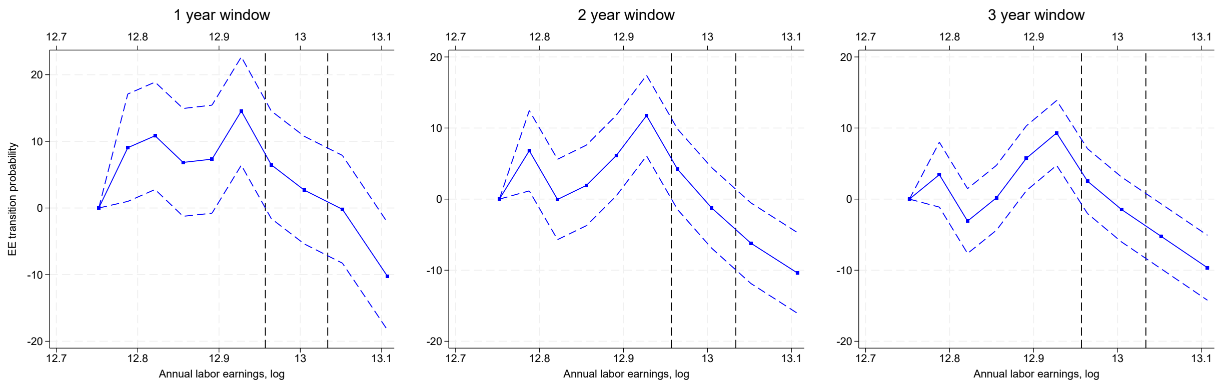
Notes: The figure presents the the percentage difference in wage growth of job stayers in the 2013 steady state, relative to the 2012 steady state. The high-income tax thresholds for 2012 and 2013 are represented by the blue and orange vertical bars, respectively.

in Figure 2. This response peaks near the 2012 threshold before turning negative beyond the 2013 threshold.

Our empirical analysis of hourly wage growth among job stayers (Figure 5) aligns closely with the model's predictions. The estimated response exhibits significant increases near the 2012 threshold, with the inverse-V pattern becoming more pronounced as we extend the estimation window. The magnitude is economically significant: peak wage growth effects reach 10%, representing an increase from 2.44% to 2.68% 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 pure shock. Our estimation thus 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,

Figure 5: Empirical Responses of Wage Growth of Job Stayers



Notes: This figure shows percentage differences in wage growth for workers remaining with their employer by income bin. First column compares outcomes between 2013 and 2012. Second (third) column compares 2013-2014 (2013-2015) versus 2011-2012 (2010-2012). Shaded areas represent 95% confidence intervals, with standard errors clustered by earnings bin. Income bins are constructed to contain approximately 50,000 workers per year between 2010-2016.

the tax reduction would increase match surplus, requiring gross wages to decline to maintain constant surplus shares—yielding the opposite wage response.[11]

To address potential confounders, we conduct additional specifications controlling for observable characteristics. We re-estimate our baseline specifications after residualizing both EE rates and wages with respect to age groups, gender, education, industry, and occupation fixed effects. The results (Figure C1, Appendix) demonstrate remarkable stability relative to the baseline estimates. Both EE rates and stayer wages maintain their inverse-V pattern with peaks near the 2012 threshold. The robustness of these patterns to extensive controls suggests effective balance in treatment and control characteristics within income bins.

5.3 Wage growth of movers

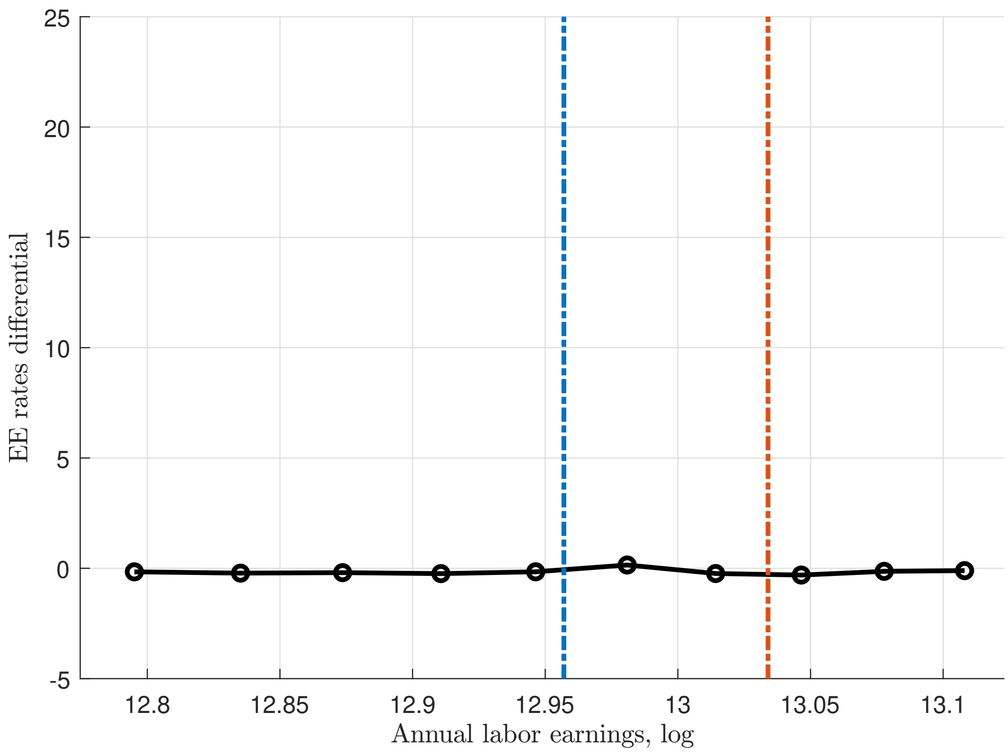
Does the tax change affect the wage growth of workers who experience a job-to-job transition? The answer to this question is no. As shown in Figure 6, the change in wage growth between 2013 and 2012 is nearly zero for any bin of the income distribution. We note that wage growth conditional on changing jobs is still positive, as implied by the calibration. It is the differential effect before and after the reform, that is approximately zero. This is because in this model, a higher job-search intensity only increases the likelihood of changing jobs, but not the wage change conditional on a job change.

In the model, wage changes are driven by two factors: the productivity difference between the current and previous job, and the extent to which the employee extracted surplus from

[11]We provide the proof in Appendix E.

the previous job. Surplus extraction depends solely on the worker's employment history—specifically, whether they interacted with other firms since their last unemployment spell and the productivity of those firms. This is because wages are shaped by all prior bargaining episodes between the worker's current employer and those encountered since starting the job. Employment history could, in theory, be influenced by tax incentives. However, in practice, this impact is negligible for the wage growth for job leavers.

Figure 6: Effects of Shifting the High-Income Tax Threshold on Wage Growth of Job Changers in the Model



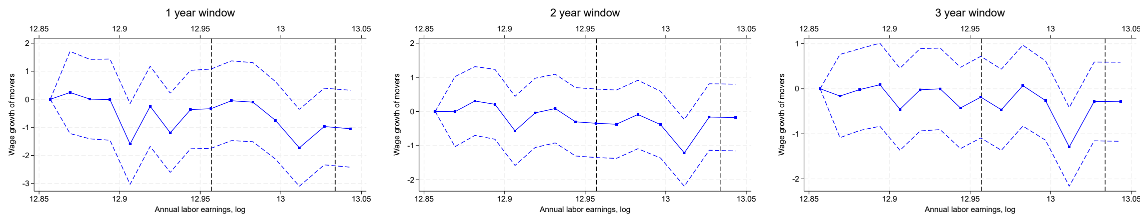
Notes: The figure shows the percentage increase in wage growth of job changers in the 2013 steady state, relative to the 2012 steady state. The tax threshold for 2012 and 2013 are represented by the vertical bars in both panels.

Figure 7 shows the empirical counterpart to the model-generated figure. In line with our model, there is no statistically significant 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 have predicted lower growth of gross wages for job leavers in response to the change in the tax schedule. 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 net wages, but a smaller growth of gross wages.[12]

[12]We provide the proof in Appendix E.

Figure 7: Empirical Responses of Wage Growth of Job Changers to Shifts in the Tax Threshold



Notes: Difference-in-difference effect of a shift in the tax threshold on EE transition rates for the leavers. Notes: the one year window results in the first column report the differential behavior of the outcome variables in 2013 relative to 2012. The two (three) year window results report differential outcomes for the outcome variables averaged of 2013-2014 (2013-2015) relative to 2011-2012 (2010-2012). Confidence interval represent 95% error bands. Standard errors are clustered at the level of earning bins.

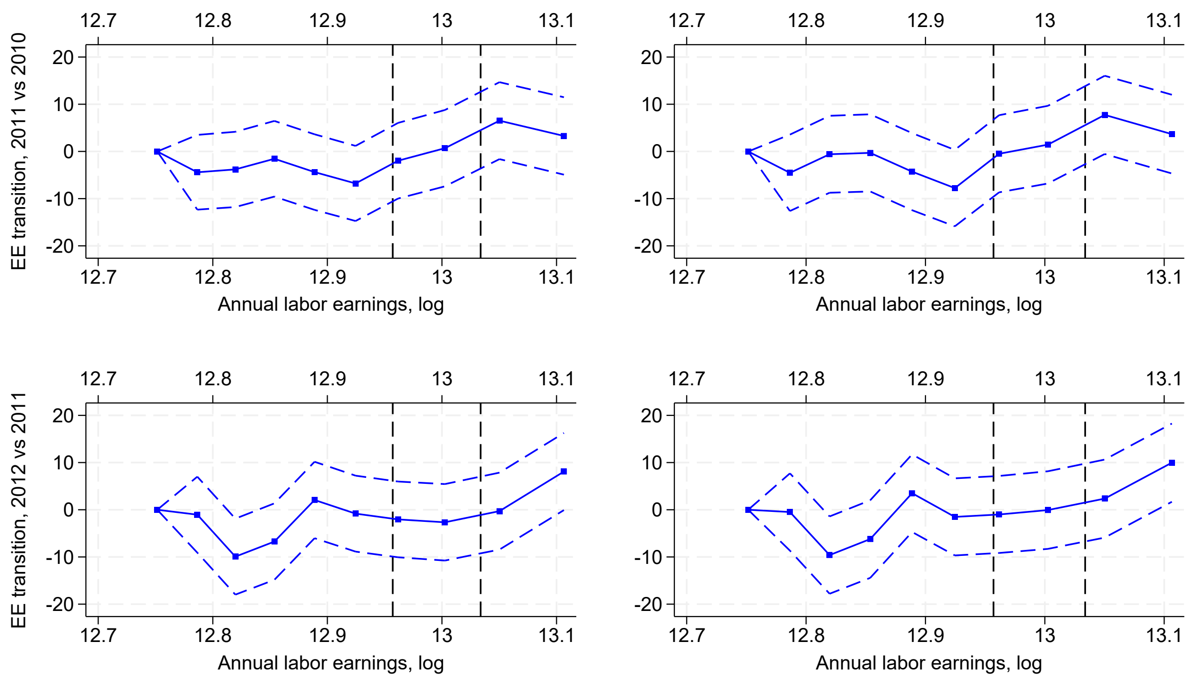
5.4 Placebo exercise

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

Figure 8 reports the results for these placebo experiments, whereby we compare the response of EE transition rates in 2011 relative to 2010 (panels in the first row) and 2012 relative to 2011 (panels in the second row). Panels to the left and right of each row report results for the raw and residualized EE data, respectively. 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.

The computation of the effects of a change in the tax threshold based on the HANK model, and reported in Figure 9, 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. Yet, it takes time to process new tax information and take decisions to change jobs. Moreover, even after one decides to look for jobs, it takes time before finding a suitable offer. Hence, it is reasonable to believe that most of the workers seeking to increase their earnings to take advantage of lower marginal tax rates, would have been able to do so only in 2013. That said, it is still possible that some workers managed to respond to the announcement of the tax reform, shift jobs and get higher earning already before the end of 2012. 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

Figure 8: Placebo experiment: Empirical Responses of EE rates in Years of No Tax Reforms



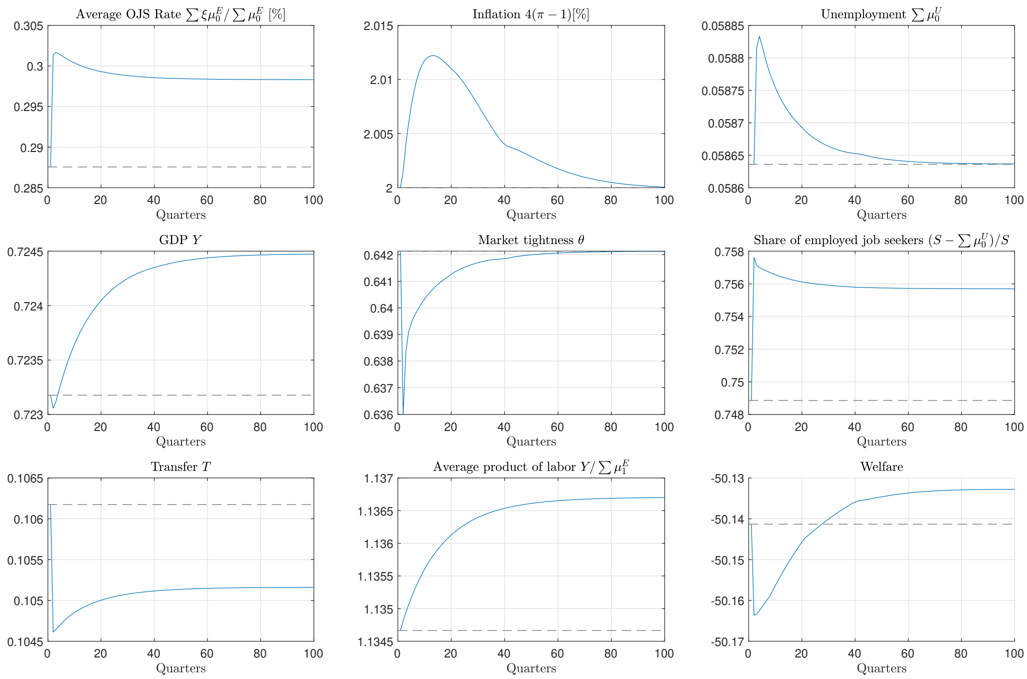
Notes: Placebo experiment: difference-in-difference effect of a shift in the tax threshold on EE transition rates. The vertical bars represent the high-income tax thresholds for the years 2012 and 2013. The upper and lower panels refer to changes over the years 2011 vs 2010 and 2012 vs. 2011, respectively. The panels in the first (second) column report results not controlling (controlling) for household characteristics, respectively.

conservative.

6 General equilibrium effects

The results in the previous section show that the model's mechanism, where the threshold-tax shock affects wage inflation through OJS, generates quantitatively reasonable responses across the income distribution. In this section, we examine the macroeconomic effects of a change in the high-income tax threshold and a shock to the cost of OJS. The reason for considering the shock to OJS is that the change in the high-income tax threshold primarily affects a small portion of the population, meaning its aggregate effects are necessarily limited. In contrast, a shock to OJS affects all workers, regardless of income level, which allows for a broader influence on the economy. Like the threshold shock, the shock to the cost of OJS exogenously shifts the incentives for on-the-job search, potentially leading to a change in workers' behavior across the entire labor market. As a result, the shock to OJS has the potential to generate quantitatively meaningful macroeconomic effects. These

Figure 9: GE effects: Increasing job-search increases inflation and unemployment simultaneously



Notes: Impulse responses to a 8% increase in the tax threshold for high-income earners.

macroeconomic transitions account for general equilibrium effects, as they are derived from the HANK model introduced in Section 2 and calibrated in Section 4.

6.1 A change to the high-income tax threshold

We now turn to investigate the effects of the tax reform on macroeconomic aggregates such as unemployment, output and price inflation, as well as the welfare implications. We do so by computing the transition path to the new stationary equilibrium featuring an eight percent permanent increase in the high-income tax threshold w^H, as dictated by the 2012 tax reform. The responses to this policy are reported in Figure 9.[13]

The tax reform lowered the marginal tax rate faced by the workers with incomes close to the 2012 high-income tax threshold, leading to a permanent increase in the average rate of OJS. In turn, this generates a persistent increase in both unemployment and inflation, as shown in the first row of Figure 9.

We notice that the shift in the tax threshold induces a fall in average government revenues. Because of the assumption that the government budget is balanced in every period,

[13]These transitions are triggered by changes in the relevant parameters, which agents did not anticipate ex-ante (MIT shocks).

lower revenues are offset in the model by lower transfers to households. Because transfers are identical across all workers, while taxes are reduced only for the rich, this income redistribution contributes to a fall in aggregate demand, due to the higher marginal propensities to consume of the poor. These contractionary effects on aggregate demand are, however, not of first-order importance for the main propagation, as shown quite clearly by the inflation response.

The mechanism leading to a simultaneous rise in both inflation and unemployment works as follows. The increase in OJS raises the share of employed job seekers. The expected return to posting a vacancy falls, given that firms are able to extract a lower share of surplus when meeting an employed worker, relative to an unemployed one. Intuitively, the employed are more expensive to hire, given that their bargaining position is higher; unlike the unemployed, employed workers can spark wage competition between poachers and incumbent employers. Wage pressures rise, and higher expected wage payments in the labor market are reflected into higher real marginal costs for the price-sector firms, which in turn are passed through to higher prices, increasing the rate of inflation persistently over the impulse response horizon.

Output falls on the impact of the shock, driven by the fall in employment. Over time though, the increase OJS rate leads to a more efficient allocation of workers up the ladder, raising the average product of labor in a way that more than compensates for the persistent fall in employment.

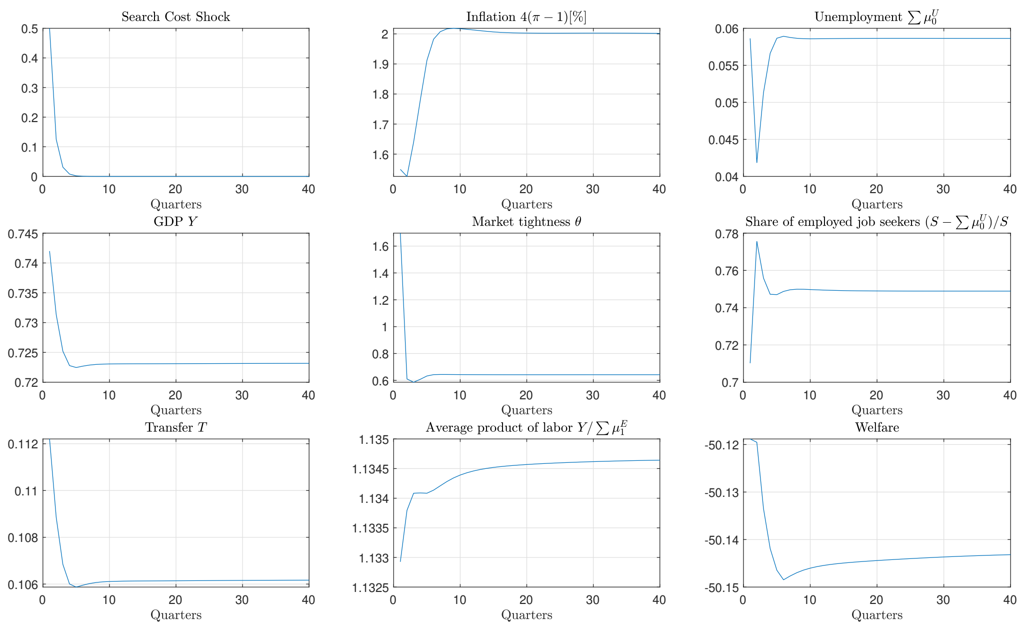
A permanent increase in the high-income tax rate produces an *a-priori* ambiguous impact on welfare, measured as the average of the workers' value functions across the steady-state distribution. In the long run, it increases the efficient allocation of workers on the ladder as well as the costs of OJS. In transition to the new steady state, it persistently reduces employment. At the calibrated equilibrium, this policy increases welfare in the long run, but decreases it persistently in the transition. In the model, OJS produces a negative externality on job creation, as it increases the share of the employed in the pool of job seekers, thereby raising the expected cost of entry. By lowering the value of searching on the job, a higher income tax allows the employed to internalize this negative externality on job matches.

The impulse responses in Figure 9 imply that in the calibrated equilibrium, the opposite policy to the one considered above, i.e., a lowering of the high-income tax threshold, would simultaneously reduce unemployment and inflation, while temporarily increasing welfare.

Quantitatively though, the effects of this particular policy are negligible. This is not surprising, given that this policy only affects a small share of high-income workers located close to the threshold, so the average rate of OJS increases only marginally. The general equilibrium effect of this policy are naturally small, and too small to be retrieved in the microdata. In the next section, we show that an alternative policy, which increases OJS costs for all the workers, has the potential to generate quantitatively strong results.

6.2 An increase in the on-the-job search *for all the workers*

Figure 10: Decreasing job-search lowers inflation and unemployment simultaneously



Notes: Impulse responses to an increase in the upper-bound parameter of the search-cost distribution.

We now study the effects of a temporary shock to the cost of searching on the job, affecting all workers at any rung of the job ladder. We think of this shock as a simple way of capturing a temporary regulatory restriction to OJS. We keep the lowerbound of the cost-shock distribution $\vartheta^l = 0$ and assume that the upperbound follows the process $\vartheta_t^u = \rho_\vartheta \vartheta_{t-1}^u + \epsilon_t$, where we set the autocorrelation coefficient $\rho_\vartheta = 0.25$ and the shock on impact to equal 0.5, which doubles the value of ϑ^u relative to steady-state.

The impulse responses to a positive cost shock are reported in Figure 10. As shown by the panel in the top-left corner, the shock is short-lived, and almost entirely gone by the end of the fourth quarter. The higher search cost produces a simultaneous fall in unemployment and inflation. Inflation decreases, reflecting the fall in hiring costs, and hence a cheaper labor service. At the same time, the fall in the share of job seekers, by lowering the expected cost of hiring, increases labor market tightness, and reduces unemployment. The resulting increase in employment, more than compensates for the decline in productivity, leading to an increase in output. In turn, higher production increases government revenues, which are transferred as a lump-sum to the households in order to maintain the budget balanced. Welfare increases, driven by the increase in employment.

Even though the fall in the share of employed job seekers is short-lived, its effects on inflation and unemployment are quantitatively large, as they fall by about 0.5 and 1.5 percentage points, respectively. We note that these results are derived from a relatively simple model that was designed to highlight OJS as a transmission channel to price inflation. As such, any quantitative result, and in particular any welfare consideration, should be simply taken as indicative of the potency of the channel within the model.

7 Conclusions

We have developed a HANK model with a job ladder and endogenous OJS search to study how the search decisions of the employed respond to tax incentives and what are the implications for wage and price inflation. We have produced impulse responses of EE rates and wages across the income distribution and compared model outcomes with estimates based on Danish microdata to validate the mechanism of the model. 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 policies targeting the incentives to search on the job may induce a positive comovement between inflation and unemployment rates, eluding the traditional Phillips-curve tradeoff.

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A Laws of motion

Define $\mathcal{E}_t^E\left(e';e,x,\alpha\right) = \left\{e \in \mathcal{E} : g^E\left(e,x,\alpha\right) = e'\right\}$, $\mathcal{E}_t^U\left(e';e\right) = \left\{e \in \mathcal{E} : g^U\left(e\right) = e'\right\}$ and $\mathcal{E}_t^R\left(e';e\right) = \left\{e \in \mathcal{E} : g^R\left(e\right) = e'\right\}$ 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

$$\mu_{0,t+1}^E\left(e',x',\alpha'\right) = \left(1-\psi^R\right)\left(1-\delta\right)\mu_{1,t}^E\left(e',x',\alpha'\right), \tag{20}$$

Intratemporal law of motion for the employed

$$\begin{aligned}\mu_{1,t}^{E}\left(e',x',\alpha'\right) = & \sum_{e\in\mathcal{E}_t^E}\mu_{0,t}^{E}\left(e,x',\alpha'\right)\left[\left[1-\xi\left(e,x',\alpha'\right)f\left(\theta\right)\right]+\xi\left(e,x',\alpha'\right)f\left(\theta\right)\sum_{\widetilde{x}<x'\alpha'}G^{x}\left(\widetilde{x}\right)\right] \\ & +\sum_{\alpha}\sum_{e\in\mathcal{E}_t^E}\mu_{0,t}^{E}\left(e,x',\alpha\right)\xi\left(e,x',a\right)f\left(\theta\right)G^{x}\left(x'\alpha'\right)\mathbf{1}_{x'\alpha'>x'\alpha} \\ & +\sum_{\alpha}\sum_{e\in\mathcal{E}_t^E}\mu_{0,t}^{E}\left(e,\underbrace{\alpha'x'}_{x},\alpha\right)\xi\left(e,\alpha'x',a\right)f\left(\theta\right)G^{x}\left(x'\right) \\ & +\sum_{e\in\mathcal{E}_t^U}\mu_{0,t}^{U}\left(e\right)f\left(\theta\right)G^{x}\left(x'\right)\mathbf{1}_{\alpha'=\frac{\underline{x}}{x'}}\end{aligned} \tag{21}$$

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

$$\mu_{0,t+1}^{U}\left(e'\right)=\left(1-\psi^{R}\right)\mu_{1,t}^{U}\left(e'\right)+\left(1-\psi^{R}\right)\delta\sum_{\alpha}\sum_{x}\sum_{e\in\mathcal{E}_t^U}\mu_{1,t}^{E}\left(e,x,\alpha\right)+\psi^{D}\sum_{e\in\mathcal{E}_t^R}\mu_{1,t}^{R}\left(e\right) \tag{22}$$

Intratemporal law of motion for the unemployed

$$\mu_{1,t}^{U}\left(e'\right)=\sum_{e\in\mathcal{E}_t^U}\mu_{0,t}^{U}\left(e\right)\left[1-f\left(\theta\right)\right] \tag{23}$$

Intertemporal law of motion for the retirees

$$\mu_{0,t+1}^{R}\left(e'\right)=\left(1-\psi^{D}\right)\sum_{e\in\mathcal{E}_t^R}\mu_{1,t}^{R}\left(e\right)+\psi^{R}\sum_{e\in\mathcal{E}_t^U}\mu_{1,t}^{U}\left(e\right)+\psi^{R}\sum_{x,\alpha,e\in\mathcal{E}_t^E}\mu_{1,t}^{E}\left(e,x,\alpha\right) \tag{24}$$

Intratemporal law of motion for the retirees

$$\mu_{1,t}^{R}\left(e'\right)=\mu_{0,t}^{R}\left(e'\right) \tag{25}$$

B Growing net earnings

Because of log utility, the marginal utility of consumption is dC/C, and because consumption equals after tax wages, the returns from search depend on the percentage increase in net earnings. Let w, T and $\hat{w}$ denote gross earnings, the tax bill, and net earnings, respectively. We study a given tax threshold $\overline{w}$, which increases the marginal tax rate from τ_0 to τ_1. We focus on the area area above the tax threshold, $w > \overline{w}$.

$$\begin{aligned} T(w) &= \tau_0\overline{w} + (w - \overline{w})\tau_1 \\ \hat{w}(w) &= w - \tau_0\overline{w} - (w - \overline{w})\tau_1, \end{aligned}$$

Noting that the marginal tax rate is indeed $\hat{w}'(w) = 1 - \tau_1$. But what is the percentage change in net wage $N(w, p)$, as we increase gross wage by factor p?

$$\begin{aligned} N(w,p) &\equiv \frac{\hat{w}(pw) - \hat{w}(w)}{\hat{w}(w)} \\ &= \frac{pw - \tau_0\overline{w} - (pw - \overline{w})\tau_1 - [w - \tau_0\overline{w} - (w - \overline{w})\tau_1]}{w - \tau_0\overline{w} - (w - \overline{w})\tau_1} \\ &= \frac{(p-1)w - (p-1)w\tau_1}{w - \tau_0\overline{w} - (w - \overline{w})\tau_1} \\ &= \frac{(p-1)(1-\tau_1)w}{w - \tau_0\overline{w} - (w - \overline{w})\tau_1} \end{aligned}$$

How does this change with w?

$$\begin{aligned} \frac{\partial N(w,p)}{\partial w} &= \frac{(p-1)(1-\tau_1)[w - \tau_0\overline{w} - (w - \overline{w})\tau_1] - (p-1)(1-\tau_1)w(1-\tau_1}{[w - \tau_0\overline{w} - (w - \overline{w})\tau_1]^2} \\ &= \frac{(p-1)(1-\tau_1)w(1-\tau_1) + (p-1)(1-\tau_1)[-\tau_0\overline{w} + \tau_1\overline{w}] - (p-1)(1-\tau_1)(1-\tau_1)}{[w - \tau_0\overline{w} - (w - \overline{w})\tau_1]^2} \\ &= \frac{(p-1)(1-\tau_1)\overline{w}(\tau_1 - \tau_0)}{[w - \tau_0\overline{w} - (w - \overline{w})\tau_1]^2}, \end{aligned}$$

which is strictly positive since $p > 1$, $\tau_1 < 1$, $\tau_1 > \tau_0$.

C Additional figures empirical

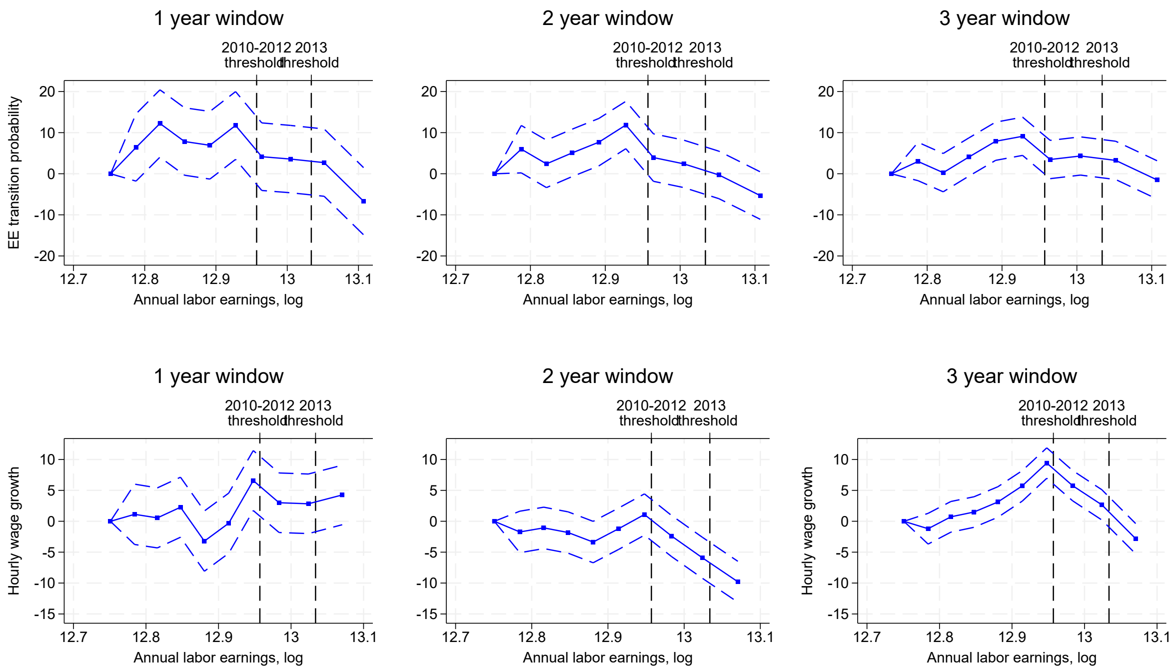

Figure C1: shift in the tax threshold - top: transitions. bottom: wage growth of stayers

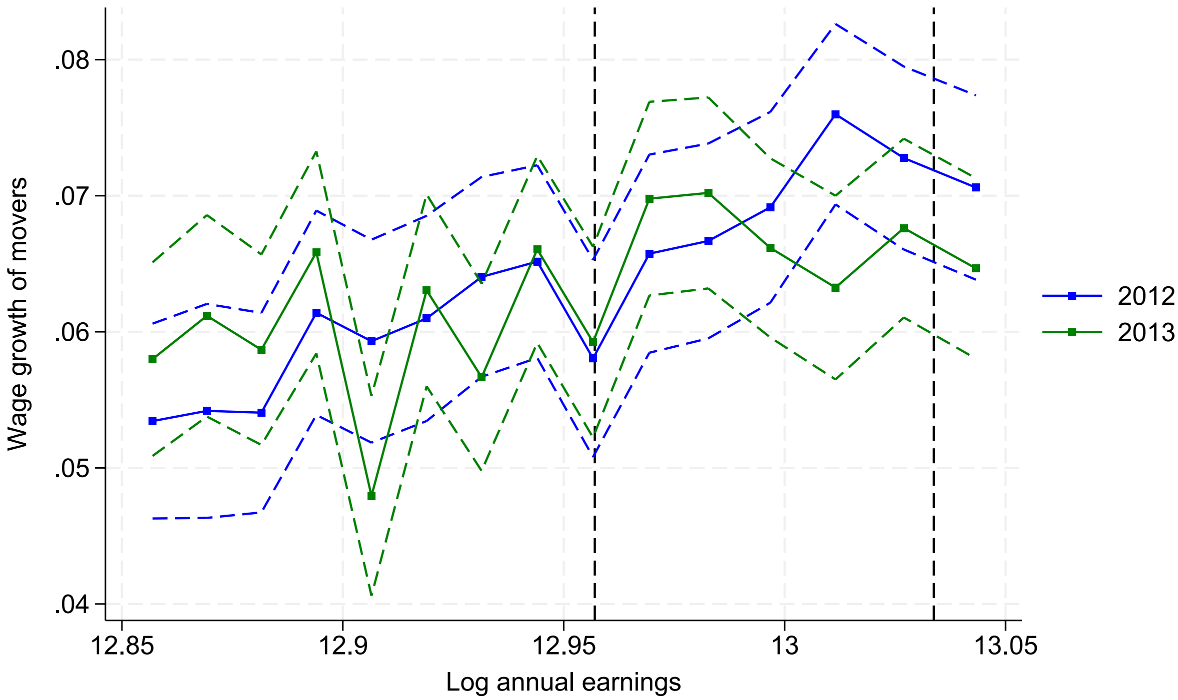

Figure C2: movers single year

D Computational Appendix

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

D.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 17 nodes on each of the three grids, for a total of 17^3 nodes. We use piece-wise linear interpolation to evaluate both policy and value functions outside of the nodes of the grids. We do not use a grid for the search cost ϕ since, given a uniform probability distribution function, we can compute all the relevant integrals analytically using a continuous support.

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:

$$\tau = \begin{cases} \tau_0, & \text{if } w \leq w_L \\ \dfrac{w_L \cdot \tau_0 + (w - w_L) \cdot \tau_L}{w}, & \text{if } w_L \leq w \leq w_H \\ \dfrac{w_L \cdot \tau_0 + (w_H - w_L) \cdot \tau_L + (w - w_H) \cdot \tau_H}{w}, & \text{otherwise.} \end{cases} \tag{26}$$

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, $V^w_0(e, x, \alpha)$ for start-of-period, and $V^w_1(e, x, \alpha)$ for end-of-period value of employment to solve the associated optimization problems (8), (2), (3), and (4) and find $\Gamma^{w+1}(e), U^{w+1}(e), V^{w+1}_0(e, x, \alpha)$, and $V^{w+1}_1(e, x, \alpha)$.

     (b) Update the job search policy function for the employed population, $I^{w+1}_{\phi<\phi^T}(e, x, \alpha)$ using equations (6) and (7) 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 (9).

(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 (21), (23), and (25).

  (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 (20), (22), and (24).

  (c) If the population distributions converge (i.e. $\max(\sup|\mu^{U}_{0,t+1}-\mu^{U}_{0,t}|, \sup|\mu^{R}_{0,t+1}-\mu^{R}_{0,t}|, \sup|\mu^{E}_{0,t+1}-\mu^{E}_{0,t}|, \sup|\mu^{U}_{1,t+1}-\mu^{U}_{1,t}|, \sup|\mu^{R}_{1,t+1}-\mu^{R}_{1,t}|, \sup|\mu^{E}_{1,t+1}-\mu^{E}_{1,t}|) < \epsilon$), 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 (13). 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. $T^{j+1} \leftarrow 0.9 \cdot T^{j+1} + (1 - 0.9) \cdot T^{j}$.

3. Calculate the savings aggregated across all workers and evaluate the asset market clearing condition (17). 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.

D.2 Solution algorithm for the dynamic equilibrium

The economy is initially in a stationary equilibrium when all agents experience a sudden tax shock $\Delta\tau_{t=0}$ at time $t = 0$. This tax shock reverts back to zero over time with a constant persistence, P. We solve for the transition numerically, allowing a sufficiently high number of periods $\bar{t}$ for the shocks to fade away and economy converge to the stationary equilibrium. In particular, we use $\bar{t} = 200$. 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, $\{\theta_t\}_{t=0}^{\bar{t}}$, and (iii) real interest rates, $\{r_t\}_{t=0}^{\bar{t}}$.

1. Create an iterator j and set $j = 0$. Guess an interest rate path $\{r_t^j\}_{t=0}^{\bar{t}}$. Using the Taylor Rule (14), calculate the associated inflation path $\{\pi_t^j\}_{t=0}^{\bar{t}}$.

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 $\{T_t^j\}_{t=0}^{\bar{t}}$ and $\{\theta_t^j\}_{t=0}^{\bar{t}}$ using the stationary equilibrium values.

   - Calculate consumption for unemployed, employed, and retired population, $C_t^U(e), C_t^E(e, x, \alpha)$, and $C_t^R(e)$ after having update the average taxation level generated by the tax shock $\Delta\tau_t$ calculated, at each time t, from equation (26).
   - Start from the stationary equilibrium value functions and iterate backward on the optimization problems (8), (2), (3), and (4) 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 (21), (23), and (25).

   (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 (20), (22), and (24).

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 (9).

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 (13).

- Evaluate the market clearing condition (17) 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 (10).

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).

E 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 valuefunctions for workers and firms are given by

For workers:

$$rE = w - \lambda(E - U) \tag{27}$$

$$rU = b + f(\theta)(E - U) \tag{28}$$

$$rJ = y - w(1+\tau) - \lambda(J - V) \tag{29}$$

$$rV = -c + q(\theta)(J - V) \tag{30}$$

Wages are given by

$$\beta(J - V) = (1-\beta)(E - U) \tag{31}$$

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:

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

Can rewrite (27) and (29) respectively as

$$E - U = \frac{w - rU}{r + \lambda} \tag{32}$$

$$J - V = \frac{y - w(1+\tau)}{r + \lambda} \tag{33}$$

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 $\beta \in (0, 1)$.