Immigration Shocks in the Presence of Income Effects*

Pedro Brinca† Hans A. Holter‡ Per Krusell§ Laurence Malafry¶

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Abstract: We document that in the U.S. economy, with low-frictions and a small welfare state, immigration shocks are associated with: i) Very high labor force participation among the immigrants. ii) An increase in native employment. We argue that the classical mechanism of income effects, which has so far been absent from economic models of immigration, can explain these empirical findings. We first make our point in a simple, static model of job search behavior. Then we develop a richer model of the labor market, featuring two sectors (high-skilled and low-skilled), participation decision, unemployment, savings and human capital accumulation. We study the arrival of a large group of low-skilled migrants (equal to 1% of the native population) who arrive in the economy with few assets and little human capital. Because they are poor an because their returns to human capital investments are high, the labor force participation of the immigrants is initially very high. The presence of many inelastic job seekers increases the value of filling a job and spurs firms to post vacancies. Thus the probability of finding a job is not reduced, even with more job seekers. The long run effect of low-skilled immigration, once the immigrants have become employed, is, however, a drop in low-skill wages. This future negative income effect on low-skilled natives increases their incentives to work in the short run. Our framework can also explain why European countries with large welfare states may experience the opposite: Immigration shocks lead to a drop in native employment.

Keywords: Immigration, Migration, Inequality, Unemployment, Savings, Income Effects, Labor Supply, Employment

JEL: E21, E24, E62, F22, J21, J61

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†NovaSBE & CEF.UP. Email: pedro.brinca@novasbe.pt

‡University of Delaware, Nova SBE and University of Oslo. Email: hansholt@udel.edu

§IIES, Stockholm University. Email: per.krusell@iies.su.se

¶University of Oslo. Email: laurence.malafry@econ.uio.no

1 Introduction

The 21st century has been characterized by episodes of large, sudden movements of people from low-income to high-income countries. Triggered by exogenous forces such as wars, economic crises, and natural disasters, these migration waves have lasting economic implications for receiving economies. Consequently, there is keen interest among policymakers and academics in understanding how host economies absorb these shocks. A central question in this debate is how large influxes of immigrants affect the labor market outcomes of native workers. Recent empirical studies focusing on the United States—a country characterized by low labor market frictions and a relatively small welfare state—have uncovered a surprising stylized fact: immigration shocks are frequently associated with an increase in native employment and labor force participation (e.g., Chassamboulli et al. (2024), Battaglia (2023), Mahajan et al. (2025).). Conversely, evidence from European countries with generous welfare states has been far more mixed, often pointing to depressed immigrant participation and negative impacts on native employment.

In this paper, we argue that the classical mechanism of income effects—which has largely been absent from modern macroeconomic models of immigration—can explain both the U.S. empirical puzzle and the divergent outcomes observed in Europe. We begin by documenting two key stylized facts for the U.S. economy. First, immigrants—particularly low-skilled immigrants—exhibit significantly higher labor force participation rates than their native counterparts. Second, using a Structural Vector Autoregression (SVAR) model, we show that immigration episodes in the U.S. induce a significant positive flow of natives into employment, driven by individuals moving out of both unemployment and inactivity.

To explain these dynamics, we propose a theoretical framework centered on wealth heterogeneity, endogenous labor force participation, and frictional labor markets. Because new immigrants typically arrive with few assets and little local human capital, their outside option to working is exceptionally poor. Consequently, their labor supply is highly inelastic: they search for jobs at high rates and, once employed, are far less likely to quit than natives. From the perspective of firms, the influx of these highly attached workers raises the average probability of match continuation. This increases the expected value of filling a vacancy, spurring a strong job-creation response that absorbs the new arrivals without crowding out natives.

Simultaneously, the shock triggers powerful income effects on the native population. In the short run, rapid integration of low-skilled immigrants exerts downward pressure on future low-skilled wages. Anticipating this future decline in earnings, low-skilled natives face a negative income effect that inter-temporally substitutes their leisure, increasing their incentive to work harder in the present. Furthermore, the arrival of poor immigrants temporarily congests public finances, reducing per-capita lump-sum transfers and reinforcing the native incentive to work. High-skilled natives, on the other hand, are enticed into the labor market through capital-skill complementarity, as the expansion of low-skilled labor increases their marginal productivity and

wages.

We formalize these insights in two steps. First, we develop a simple, static model of job search behavior to clearly illustrate how the arrival of wealth-poor immigrants dilutes the pool of "insincere" searchers. This compositional change boosts vacancy creation, raising the job-finding rate for everyone and lowering native unemployment. Second, to quantify these effects over time, we build a rich heterogeneous-agent, life-cycle model featuring incomplete markets, frictional unemployment, two skill sectors (high and low), endogenous labor market participation, savings, and human capital accumulation. We also model detailed fiscal structures, including progressive income taxation, unemployment insurance, and government transfers.

We use this quantitative model to study the transition dynamics of a large, unexpected migration shock—equal to 1% of the working-age population—arriving as low-skilled workers with zero assets. In our benchmark U.S. calibration, the model successfully reproduces our stylized facts. Immigrant labor force participation approaches 100%, and the strong firm vacancy response allows them to integrate rapidly. Native employment rises in the short run, and aggregate welfare losses for natives are negligible (0.15% consumption equivalent), though they are distinctly distributional: low-skilled natives suffer modest welfare losses, while high-skilled natives and retirees (who benefit from higher returns to capital) experience welfare gains.

Finally, our framework provides a natural explanation for why European countries often experience different outcomes. We run counterfactual experiments replacing the U.S. fiscal system with a high-tax, high-transfer system calibrated to Denmark. In this environment, a generous welfare state dramatically improves the outside option for both immigrants and natives. Immigrants participate at much lower rates upon arrival, severely dampening the positive externalities of match continuation for firms. Furthermore, generous transfers cushion natives against the negative income effects of future wage depressions. As a result, native labor supply remains highly elastic, and the same immigration shock leads to a sustained drop in native employment.

Ultimately, this paper bridges the gap between empirical observations of immigration shocks and macroeconomic theory. By incorporating extensive-margin labor supply decisions and incomplete markets into a frictional labor environment, we demonstrate that the macroeconomic absorption of immigrants—and its impact on native welfare and inequality—depends fundamentally on the host country's welfare state and the resulting income effects on household labor supply.

1.1 Relation to the Literature

Broadly speaking this paper contributes to an already rich literature on the impacts of immigration. We see the major contribution of this investigation to the specific instance of a large discrete migration shock, as opposed to permanent changes in rates of immigration, which other studies have focused on. In that sense, we shed light on the dynamics of a post-shock transition, rather than the long-run implications of changes in the steady state share of immigrants. This paper can

thus be seen as adjacent to the literature on the effects of transitory macroeconomic shocks, with application to labor supply shocks. Here there is a growing body of empirical work, such as Foroni et al. (2018), Furlanetto and Robstad (2019), and Schiman (2021).

In addition, much of the focus on migration impacts has been on wages. More recent work, which we follow, has expanded consideration to frictional labor markets - particularly equilibrium unemployment as a result of matching frictions. See, for example, Chassamboulli and Palivos (2014), Moreno-Galbis and Tritah (2016), Battisti et al. (2018), among others. Our study expands the consideration of frictional unemployment to the participation margin and an examination of the changes in flows between labor states as a result of a migration-induced labor supply shock. A major implication of this setting is that changes in the incentives for work, which arise as a result of the shock, will manifest primarily in the participation margin - both for natives and arrivals. Settings with inelastic labor supply will tend to over-emphasize the impact on unemployment, employment and wages. In addition, we add inelastic capital supply in general equilibrium and non-linear utility in an incomplete markets setting, which allows for a more comprehensive discussion of welfare impacts across the life-cycle and implications for inequality.

Finally, our comparison of labor market and welfare state institutions in the context of migration shocks echoes the literature that grew out of the desire to explain differences in unemployment across advanced economies (e.g. the pattern of hysteresis in the OECD). One branch of this literature focuses on the interaction of shocks and existing institutions as an explanation for the observed pattern in labor market outcomes, for example, Ljungqvist and Sargent (1998), Blanchard and Wolfers (2000), and Nickell et al. (2005), which examine a broad class of macroeconomic shocks. And more specifically relevant to the case of immigration shocks interacting with labor market institutions, Angrist and Kugler (2003) and D'Amuri and Peri (2014).

The rest of the paper is organized as follows: In Section 2 we document our empirical stylized facts. Section 3 builds a simple static job search model to illustrate how wealth effects shapes the impact of immigration shock. Section 4 presents the quantitative model and theoretical framework; Section 5 presents the calibration strategy for the benchmark economy; Section 6 presents the results of the benchmark transition after an immigration shock in the U.S. economy; Section 7 introduces a European welfare state in the U.S: economy and studies the implications for the effects of an immigration shock. Section 8 concludes.

2 Stylized Facts

In this section we document some stylized facts about inequality and the labour market experience of immigrants in the US. In addition we show evidence that immigration shocks (as defined by changes in the share of immigrants in the population) positively affect the labor market outcomes of natives by increasing the flows of natives into employment from both the unemployment pool, as well as, non-participation. It is a well documented fact that immigrants have a different skill

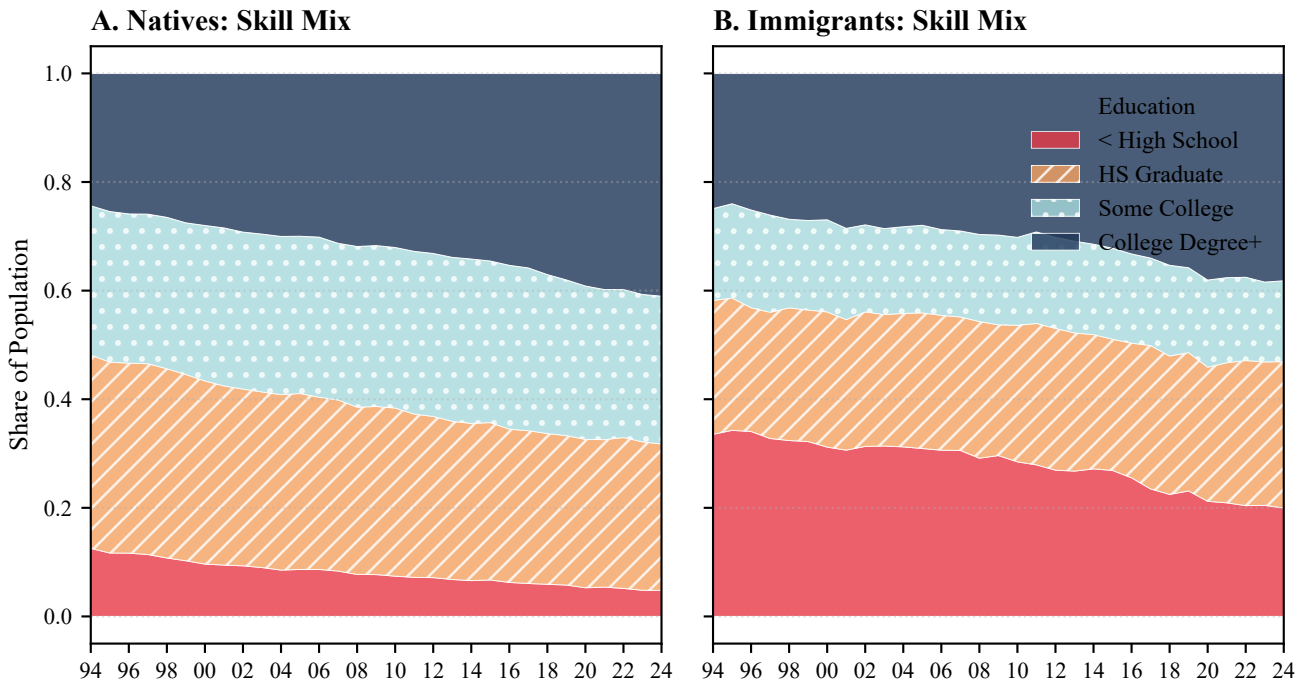


Figure 1: The composition of immigrants and natives by educational attainment

mix than the native population. Figure 1 shows that immigrants have a much larger concentration in the lower education brackets. In addition, there is evidence that reported educational status is an imperfect indicator of the strata of the labor market that immigrants are participating in (see, for example, Dustmann et al. (2013) and Mattoo et al. (2008)). For many reasons, including those related to low elasticity of labor supply, immigrants downgrade on arrival.

In general, there are large gaps in wealth and assets between immigrants and natives (see, for example, Bauer et al. (2011) and Cobb-Clark and Hildebrand (2006)). These are particularly stark at arrival, and for low skill immigrants where (median) immigrants at entry have nearly eight times less financial wealth than (median) natives. There is also a significant labor market participation gap between immigrants and natives, particularly at lower levels of educational attainment. Figure 2 illustrates the development of this gap over the last thirty years. Immigrant worker's attachment to the labor force, as measured by participation, is incredibly strong in comparison to their native counterparts at lower educational attainment levels. We take these relatively stark statistics as a starting point on how to think about immigration shocks in a model with endogenous labor supply and wealth inequality.

2.1 VAR

In order to gain insight into the macroeconomic implications of immigration shocks particularly in a labor market characterized by frictional unemployment and elastic labor supply we follow the empirical framework established by Chassamboulli et al. (2024). Here we analyze the dy-

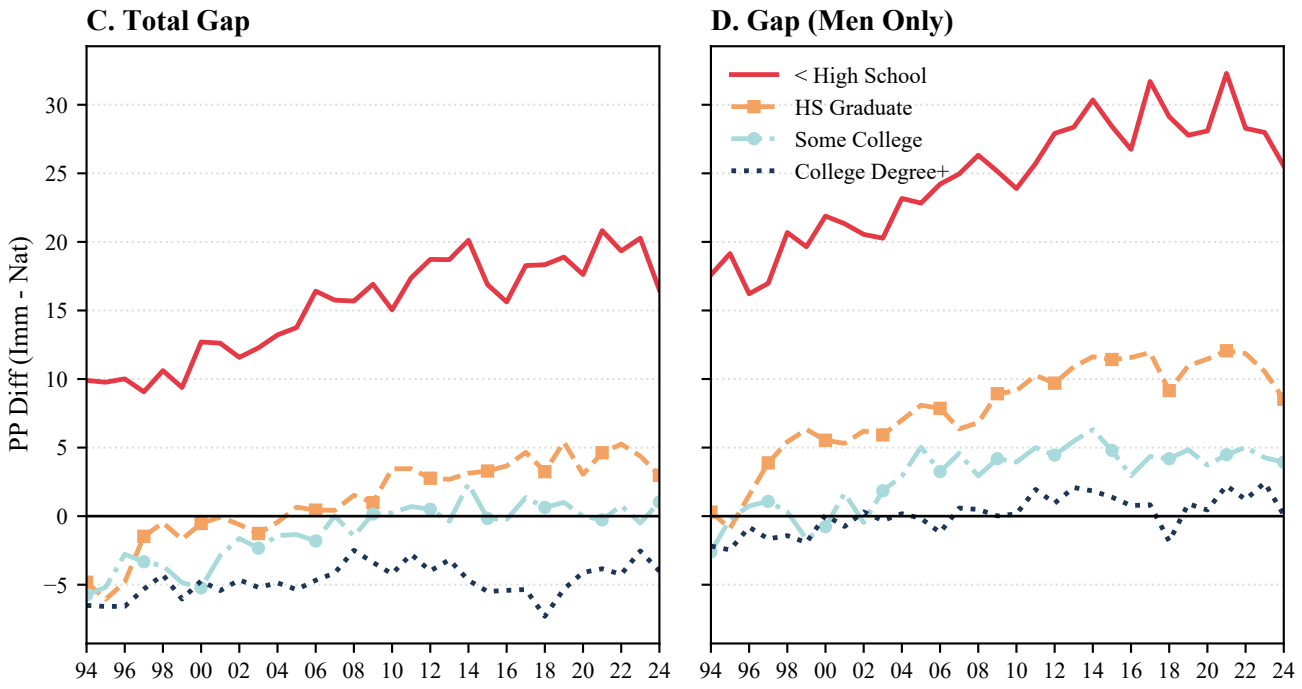


Figure 2: The participation gap between immigrants and natives by educational attainment

namic responses of the labor market to a migration shock as measured by changes in the share of immigrants in the population using a Structural Vector Autoregression (SVAR) model.

The baseline reduced-form VAR model is specified as:

$$Y_t = C(L)Y_{t-1} + \epsilon_t \tag{1}$$

where Y_t is a vector of endogenous variables, $C(L)$ is a matrix of polynomials in the lag operator L, and ϵ_t is a vector of reduced-form innovations. All variables enter the model in first differences of their logarithms to ensure stationarity. The model is estimated within a Bayesian framework employing a Minnesota prior. This prior incorporates fixed residual variances that govern the tightness on own lags, cross-lags, and the harmonic decay of the lag structure, thereby mitigating the risk of over-fitting often associated with high-dimensional VAR systems.

To identify structural shocks, we employ a recursive identification scheme via Cholesky decomposition. The ordering of variables in Y_t reflects structural assumptions regarding the speed of adjustment and information transmission in the labor market. In this setup, the migration variable is ordered prior to the labor market transition rates. This assumes that while migration shocks can have a contemporaneous impact on labor market outcomes, innovations in transition rates (such as hiring or separations) only affect the immigrant share with a lag.

In the preferred specification, the vector of endogenous variables Y_t is ordered as follows:

$$Y_t = [\Delta \text{ImmShare}_t, \Delta \ln s^{EN}_{nat,t}, \Delta \ln s^{EU}_{nat,t}, \Delta \ln f^{UE}_{nat,t}, \Delta \ln f^{NE}_{nat,t}]' \tag{2}$$

where ImmShare_t is the immigrant share of the labor force, $f_{nat,t}$ and $s_{nat,t}$ represent the *native* job-finding and job-separation rates between the three labor states, respectively.

The empirical analysis utilizes monthly data from the Current Population Survey (CPS) to construct gross flows between the labor states for both immigrants and natives. Immigrants are defined as foreign born.

A primary concern when analyzing high-frequency labor market transitions is the presence of reporting bias and classification error in household surveys. As documented by Abowd and Zellner (1985), spurious transitions between employment (E), unemployment (U), and inactivity (N) can significantly inflate gross flow estimates. To address this, we apply the reclassification methodology of Abowd and Zellner (1985).

Furthermore, to ensure that the estimated transition rates are consistent with the observed evolution of aggregate labor market stocks, the flows are margin-adjusted following the procedure described in Shimer (2012). All time series are deseasonalized using the X-13ARIMA-SEATS procedure.

Figure 3 shows that the immigration shock induces a significant positive flow of natives into employment from both the pool of unemployed, as well as enticing natives out of inactivity. In fact, the impact on the flows out of inactivity into employment are even stronger in the cumulative response. Explaining both these positive flows to employment requires a theory for why job matches increase and also why participation should increase. We set forth in the following sections to do so, first in a static setting to illustrate our mechanism and then in fully dynamic model where we can see how examining a transition can help our interpretation of this empirical evidence.

3 Static Model

In the previous section we showed that the labor force participation rate is significantly higher for low-skilled immigrants than for low skilled natives and that the job separation rate is lower for low-skilled immigrants. We also documented that in response to an immigration shock: *native* workers' job finding rate increases and their job separation rate decreases. In this section we develop a simple static model to illustrate that income effects can explain these empirical findings.

The model is static and without capital. Aside from their labor market status, households are heterogeneous in two dimensions. First, they are exogenously assigned to one of two sectors, high- and low-skill, $s \in \{L, H\}$, in which they can choose to search for work or not participate. Let $\Phi \in (0, 1)$ be the share of low-skill households. Second, in each sector, there is a continuum of households differentiated by their asset endowment, which is drawn from some distribution. The only uncertainty in the model arises from frictional labor market search and the idiosyncratic risk of search being unsuccessful.

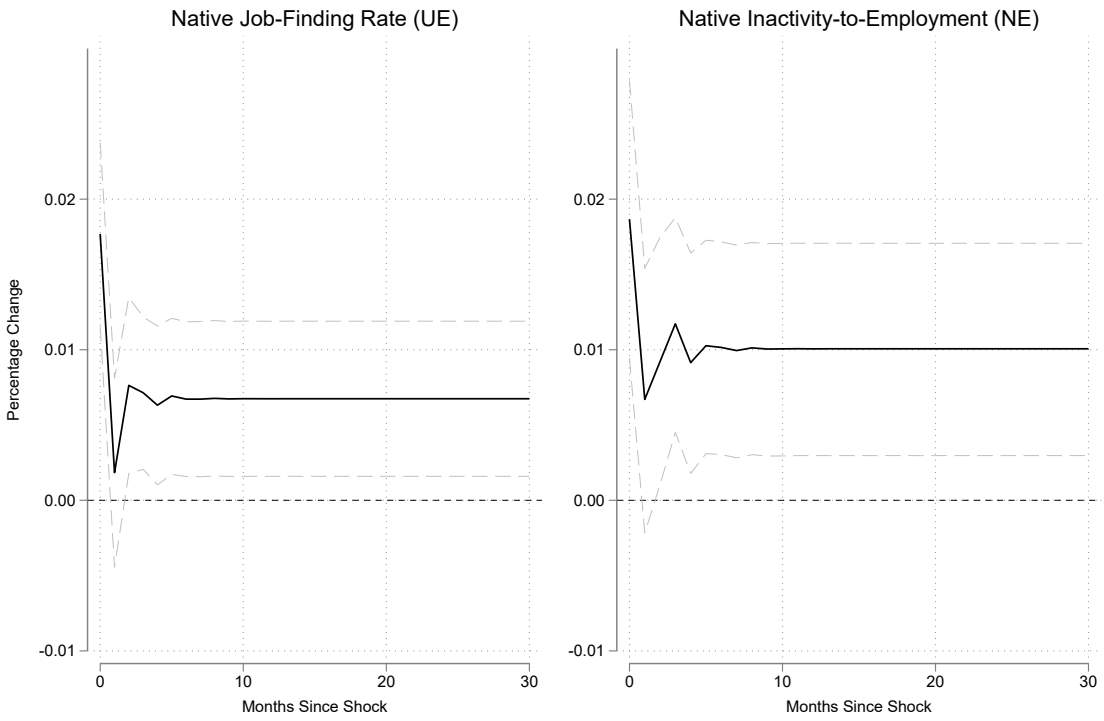


Figure 3: The native hiring response to an immigration shock

3.1 Households

Households have concave utility function, $u(c)$, in their level of consumption. In addition, there is a fixed utility cost of searching for work, Ω, and a utility cost of working, Υ. Households only make extensive margin labor supply decisions, i.e. the number of hours worked, conditional on working, is fixed. They first decide whether or not to search for a job, and then in the case that a job is found, whether or not to keep it. Searchers, in sector s, are randomly matched to a relevant vacancy with probability, λ_s^w. If search is unsuccessful, households are eligible for unemployment benefits, UI_s. The household problem is summarized by:

$$\max_{\text{search,work}} \mathbf{E}u(c_{s,i}) - \mathbb{1}_{[search]} \cdot (\Omega + \lambda_s^w \Upsilon \cdot \mathbb{1}_{[work]}) \tag{3}$$
$$c_{s,i} = w_s + a_i \quad \text{if employed,}$$
$$c_{s,i} = UI_s + a_i \quad \text{if unemployed,}$$
$$c_{s,i} = a_i \quad \text{if inactive}$$

In this static setting, a household has to make two decisions, which are associated with four possible outcomes. First, if they never search, then they will receive the inactivity payoff with certainty. Second, if they search and do not find a job, they will have access to unemployment benefits, UI_s. Third, if they successfully search for a job and accept it, they will receive the wage, w_s. Finally,

and importantly, a household that has incurred the sunk search cost may still choose inactivity (when rational to do so). This introduces the potential for "insincere" searchers, whose behavior is characterized by paying the search cost for a chance of receiving UI_s and walking away from a successful match otherwise. This can happen if UI_s is relatively large compared to w_s and is more likely to happen for wealthier households due to the concavity of the utility function.

Conditional on a successful match, this household "quitting" behavior is captured by a level of assets, $a > \breve{a}$, at which the return to work does not compensate for the disutility. Thus $\breve{a}_s$ denotes the cutoff that makes a matched worker indifferent between accepting the job offer and inactivity, which solves:

$$u(w_s + \breve{a}_s) - \Upsilon = u(\breve{a}_s) \tag{4}$$

To complete our categorization of worker behavior in the model we now turn to the search decision. The nuance in this decision arises from the heterogeneity of the asset endowment and the existence of insincere searchers over a given range of assets. Let $\hat{a}_s$ denote the level of assets at which a household in sector s is indifferent to search, which solves:

$$\lambda_s^w \left[(1 - \pi_s^q(\hat{a}_s))(u(w_s + \hat{a}_s) - \Upsilon) + \pi_s^q(\hat{a}_s)u(\hat{a}_s)\right] + (1 - \lambda_s^w)u(UI_s + \hat{a}_s) - \Omega = u(\hat{a}_s) \tag{5}$$

Where $\pi^q(a)$ is the policy function for "quitting" as a function of wealth. For simplicity, we assume the indifferent household (i.e. the household with endowment $\breve{a}$) accepts the job.

$$\pi^q(a) = \begin{cases} 1, & \text{if } a > \breve{a} \\ 0, & \text{otherwise} \end{cases}$$

The relative position of these two cutoffs, $\breve{a}$ and $\hat{a}$, determine the behavior of the marginal searcher (i.e. the household with endowment $\hat{a}$) and the mass of potential quitters. If $\breve{a} > \hat{a}$, then all searchers are "sincere", since costly search has screened out those who would refuse a job offer. Alternatively, when $\breve{a} < \hat{a}$ we will have a mass of searchers that will walk away from a successful match.

Thus *effective* labor supply in sector s is a function of these cut-offs:

$$L_s = \int^{min\{\breve{a}_s, \hat{a}_s\}} f_s(a)\, da \tag{6}$$

Where $f_s(a)$ is the sector s population density over assets. Note that the mass of labor supply here is dependent on the relevant asset cutoff that represents the upper bound of households with a genuine intent to participate in productive activity. Search, in itself, is not indicative of this in the model, as it would be in labor market statistics, where it is hard to infer insincere searchers. Employment in sector s, $E_s = \lambda_s^w L_s$, is the share of genuine searchers who are successfully matched.

Figure 4 illustrates the case where a positive mass of insincere searchers exists, denoted by Q. Note that $Q_s = \int_{\check{a}_s}^{\hat{a}_s} f_s(a)\, da$ and the number of searchers, S, is given by $S_s = L_s + Q_s$.

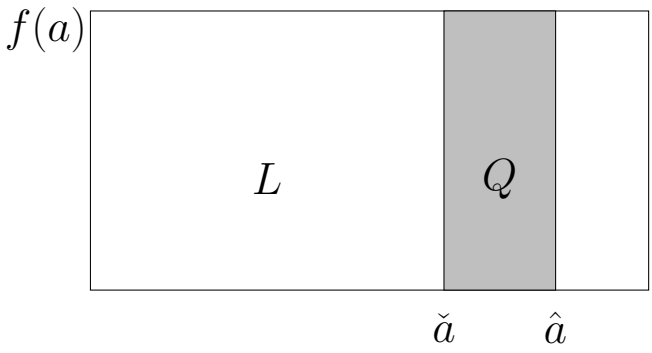


Figure 4: Illustrating a mass of insincere searchers

In the above case, where $\hat{a} > \check{a}$, the model accounts for two types of unemployment, frictional and structural. The first group are genuine searchers held out of employment by the existence of a matching friction, and the second are those enticed into search by the unemployment benefit. Unemployment in sector s is $U_s = (1 - \lambda_s^w)(L_s + Q_s)$. Note that the unemployment rate of sector s is formed with $L_s + (1 - \lambda_s^w)Q_s$ as the denominator, $u_s = \frac{U_s}{L_s + (1-\lambda_s^w)Q_s}$. Matched searchers from region Q resign themselves to inactivity.

3.2 Firms

For the sake of consistency with our dynamic model below, we adopt much of the firm structure from Section 4, although capital is not used in production in the static model. A representative competitive firm operates a final good production technology where two intermediate goods (high-skill and low-skill) are combined to produce the final good. The intermediate goods are produced by many competitive firms, using labor of each skill type and a linear production technology. Employed workers are hired at the extensive margin only and receive sector wages equal to a given fraction of the marginal product of their respective input.

The final production good, Y, combines two inputs, denoted as low and high skill, using a constant returns CES production function with share parameter $\alpha \in (0, 1)$, and substitution parameter, ν.

$$Y = [\alpha E_L^{\nu} + (1 - \alpha) E_H^{\nu}]^{\frac{1}{\nu}} \tag{7}$$

Competitive prices of the intermediate goods, p_s, are given by:

$$p_L = \alpha E_L^{\nu-1} Y^{1-\nu} \tag{8}$$

$$p_H = (1 - \alpha) E_H^{\nu-1} Y^{1-\nu} \tag{9}$$

Thus, a worker's wage is decreasing in the level of employment in their own sector and increasing in the level of employment in the other sector. We assume that firms in the intermediate goods sectors can freely enter the market and post vacancies directed at workers in each sector. There is a sunk cost associated with vacancy creation, ξ_s, and the value of posting a vacancy in sector s is thus given by:

$$\mathcal{V}_s = -\xi_s + \lambda_s^f (1 - \Pi_s^q) J_s \tag{10}$$

where λ_s^f is the probability that the firm finds a match, $1 - \Pi_s^q$ is the probability of match continuation, where

$$\Pi_s^q = \frac{\int_{\check{a}_s}^{\hat{a}_s} f_s(a)\, da}{\int^{\hat{a}_s} f_s(a)\, da} = \frac{Q_s}{S_s} \tag{11}$$

is the share of searchers who are insincere, and

$$J_s = p_s - w_s \tag{12}$$

is the value of a filled job. We assume:

$$w_s = \kappa p_s \tag{13}$$

where $\kappa \in (0, 1)$ is the fixed share of the value of a productive match claimed by the worker.[1]

Equation 10 shows that the job creation motive in our model depends on three different factors related to immigration. First, is the probability of a successful match, λ_s^f, which increases when the labor market tightness falls and would, all else equal, be the result of an increase in the number of workers (immigrants). Second, is the match separation probability, Π_s^q, which depends on the *type* of households that make up the pool of searchers. When the fraction of insincere searchers is large (recall the mass Q in Figure 4), the probability of match continuation is low. However, when immigration changes the composition of searchers it will also change this probability. For example, if immigrants have low levels of wealth, they will *increase* the probability of match continuation by diluting the concentration of insincere searchers in the search pool. Third, is the value of a productive match, J_s, which depends on the degree of diminishing returns and on the productivity gains due to skill complementarity in the final goods production function. Thus increased employment in one sector will lead to less valuable matches in that sector, but an increase in the value of a filled job in the other sector. Thus, we should expect an increase in job vacancies

[1] Modeling the wage bargaining game would imply a within-skill wage dispersion that depends on the distribution of assets. In the dynamic context this complicates the inter-temporal decision since households have an additional incentive to accumulate assets in order to improve their position in any forthcoming wage bargain. Since we have set this channel aside in the dynamic model, we also do so here.

in the high skill sector, if the level of employment rises in the low skill sector and vice versa.

3.3 Matching

Matches between searchers and vacancies in each sector are randomly assigned. The sector-specific matching function, $M(V_s, S_s)$, produces matches taking the number of vacancies, V_s, and the number of searchers, S_s, as inputs. The function is increasing in both arguments and has standard features from the literature, being at least twice differentiable, homogeneous of degree 1, and satisfying the Inada conditions. Let $\theta_s = \frac{V_s}{S_s}$ be labor market tightness in sector s. Then we can write worker and firm matching probabilities as a function of market tightness,

$$\lambda_s^w = \frac{M_s}{S_s} = M(\theta_s, 1)$$
$$\lambda_s^f = \frac{M_s}{V_s} = M(1, \frac{1}{\theta_s}).$$

3.4 Government

In the static model we leave aside the institutional detail of public finance and proceed with a very simple implementation of the government budget constraint, where unemployment insurance is financed from a public funds endowment. Later in the fully dynamic model we will incorporate more institutional detail on, for example, progressive income taxation, public pension schemes and a binding government budget constraint.

3.5 Model Timing

The timing of the model is as follows: first, households receive their skill and asset endowment. Second, households decide whether or not to search, while the firms in the high-skill and low-skill sectors simultaneously decides whether to enter the market. Third, matched workers decide whether to keep the job or to enter inactivity (which does not give rights to UI). Firms have perfect knowledge of the distribution of household assets and skills and thus the probability of finding a worker who will accept employment. All risk is idiosyncratic, so aggregate levels and prices are well understood at the point decisions are made.

3.6 Equilibrium

In the decentralized equilibrium:

1. Households solve their problem, 3, given the prevailing wage, w_s, and worker match probability, λ_s^w, in their sector. For a given wage and match rate this implies an effective labor supply, L_s, and search pool, S_s, in each sector.

2. Taking firm match probability, λ_s^f, match continuation probability, $1-\Pi_s^q$, and intermediate good price, p_s, as given, the competitive intermediate goods producing firms solve their vacancy creation problem, Eq. 10.

3. Free-entry implies that the the expected value of vacancy creation, $\mathcal{V}_s$, is zero.

4. The matching probabilities, λ_s^w and λ_s^f, are consistent with the number of searchers implied by the household problem and the number of vacancies implied by the free-entry condition.

5. Wages and intermediate goods prices, w_s and p_s, are consistent with the effective labor supply implied by the household problem, L_s, and the worker match rate, λ_s^w and determined by the production technology in Equation 7 and workers' share of a productive match, κ.

6. The aggregate resource constraint binds, $\int c = Y + \int a + \sum_s UI_s U_s$.

3.7 Calibration

We proceed by making functional form assumptions. Utility is logarithmic in consumption and the native asset endowment in each sector is distributed uniformly between 0 and A_s. The sector specific matching functions are Cobb-Douglas, $M_s = \chi_s U_s^{\eta} V_s^{1-\eta}$.

With these functional forms, we can give explicit expressions for the wealth cutoffs that identify the marginal searcher, $\hat{a}_s$, and the marginal supplier of labor, $\check{a}_s$, in each sector:[2]

$$\hat{a}_s, \check{a}_s = \begin{cases} \frac{UI_s}{e^{\frac{\Omega_s}{1-\lambda_s^w}}-1}, \quad \frac{w_s}{e^{\Upsilon_s}-1} & \text{if } \hat{a} > \check{a} \\ \arg\min_a \left| (1+\frac{w_s}{a})^{\lambda_s^w} (1+\frac{UI_s}{a})^{1-\lambda_s^w} - e^{\lambda_s^w \Upsilon_s + \Omega_s} \right|, \quad \frac{w_s}{e^{\Upsilon_s}-1} & \text{otherwise} \end{cases} \tag{14}$$

Recall that the market wage in each sector is a fixed share, κ, of the marginal product of labor in the relevant sector, $w_s = \kappa \alpha_s E_s^{\nu-1} Y^{1-\nu}$. We assume that the unemployment benefit is paid as a replacement rate (RR) of the market wage, $UI_s = RR \cdot w_s$, so the value of the benefit varies with the wage.

We parameterize the benchmark with both exogenously set parameters and endogenously chosen parameters following a simulated method of moments approach. Table 1 summarizes the calibration choices.

So far in the model description we have not included any government policy, other than the replacement rate of unemployment insurance. For our illustrative quantitative experiments we add a proportional flat tax on both earned income and UI, as well as an unconditional uniform transfer. We do not model government debt, and do not require that the budget balances in the static model

[2] These expressions are relatively easy to interpret for the first case (i.e. when $\hat{a} > \check{a}$) when Q has strictly positive mass, which is the relevant case for our mechanism.

and again assume that government outlays in excess of tax collected are paid by a public funds endowment. However, to illustrate the income effect channel through which immigration affects native labor supply, which will be key in our dynamic model, we allow for a lump sum transfer, g, which is congested by the new arrivals. Specifically, the budget constraints become:

$$
\begin{aligned}
c_{s,i} &= (1-\tau)w_s + a_i + \frac{g}{pop} \quad \text{if employed,} \\
c_{s,i} &= (1-\tau)UI_s + a_i + \frac{g}{pop} \quad \text{if unemployed,} \\
c_{s,i} &= a_i + \frac{g}{pop} \quad \text{if inactive}
\end{aligned}
$$

Table 1: Static Model Calibration

Parameter	Value	Description	Details or relevant moment
Exogeneously Chosen Parameters			
Φ	0.64	Share of low-skill workers	CPS 2019
A_s	$1.02, 4.68$	Upper-bound of asset endowment	Wealth to earnings ratios (1.5 for low skill and 3.5 for high skill)
κ	0.69	Worker's claim on revenue	We use the dynamic model value, where we have chosen to match the labor share.
ν	0.4	CES Elasticity	Krusell et al. (2000)
η	0.72	Elasticity on matching function	Krusell et al. (2010)
Ω_s	$\Upsilon_s/25$	Utility cost of search	Fixed fraction of disutility of work (motivated by ca. 2 hours search activity per week, American Time Use Survey)
RR	0.53	UI wage replacement rate	OECD benefits calculator
τ	0.28	Labor income tax	Trabandt and Uhlig (2011)
g	0.35	Transfer generosity as a share of average earnings	Linear average of CBO's means-tested transfer rates for bottom half income groups (Distribution of Household Income, 2019).
Endogenously Calibrated Parameters (SMM)			
χ	0.926	Joint matching function efficiency	Aggregate market tightness of 1.
ξ_s	$0.095, 0.174$	Vacancy posting costs	Sectoral unemployment rates (0.08 and 0.03)
Υ_s	$0.168, 0.074$	Utility cost of work	Sectoral employment rates (0.69 and 0.84)
α	0.39	Low skill productivity share	Skilled wage premium of 2

3.8 The Impact of an Immigration Shock

We now perform a simple experiment in our calibrated static model to illustrate the mechanisms through which immigration can impact the economy. To study the impact of an immigration shock we start with the benchmark calibration described above and varying masses of immigrants to the population. These new arrivals have a different distribution of both skills and assets compared to the "natives" (we do not model previous cohorts of immigrants as being distinct from the native population and thus the term "natives" refers to the population *in situ* prior to the shock, i.e. incumbents). Specifically, we assign all the new arrivals to the low skill sector, and give them a wealth endowment drawn from a uniform distribution between $[0, B]$. For the time being, we set $B = A_{low}/2$. Immigrant labor is assumed to be a perfect substitute for native labor, and unlike in the dynamic model below, immigrants have the same level of human capital as natives (conditional on skill). We let the size of the immigration shock as a share of the total native population vary from from 0 to 3%. Figure 5 illustrates the impact of the shock on labor market outcomes in the low skill sector - where the immigrants are competing directly with natives - and Figure 6 illustrates the impacts on the high skilled sector and on the aggregate labor market.

The results qualitatively confirms our stylized facts. The immigrants arrive and, due to their relatively low wealth, search at a very high rate (determined by the share of immigrants with wealth below $\hat{a}$). This expansion in the number of searchers induces a response from firms who make their vacancy posting decision in light of: the change in the probability of matching with a worker (through labor market tightness, θ_s), the change in the probability of that worker accepting the job (through the match separation risk, Π_s^q), and the value of a filled job in their sector (through diminishing returns and skill complementarity).

Because all the immigrants enter the low skill sector, we can attribute the impacts on the high skill sector to skill complementarity (see the top three panels in Figure 6). As expected, wages, participation and employment rise among high skill natives as a result of the value of a filled job increasing. Unemployment falls in the high skill sector. In the low skill sector, however, natives face direct competition in the labor market from the new arrivals. Because they are poorer, the labor supply of immigrants is less elastic than for natives, which manifests in higher search and participation rates, lower quitting rates, and thus higher employment. The increase in employment in the low skill sector leads to diminished wages and changes the labor supply decisions of natives. The substitution effect dominates the positive income effect form the fall in g with respect to participation and search, which falls for low skill natives.

However, importantly, low skill separations also decrease (satisfying our stylized fact) and we see a fall in native low skill unemployment (also an empirical finding in Chassamboulli et al. (2024)). The decrease in native low skill separations is indicative of a change in the pool of searching workers beyond the inclusion of the new immigrants. The immigration shock also works to screen out insincere natives by increasing the job finding rate (firms post more vacancies due to

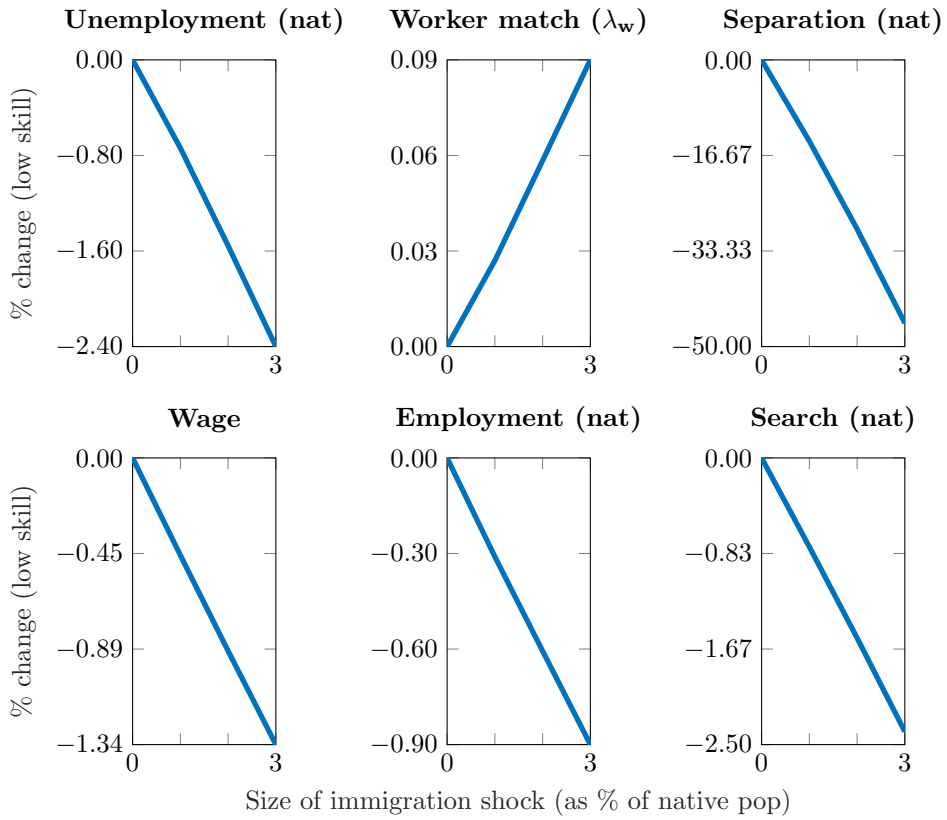


Figure 5: The Impact of Immigration on Labor Market Outcomes (low-skill Natives)

higher value of filled jobs) and thus decreasing the probability that an insincere worker will end up with UI (their desired outcome from search). Therefore, while immigration has a negative impact on native wages, it provides a positive externality for sincere native searchers in the form of an increased probability of finding work. Furthermore due to the concavity of the utility function, the fall in g also makes it less attractive to quit relative to accepting a job, further reducing the quitting rate. While native employment rises in aggregate (middle bottom panel of Figure 6), that is the combined employment response of low and high skill natives, low skill native employment falls in our static model. In our dynamic model below, we will see that immigration can induce a positive employment response even among low skill natives competing directly for jobs with the new arrivals. This will be due to a positive income effect on labor supply today due to lower wages in the future.

To illustrate the mechanisms at work during an immigration shock, we have presented a brief exercise in our calibrated static model. The purpose of this exercise was to show how we can derive the qualitative results presented in the stylized facts section in a simple intuitive framework. In particular, the surprising findings that an immigration-based labor supply shock can induce a response where: the *native* job finding rate increases, native job separations fall, and native unemployment is diminished can all be explained through income effects in a simple static model. In the next section we will study a richer dynamic model, where the same effects are present.

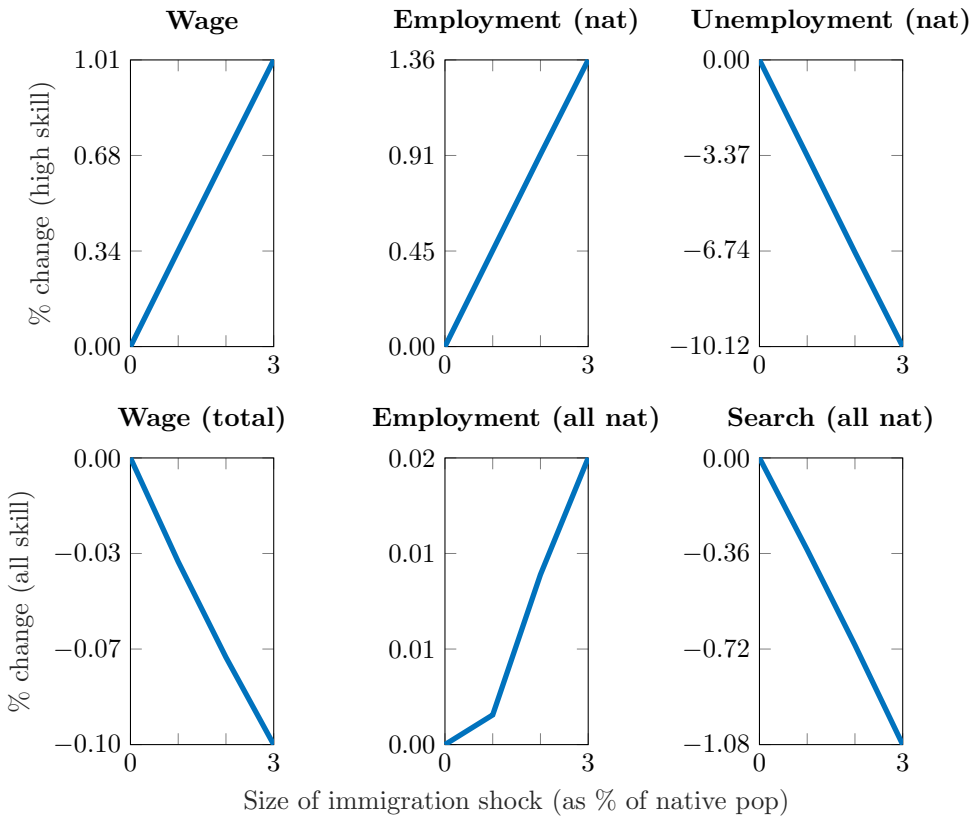


Figure 6: The Impact of Immigration on Labor Market Outcomes (natives, high-skill and total)

4 The Quantitative Model

We extend the labor market matching model of Krusell et al. (2010) to a life-cycle model, where households face idiosyncratic labor productivity shocks, accumulate experience, and can choose whether or not to participate in the labor market. The aggregate production function is a nested CES with two intermediate input sectors that are segregated by worker skill (high-skill and low-skill), so that the supply of one type of labor can affect the wages of the other type. Furthermore, we make one simplification, relative to Krusell et al. (2010), by assuming that wages are a given fraction of firm profit rather than determined during a Nash bargaining stage.

4.1 Consumers

The economy is populated by L overlapping generations of finitely-lived households. Time is discrete and there are 8 time-periods in a year (a period is roughly six weeks). All native households, who have not immigrated, start life at age 20 and enter retirement at age 65. Let l denote the household's age. Retired households face an age-dependent probability of dying, $\pi(l)$ and die for certain at age 100.[3] We assume that the size of the population is fixed (there is no

[3]This means that $L = 81 * 8 = 648$.

population growth in the absence of immigration waves). We normalize the size of each new cohort to 1. Using $\omega(l) = 1 - \pi(l)$ to denote the age-dependent survival probability, by the law of large numbers the mass of retired agents of age $l \geq 360$ still alive at any given period is equal to $\Omega_l = \prod_{j=360}^{j=l-1} \omega(j)$. The fraction of households who die leave unintended bequests. These bequests are used to increase the return on savings among retirees in the same cohort. One way to think of this is as if retirees in each cohort own shares of a mutual fund and the shares of the dying owners are redistributed proportionally among the living owners. The surviving retirees of age l get a return $1 + (r - \delta)/\omega(l - 1)$ on their savings, where $(r - \delta)$ is the return on capital after depreciation.

In addition to age differences, households are heterogeneous with respect to asset holdings, a, labor market experience, e, and idiosyncratic productivity, z. Finally, they also differ in terms of a permanent ability or type component, s, i.e. they have a starting level of productivity that is realized at age 20 (the start of working life). s will determine the household's sector of work. In every period of active work-life a currently non-working household will decide whether or not to participate in the labor market and try to find a job in the next period, $n'_u \in \{0, 1\}$, whereas currently employed households decide whether to continue working in their job or to immediately quit and exit the labor force, $n_{em} \in \{0, 1\}$. There is an age- and type-dependent fixed utility cost, Υ, of working. Search is assumed to be costless, but there is a time varying, Gumbel-distributed taste shock, ς, for participating in the labor market.[4] Households who loose their job for exogenous reasons and continue to search for a new one will receive an unemployment benefit, T, which they will have a probability P_{UI} of keeping (P_{UI} is set to match UI duration). Employed households gain 1 unit of labor market experience per period and the experience level of unemployed households depreciates at a rate, δ_e. Households also decide how much to consume, c, and next period's asset holdings, a'. Retired households make no labor supply decisions but receive a social security payment, Ψ.

4.1.1 Individual Labor Productivity

We will assume that the individual's wage is a fraction, κ, of the profit of the firm where she is employed. The profit of the firm will in turn depend on the individual's productivity, on prices and on the aggregate output across sectors. Individual productivity depends on experience, e, sector specific productivity, γ_{0s}, and an idiosyncratic productivity shock, z. The idiosyncratic shock follows an AR(1) process:

$$z' = \rho z + \epsilon, \quad \epsilon \sim N(0, \sigma_\epsilon^2). \tag{15}$$

[4]The taste shock is helpful both for matching labor market flows and for computational reasons.

Thus, the units of labor, N_i, supplied by an individual i is given by:

$$N_i(e, s, z) = e^{\gamma_{0s}+\gamma_{1s}e_i+\gamma_{2s}{e_i}^2+z_i}. \tag{16}$$

The sector specific experience profile of wages is thus captured by γ_{1s} and γ_{2s}. An individual who works positive hours receive 1 unit of labor market experience. For individuals who do not work, experience depreciates at rate, δ_e.

4.1.2 Preferences

The momentary utility function of a household, $U(c, n)$, depends on consumption and labor supply, $n \in \{0, 1\}$, and takes the following form:

$$U(c, n) = \frac{c^{1-\zeta}}{1-\zeta} - \Upsilon \cdot \mathbb{1}_{[n=1]}. \tag{17}$$

Υ is here an individual disutility from working. The disutility from working depends on age and sector of work:

$$\Upsilon = \Upsilon_{0s} + \Upsilon_{1s}l + \Upsilon_{2s}l^2 \tag{18}$$

In addition there is a Gumbel distributed preference shock, ς, that determines the individual's preference for participating in the labor market, $n \in \{0, 1\}$, where for an employed individual participating would be equivalent to working and for a non-working individual participating would be equivalent to searching for a job.

The utility function of retired households has one extra term, as they gain utility from the bequest they leave to living generations:

$$D(a') = \varpi \ln(a'), \tag{19}$$

where a' assets in the next period. The expected discounted lifetime utility of household i is given by:

$$V_i = \mathbb{E}_0 \left[\sum_{l=L}^{J} \beta^{l-1} \left[\Omega_l u(c_{il}, n_{il}) + (\Omega_l - \Omega_{l+1}) D(a_{il+1}) + \Omega_l n_{il} \varsigma_{il} \right] \right], \tag{20}$$

where β is the discount factor and $\Omega_l = 1$ for $l \leq 360$ (age 65).

4.2 Government

We assume that the government runs a balanced budget where it levies social security taxes, τ_{ss}, labor income taxes, $\tau_n(w)$, capital taxes, τ_a, and consumption taxes, τ_c. The social security taxes, capital taxes and consumption taxes are assumed to be flat. To model the non-linear labor income tax, we use the functional form proposed in Benabou (2002) and recently used in Heathcote et al. (2017), Holter et al. (2019):

$$wa = \Theta_0 w^{1-\Theta_1}$$

where w denotes pre-tax (labor) income, wa after-tax income, and the parameters Θ_0 and Θ_1 govern the level and the progressivity of the tax code, respectively.[5] Heathcote et al. (2017) argue that this fits the U.S. data well.

The tax revenue is used to pay social security benefits, Ψ, to retirees, finance expenditures on pure public consumption goods, G, which enter separably in the utility function, interest payments on the national debt, rB, lump sum redistribution, g, and unemployment benefits, T. We assume that there is some outstanding government debt, B, which is constant over time. Transfers are also assumed to be constant in the benchmark calibration.

Unemployed individuals who were previously employed, whose jobs were exogenously destroyed (they did not voluntarily quit), and who continue to participate in the labor force (they are searching for work) receive unemployment benefits which are a function of the earnings they would have received if employed. Let υ denote the percentage of the wage that is paid as a benefit. There is a minimum unemployment benefit, denoted by $\underline{\mathrm{T}}$, and a maximum unemployment benefit, denoted by $\bar{T}$,. If the replacement benefit falls below or above these extremes, then the agent receives either the minimum or the maximum benefit. The unemployment benefit is thus given by:

$$T_t = \underbrace{\underline{\mathrm{T}}\, 1\{\upsilon w_t < \underline{\mathrm{T}}\}}_{Minimum\,Benefit} + \underbrace{\upsilon w_t\, 1\{\underline{T} \leq \upsilon w_t \leq \bar{T}\}}_{Replacement\,Income} + \underbrace{\bar{T}\, 1\{\upsilon w_t > \bar{T}\}}_{Maximum\,Benefit} \tag{21}$$

w_t is here the hypothetical labor income of the individual had she been matched with an employer this period. This implies that the UI payment is partially subject to the same income risk that the productive wage is. Because unemployment benefits are temporary there is a per period probability, P_{UI}, of keeping the right to unemployment benefits, when continuing to search for work.

Let R be the government's revenues from the labor, social security, capital and consumption taxes. Denoting the fraction of unemployed individuals by Ξ, letting $\hat{T}$ denote the average value of the unemployment benefit, and suppressing time subscripts, we can write the government budget

[5] A detailed discussion of the properties of this tax function is provided in the appendix of Holter et al. (2019).

constraints as:

$$g\left(360+\sum_{q>360}\Omega_q\right)+360\hat{T}\Xi+G+(r-\delta)B+\Psi\left(\sum_{q>360}\Omega_q\right)=R \tag{22}$$

The government spends resources on per capita transfers (times the number of individuals in the economy), on unemployment benefits for unemployed individuals, on government consumption, on servicing the interest, $r-\delta$, on outstanding government debt, and on pensions. It has to finance these outlays through tax revenue.

4.3 Labor Market

The labor market setup is, with some exceptions, similar to the environment of Krusell et al. (2010). Instead of determining wages by Nash bargaining, we assume that the worker's wage, $w(e,s,z)$, is a fraction, κ, of the firm's profit. Furthermore, we extend Krusell et al. (2010) to a two-sector environment with production externalities between the sectors and we let individuals decide whether or not to participate in the labor market.

4.3.1 Matching

There are many firms, one per "job", and they act competitively in the labor market. The labor market has two sectors, distinguished by the skill type, s, of workers, which can be high-skill or low-skill. Vacancies and unemployed workers are randomly matched each period according to an aggregate matching function for sector s. Each aggregate matching function, $M_s(U_s,v_s)$, gives the number of matches in a period, given the number of unemployed workers, U_s, and number of vacancies, v_s in sector s. M_s follows the typical characteristics from the matching literature (i.e. constant returns to scale and increasing in both arguments). The probability that a vacancy in sector s is filled in the current period is given by, $\lambda_s^f=M_s(U_s,v_s)/v_s$. This can be re-written as a function of market tightness, $\theta_s=\frac{v_s}{U_s}$, $M_s(1/\theta_s,1)$. Likewise the probability of an unemployed worker becoming employed in the current period is, $\lambda_s^w=M_s(U_s,v_s)/U_s$ which can also be written as a function of market tightness, $\lambda_s^w=\theta_s\lambda_s^f$.

We assume that job separations can occur exogenously and with sector-specific probability σ_s, or endogenously. Workers that quit are, however, not participating in this period's labor market (they would not be eligible for UI benefits). Let P_s be the fraction of workers participating in the labor market. We assume that it takes at least one period to find a job so that someone moving from non-participation to participation will be unemployed in that period. Then we can write the

dynamics of the unemployment rate, u_s, in sector s as:

$$\begin{aligned} u'_s P'_s &= (1-\lambda_s^w)u_s P_s + \sigma_s(1-u_s)P_s + (P'_s - P_s) \\ u'_s &= (1-\lambda_s^w)u_s \frac{P_s}{P'_s} + \sigma_s(1-u_s)\frac{P_s}{P'_s} + \frac{(P'_s - P_s)}{P'_s} \end{aligned} \tag{23}$$

In a steady state with constant participation we would have the familiar relationship:

$$u'_s = (1-\lambda_s^w)u_s + \sigma_s(1-u_s) \tag{24}$$

4.3.2 Asset Structure

We use the same asset structure as in Krusell et al. (2010), which allows us to keep track of an indeterminate asset portfolio, a, with return equal to the gross interest rate (due to a no arbitrage condition). The consumers face idiosyncratic productivity and employment status shocks, but we assume that there are no insurance markets for these idiosyncratic shocks. Other than public debt, the consumers can hold only two kinds of assets: capital, k, which is used as an input for production, and equity, m, which is a claim to an equal weighted portfolio of all the firms' profits. The total value of the firms is denoted by p. Alternatively, we can say that there is one "representative firm"—with a continuum of jobs—whose value is p. Let r be the return to capital and d be the dividend paid to the holders of equity. We normalize the total amount of equity to one. The equity price p has to satisfy the following equation:

$$p = \frac{d+p}{1+r-\delta} \tag{25}$$

where δ is the depreciation rate of capital. No arbitrage implies that the return on capital is equal to the return on equity as well as government debt. Let q denote the inverse of the gross real interest rate, $q \equiv \frac{1}{1+(r-\delta)}$. Because capital and equity are equivalent from the consumer's viewpoint, we do not have to keep track of the portfolio composition. In the following, we use assets, a, as the consumer's state variable:

$$a \equiv k + m + b \tag{26}$$

4.3.3 Employment, Unemployment, and Participation

We distinguish between two types of working-age consumers, those who are employed and those who are not working (inclusive of both unemployed and non-participating working-age consumers). Non-working consumers who were previously working may have access to unemployment benefits, $UI \in 0, 1)$. When age is 65 or higher, $l > 360$, the consumer is retired and there is no distinction

between working and not working. The sector in which they are assigned (as a function of their skill-type) is again indexed by s. Non-working consumers may choose to not participate in the labor force. Similarly working consumers may choose to quit and not participate anymore. If not participating this period, they will begin the next period as non-working.

Employed Consumers An employed, working-age ($l < 360$) consumer solves the following problem for a given w:

$$\begin{aligned}
W(a,e,s,z,l) &= \max_{c,a',n} u(c,n) \\
&+ \mathbb{1}_{[n>0]}\beta\omega(l)\Big[\sigma E_z[U(a',e',s,z',UI'=1,l')] + (1-\sigma)E_z[W(a',e',s,z',l')]\Big] \\
&+ (1-\mathbb{1}_{[n>0]})\cdot\beta\omega(l)E_z[U(a',e',s,z',UI'=0,l')] \\
&\text{s.t.:} \\
&a' = (1+(r-\delta)(1-\tau_a))a + w(e,s,z)(1-\tau_{ss}+\tau_n(w(e,s,z))) + g - c(1+\tau_c) \\
&e' = e+1, \quad z' = \rho z + \epsilon, \quad \epsilon \sim N(0,\sigma_\epsilon^2), \qquad l' = l+1, \quad a' \geq \underline{a}, \quad n \in \{0,1\}
\end{aligned} \tag{27}$$

Where $U(\cdot)$ is the value function of a non-working consumer, and $W(\cdot)$ is the value function of an employed consumer. E_z is the expectation operator over tomorrow's productivity shock, z. The consumer chooses whether or not to continue working for the current employer, $n_{em}(a,e,s,z,l) \in \{0,1\}$, and thus whether to participate in this period's labor force. If she continues to work, $n=1$, she will be employed in the next period unless the job is exogenously dissolved with probability σ. If the latter happens she will have access to unemployment insurance in the next period. If she decides to stop working, she is not participating in the labor force and will not have a job in the next period. She will also not have access to unemployment benefits. We denote the savings decision of employed workers by $\psi_{em}(a,e,s,z,l)$. One should note that the state dependent wage $w(e,s,z)$ will be a general equilibrium outcome, but is taken as given by the consumer when solving her utility maximization problem.

Non-working Consumers A non-working working-age ($l < 360$) consumer solves the following problem:

$$
\begin{aligned}
U(a,e,s,z,UI,l) &= \max_{c,a',n'} u(c,n=0) \\
&+ \mathbb{1}_{[n'>0]} \cdot \beta\omega(l)\Big[(1-\lambda_s^w)E_{zP_{UI}}[U(a',e',s,z',UI',l')] + \lambda_s^w E_z[W(a',e',s,z',l')]\Big] \\
&+ (1-\mathbb{1}_{[n'>0]}) \cdot \beta\omega(l)E_z[U(a',e',s,z',UI'=0,l')] \\
&\text{s.t.:} \\
&a' = (1+(r-\delta)(1-\tau_a))a + g + T*UI*\cdot\mathbb{1}_{[n'=1]} - c(1+\tau_c) \\
&e' = e(1-\delta_e), \quad z' = \rho z + \epsilon, \quad \epsilon \sim N(0,\sigma_\epsilon^2), \qquad l' = l+1, \quad a' \geq \underline{a}, \quad n' \in \{0,1\}
\end{aligned} \tag{28}
$$

In addition to deciding on next period's asset level, $\psi_u(a,e,s,z,UI,l)$, a non-worker must make a decision, $n'_u(a,e,s,z,UI,l)$, about whether or not to participate in this period's labor force and try to find a job for the next period. Unemployed workers, who are eligible and participating in the labor force, searching for a job, receive an unemployment benefit, T, from the government as specified in Equation 21. UI eligible workers have a probability, P_{UI}, of keeping the eligibility until the next period.

Retired Consumers Retired consumers, $l > 360$, only need to decide how much to consume and save. Their problem can be written:

$$
\begin{aligned}
U(a,s,l) &= \max_{c,a'} u(c,n=0) + \beta\omega(l)U(a',s,l') \\
&\text{s.t.:} \\
&a' = (1+(r-\delta)(1-\tau_a))a + g + \Psi - c(1+\tau_c) \\
&l' = l+1, \quad a' \geq \underline{a}
\end{aligned} \tag{29}
$$

4.4 Firms

There are many firms operating in competitive markets. Firms operating in the competitive final goods market produce with nested CES technology:

$$Y = [(\alpha)Y_L^\nu + (1-\alpha)Q^\nu]^{1/\nu} \tag{30}$$

where Y_L is an input created from low-skill labor using linear technology. Q is an input created in a competitive market with the following CES technology:

$$Q = [xk^\varphi + (1-x)Y_H^\varphi]^{1/\varphi} \tag{31}$$

combining capital and intermediate input Y_H, which is created using high-skill labor in a linear production function in the effective labor supply of the matched worker $N_i(e, s = H, z)$.

There are matching frictions in the labor input markets Y_s, where $s \in \{L, H\}$. There is a flow cost of posting a vacancy, ξ_s. Let the measure of unemployed workers, participating in the labor force, in sector s be $\Phi_{u,n'=1}(a, e, s, z, l)$ The value of posting a vacancy, V_s, is:

$$V_s = -\xi_s + q[(1 - \lambda_s^f)V_s + \lambda_s^f \int J(a, e, s, z, l) d\Phi'_{u,n'=1,s}] \tag{32}$$

The value of a filled job in sector s, given the price of the output good, p_s, the wage $w(e, s, z)$ and other characteristics of the worker is:

$$J(a, e, s, z, l) = n_{em}(a, e, s, z, l)\Big(p_s Y_s(e, s, z) - w(e, s, z) + q[\sigma V_s + (1 - \sigma)E_z[J(a', e', s, z', l'))]]\Big) \tag{33}$$

where $n_{em}(a, e, s, z, l)$ is the labor force participation decision of the worker. If $n = 0$ the job is dissolved. Note that J depends on all the worker's state variables a, e, s, z and l, because the worker may decide to leave the firm. If she continues in her job then with probability $(1 - \sigma)$ the firm continues to be matched with the same worker. Also note that $J(\cdot) = 0$ when $l = l_{ret}$. p_s is the marginal product of the intermediate goods, Y_s.

$$p_L = \alpha Y_L^{\nu-1} Y^{1-\nu} \tag{34}$$

$$p_H = (1 - \alpha)(1 - x)Y_H^{\varphi-1} Q^{\nu-\varphi} Y^{1-\nu} \tag{35}$$

In equilibrium the total period profit from all firms in sector $s = s$ is:

$$\Pi_s = \int n_{em}(a, e, s, z, l)(p_s Y_s(e, s, z) - w(e, s, z)) d\Phi_s \tag{36}$$

The dividend from owning a share of all firms is the sum of profits minus the total vacancy costs:

$$d = \Sigma_s\Big(\Pi_s - \xi_s v_s\Big) \tag{37}$$

The final product firm's first order condition with respect to capital implies that $p_k = \frac{\partial Y}{\partial k}$.

$$p_k = (1 - \alpha)x k^{\varphi-1} Q^{\nu-\varphi} Y^{1-\nu} = r - \delta \tag{38}$$

4.5 Wage Determination

Workers receive a constant fraction, $\kappa \in (0, 1)$, of the firm's revenue as their wage:

$$w(e, s, z) = \kappa p_s Y_s(e, s, z) \tag{39}$$

Admittedly, this simplification is not benign and implies that a worker's negotiated wage is not dependent on their outside option. For example, specifying the wage formation this way implies that employers can not offer lower wages to poorer, but equally productive workers. This shuts down a channel whereby an increase in the share of poor workers engaged in search would induce a positive demand response from firms expecting a larger surplus from the wage bargaining game, as is true of immigrants in Moreno-Galbis and Tritah (2016).

4.6 Taste Shocks

Maximization problems featuring a combination of discrete and continuous choices are often characterized by non-concavities, which can lead to discontinuities in the value and policy functions and complicate numerical solutions. Similar to Ishakov and Keane (2020), we include "taste shocks" related to the dis-utility of labor force participation in order to alleviate the issues that arise in a deterministic setting. Thus we add a preference shock, ϵ^{taste}, that is added to the consumer's deterministic utility related to the labor supply. Define X as the state space compromising (a, e, s, z, UI, l), we introduce an additional state, h, for the taste shock. $\mathcal{W}(\mathcal{X}) = \max_n W(X, n) + \lambda_{taste}\varsigma(n)$

4.7 Model Timing

The timing of the model is as follows: at the start of the period, the matches of firms and workers that decided to search in the previous period are determined, some previously existing jobs are exogenously destroyed, and the transitory productivity shocks are realized. Next, households decide on this period's consumption, savings and participation choice, where matched workers stay in the match or quit and leave the labor force, while un-matched households decide whether or not to search; finally, firms without a match post vacancies, firms with job matches from last period set wages, produce and trade intermediate goods, and pay wages and dividends, while the final good firms rent capital and combine inputs.

4.8 Stationary Recursive Competitive Equilibrium

Let $\Phi(a, e, s, z, UI, l)$ be the measure of households with the corresponding characteristics. We now define a stationary recursive competitive equilibrium as follows:

Equilibrium Definition:

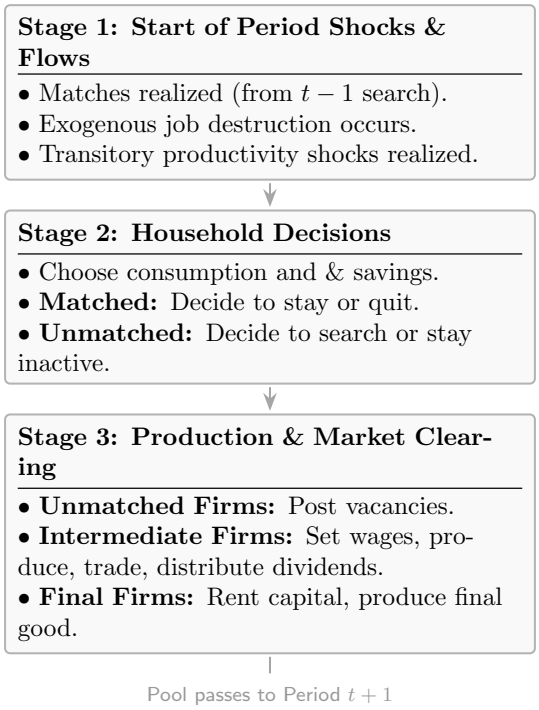


Figure 7: Model Timing within Period t

1. *Consumer Optimization:*

   The value functions, $W(a, e, s, z, l)$ and $U(a, e, s, z, UI, l)$, and policy functions, $\psi_{em}(a, e, s, z, l)$, $\psi_u(a, e, s, z, UI, l)$, $n_{em}(a, e, s, z, l)$ and $n_u(a, e, s, z, UI, l)$ solve the consumers' optimization problem given the prices, $w(e, s, z)$, p, p_s, p_k and r, matching probabilities, λ_s^f and λ_s^w, dividend d, and initial conditions.

2. *Firm Optimization:*

   The value function, $J(a, e, s, z, l)$, solves the firms' problem, given the prices, $w(e, s, z)$, and r, the workers' decision rules and the distribution of workers. Given the probability of finding a worker in each sector, λ_s^f, the interest rate, r, the workers' decision rules and the distribution of searching, unemployed workers in each sector, $\Phi_{u,n'=1,s}$, V_s satisfies 32.

3. *Free Entry:*

   The number of vacancies posted in each sector, v_s, is consistent with firm free entry: $V_s = 0$

4. *The asset market market clears:*

   The supply of capital by workers equals the demand for capital by firms and the government:

$$\int \psi_{em}(a, e, s, z, l) d\Phi_e + \int \psi_u(a, e, s, z, UI, l) d\Phi_u = \int \psi_f(e, s, z) d\Phi_e + Z + B$$

   The no arbitrage condition 25 holds and dividends, d satisfies 37.

5. *Aggregate Resource Constraint:*

$$\int cd\Phi+\delta K+\Sigma_s v_s\xi_s+G=Y=\left[\alpha(\int Nd\Phi_{e,s=1})^{\nu}+(1-\alpha)(\int[(xk^{\varphi}+(1-x)N^{\varphi}]^{1/\varphi}d\Phi_{e,s=2})^{\nu}\right]^{1/\nu}$$

6. *Matching:* λ_s^f and $\lambda^w s$ are functions of v_s and u_s as in Section 4.3.1

7. *Wage determination*

   The wages, $w(e,s,z)$ satisfies 39

8. *The government budget balances:*

$$g\int d\Phi+G+(r-\delta)B+$$
$$\int_{l<361}T(e,s,z)d\Phi+\Psi\int_{l\geq 361}d\Phi=\int\left(\tau_a(r-\delta)a+\tau_c c\right)d\Phi+\left(\int_{l<361}\tau_n w(e,s,z)d\Phi\right)d\Phi$$
$$+\tau_{ss}\left(\int_{l<361}w(e,s,z)d\Phi\right)$$

4.9 Immigration Shock and Transition

The immigration scenario in this paper is motivated by the large European migration wave starting in 2015 and lasting for a few years. Specifically, the experiment that we consider is a sudden, unanticipated, inflow of immigrants at time 1. The experiment resembles an "M.I.T" shock, i.e., an unexpected, never-again-to-occur departure from an initial steady state.

We assume that the immigrants when they arrive are relatively young (uniformly distributed between 20 and 40 years of age), poor (0 assets), and have no human capital relevant to the labor market in the receiving economy (they are all low-skilled with 0 units of experience). Other than these demographic differences, immigrants are similar to natives. They can enter the labor force and begin to accumulate assets and labor market experience.

We assume that all tax rates (τ_{ss}, $\tau_n(w)$, τ_a, τ_c), pensions, Ψ, as well as government spending, G/Y, and debt, B/Y, as fractions of GDP stay constant during the transition. The lump-sum transfer to individuals, g_t, varies over time and adjusts to clear the government budget. Other time-dependent variables will be the distribution of households, Φ_t, the labor market tightness in each sector, θ_{st}, the aggregate capital stock, K_t, the interest rate, r_t, and wage schedule, $w_t(e,s,z)$.

For sake of brevity, the equilibrium definition will not be stated here but the key change is that the dynamic programming problem of households needs another state variable: time, t, capturing all the changes in policy and price variables relevant in this maximization problem. The numerical solution of the model necessitates guessing on paths for all the variables that will depend on time and then solving this maximization problem backward, after which the guess is updated; the

method is similar to that used in Krusell and Smith (1999) and Brinca et al. (2016).

5 Calibration

This section describes our calibration of the model in Section 4. Our baseline calibration is meant to represent the US economy.

The model economy is calibrated for four broad categories: Preferences and technology, demographics and productivity, labor market, and government. The calibration strategy involves both exogenous parameter setting and endogenous simulated method of moments (SMM) for objects which are not easily estimated outside the model. A model period is equal to 6 weeks.

5.1 Preferences and Technology

The coefficient of relative risk aversion, η, is set to 1.2. Pure time preference, β, is set to match the capital-output ratio of 3.5 annual. The parameters governing input substitution in the CES production function are adopted from the estimates made in Krusell et al. (2000). These estimates imply an elasticity of substitution between labor types of 1.67, and an elasticity of substitution between high-skill labor and capital of 0.67. The parameters that affect factor shares, α and x, are targeted to match the employment level of the low-skill sector and a college-plus earnings premium of about 1.9. The set of parameters describing the fixed costs of labor market participation, Υ detailed in Object 18 (six in total), are chosen in order to replicate the observed employment rates (ratio of employed over population) for two age cohorts over both sectors (ages 30-39 and 55-64), as well as the persistence of employment for all workers and the employment rate of high skill workers.

5.2 Labor Market

The labor market has two *exogenously* segregated skill sectors, which are identified empirically by educational achievement. The high-skill sector consists of workers who have completed at least a bachelor-equivalent level of education. The low-skill sector consists of the remainder of workers, who have not achieved this level of education. The US Current Population Survey (CPS) puts this split at 36% to 64%, for high- and low-skill respectively. In our model, job separations occur through endogenous quitting and the exogenous dissolution of the match. We set the exogenous separation rate in each sector to match the gross separation rate by skill as reported in Chassamboulli and Peri (2015), which are inclusive of flows to both unemployment and non-participation. The elasticity on the matching function, η, is also constant across sectors, and set equal to 0.72, as chosen in Krusell et al. (2010). We also take the stance, as does Shimer (2005), that market tightness is 1 in equilibrium. In our setting this holds across both sectors. Then our calibration

strategy proceeds from this assumption when setting χ_s, the coefficient on the matching function. We choose χ_s in each sector in order to match the unemployment observed for each sector, when tightness, θ_s, is equal to 1. In order to allow for flows from non-participation directly to employment, we count the unemployed as those who have searched for at least one model period. Thus, workers who are matched in their first period of search are counted in the aforementioned flow. The vacancy posting cost, ξ_s is chosen such that $V_s = 0$, the free-entry condition, is satisfied in each sector. Workers' claim on revenue, κ, is fixed to match an economy-wide labor value share of 0.6.

5.3 Demographics and Productivity

The depreciation of experience δ_e, is chosen such that the decrease in earnings associated with a one month jobless spell is 1.2% as reported by Ortego-Marti (2016). The variance of the transitory income shock, $\sigma^2_{u,s}$, is used to target the variance of log earnings by skill; the persistence of the transitory income shock by skill, $\rho_{u,s}$, is estimated from PSID by pooled regression. Sector-specific productivity, $\gamma_{0,s}$, is equalized across sectors and set through the normalization of average earnings of all employed workers to one. The slopes of the linear sector-specific experience-productivity profile, $\gamma_{1,s}$ are set in order to replicate the ratio of age cohort earnings, ages 55-64, over economy-wide average earnings.

5.4 Government

The unemployment replacement rate is set according to data from the OECD, with unemployed workers receiving 53% of their last observed wage. However, this amount is bound below and above by fractions of average earnings, 0.14 and 0.35. Lumpsum transfers are equal to 12.6% of GDP according to Oh and Reis (2012). $\Psi_{pension}$ (OECD or social security admin. avg ss payment as fraction of earnings - 15.9% - all of the contributions are made by workers, none by employer.)

6 The Impact of Large Immigration Shocks in the U.S.

In this section we study the effects of a large, sudden inflow of low-skilled immigrants into our model, which we have calibrated to resemble the U.S. economy. We find that the short-run effects of an immigration shock is very much in line with the empirical evidence in Section 2 and in the recent empirical literature on immigration in the U.S. The participation rate of immigrants is very high and the employment of native workers increases, both due to a higher participation rate (including fewer quits) and a higher job finding rate. We argue that this can all be explained by the presence of income effects in our model.

We perform the following transition experiment, as described in Section 4.9, in our calibrated

Table 2: Parameters Calibrated Exogenously

Parameter	Value	Description	Source
Preferences and technology			
ζ	1.2	Co-efficient of relative risk aversion	Author choice
ν, φ	0.401, -0.495	CES substitution parameters	Krusell et al. (2000)
Labor market			
η	0.72	Elasticity on the matching function	Krusell et al. (2010)
$\Phi_{s=1}$	0.64	Share of low-skill agents	CPS 2019
Demographics and productivity			
$\rho_{u,s}$	$0.985, 0.985$	Persistence of transitory shock by sector	PSID
Government			
g	0.07	Lump sum transfer rate (on average earnings)	
υ	0.53	Replacement rate of UI	OECD benefits calculator
$\bar{T}, \underline{\mathrm{T}}$	0.14, 0.35	Upper and lower bound of UI (share of average earnings)	OECD benefits calculator
P_{UI}	0.75	Probability of UI eligibility continuation	Match expected duration of UI (OECD benefits calculator)
$\tau_a, \tau_c, \tau_{ss}$	0.364, 0.047, 0.159	Tax rate of capital gains, consumption, and social security	OECD
Ω_0, Ω_1	0.89, 0.14	Parameters for level and progressivity of labor income tax	Holter et al. (2019)

economy. While in a steady state equilibrium, the model economy is subjected to a once-and-never-again unexpected influx of migrants (an "MIT shock"), who all arrive at the beginning of period 1. The size of this shock is equal to 1% of the working-age population, but their composition differs markedly from the distribution of characteristics in the native population. First, they are all of the low-skill type, meaning that they search and work only in the low-skill sector. Second, they are of a lower average age than natives, with age at arrival being uniformly distributed between 20-40 years. Third, they have no assets on arrival, nor local-specific human capital. We assume that they are allowed to begin job search immediately, while receiving the universal lump-sum transfer, but no additional material support. In addition, they are not eligible for unemployment insurance until they enter employment and their match is exogenously terminated. Table 4 summarizes some of the labor market outcomes in the initial steady state.

We proceed by discussing the experience of the arrivals. Figure 8 shows the short-run experience of immigrants after arrival. Due to their poor outside option and high returns to participation, the

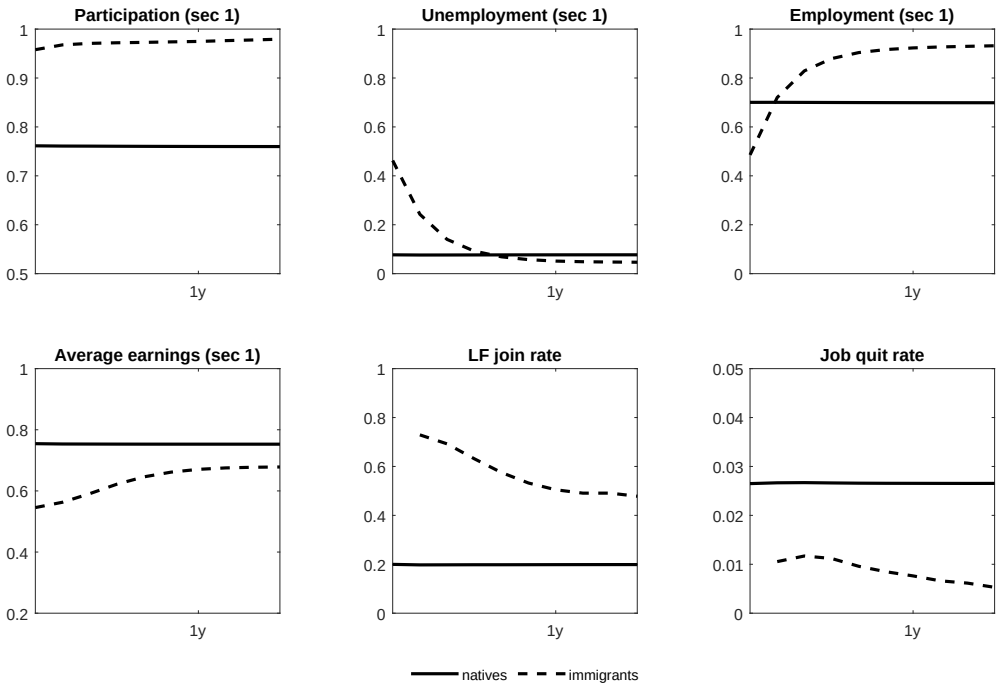


Figure 8: Immigrant Experience in the Short Run

arrivals participate at a very high rate (nearly 96%). By assumption, these new arrivals have the same preferences as natives, so their dis-utility of work is identical to natives of the same age. Their higher propensity to participate is driven by their low asset position, their relative youthfulness, and their lack of locally marketable human capital. These additional considerations arise from their intertemporal labor supply decision in the presence of human capital accumulation. As Imai and Keane (2004) explain in the context of a learning-by-doing setting, young households base their labor supply decisions on a "shadow wage", which incorporates a greater opportunity cost of leisure due to forgone human capital accumulation. Since the migrant cohort is both younger and without any accumulated local experience they will also tend to exceed native participation for this reason. First, in the absence of savings, their only outside option is to consume the universal benefit, so when it is low, the market wage is relatively attractive. Second, the disutility of work is increasing in age, so all else equal a cohort with lower average age will tend to participate more. Finally, due to the concavity of the value function in experience, the marginal benefit of experience is higher for those who have little. This high participation rate translates into a high employment rate after the searching arrivals are picked up from the unemployment pool, which takes a little under a year in the benchmark economy.

To understand why the unemployment rate of immigrants falls to a lower level than that of their native counterparts, we can examine the job separation flow. The flow out of employment is characterized by two components. The first is the exogenous termination rate, which (like the job finding rate) affects both native and migrant workers equally. The second component is the

endogenous quit rate, which characterizes the movement of employed workers to non-participation. From Figure 8 we can see that the migrants are much less likely to separate from their job willfully, which means that employment persistence is higher among the new arrivals. The higher employment persistence implies less churn through the three labor states and thus a lower unemployment, once searching migrants have been matched into employment.

An interesting thing to note about this situation, is that from the perspective of job creators, the inclusion of searching workers who have a relatively low propensity to quit, means that the probability of job continuation rises in expectation. From Equation 33 we can see that the value of a filled job is decreasing in the match-specific separation rate. Since we assume that vacancies can be directed at specific sectors, but not for specific demographic types (i.e. natives or migrants) of workers in those sectors, the low quit rate would act as a positive externality on native workers by lowering the average match separation rate, and all else equal, raising the expected value of a filled job. This leads firms to post more vacancies and is quantitatively important during the phase of the transition when new arrivals make up a large portion of job seekers.

Running counter to this effect, we see that average earnings of the arrivals is much lower than natives, starting at about 72% of an average Sector 1 worker. There are two reasons for this: first, they have no local-specific human capital, since they have not spent any time accumulating local experience; and second, there is a selection issue, where natives' elasticity of participation is higher than the arrivals due to their more attractive outside option (higher private savings) and lower opportunity cost of leisure (older with more experience). Natives who have had a bad productivity realization, are more likely to exit employment and wait for their earnings' prospects to recover, while the new arrivals do not have this luxury. In expectation, matches formed with the new arrivals will be less productive than a native, which would tend to lower the value of a filled job, especially when the unemployment pool is dominated by the new arrivals.[6]

The aggregate job creation response to the migration shock is a combination of these two cohort composition channels, as well as two additional aggregate state considerations. Job creation will tend to increase because the labor market tightness has fallen with the labor supply expansion, and vacancy posting will tend to decrease because capital is supplied inelastically. The increased probability of a successful match will entice job creation, so many new searchers increases labor demand. However, capital accumulation lags job creation and thus the surplus of each match is diminished since capital is spread more thinly across workers.

What are the effects of these new entrants on the economy, particularly wages and labor demand? The high participation rate from new arrivals means that, upon entry, the pool of searching workers in the low-skill sector expands by nearly the full size of the shock. This means

[6]In an alternate assumption on wage bargaining, these two aspects might work together, but it also illustrates the importance of labor market institutions. In a setting where wage setting is decoupled from an individual's outside option (say wage floors or collective bargaining) the labor demand response may not respond as positively to an influx of poor workers, like it would when firms can exploit immigrants' poor bargaining position in a wage setting game.

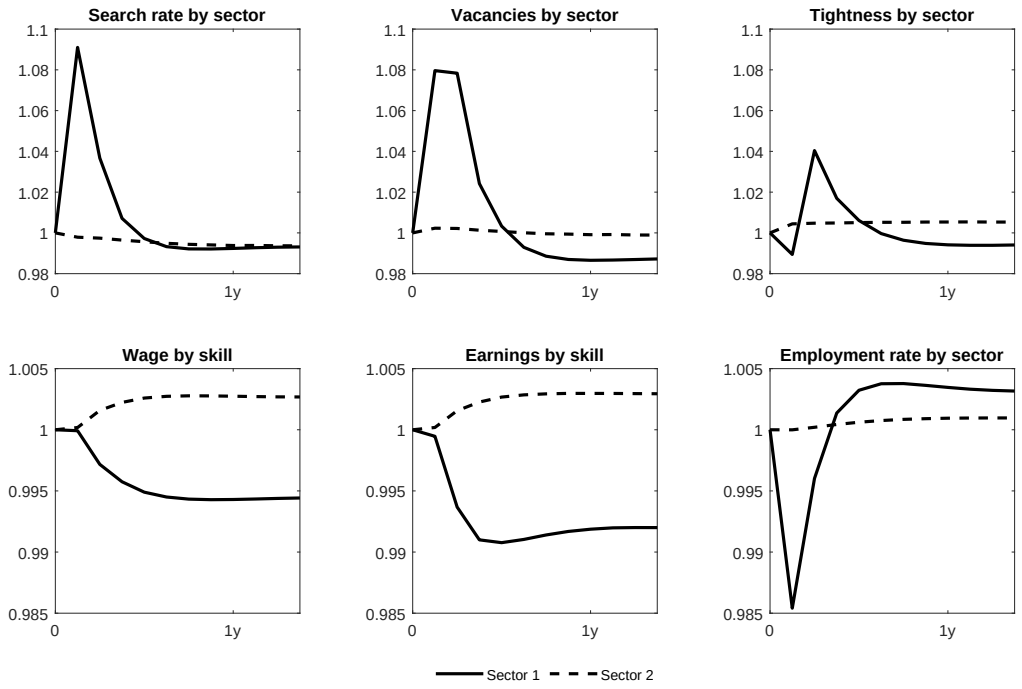


Figure 9: Economy-wide Impacts of the Immigration Shock by Sector

that the search rate of all agents in that sector increases by 9.5% as a result of the shock. The rate of integration of these new arrivals into employment is of first order importance in determining the impact over the transition. On one hand, the low-skill wage is decreasing in low-skill employment, because of the diminishing marginal product. Therefore a rapid integration of the migrants leads to a rapid fall in the low-skilled sector wage. On the other hand, the high-skill wage is increasing in the low-skilled sector's output, so rapid integration of new low-skill workers translates into a boost in the marginal product of native high-skill workers through skill-complementarity.

While the new arrivals are searching, firms face a less tight labor market and their probability of creating a match increases. We have discussed above how the migrants change the vacancy posting decision of firms, particularly their elasticity of participation (i.e. through their low quitting rate). In response to the spike in job searchers, firms are induced to increase their vacancy posts while the probability of a match success and value of filled job is high. Figure 9 illustrates the response in labor market tightness in the short run. During the initial surge in job search, tightness falls. However, in the very next period labor demand responds strongly and we see the vacancy posting response is even greater than the job search response, resulting in a relatively tight labor market. This illustrates the benchmark economy's strong accommodation of such a labor supply shock - which as we will see later can depend on the prevailing institutional environment in the host-economy.

What are the implications for natives? We focus first on the experience of the sector 1 natives, who compete directly for jobs with the new arrivals. Figure 10 illustrates the short run response

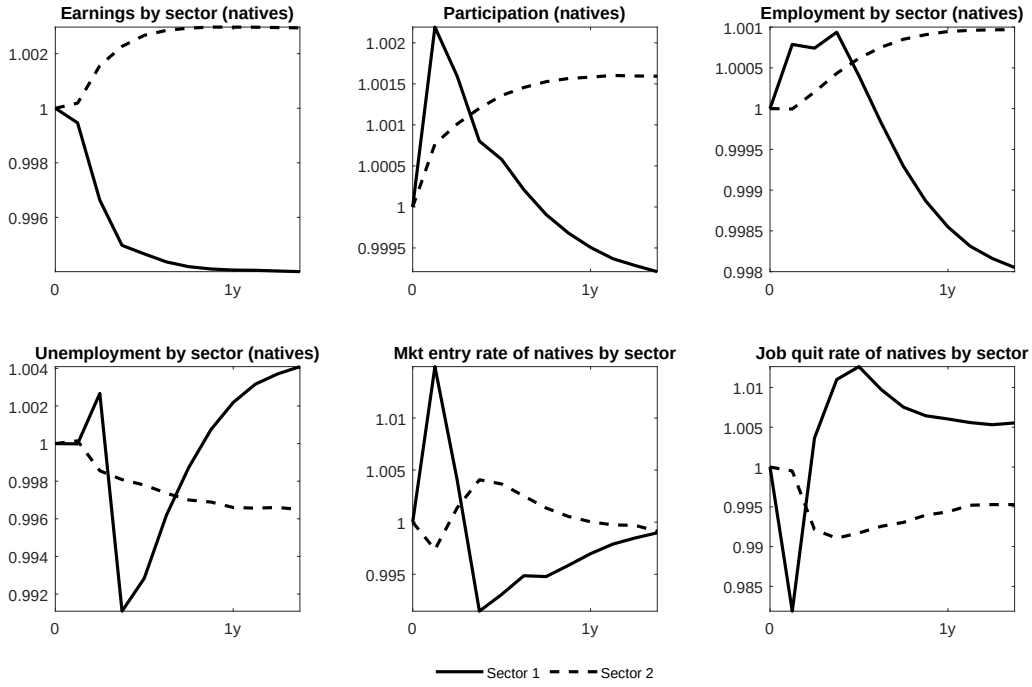


Figure 10: Short-run Impacts of the Immigration Shock on Native Workers by Sector

of natives to the migration shock. We observe that low-skilled native employment increases for more than half a year, following the shock (top right panel). At the peak, the increase in native employment is almost 1%. There are two different factors leading to this result. First, the native participation rate initially increases and the native quit rate initially falls. Second, we saw above that market tightness increases in response to the immigration shock (except in period 1), leading to lower unemployment.

The behavioral response of natives, increased participation, is driven by income effects. Here there are two types of positive income effects on native labor supply. First there is an inter-temporal substitution effect, as the natives anticipate the future drop in wages while the new arrivals are increasingly integrated into the low-skill sector (left panel of Figure 11). Second there is a direct positive income effect from a fall in lumpsum transfers (middle panel of Figure 11). It takes some time for all the immigrants to find work and they also have lower wages, wealth and consumption than natives, resulting in lower short-run per capita tax revenues and thus a lower lumpsum transfer. The first effect is, however, strongest.[7]

The positive effect on low-skilled native employment are, however, in the short run. In the medium to long run (1+ years) the effect of the immigration shock is reduced wages and employment in the low-skilled sector. Figure 11) shows for how long wages remain depressed and Figure 12 show that participation and employment is lowered and unemployment is elevated for native

[7]We can show this by running the same experiment and keeping the transfer constant.

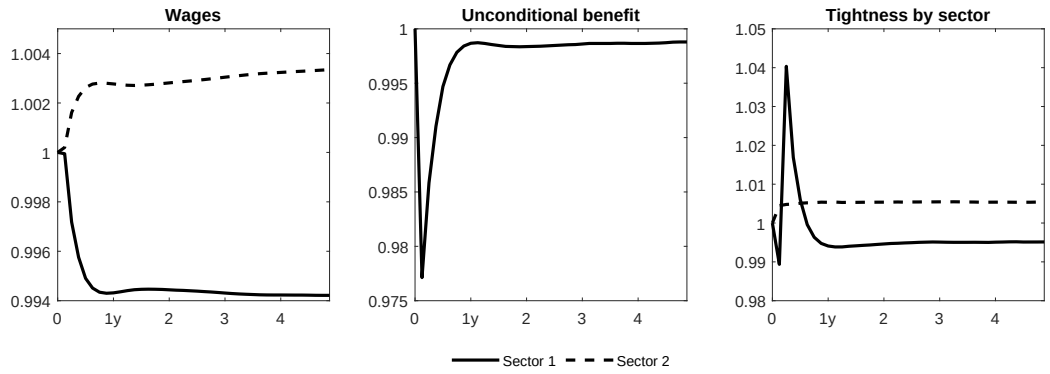


Figure 11: Short-run Impacts of the Immigration Shock on Native Workers by Sector

low-skill workers for many years. The addition of the new arrivals into the low-skill labor market means that the wages in that sector remain low until this cohort retires from participation. This continued participation holds sector 1 wages down, and sector 2 wages up. From the perspective of unemployment, sector 1 native workers will also suffer in the sense that they want to work, but are held out of employment by frictional matching. The lower wage makes non-participation more attractive. This will in turn reduce the value of a filled vacancy for firms who will reduce hiring and the labor market will become less tight.

While more muted, the sector 2 implications of low-skilled immigration are also interesting. With skill complementarity, the marginal product of high-skill labor is increasing in low-skill employment. Labor force participation increases as the substitution effect dominates, with sector 2 workers quitting less. Vacancies spike just after impact, raising tightness in the high-skilled labor market, which remains elevated for years due to a combination of lower unemployment and an increased number of vacancies. The effect on high-skilled wages is persistent as a result of the expansion of low-skilled employment. High-skilled employment peaks around 2 years after the shock, and begins to fall afterwards, despite the elevated wage.

To put the impact on natives into perspective, Figure 12 shows the native displacement effect of the migration shock as the number of natives who are affected per 100 new arrivals. One year after the shock, the total number of natives displaced from participation in the labor force is close to zero. Here the roughly four new entrants from the high-skill sector almost exactly offset four displaced low-skill natives. The effect on unemployment is quite small, with no significant change for the high-skill sector, and the medium term increase of one additional native held out of work by frictional unemployment. The results highlight the quite small displacement impact of the migration shock, especially several years into the transition.

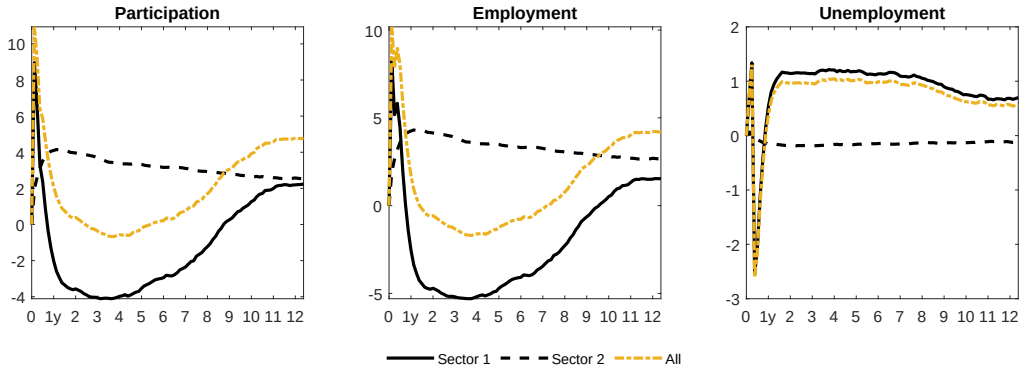


Figure 12: Change in the Number of Natives Engaged in Each Labor State (per 100 migrants)

6.1 Implications for Inequality and Welfare

The immigration shock also has implications for inequality and welfare among the natives. The effect on wages across sectors pushes earnings of low-skill natives down and high-skill natives up, resulting in a small (0.3 %) increase in earnings inequality after 5 years (measured as the co-efficient of variation on earnings). In addition, wealth inequality increases by about 0.1% after 12 years. The overall impact on native welfare is slightly negative with a 0.15% consumption equivalent loss from living through the shock. However, the welfare impacts are distributed unevenly across groups. On average, a low-skill native will experience a loss of welfare equal to 0.44% consumption equivalents, while natives in the high-skill sector will see their welfare rise by around 0.55%.

There are additional welfare considerations for groups that are not necessarily exposed to the costs and benefits of changes in the labor market. For example, retired persons at the time of the shock rely on their social security benefits, the universal lump sum transfer, and their private savings. The migration shock has different implications for these sources of non-labor income. In regards to the social security benefit, we assume that it is constant across the transition and thus the migration shock will not influence this channel. In this sense, it is a defined-benefit plan like the U.S. social security system. However, retired households also rely on the lump sum transfer, which is ultimately diminished due to congestion. Despite migrants strong propensity to work, they are not as productive as the average worker and use more resources than they contribute, especially early in the transition when they are not employed, or lacking experience. In terms of private savings, retired households will see a boost in the value of their asset portfolio due to an increase in the return on capital and value of the firm.[8] In the benchmark experiment, the average retired household ultimately gains from the migration shock, seeing an average increase in consumption

[8]Recall that we target an age-wealth moment (asset holdings of 75-80 year olds) using the bequest motive in the preference specification, so our calibration takes into account the relative importance of private savings to government transfers for pension-age households.

equivalent welfare equal to 0.13%. This implies that the increase in the return on their private assets more than compensates for the diminished uniform transfer along the transition.

The dynamics of welfare impacts over the transition are such that the "early "generations of natives are less affected from the wage impacts than those who come later. This is because the immigrant cohort has not been well-integrated at the beginning of the transition, and the full effect of the wage adjustment will not be felt until the migrants saturate the low-skill employment pool. As the new arrivals are integrated and matched into employment, low-skilled natives face lower wages, and high-skilled workers see their labor market returns rise. However, the impacts on the return on assets are strongest early in the transition, while they are relatively scarce, so agents with relatively high wealth at the time of the shock will benefit more from this channel.

7 Immigration with a European Tax and Transfer System

The international empirical evidence on immigrant participation in the labor market and the effects on native employment has been mixed. In European countries there are reports of low immigrant participation rates and a negative effect of immigration on native employment rates. We argue that this can also be explained by income effects. Many European countries have large welfare states with high taxes and generous transfers. This reduces the incentives to participate in the labor market. The return to work is lower and the outside option is higher both for immigrants and natives. With lower immigrant participation the pressure on future wages compared to current wages will be smaller. There is not a strong positive income effect on native labor supply from a future drop in wages, and with native labor supply now being much more elastic we see a drop in native employment.

To clearly illustrate the impact of income effects induced by generous transfers, we conduct two experiments in this section. In both experiments we insert a Danish tax code, which we estimate using OECD data, into the U.S. economy. It is well known that Denmark has among the highest taxes in the world. In the first experiment we assume that the increase in revenue is used for wasteful government spending. In this case both immigrants and natives are very poor due to the high taxes and their labor supply is inelastic. In this case we observe an even stronger positive impact of the immigration shock on native employment. In the second experiment we instead assume that all the extra revenue from the high Danish taxes are redistributed to households as a lump sum. In this case labor supply is very elastic and we observe a strong negative effect on native employment following the immigration shock.

7.1 Danish High-tax Society Without Transfers

Potential host countries differ markedly with respect to the nature of taxation and welfare state institutions. These institutions alter labor supply decisions by reducing consumption risk and nar-

rowing the gap between work and non-participation. In addition they are financed by distortionary taxation, which reduces the after-tax surplus of a successful match and tends to diminish labor demand. In our model we account for a multitude of taxation including the level and progressivity of labor income taxation. In this counter-factual economy, we hold all parameters from the benchmark calibration constant, except for the tax regime. Specifically, we take the fiscal structure of Denmark and replace all taxation parameters to reflect Denmark's taxation and public spending. The UI system is not changed. To distinguish between the effects of taxation and the transfers they finance, we examine two scenarios for how the change in tax revenue is handled. In the first scenario, the government's balanced budget constraint is achieved by altering the pure public consumption good, G, in the steady state. In the second scenario, we alter the lump sum transfer, g to balance the budget in the steady state. Note that in both of these cases the government's budget constraint over the transition is balanced only by the lump sum transfer. These contrasting assumptions represent the two aspects of how changing the fiscal structure of the receiving economy will affect labor supply decisions, and will also have different implications for the welfare outcomes of natives over the transition.

Table 5 summarizes the changes in tax parameterization from the Benchmark economy. The difference in capital gains and consumption taxation rates are 14 percentage point and 30 pp increases respectively. The change in the income tax regime (both level and progressivity) translates into an equilibrium increase in the average tax rate on earnings of a low skill worker from 0.08 in the benchmark economy to 0.15; and 0.15 to 0.26 for the average high skill worker. Clearly this represents a quantitatively large increase in the size of the public sector. The effect on the steady state labor market is summarized in Table 6. The main effect of these parameter changes is to decrease the private consumption possibilities for households. Since tax revenues are not recycled to the lump sum transfer, the increase in taxation (particularly consumption taxes which increase more than seven fold) reduces household disposable income across the distribution and in all states (e.g. non-participation, retirement, etc.). So even though labor income taxation has increased, the negative income effect dominates and we see an increase in labor supply (more participation, fewer quits, etc.) in the high taxation steady state. Notably, equilibrium participation and employment are higher. In addition, the unemployment rates of both skill classes are *lower*, as a result of reduced quitting and higher employment persistence. The equilibrium job find rate is relatively unchanged, as both vacancies and job searchers decline slightly in this counterfactual (due to the decline in the value of a filled job and, at the same time, a rise in employment persistence due to fewer separations).

The transition experiment in this counter factual economy is characterized by an even stronger participation rate from the new arrivals. Shortly after the shock, participation of the migrants approaches 100% due to the diminished generosity of the unconditional transfer in comparison to the market wage in a world with much higher taxes. The flows are such that immigrants in the first few years after arrival are held out of employment only by the matching friction and exogenous



Figure 13: High-tax Economy: Change in the Number of Natives Engaged in Each Labor State (per 100 migrants)

separation rate. Their earnings trajectory is below the benchmark scenario because of the selection of lower productivity migrants, who otherwise would be non-participants as they await a better productivity draw.

In terms of the response of natives over the transition experiment, the high tax environment exhibits an expansion in participation from the low skill natives that is sustained over the transition. This is in stark contrast to the benchmark case where participation increased initially due to the future wage effect, but eventually falls due to the substitution effect dominating. The high tax environment establishes a situation where the income effect dominates the low skill native labor supply response. Likewise, the high skill natives response is characterized by a stronger increase in labor supply than in the benchmark experiment. Figure 13 shows the change in labor market status for native workers per 100 migrants, illustrating the sustained elevated employment of all native workers.

From a welfare perspective, natives, as a whole, lose more as a result of the migration shock than under the benchmark experiment, losing 0.24% CE versus 0.15%. This includes an increase in welfare loss concentrated in the low skill workers of 0.49% CE, and a diminished benefit for the high skill workers 0.32%. The gain experienced by retired natives is about equal to that under the benchmark experiment. On average, a migrant who arrives in the high tax counterfactual would be 20% worse off in terms of consumption equivalent than if they had arrived in the benchmark economy.

7.2 Danish Welfare State With Generous Transfers

In the *High-tax welfare state* economy when the government balances the steady state budget by adjusting the lump sum transfer there are significant repercussions for steady state labor supply

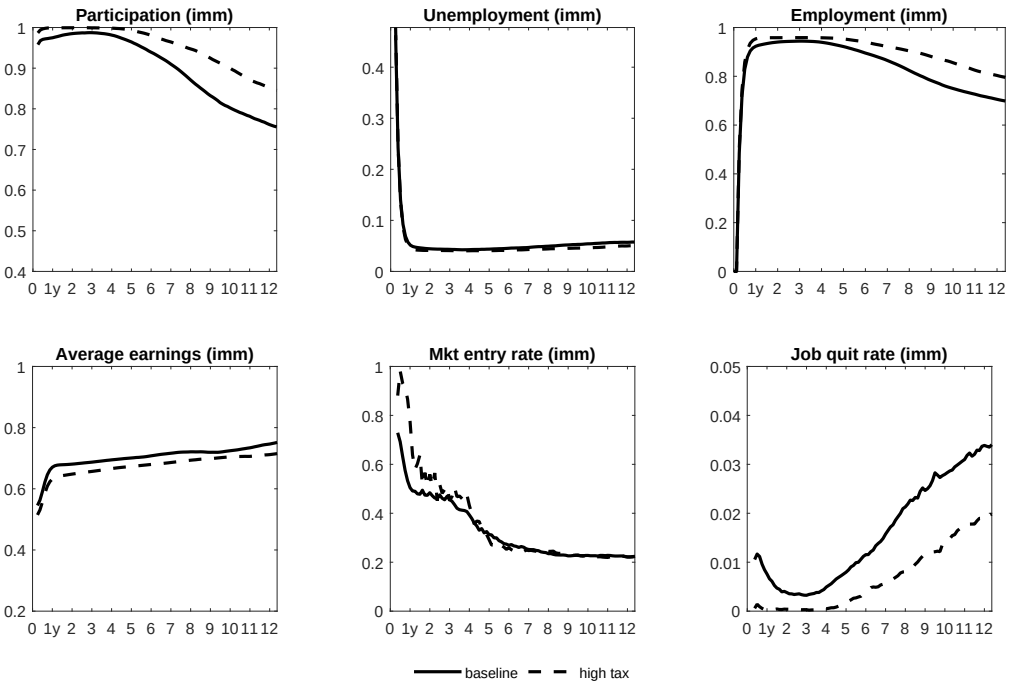


Figure 14: High-taxation Economy: Immigrant Integration Over Longer Horizon

incentives. Table 7 summarizes some labor market outcomes in this counterfactual. In level terms, the lump sum transfer nearly doubles in size to the transfer in the *benchmark* economy. The result is a much lower equilibrium employment rate of natives as a result of low participation. In addition, steady state unemployment is also much higher for several reasons. Despite holding the parameterization of the matching friction constant, the probability of finding a job decreases in both sectors, and the effect on the high skill matching rate is particularly strong. This is a result of diminished job creation incentives, and low labor market tightness. The main contributor to low vacancies is the low probability of match continuation, and - given the fixed vacancy posting cost - firms create fewer positions across both sectors. In general, there is much less persistence in every labor market state, and thus churn is much higher in this counterfactual economy. Workers quit their jobs at around five times the rate in the Benchmark, but also re-enter participation (search) at a higher rate, which creates a larger pool of unemployed as they await a match. This churn is bad for job creation because the lack of match persistence means that the value of a filled job falls as a result of a low continuation probability.

On arrival, immigrants do participate at a higher rate than natives, but this gap falls much quicker than in the *benchmark*. Figure 15 displays the experience of immigrants (as a ratio to sector 1 natives) over the transition in the *generous transfer* counterfactual. In comparison to the *benchmark*, immigrants no longer consistently participate at a higher rate than natives. In the beginning of the transition, new arrivals are induced to participate at a much higher rate than

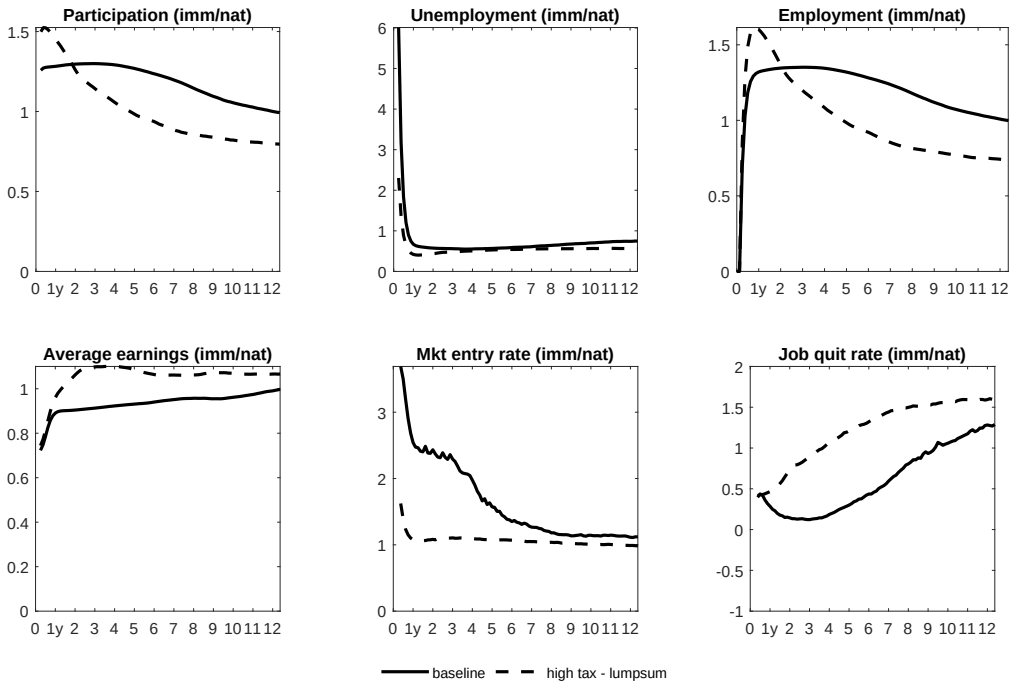


Figure 15: High-transfer Economy: Impacts on Native Workers by Sector Over Longer Horizon

natives (1.5 times more likely to participate than their native counterparts in sector 1). However, this is not sustained and, after about 5 years, migrant participation crosses the natives' rate and they begin leaving employment at a higher rate. This is in contrast to the sustained elevated participation of the migrants under the *benchmark*, where they converge to the native employment rate after 12 years.

How do the natives fare under this scenario? The effect on sector 1 wages is relatively stronger than in the benchmark scenario, at least on impact. Low skill wages fall by more in the first two years after the shock (in percentage terms), but begin to recover in comparison to the benchmark over the medium term. Thus there is no benefit to working hard in the short-run. This difference can be attributed to the softening of immigrant participation (and thus their employment). Low-skill natives greatly reduce their labor supply one year after the shock, which is a dramatic difference from the benchmark. The combination of the decrease in the attractiveness of the after-tax market wage and the increase in the unconditional transfer has a dramatic effect on the elasticity of labor supply. This fact is illustrated in Figure 16, which shows the change in natives across each labor state per 100 arrivals. The retraction in native employment is early and strong in comparison to the benchmark case, and only recovers as the migrants transition out of participation several years after arrival.

The welfare implications improve for the average native, but are still negative, where the migration shock results in a 0.1% loss in consumption equivalent. This consists of a loss of 0.26%

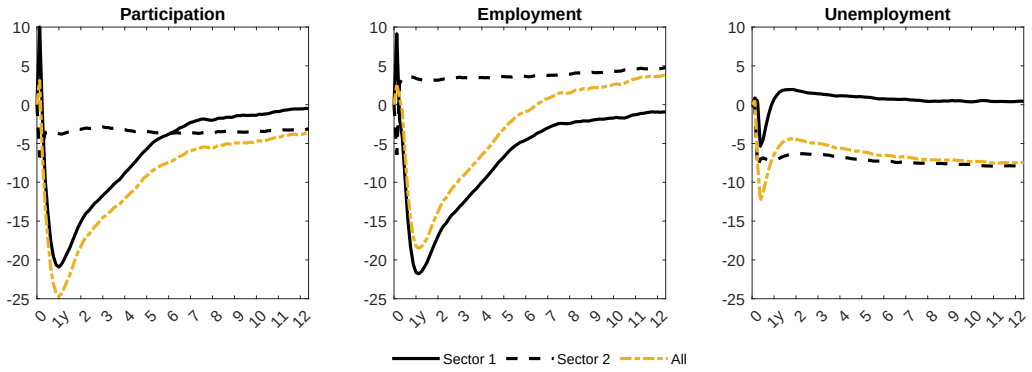


Figure 16: High-transfer Economy: Change in the Number of Natives Engaged in Each Labor State (per 100 migrants)

CE for the average low skill native, and a gain of 0.25% for the average high skill native who lives through the transition. From the perspective of the migrants, they would experience an increase of welfare equal to 8.6% CE from arriving in the high transfer economy over the benchmark.

8 Conclusion

We have presented a quantitative framework for studying large migration events as labor supply shocks to an economy characterized by frictional unemployment and welfare state institutions. We demonstrate that recent empirical evidence from the U.S., showing that immigration shocks are associated with high immigrant labor force participation, increased native employment and reduced or unchanged native unemployment in the short run is consistent with our framework. We can also explain that European countries with large welfare states may experience the opposite: Large inflows of immigrants are associated with lower immigrant participation and a drop in native employment.

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A Appendix

A.1 Computational Algorithm (Steady State)

1. Guess the aggregate capital stock K.

2. Guess the market tightness in each sector, θ_s, labor supply in efficiency units in each sector Y_s and the lump-sum transfer, g.

3. Prices are implied by the capital stock and sectoral labor supply:

$$p_L = \alpha Y_L^{\nu-1} Y^{1-\nu} \tag{40}$$
$$p_H = (1-\alpha)(1-x) Y_H^{\varphi-1} Q^{\nu-\varphi} Y^{1-\nu} \tag{41}$$
$$p_k = (1-\alpha) x k^{\varphi-1} Q^{\nu-\varphi} Y^{1-\nu} = r - \delta \tag{42}$$

4. Solve the firm's problem and determines the wages, $w(e, s, u)$. Taking the capital stock, K, and the output in each sector, Y_s, as given we can solve the firm's problem and determine the state dependent wages.

5. Solve the consumer's problem. We can solve the consumer's problem backwards, knowing that at age 99 and 7/8 next period's value function is 0.

6. With the state dependent wages and policy functions for workers and firms in hand, simulate the life-cycle consumption, saving and labor force participation choices of the workers and the capital choices of the firms where the workers are employed.

7. Calculate the right hand side of V_s as :

$$-\xi_s + q\pi_s^w \int J(a, e, s, u, l) d\Phi'_{us}$$

   This quantity should be 0 in equilibrium. If it is positive, increase θ_s, and if it is negative, decrease θ_s.

8. Check if the guesses for θ_s, Y_s and g are correct. If not we should update those guesses.

9. Finally check if the demand for assets equals the supply of assets:

$$\int \psi_{em}(a, e, s, u, \Upsilon, l) d\Phi_e + \int \psi_u(a, e, s, u, \Upsilon, l) d\Phi_u = K + Z + B$$

   Where $Z = \int J(e, s, u, l) d\Phi_e$ is the value of the firms in the economy. If asset supply is higher than demand, decrease K and if asset supply is lower than demand, increase K.

A.2 Additional Tables and Figures

Table 3: Parameters calibrated endogenously and their related moments (SMM)

Parameter	Value	Description	Related moment
Preferences and technology			
β	0.933	Annualized time preference	Capital-output ratio (3.5 annual)
α, x	0.565, 0.725	CES Factor shares	Average employment rate of low-skill workers (0.69), college+ earnings premium (1.9)
$\Upsilon_{0,s}$, $\Upsilon_{1,s}, \Upsilon_{2,s}$	1.0795, 0.029, -0.000235; 0.86595, 0.0332, -0.000315	Utility costs of participation by age and skill	Employment rate of high-skill workers (0.84); Employment persistence of workers (0.85); Employment rates by age cohort and educational attainment March CPS 2019 (ages 30-39, low skill 0.75 and high skill 0.87; ages 55-64, low skill 0.58 and high 0.74)
Beq_{motive}	355	Utility parameter governing bequest motivation	The ratio of assets among age cohort 75-80 over average asset position, (1.51).
σ^2_{taste}	0.182	Variance of mean-zero taste shock	The taste shock is assumed to be equal across skill types, and the s.d. is chosen in order to match the gross flow of workers from non-participation to participation, reported as 0.081 monthly in Krusell et al. (2011).
Labor market			
χ_s	0.505, 0.791	Matching function efficiency	Unemployment rate by skill (low 0.077 and high 0.033)
ξ_s	2.917, 10.033	Vacancy posting costs	Market tightness (1 in both sectors) as in Shimer (2005)
σ_s	0.0214, 0.0216	Exogenous job separation rate by sector	Gross separation rates by sector as reported in Chassamboulli and Peri (2015)
κ	0.69	Worker's claim on revenue	Labor value share (0.60)
Demographics and productivity			
δ_e	0.0835	Depreciation of experience	1.2% wage decrease over 1 month unemployment, Ortego-Marti (2016)
$\sigma^2_{u,s}$	0.164, 0.156	Variance of productivity shock	Variance of log earnings by educational attainment (low 0.84 and high 0.76)
$\gamma_{0,s}$	-0.5875	Sector specific productivity	Equalized across sectors. Normalize average earnings of all employed workers to 1.
$\gamma_{1,s}$	0.0245, 0.0185	Linear experience productivity profile	Age cohort earnings 55-64 by educational attainment relative to sector average, March CPS (age 30-39 low 0.81 and high 1.49; age 55-64 low 0.90 and high 1.63)

Table 4: Steady State Labor Market Outcomes in the Benchmark Economy

Skill sector	Participation	Employment	Unemployment	$p(jobfind)$
low	0.76	0.70	$7.68 \cdot 10^{-2}$	0.51
high	0.86	0.83	$3.29 \cdot 10^{-2}$	0.79

Table 5: High Taxation Counterfactual - Altered Parameters

Parameter	New value	Description	Benchmark value
$\tau_a, \tau_c, \tau_{ss}$	0.506, 0.349, 0.11	Tax rate of capital gains, consumption, and social security	0.364, 0.047, 0.159
Ω_0, Ω_1	0.786, 0.258	Parameters for level and progressivity of labor income tax	0.89, 0.14

Table 6: Steady state moments of the high tax economy

Skill sector	Participation	Employment	Unemployment	$p(jobfind)$
low	0.83	0.77	$6.39 \cdot 10^{-2}$	0.51
high	0.90	0.87	$3.18 \cdot 10^{-2}$	0.78

Table 7: Steady State Moments of the Generous Transfer Economy

Skill sector	Participation	Employment	Unemployment	$p(jobfind)$
low	0.52	0.43	0.17	0.47
high	0.70	0.61	0.12	0.46