Should I Stay or Should I Go? Austerity, Unemployment and Migration∗

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30th April 2018

Abstract

High unemployment and fiscal austerity during the Great Recession have led to significant migration outflows from the periphery of Europe. This paper introduces endogenous migration in a small open economy DSGE model to analyze the business cycle effects of fiscal consolidation instruments and their interaction with migration. A tax-based consolidation increases migration outflows, which exacerbates the induced GDP contraction. As a result, the unemployment gains from migration are only temporary. Labor tax hikes also lead to a persistent increase in the intensity with which current workers look for a job abroad. Taking into account the migration of the employed not only limits the short-run unemployment gains from migration but also reverses them substantially in the medium run due to a deeper demand contraction. Government spending cuts, on the other hand, have a non-monotonic impact on migration: initially outflows are higher due to the negative demand effect, while later this is reversed due to the wealth effect which decreases hours and increases the wage. A repatriation policy generates a return of migrants, a boost in demand, a fall in the real wage and an increase in unemployment.

JEL classification: E32, F41
Keywords: fiscal consolidation, migration, matching frictions, on-the-job search.

∗We are grateful to S. Lazaretou from the Bank of Greece for sharing data. We also thank J. Fernandez-Blanco, E. Dioikitopoulo, A. Marcet, R. Santaeulalida-Llopis and E. Pappa. as well as participants in many seminars and conferences, for helpful comments and discussions. J. Caballe acknowledges financial support through the European Union’s Horizon 2020 Program grant 649396 (ADEMU), the MINECO/FEDER grant ECO2015-67602-P, and the grant 2017 SGR 1765 from the Generalitat de Catalunya. This paper does not represent the views of the Bank of Spain or the Eurosystem.

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1 Introduction

Worsening labor market conditions and fiscal tightness in the aftermath of the recent crisis have led to increased migration outflows from peripheral countries of Europe (see Figure 1).\(^1\) The surge in unemployment rates and the lack of work opportunities, together with fiscal austerity involving tax hikes, cuts in social benefits and restrictions in new recruitment of public employees, have contributed to this notable increase in migration flows.\(^2\) For instance, Greece and Spain exhibited net migration outflows in 2013, representing 2.2% and 1.9% of the workforce, respectively (Lazarou 2016)). Over the period 2010-2015, more than 600,000 Greek residents left the country in search of employment, better pay and better social and economic prospects (see Figure 2).\(^3\) In the case of Spain, migration outflows went from an average of 0.4% of the population over the period 2008-2010 to 1.2% in 2012, (Izquierdo et al. 2016). Since 2010, outflows have totaled more than 400,000 per year, which is, both in absolute and relative terms, the highest level of emigration in Spanish history.\(^4\) The goal of this paper is twofold. First, we study the macroeconomic consequences of migration and the implications for business cycle fluctuations. Second, we shed light on the interaction between fiscal consolidation and endogenous migration decisions.

Although mobility in response to disparate labor market conditions might result in improvements in aggregate employment, the impact on local adjustments hinges on a number of factors. First, as migrants flow abroad, labor market tightness increases in the home country, putting upward pressure on wages and hampering firms’ marginal costs. Additionally, and insofar as employed workers also choose to emigrate, firms not only find it more costly to

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\(^1\)In general, data on migration has limitations in terms of scope, detail and time span. For instance, data on adjusted net migration from Eurostat, being a statistical construct, includes adjustments in population statistics. As Izquierdo et al. (2016) discuss, migration data typically relies on migrants enrolling in voluntary (municipal) registries or in consulates and embassies. Moreover, because delays in enrollments are likely to occur, and because permanent migrants are more likely to self register, the magnitude and timing of migration data can only be approximate. Other sources used to gauge the dimension and characteristics of the recent migration flows include survey data, like Triandafyllidou and Gropas (2014) and Labrianidis and Pratsinakis (2016) for Greece.

\(^2\)Prior to the crisis, immigration from countries that had recently joined the EU or from outside the block contributed to migration surpluses in peripheral member-states.

\(^3\)In 2014, the unemployment rate in Greece rose to around 28%, more than triple that of 2008, with a profound impact on the mobility decisions of the Greek people, previously considered as the least favorable Europeans, after the Cypriots, towards long distance mobility (Commission 2006). The migration response to the crisis has been considerable in Europe, in contrast to the U.S. where no evidence of greater inter-regional labor mobility is found in reaction to labor market shocks (Jauer et al. 2014).

\(^4\)This involves high mobility of foreign nationals: in 2012 approximately 5% of foreign residents in Spain left the country. However, since 2007 there is also net emigration of Spaniards born in Spain with outflows tripling between 2006-2012 (Izquierdo et al. (2016)). Data for 2012 in the same study reveal that 39.2% of those outflows was directed to other EU countries and 30.8% to South America. In the case of Greece, Germany and the UK concentrate together more than half of the post 2010 emigration. The USA and Australia seem to be the next most popular destinations, followed by several other European destinations (Labrianidis and Pratsinakis (2016)).
hire new workers but also face a shortage of labor. For instance, Labrianidis and Pratsinakis (2016) report that half of those leaving Greece after 2010 were employed at the time of emigration.\(^5\) Second, migrants take with them not only their labor supply, but also their purchasing power, inducing a higher fall in internal demand during bad times. Although this impact can be mitigated if emigrants send some of their earnings back home, remittances inflows in the periphery have not increased at the same rate as emigration and amount only to a small portion of total GDP.\(^6\) On the other hand, the impact on aggregate demand depends on the degree of openness and the importance of home bias in the demand for tradable goods. As shown by Farhi and Werning (2014), when a region experiences demand shortfalls in the non-tradable sector, emigration can serve as a rebalancing mechanism by which labor supply is reduced to meet lower demand, leaving workers who do not migrate in an unchanged situation. By contrast, when two regions are highly integrated, an increase in emigration can lead to an increase in external demand, employment and consumption in the country of origin. However, in most typical cases, where trade integration is lower, the increase in external demand might not compensate for the fall in internal demand.

Notably, labor mobility also has fiscal consequences. On the one hand, migration shifts the tax base, both by affecting private demand and, to the extent that employed workers decide to leave, by reducing taxable income. However, migration decisions also depend on migrants’ expectations regarding future socioeconomic conditions and the security of their future in the home country. In other words, migrants may leave due to the worsening of the domestic fiscal stance and the perception of future austerity. On the other hand, migration can act as a fiscal stabilizer, mitigating increases in unemployment and therefore lifting fiscal pressure off national governments by reducing the payments of unemployment benefits.\(^7\)

This paper assesses the interplay between migration, fiscal consolidation, and the macroeconomy in comparison to a counterfactual situation of immobility. To this end, endogenous migration decisions are introduced in a Dynamic Stochastic General Equilibrium (DGSE) model of a small open economy with sticky prices and search and matching frictions. Both the employed and the unemployed have an incentive to migrate abroad where better wage and employment opportunities exist. We assume that the employed members of the house-

\(^5\)Several sample surveys investigating the qualitative characteristics of these emigrants have coincided in that the typical migrant is young, single, highly skilled, and having at least two years of work experience (see, e.g., Triandafyllidou and Gropas (2014), Labrianidis and Pratsinakis (2016)).

\(^6\)Data on remittances over GDP from the World Bank for 2013 are as follows: Ireland: 0.33%, Greece: 0.34%, Spain: 0.75%, and Portugal: 1.95%. The Hellenic Observatory survey on Greek migration reveals that only 19% of migrants send remittances, suggesting that “emigration contributes mainly to the subsistence and/or the socioeconomic progress of the emigrants themselves and not of the household” (Labrianidis and Pratsinakis (2016)). This and the Newdiaspora survey, also on Greek migration, reveal that the vast majority of migrants (68% and 64% respectively) neither sends nor receives money (Labrianidis and Pratsinakis (2016)).

\(^7\)For instance, Bräuning (2014) estimates that a scenario of no mobility would have made a difference of nearly 11 pp in the jobless rate for Ireland and 8.2 pp for Spain in 2013.
hold will only migrate having secured a job abroad, while the unemployed members migrate to continue their job search abroad. The model therefore features cross-border on-the-job search (henceforth, OTJ search). Apart from supplying labor, migrants pay taxes and consume part of their income abroad. Changing country of residence is subject to a moving cost and living abroad entails a utility cost.

We first investigate the importance of the migration channel over the business cycle through the dynamic responses of our model to positive TFP and risk premium shocks. To this end, we perform a comparison of the model with migration to a benchmark version of the model without migration. We find that a TFP shock induces a return of migrant jobseekers, which reinforces the increase in aggregate demand and output, while mitigating the reduction of unemployment. Workers reduce substantially the intensity with which they look for jobs abroad, which reinforces further the decrease in the total stock of migrants and the boost in employment, aggregate demand and output, while mitigating the return of migrant jobseekers relative to a model without cross-border OTJ search, since for the household the migration of the employed is translated immediately into a job match abroad. An increase in the risk premium leads to an increase in migrant jobseekers, which reinforces the decrease in aggregate demand and output, with some unemployment gains. In addition, OTJ search abroad increases, driven by the reduction in the real wage.

We then investigate the economic consequences of migration during fiscal consolidation episodes. In particular, we consider fiscal consolidations implemented via cuts in public expenditures or increases in labor income tax rates. Fiscal consolidation is modeled as a negative shock to the debt target, in a fashion similar to Erceg and Lindé (2013), Pappa et al. (2015) and Bandeira et al. (2018). Our findings indicate that a tax-based consolidation leads to an increase in migration outflows, which exacerbates significantly the induced GDP contraction through a negative impact on internal demand. As a result, the unemployment gains from migration are only temporary. Labor tax hikes also lead to a persistent increase in the intensity with which current workers look for a job abroad. Taking into account the migration of the employed not only limits the short-run unemployment gains from migration but also reverses them substantially in the medium run due to a deeper demand contraction. Government spending cuts, on the other hand, have a non-monotonic impact on migration: initially outflows are higher due to the negative demand effect, while later this is reversed due to the wealth effect which decreases hours and increases the wage. As with tax hikes, taking into account the migration of the employed not only limits the short-run unemployment gains from migration but also reverses them in the medium run. However, government spending cuts, overall, have a relatively small impact on migration as this instrument impacts directly on aggregate absorption and does not deteriorate labor market conditions as strongly as tax
Our paper contributes to the literature on the macroeconomic effects of migration by exploring the business-cycle and fiscal implications of labor force outflows from a small open economy with debt consolidation. We therefore depart from existing studies that examine the implications of migration on the destination economy (see, e.g., Battisti et al. (2017), Lozej (2017), Braun and Weber (2016), Kiguchi and Mountford (2017), Dustmann and Frattini (2014), Storesletten (2000), Canova and Ravn (2000)) by disentangling the effects on the origin country.\(^8\) Related papers, without unemployment and fiscal consolidation, are Farhi and Werning (2014), who study labor mobility and macroeconomic adjustment within a currency union, and Mandelman and Zlate (2012), who develop a two-country model with endogenous migration decisions to study the role of remittances for the Mexican economy. Finally, a link can also be established with previous studies featuring OTJ search with real business-cycle models (see, e.g., Dolado et al. (2009), Tüzemen (2017)), but without cross-country labor mobility.

The rest of the paper is organized as follows. Section 2 presents our DSGE model and Section 3 discusses our calibration. Sections 4 and 5 analyze our results, while Section 6 extends the model with OTJ search abroad. Section 7 presents additional exercises and Section 8 concludes the paper.

## 2 A Small Open Economy Model with Migration

We introduce labor force mobility in a standard small open economy (SOE hereafter) DSGE model with search and matching frictions. The SOE is labeled Home, whereas the rest of the world is denoted by Foreign. We consider a scenario where Foreign tends to have higher wages and more employment opportunities than Home. Hence, when we introduce endogenous migration decisions in the model, unemployed jobseekers from Home will have an incentive to migrate to Foreign. Apart from supplying labor, migrants pay taxes and consume part of their income in Foreign.

Home nationals are part of a representative household. In terms of their labor market status, household members can be employed or unemployed.\(^9\) Home nationals can participate

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\(^8\)Our paper is also related to the literature that examines the steady-state effects of immigration within search and matching models. Ortega (2000) studies a two-country model, in which unemployed workers decide where to search for a job. Chassamboulli and Palivos (2014) analyze the effects of immigration into the U.S., while Liu (2010) and Chassamboulli and Peri (2015) examine the effect of illegal immigration into the U.S.

\(^9\)Introducing endogenous labor force participation does not alter substantially our results. The main impact is that fiscal consolidation leads to a decrease in labor force participation and therefore in the unemployment rate in the short run (results available upon request). Keeping this out of our analysis allows us to focus better on the effect of migration on unemployment.
in the domestic and the foreign labor markets. However, changing country of residence is subject to a moving cost. Moreover, living abroad entails utility costs (see, e.g., Hauser (2014)). Together with labor supply decisions (hours), consumption and savings are defined at the household level.\textsuperscript{10} On the production side, following standard practice in the literature (see, e.g., Erceg and Lindé (2013)), we separate the decisions regarding factor demands from price setting to simplify the description of the model. There are three types of firms: (i) competitive firms that use labor and effective capital to produce a non-tradable intermediate good, (ii) monopolistic retailers that transform the intermediate good into a tradable good, and (iii) competitive final goods producers that use domestic and foreign produced retail goods to produce a final, non-tradable good. The latter is used for private and public consumption, as well as for investment. Price rigidities arise at the retail level, while labor market frictions occur in the intermediate goods sector. The government collects taxes and issues debt to finance public consumption spending, lump-sum transfers, and the provision of unemployment benefits.

In what follows below, the conventional $\star$ denotes foreign variables or parameters. All quantities are in aggregate terms.

2.1 Home

2.1.1 Nationals, Residents and Migrants

The total number of Home nationals is assumed to be constant and equal to $\bar{n}$. On the contrary, the number of Home residents varies depending on changes in the stock of Home migrants in Foreign, with the latter varying over time either due to new outflows from Home or due to returns from Foreign. Denoting by $m_{e,t}$ the stock of emigrants originating from Home and by $N_t$ the resident population, total nationals from Home are

$$\bar{n} = N_t + m_{e,t}$$

At any point in time, Home nationals are either employed in Home $n_t$, employed emigrants $n_{e,t}$, or unemployed jobseekers $u_t$. Among those looking for a job, a share $s_t$ is searching in Home, while the remaining $1 - s_t$ is job-seeking in Foreign. Hence, the composition of Home residents by labor market status is given by

$$N_t = n_t + s_t u_t$$

\textsuperscript{10}See Andolfatto (1996) for an application of the big household assumption in a framework with labor-market search.
In turn, migrants can either be employed or job-seeking in Foreign

\[ m_{e,t} = n_{e,t} + (1 - s_t) u_t \] (3)

with \((1 - s_t) u_t\) representing unemployed immigrants in Foreign at time \(t\). In the domestic labor market, jobs are created through a matching function of the form

\[ m_t = \mu_1 (v_t)^{\mu_2} (s_t u_t)^{1-\mu_2} \] (4)

where \(m_t\) denotes matches, \(v_t\) denotes vacancies posted by firms, \(\mu_1\) measures the efficiency of the matching process and \(\mu_2\) denotes the elasticity of the matching technology with respect to vacancies. We define the probabilities of a jobseeker to be hired, \(\psi_{H,t}\), and of a vacancy to be filled, \(\psi_{F,t}\), as follows:

\[ \psi_{H,t} = \frac{m_t}{s_t u_t} \quad \text{and} \quad \psi_{F,t} = \frac{m_t}{v_t} \]

The law of motion of resident employment in Home, \(n_t\), is thus given by:

\[ n_{t+1} = (1 - \sigma) n_t + \psi_{H,t} s_t u_t \] (5)

where \(\sigma\) denotes the exogenous separation rate. Similarly, the law of motion for immigrant employment \(n_{e,t}\) is then given by

\[ n_{e,t+1} = (1 - \sigma^*) n_{e,t} + \psi_{H,t}^* s_t (1 - u_t) \] (6)

For simplicity, we assume that immigrant workers remain in Foreign when they loose their job through exogenous separations.\(^{11}\)

### 2.1.2 Households

The representative household consists of a continuum of infinitely lived agents. The household derives utility from a consumption bundle, \(C_t\). The household also suffers disutility from having members abroad, \(m_{e,t}\), and from hours worked at home and abroad, \(h_t\) and \(h_{e,t}\)

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\(^{11}\)This assumption facilitates the derivation of the asset values of job-seeking in the wage determination problem. As we explain below, because the value of job-seeking at home or abroad is equalized in equilibrium, having workers that lose their jobs joining the pool of jobseekers in a particular country does not distort the decisions of the household.
respectively. The instantaneous utility function is given by

$$
U(C_t, m_{e,t}, h_t) = \frac{(C_t - \zeta \tilde{C}_t)^{1-\eta}}{1-\eta} - \frac{\Omega(m_{e,t})^{1+\mu}}{1+\mu} - \frac{(h_t^{1+\xi} n_t + h_{e,t}^{1+\xi} n_{e,t})}{1+\xi}
$$

where $\eta$ is the inverse of the intertemporal elasticity of substitution, $\zeta$ is the parameter determining external habits in aggregate consumption, $\tilde{C}_t$, $\Omega, \chi > 0$ and $\mu, \xi > 0$ are parameters associated with the disutility of living abroad and hours worked. In principle, hours worked might differ between resident and migrant workers. The latter are taken as exogenous here (and equal to the hours for native workers in Foreign). However, to keep with the representative household framework, we assume that all agents pool consumption risk perfectly (see, e.g., Merz (1995), Andolfatto (1996), and Kaplan and Schulhofer-Wohl (2017)). Hence, the consumption bundle is evenly shared by all household members and is composed of goods purchased by Home residents, $c_t$, and by emigrants, $c_{e,t}$:

$$
C_t = c_t + e_t c_{e,t}
$$

where $e_t$ is the real exchange rate.

The budget constraint, in real aggregate terms, is given by:

$$
(1 + \tau^c) c_t + i_t + b_{g,t} + e_t r_{f,t-1} b_{f,t-1} + \frac{\phi_u}{2} ((1 - s_t) u_t - (1 - s) w)^2 \leq
$$

$$
(1 - \tau^n) w_t n_t + \left[ r_{t}^k - \tau^k (r_{t}^k - \delta_t) \right] x_t k_t + r_{t-1} b_{g,t-1} + e_t b_{f,t} + e_t \Xi_t + bs_t u_t + \Pi_t + T_t
$$

where $\phi_u$ captures relocation costs for the unemployed crossing the border, with respective flows expressed as the number of migrant jobseekers in Foreign relative to their steady-state value $(1 - s) u$, $w_t$ is the hourly wage, $r_{t}^k$ is the return on effective capital, $b$ denotes unemployment benefits and $\Pi_t$ are profits from monopolistic retailers. Taxes on private consumption, private capital, labor income and lump-sum transfers are given by $\tau^c$, $\tau^k$, $\tau^n$, and $T_t$, respectively. Government bonds are denoted by $b_{g,t}$, and pay the return $r_{t}$, while $b_{f,t}$ denote liabilities with the Foreign.\footnote{In other words, the household lends to the government and borrows from abroad. Assuming government debt is only held by domestic households is in line with the empirical pattern for the “repatriation of public debt” after 2009 in the GIIPS (See Figure 1 in Bruti and Sauré (2016)), supported by the secondary market theory of Broner et al. (2010).}

Migrants’ total income, composed of labor income as well as unemployment benefits, is divided between remittances sent to Home, denoted by $e_t \Xi_t$ (in units of the Home final good),
and consumption $c_{e,t}$ of the Foreign final good so that\footnote{Free movement of workers has long been enshrined in EU law and is considered a cornerstone of its single market architecture. However, although discrimination of job applicants, remuneration and other conditions based on nationality is illegal, jobseekers do not enjoy equal access to social benefits in their host country.}: \footnote{We abstract from endogenizing the allocation of total immigrant income between remittances and consumption of the foreign good, which would require to either assume that the household in Home makes this decision or to model immigrants as separate optimizing agents. Given that remittances have increased much less than migration outflows from Europe’s peripheral countries in the recent years, as emphasized in the Introduction, we leave endogenizing such choice outside the scope of our paper.}

\begin{equation}
\Xi_t + (1 + \tau^c) c_{e,t} = (1 - \tau^{n*}_t) w^*_t h_{e,t} n_{e,t} + (b/c_t) (1 - s_t) u_t
\end{equation}

Note that implicitly we assume that natives and immigrants are perfect substitutes and receive the same wage in Foreign (see, e.g., Mandelman and Zlate (2012)). This is in line with the educational and skill profile of the recent migrants within Europe. Following Mandelman and Zlate (2012), we assume a remittances rule of the form:

\begin{equation}
\Xi_t = \Xi \varrho \left( \frac{(1 - \tau^{n*}_t) w^*_t}{(1 - \tau^n_t) w_t} \right)^\rho \Xi
\end{equation}

The rationale behind (10) is that remittances represent an altruistic compensation mechanism between migrant and domestic workers. In other words, assuming $\rho > 0$, a relative improvement in the wage premium abroad leads to an increase in remittances.\footnote{We abstract from endogenizing the allocation of total immigrant income between remittances and consumption of the foreign good, which would require to either assume that the household in Home makes this decision or to model immigrants as separate optimizing agents. Given that remittances have increased much less than migration outflows from Europe’s peripheral countries in the recent years, as emphasized in the Introduction, we leave endogenizing such choice outside the scope of our paper.}

The household owns the capital stock, which evolves according to:

\begin{equation}
k_{t+1} = \left[ 1 - \frac{\omega}{2} \left( \frac{i_t}{i_{t-1}} - 1 \right)^2 \right] i_t + (1 - \delta_t) k_t
\end{equation}

where $i_t$ is private investment and $\omega$ dictates the size of investment adjustment costs. Following Neiss and Pappa (2005), the depreciation rate $\delta_t$ depends on the degree $x_t$, of capital utilization according to:

\begin{equation}
\delta_t = \bar{\delta} (x_t)^\iota
\end{equation}

where $\bar{\delta}$ and $\iota$ are positive constants.

The problem of the household is to choose $c_t$, $k_{t+1}$, $i_t$, $x_t$, $b_{g,t}$, $b_{f,t}$, $n_{t+1}$, $n_{e,t+1}$, $h_t$, and $s_t$ to maximize lifetime utility subject to the budget constraint, the laws of motion of resident and immigrant employment, taking the probability of finding a job in Home and Foreign as given, the law of motion of capital, the definition of capital depreciation, and the composition of the population. We report the full set of first order conditions in the Appendix and focus here on those that determine labor market participation, jobseeking and migration. Denoting by $\lambda_{c,t}$, $\lambda_{n,t}$ and $\lambda_{e,t}$ the Lagrange multipliers on the budget constraint and on the laws of
motion of domestic and migrant employment, (5) and (6), the first order conditions with respect to \( n_{t+1}, n_{e,t+1}, u_t, \) and \( s_t \) are given by:

\[
\lambda_{n,t} = \beta \left[ \lambda_{c,t+1} (1 - \tau^n) w_{t+1} h_{t+1} - \chi \frac{h_{t+1}^{1+\xi}}{1+\xi} \right] + \beta (1 - \sigma) \lambda_{n,t+1} \tag{13}
\]

\[
\lambda_{e,t} = \beta \left[ \lambda_{c,t+1} (1 - \tau^{n*}) e_t w_{t+1}^* h_{e,t+1} - \chi \frac{h_{e,t+1}^{1+\xi}}{1+\xi} - \Omega (m_{e,t+1})^\mu \right] + \beta (1 - \sigma^*) \lambda_{e,t+1} \tag{14}
\]

\[
\psi_{H,t} \lambda_{e,t} - \lambda_{c,t} [\phi_u ((1 - s_t) u_t - (1 - s) u)] = \lambda_{n,t} \psi_{H,t} \tag{15}
\]

The first two expressions, (13) and (14), determine the evolution of the value of being employed in Home and in Foreign, respectively. In both cases, the value for the household of a newly established match equates to the net direct utility gain, which is equal to the utility value of the net wage minus the disutility from supplying hours worked and from having members abroad in the case of (14), plus the continuation value of the match, which depends on the exogenous termination rate.\textsuperscript{15} Finally, the first order condition with respect to \( s_t \), (15), shows that, at the margin, the value of jobseeking at home and abroad, with the latter including again the utility-adjusted cost of moving abroad, must be equalized. In other words, household members will not search for a job in Home when the value of searching abroad is higher, and vice versa.

2.1.3 Intermediate goods firms

Intermediate goods are produced with a Cobb-Douglas technology:

\[
y_t = A_t (h_t n_t)^{1-\phi} (x_t k_t)^\phi \tag{16}
\]

where \( k_t \) and \( n_t \) are capital and labor inputs, \( x_t \) is the degree of capital utilization, and \( A_t \) is an exogenous stationary TFP process.

Since current hires give future value to intermediate firms, the optimization problem is dynamic, with firms maximizing the discounted value of future profits. The number of workers currently employed, \( n_t \), is taken as given and the employment decision concerns the number of vacancies posted in the current period, \( v_t \), so as to employ the desired number of

\textsuperscript{15}Note that, given our timing assumption, a new match becomes productive one period ahead.
workers next period, $n_{t+1}$. For firms, the law of motion of employment is given by:

$$n_{t+1} = (1 - \sigma) n_t + \psi_{F,t} v_t$$

Firms also decide the amount of the private capital, $k_t$, to be rented from the household at rate $r^k_t$. The problem of an intermediate firm with $n_t$ workers currently employed can be written as:

$$Q(n_t) = \max_{k_t, v_t} \{ p_{x,t} y_t - w_t h_t n_t - r^k_t x_t k_t - \kappa v_t + E_t \beta_{t+1} Q(n_{t+1}) \}$$

where $p_{x,t}$ is the relative price of intermediate goods with the final good being the numeraire, $\kappa$ is the cost of posting a new vacancy, and $\beta_{t+1} = \beta \lambda_{ct+1}/\lambda_{ct}$ is the household’s subjective discount factor. The maximization takes place subject to the law of motion of employment, where the firm takes the probability of the vacancy being filled as given. The first order conditions with respect to capital and vacancies are:

$$r^k_t = \phi \frac{p_{x,t} y_t}{k_t x_t}$$  \hspace{1cm} (17)

$$\frac{\kappa}{\psi_{F,t}} = E_t \beta_{t+1} \left[ (1 - \phi) \frac{p_{x,t+1} y_{t+1}}{n_{t+1}} - w_{t+1} h_{t+1} + (1 - \sigma) \frac{\kappa}{\psi_{F,t+1}} \right]$$  \hspace{1cm} (18)

According to (17) and (18), the value of the marginal product of capital equals the real rental rate and the marginal cost of hiring an additional worker is set equal to the expected marginal benefit. The latter includes the marginal productivity of labor minus the wage plus the continuation value, knowing that with probability $\sigma$ the match can be destroyed.

### 2.1.4 Wage bargaining

Wages are determined by splitting the surplus of a match between the worker and the firm according to their relative bargaining powers. Denoting by $\vartheta \in (0, 1)$ the firms’ bargaining power, the splitting rule is given by $(1 - \vartheta) (1 - \tau^n) S_{f,t} = \vartheta S^H_{h,t}$, where $S^H_{h,t}$ denotes the worker’s surplus from a match in Home and $S_{f,t}$ denotes the surplus of the firm. The surplus for workers consists of the asset value of employment net of the outside option given by the value of being unemployed. As shown in the Appendix, the worker’s surplus from a match in Home can be written as:

$$S^H_{h,t} = (1 - \tau^n) w_t h_t - b - \frac{\lambda}{1 + \xi} \frac{h^{1+\xi}_{t+1}}{\lambda_{ct+1}} + (1 - \sigma - \psi_{H,t}) E_t \beta_{t+1} S^H_{h,t+1}$$
In turn, the firm’s surplus, $S_{f,t}$, is given by:

$$S^F_t = (1 - \phi) \frac{p_{x,t} y_{t}}{n_t} - w_t h_t + (1 - \sigma) \frac{K}{\psi_{F,t}}$$

Using the above expressions, the real wage income determined by the splitting rule of the Nash bargaining $w_{n,t} h_t$ is given by:

$$w_{n,t} h_t = (1 - \vartheta) \left\{ p_{x,t} (1 - \phi) \frac{y_t}{n_t} + \frac{\psi_{H,t}}{\psi_{F,t}} K \right\} + \frac{\vartheta}{(1 - \tau^R)} \left\{ b + \frac{\chi}{\lambda_{c,t}} \frac{h_t^{1+\xi}}{1 + \xi} \right\}$$  \hspace{1cm} (19)

The negotiated outcome is a weighted average of the two surpluses. The first term, weighted by the worker’s bargaining power $(1 - \vartheta)$, includes the value of the marginal product of labor and the continuation value of the match to the firm, corrected by the continuation value of the match to the household. The second term consists of the immediate outside option of being unemployed, corrected for the disutility from hours.

We introduce wage rigidity in a similar fashion to Monacelli et al. (2010) by assuming that real wages evolve according to the following rule:

$$w_t = \rho_w w_{t-1} + (1 - \rho_w) w_{n,t}$$  \hspace{1cm} (20)

where $\rho_w \in (0, 1)$ measures the degree of real wage rigidity.16

### 2.1.5 Retailers

There is a continuum of monopolistically competitive retailers indexed by $i$ on the unit interval. Retailers buy domestic intermediate goods and differentiate them with a technology that transforms one unit of intermediate goods into one unit of retail goods, and, thus, the relative price of intermediate goods, $p_{x,t}$, coincides with the real marginal cost faced by the retailers. Let $y_{i,t}$ be the quantity of output produced by retailer $i$. These goods are aggregated into a tradable good, which is given by:

$$y_{r,t} = \left[ \int_0^1 (y_{i,t})^{\epsilon - 1} \, di \right]^{\frac{1}{\epsilon - 1}}$$

where $\epsilon > 1$ is the constant elasticity of demand for each variety of retail goods. The aggregate tradable good is sold at the nominal price $P_{r,t} = (\int (P_{r,r,t})^{\epsilon - 1} \, di)^{\frac{1}{\epsilon - 1}}$, where $P_{r,r,t}$ is

---

16Introducing nominal wage stickiness within a search and matching framework where wages are the result of bargaining between households and firms who behave optimally is not trivial and is beyond the scope of our paper.
the price of each variety \( i \). The demand for each intermediate good depends on its relative price and on aggregate demand:

\[
y_{i,t} = \left( \frac{P_{i,r,t}}{P_{r,t}} \right)^{-\epsilon} y_{r,t}
\]

We assume that in any given period each retailer can reset its price with a fixed probability \( 1 - \lambda_p \). Firms that are able to reset their nominal price choose \( P_{i,r,t}^* \) so as to maximize expected real profits given by:

\[
\Pi_t(i) = \mathbb{E}_t \sum_{s=0}^{\infty} (\beta \lambda_p)^s \lambda_{ct+s} \left( \frac{P_{i,r,t}}{P_{t+s}} - p_{x,t+s} \right) y_{i,t+s}
\]

subject to the respective demand schedule. Since all firms are ex-ante identical, \( P_{i,r,t}^* = P_{r,t}^* \) for all \( i \). The resulting expression for the real reset price \( p_{r,t}^* \equiv P_{r,t}^* / P_t \) is:

\[
\frac{p_{r,t}^*}{p_{r,t}} = \frac{\epsilon}{(\epsilon - 1) D_t} \frac{N_t}{N_t+1}
\]

where:

\[
N_t = p_{x,t} y_{r,t} + \lambda_p \mathbb{E}_{t+1} (\pi_{r,t+1})^\epsilon N_{t+1}
\]

\[
D_t = p_{r,t} y_{r,t} + \lambda_p \mathbb{E}_{t+1} (\pi_{r,t+1})^{\epsilon-1} D_{t+1}
\]

where \( p_{r,t} \equiv P_{r,t} / P_t \) and \( \pi_{r,t} \) denotes producer price inflation. Under the assumption of Calvo pricing, the price index, in nominal terms, is given by:

\[
(P_{r,t})^{1-\epsilon} = \lambda_p (P_{r,t-1})^{1-\epsilon} + (1 - \lambda_p) (P_{r,t}^*)^{1-\epsilon}
\]

The aggregate tradable good is sold domestically and abroad:

\[
y_{r,t} = y_{l,t} + y_{m,t}^*
\]

where \( y_{l,t} \) is the quantity of tradable goods sold locally and \( y_{m,t}^* \) the quantity sold abroad.
2.1.6 Final Goods Producer

Finally, perfectly competitive firms produce a non-tradable final good, \( y_{f,t} \), by aggregating domestic, \( y_{l,t} \), and foreign, \( y_{m,t} \), aggregate retail goods using a CES technology:

\[
y_{f,t} = \left[ (\varpi)^{\frac{1}{\gamma}} (y_{l,t})^{\frac{1-\varpi}{\gamma}} + (1 - \varpi)^{\frac{1}{\gamma}} (y_{m,t})^{\frac{1-1}{\gamma}} \right]^{\frac{\gamma}{1-\gamma}}
\]

The home bias parameter, \( \varpi \), denotes the fraction of the final good that is produced locally. The elasticity of substitution between home-produced and imported goods is given by \( \gamma \). Final good producers maximize profits \( y_{f,t} - p_r y_{l,t} - \epsilon t p_{r,t}^\star y_{m,t} \) each period, where \( p_{r,t} \) and \( p_{r,t}^\star \) denote the real price of aggregate retail goods produced in Home and in Foreign, respectively, and we have assumed the law of one price holds. Solving for the optimal demand functions gives:

\[
y_{l,t} = \varpi (p_{r,t})^{\frac{1}{\gamma}} y_{f,t}
\]

\[
y_{m,t} = (1 - \varpi) (\epsilon t p_{r,t}^\star)^{\frac{1}{\gamma}} y_{f,t}
\]

The nominal consumer price index, \( P_t \), is defined implicitly by substituting out \( y_{l,t} \) and \( y_{m,t} \) in the CES above by the respective demand curves, which yields:

\[
1 = \varpi (p_{r,t})^{1-\gamma} + (1 - \varpi) (\epsilon t p_{r,t}^\star)^{1-\gamma}
\]

where \( p_{r,t} = P_{r,t}/P_t \) and \( p_{r,t}^\star = P_{r,t}/P_t^\star \) are the retail prices in Home and in Foreign, respectively, denominated in each country’s numeraire.

2.1.7 Government

Government expenditure consists of unemployment benefits, consumption expenditure and lump-sum transfers, while revenues come from consumption, capital income and labor income taxes. The primary deficit is, therefore, defined by:

\[
DF_t = bu_t + g_t + T_t - \tau^n w_t h_t n_t - \tau^k (r_t^k - \delta_t)x_t k_t - \tau c_t
\]

and the government budget constraint is given by:

\[
r_t^{-1} b_{g,t-1} + DF_t = b_{g,t}
\]
The government has two potential fiscal instruments, labor income tax rates $\tau^n$ and public consumption expenditure $g$. The other tax rates, $\tau^k$ and $\tau^c$, will be treated as parameters. We consider each instrument separately, assuming that if one is active, the other remains fixed at its steady state value. For $\Psi \in \{\tau^n, g\}$, following Erceg and Lindé (2013) and Pappa et al. (2015), we assume fiscal rules of the form:

$$\Psi_t = \Psi^{(1-\beta_{\Psi_0})} \Psi_{t-1}^{\beta_{\Psi_0}} \left[ \left( \frac{\tilde{b}_{g,t}}{\tilde{b}_{g,t}^0} \right)^{\beta_{\Psi_1}} \left( \frac{\Delta \tilde{b}_{g,t+1}}{\Delta \tilde{b}_{g,t+1}^0} \right)^{\beta_{\Psi_2}} \right]^{(1-\beta_{\Psi_0})} \quad (31)$$

where $\tilde{b}_{g,t} \equiv \frac{b_{g,t}}{g_{dp}}$ is the debt-to-GDP ratio, parameters $\beta_{\Psi_1}$ and $\beta_{\Psi_2}$, are positive for $\Psi = \tau^n$, and negative for $\Psi = g$, and $b_{g,t}^T$ is the target debt-to-GDP ratio, given by the AR(2) process:

$$\log b_{g,t}^T - \log b_{g,t-1}^T = \rho_1 (\log b_{g,t-1}^T - \log b_{g,t-2}^T) + \rho_2 (\log b_{g,t-1}^T - \log b_{g,t-2}^T) - \varepsilon^b_t \quad (32)$$

where $\tilde{b}$ is the steady state level of the debt-to-GDP ratio and $\varepsilon^b_t$ is a white noise process representing a fiscal consolidation shock. We therefore consider a gradual (effectively permanent) reduction in the target for the debt-to-GDP ratio (see also Erceg and Lindé (2013), Pappa et al. (2015), Bandeira et al. (2018)). As we explain below, for the fiscal rule (31), we calibrate the set of three parameters for each fiscal instrument in such a way that the actual debt-to-GDP ratio meets the new, lower target at the same time across the different instruments.

### 2.1.8 Resource constraint

The non-tradable final good is sold for private and public consumption, $c_t$ and $g_t$, and for investment, $i$. However, costs related to vacancy posting and moving to/from Foreign reduce the amount of resources available:

$$y_{f,t} = c_t + i_t + g_t + \kappa v_t + \frac{\phi_u}{2} ((1 - s_t) u_t - (1 - s) u)^2 \quad (33)$$

Aggregating the budget constraint of households using the market clearing conditions, the budget constraint of the government, and aggregate profits, we obtain the law of motion for net foreign assets, which corresponds to the current account and is given by:

$$e_t (r_{f,t-1} b_{f,t-1} - b_{f,t}) = nx_t + e_t \bar{e}_t \quad (34)$$
and where \( nx_t \) are net exports defined as:

\[
nx_t = p_{r,t} y^*_{m,t} - e_t p^*_{r,t} y_{m,t}
\]  

(35)

Real GDP is defined as:

\[
gdp_t = y_{f,t} + nx_t
\]  

(36)

Using conditions (25) and (35), together with the fact that in equilibrium \( y_{f,t} = p_{r,t} y_{r,t} + e_t p^*_{r,t} y_{m,t} \), real GDP can equally be expressed as \( gdp_t = p_{r,t} y_{r,t} \).

### 2.1.9 Monetary policy

The monetary authority sets the gross nominal interest rate to target zero net inflation:

\[
R_t = \rho_R R_{t-1} + (1 - \rho_R) \rho_\pi \pi_t
\]  

(37)

where consumer price inflation, \( \pi_t \), is defined as:

\[
\pi_t = \frac{P_t}{P_{t-1}}
\]  

(38)

while the gross nominal interest rate, \( R_t \), is defined through the Fisher equation:

\[
r_t = \frac{R_t}{E_t \pi_{t+1}}
\]  

(39)

Finally, we introduce a risk premium charged to Home households depending on the relative size of net foreign liabilities to real GDP:

\[
r_{f,t} = r^*_{t} \exp \left\{ \Gamma \frac{b_{f,t+1}}{gdp_t} \right\}
\]  

(40)

where \( \Gamma \) is the elasticity of the risk premium with respect to liabilities (see also Schmitt-Grohé and Uribe (2003)).

### 3 Calibration

We solve the model by linearizing the equilibrium conditions around a non-stochastic zero-inflation steady state. Table 1 shows the key parameters and steady-state values targeted in our calibration. We calibrate the model at a quarterly frequency and normalize per capita
GDP to 1. Net foreign assets and public debt represent 10% and 90% of annual GDP, with private consumption accounting for 63% of GDP, government spending to 20% and capital investment just under 18%.\textsuperscript{17} The ratio of remittances over GDP in the steady state (3%) is chosen such that per capita consumption between non-migrant and migrant labor force participants is equalized. Specifically, we set the ratio of Home-purchased consumption over non-migrant labor participants equal to the ratio of Foreign-purchased consumption over migrants.

We set the discount factor, $\beta$, to 0.99, implying an annual interest rate of 4%. Utility from consumption takes the log-form and external habits are set equal to 0.75. Following Erceg and Lindé (2013), we assume a degree of home bias equal to 0.80, and an elasticity between domestically produced and imported goods equal to 1.2, which is a standard value in the international business cycle literature. The elasticities of hours worked and migration are set equal to 1. On the production side, we set the capital share equal to $1/3$, the depreciation rate to 2.5%, and the degree of investment adjustment costs equal to 8. The steady-state price markup over marginal costs is set to 10%, with the degree of price stickiness, $\lambda_p$, set equal to 0.75 (such that price contracts last on average 12 months).

Regarding the labor market, we start by normalizing total nationals of Home, $\bar{n}$, to unity, of which 10% reside abroad.\textsuperscript{18} The unemployment rate in Home is assumed to be equal to 12%, while in Foreign is half of that in Home, 6%. This implies that the share of unemployed Home nationals looking for a job abroad is 8%. For simplicity, we assume that the exogenous termination rates in the domestic and foreign labor markets are both equal to 6%. This, together with the unemployment rates in each country, implies that the job-finding probability in Home is lower than in Foreign (0.46 and 0.56, respectively). By setting the vacancy-filling probability in Home equal to 0.50, we pin down the efficiency of the matching technology, $\mu_1$, whereas setting the replacement rate, $b/w$, to 34% pins down the firm’s power in the wage bargaining problem, $\varphi = 0.38$. Likewise, the relative weight of the migration disutility term, $\Omega$, depends on the average wage differential between the two countries, which we calibrate to 5%.\textsuperscript{19} We set the degree of real wage rigidity $\rho_w$ equal to 0.5. We assume that total vacancy costs represent 1% of GDP and we standardize hours to 1. Finally, we choose a value for pecuniary migration costs $\phi_u$ such that we broadly match the dynamics of migration outflows in Greece in our simulation exercises below (see Figure

\textsuperscript{17}Public debt in euro area (18) has fluctuated around 90% of GDP since 2012.
\textsuperscript{18}Measuring the stock of national residing abroad is not straightforward, as noted in the Introduction. Nevertheless, data from the UN Population Division at the Department of Economic and Social Affairs shows that the share of nationals living abroad in 2015 was above 8% for Greece, 19% for Ireland and 22% for Portugal, whereas the stock for Spain and Italy is reported to be close to 5%. All numbers were higher compared to the previous data points, for 2010.
\textsuperscript{19}See Section 6 for sensitivity analysis.
The long-run response of the nominal interest rate to inflation is assumed to be equal to 1.75, while the inertia coefficient in the Taylor rule is set to 0.80. The elasticity of the spread between domestic and foreign interest rates, \( \Gamma \), is set to 0.001. We calibrate the public-debt target rule (32) such that the cut in the debt target is implemented gradually over 10 quarters, remaining below its steady state for an arbitrarily larger number of quarters. For the fiscal rule (31), we calibrate the set of three parameters for each fiscal instrument in such a way that the actual debt-to-GDP ratio meets the new, lower target at the same time across the different instruments and at around 20 quarters after the decision to consolidate is taken. Finally, we set the steady-state labor income tax rate at 20%.

In the analysis that follows, we compare the results of three versions of the model: (i) without migration, (ii) with migration of the unemployed, and (iii) with migration of both the unemployed and employed (see section 6). To compare the dynamics across the different specifications, we eliminate potential differences in the steady states between models. In practice, we work with the full model with migration of both the unemployed and the employed, setting all variables related to migration and OTJ search abroad to their steady state values when considering the cases of no migration or no OTJ search abroad.

### Table 1: Calibration

<table>
<thead>
<tr>
<th>National Accounts:</th>
<th>( gdp )</th>
<th>1.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>real GDP per capita</td>
<td>( gdp )</td>
<td>1.00</td>
</tr>
<tr>
<td>net foreign assets</td>
<td>( b_f/gdp )</td>
<td>( 4 \times (0.10) )</td>
</tr>
<tr>
<td>public debt</td>
<td>( b_g/gdp )</td>
<td>( 4 \times (0.90) )</td>
</tr>
<tr>
<td>public spending</td>
<td>( g/gdp )</td>
<td>0.20</td>
</tr>
<tr>
<td>remittances</td>
<td>( \Xi/gdp )</td>
<td>0.03</td>
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</table>

<table>
<thead>
<tr>
<th>Utility:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>discount factor</td>
<td>( \beta )</td>
<td>0.99</td>
</tr>
<tr>
<td>intertemporal elasticity</td>
<td>( \eta )</td>
<td>1.01</td>
</tr>
<tr>
<td>external habits in consumption</td>
<td>( \zeta )</td>
<td>0.75</td>
</tr>
<tr>
<td>home bias in consumption</td>
<td>( \varpi )</td>
<td>0.80</td>
</tr>
<tr>
<td>elasticity home/imported goods</td>
<td>( \gamma )</td>
<td>1.20</td>
</tr>
<tr>
<td>migration elasticity</td>
<td>( \mu )</td>
<td>1.00</td>
</tr>
<tr>
<td>elasticity hours worked</td>
<td>( \xi )</td>
<td>1.00</td>
</tr>
</tbody>
</table>
### Table 1: Calibration (continued)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Production:</strong></td>
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</tr>
<tr>
<td>capital share in production</td>
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<tr>
<td>capital depreciation rate</td>
<td>$\bar{\delta}$</td>
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<tr>
<td>investment adjustment costs</td>
<td>$\omega$</td>
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<tr>
<td>price monopolistic elasticity</td>
<td>$\epsilon$</td>
<td>11</td>
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<tr>
<td>price Calvo lottery</td>
<td>$\lambda_p$</td>
<td>0.75</td>
</tr>
<tr>
<td><strong>Labor market:</strong></td>
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<td></td>
</tr>
<tr>
<td>total population</td>
<td>$\bar{n}$</td>
<td>1</td>
</tr>
<tr>
<td>unemployment rate</td>
<td>$su/(su + n)$</td>
<td>0.12</td>
</tr>
<tr>
<td>stock of migrants</td>
<td>$m_e/\bar{n}$</td>
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</tr>
<tr>
<td>vacancy-filling probability</td>
<td>$\psi_F$</td>
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<tr>
<td>vacancy posting costs</td>
<td>$\kappa_v/gdp$</td>
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<tr>
<td>replacement rate</td>
<td>$b/w$</td>
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</tr>
<tr>
<td>termination rates</td>
<td>$\sigma, \sigma^*$</td>
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</tr>
<tr>
<td>Foreign unemployment rate</td>
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<td>Foreign wage premium</td>
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<td>wage stickiness</td>
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<tr>
<td>pecuniary migration costs</td>
<td>$\phi_u$</td>
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<tr>
<td><strong>Policy:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taylor rule: $i_{t-1}$</td>
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</tr>
<tr>
<td>Taylor rule: $\pi_t$</td>
<td>$\rho_\pi$</td>
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</tr>
<tr>
<td>elasticity country premium</td>
<td>$\Gamma$</td>
<td>0.001</td>
</tr>
<tr>
<td>labor income tax</td>
<td>$\tau_n$</td>
<td>0.20</td>
</tr>
<tr>
<td>public debt target</td>
<td>$\rho_1, \rho_2$</td>
<td>0.6, 0.000001</td>
</tr>
<tr>
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</tr>
<tr>
<td>fiscal rule: government spending</td>
<td>$\beta_{g0}, \beta_{g1}, \beta_{g2}$</td>
<td>0.6, 1.75, 1.5</td>
</tr>
</tbody>
</table>

## 4 Migration Over the Business Cycle

We begin our analysis by showing responses to standard shocks in the business-cycle literature, namely shocks to technology and the risk premium, since our paper is motivated by the experience of peripheral countries in Europe. The goal is, first, to examine the behavior of the migration variables in response to these shocks, and, second, to verify that our model generates plausible results in response to those shocks.
4.1 TFP shock

The solid lines in Figure 3 for the model without migration confirm that a positive TFP shock leads to an increase in consumption, investment and GDP in the economy, while it decreases the unemployment rate. With the increase in the marginal product of labor, firms post more vacancies and increase real wages. The job finding rate increases and pushes up on employment. Due to sticky prices, markups increase and so the rise in profits becomes larger than the increase in wages. Because the labor-reducing income effect of higher profits dominates the labor-increasing effect of higher wages, hours fall. Given the positive supply shock, prices go down, the competitiveness of the economy improves, and the real exchange rate depreciates, which leads exports to go up. On the other hand, the increase in demand leads to an increase in imports and therefore a decline in net exports after the very short run.

When we allow for cross-border labor mobility, the dashed lines in Figure 3 show that the household reduces the share of unemployed jobseeking abroad, which decreases the stock of migrants. The resulting increase of labor supply in the domestic labor market leads to a smaller increase in the real wage and a higher increase in consumption relative to the model without migration. With the return of some migrants, the job-finding rate increases by less. On the other hand, the increase in consumption from the returning migrants leads firms to post more vacancies in order to increase production capacity. Employment and GDP rise more than in the case without migration. For the unemployment rate we include two measures: “U rate (jbsk. in H only)” takes into account only unemployed of Home nationality who are jobseeking in Home. This measure shows that the unemployment rate rises in the very short run, given that fewer unemployed jobseekers are now directed towards the foreign labor market, while it subsequently falls, as more jobs are created in the domestic labor market, but to a smaller extent compared to the model without migration. On the other hand, the other measure (“unemployment rate”) helps to capture the case in which unemployed jobseekers who have moved abroad but receive the unemployment benefit in Home are still counted in the local pool of unemployed. Obviously, this measure cannot capture the effect of labor mobility on the unemployment rate.\[20\]

In sum, a positive TFP shock induces a return of migrant jobseekers. On the one hand, this has a negative impact on unemployment, but on the other hand, it reinforces the positive effects of the shock on consumption, investment and GDP.

\[20\]Given the imperfect degree of registrations for migrants it is natural to expect that the actual unemployment rate falls between the estimation of the two mesures provided here.
4.2 Risk-premium shock

Given that our motivation comes from the experience of Greece and Spain in the Great Recession (see the Introduction), it is clear that the case of monetary policy shocks is not interesting in this context. However, a the possibility or shocks to risk premia is important to consider. We therefore examine next such a shock, normalised to generate a 1% increase in the nominal interest rate. Results are reported in Figure 4.

Starting with the model without migration (solid lines), an increase in the risk premium implies from the law of motion for net foreign assets in (34) that the real exchange rate depreciates and exports increase. Inflation rises because imports become more expensive and the household reduces consumption. Investment and GDP also fall. In the labor market this is translated into a decrease in vacancies, wages and employment. The household increases hours in an effort to fight the fall in purchasing power.

When migration is allowed (dashed lines), the household increases the fraction of unemployed members searching for a job abroad in response to the fall in wages and the job-finding probability. Due to this reduction in labor supply in Home, employment falls by more relative to the scenario without migration. The unemployment rate that is adjusted for emigration “U rate (jbsk. in H only)” falls in the very short run, given that more unemployed jobseekers are now directed towards the foreign labor market, while it subsequently rises, as fewer jobs are created in the domestic labor market, but to a smaller extent compared to the model without migration.

In sum, an increase in the risk premium induces higher migration outflows of jobseekers. On the one hand, this has a positive impact on unemployment, but on the other hand, it reinforces the negative effects on consumption, investment and GDP.

5 Migration and Fiscal Consolidation

In this section, we consider a shock that drives the debt-to-GDP target 10% below its steady state. We simulate the responses to this shock with labor income taxes or government spending adjusting to achieve fiscal consolidation after 20 quarters. We then compare the effects of the consolidation under the two instruments with and without migration.

5.1 Labor tax hikes

We begin with the case of tax-based consolidation, shown in Figure 5. In the model without migration (solid lines) the labor tax hike decreases hours, by affecting negatively the incentives to work. Consumption and investment fall, given the drop in after-tax income. The
drop in demand leads to a fall in vacancies, the job finding probability, employment and GDP. Furthermore, the rise in labor taxes increases unemployment and the real wage, since workers demand higher wages to compensate for the higher tax burden. The deterioration of the competitiveness of the economy leads to a real exchange rate appreciation. The fall in consumption and investment demand leads to a fall in the demand for imports, reflected in the increase of net exports.

When we introduce migration (see dashed lines in Figure 5), the significant fall in the job-finding probability induces the household to increase the share of unemployed members who look for a job abroad, which increases the stock of migrants. Emigration leads to a stronger fall in consumption and investment relative to the model without migration, which explains the deeper contraction of GDP. We also observe a stronger effect on the real exchange rate and net exports. Vacancies and employment fall substantially more, given the stronger contraction in demand. The real wage increases by more now due to the decrease in labor supply. The unemployment rate that is adjusted for emigration “U rate (jbsk. in H only)” falls in the very short run, given that more unemployed jobseekers are now directed towards the foreign labor market, while it subsequently rises, as fewer jobs are created in the domestic labor market, but to a smaller extent in the short run compared to the model without migration. This is due to the more negative response of vacancies and employment. The unemployment gains from migration are therefore only temporary here.

In sum, labor tax hikes induces higher migration outflows of jobseekers. On the one hand, this has a short-run positive impact on unemployment, but on the other hand, it reinforces the negative effects on consumption, investment and GDP. In other words, migration leads to stronger adverse effects from tax-based consolidation, with the exception of the real wage and the short-run unemployment rate.

5.2 Public spending cuts

Starting with the case of government spending cuts in a model without migration, the solid lines in Figure 6 confirm the well-known positive wealth effect for the household that increases consumption and investment in expectation of lower taxes in the future. The household also reduces its labor supply, through a decrease in hours. At the same time, the fall in government spending has a negative demand effect, which induces vacancies, and consequently the job finding rate, to fall. This leads to a persistent fall in employment and an increase in unemployment. The real wage goes down, given the drop in labor demand, but then increases in the medium run, given the reduction in labor supply. The real exchange rate depreciates, given the fall in demand, prices and wages. Real GDP falls persistently since the cut in government spending directly reduces aggregate demand in the economy. Imports
fall too, given the drop in demand, which increases net exports.

When migration is allowed (see dashed lines), the negative demand shock induces the household to initially increase the share of unemployed jobseekers abroad, which increases the stock of migrants. This mitigates the increase in consumption and deteriorates the response of employment. However, the response of GDP between the two models hardly differs, as the main driver here is the reduction of aggregate demand caused by the government spending cut itself. Moreover, the increase in migration is relatively small and rather short-lived: the share of unemployed jobseekers abroad and the stock of migrants fall in the medium run as the real wage increases above its steady-state level.

In sum, a spending-based consolidation has a non-monotonic effect on migration outflows of jobseekers and therefore on unemployment. Migration leads to weaker positive effects on consumption and stronger negative effects on employment. As with labor tax hikes, the unemployment gains from migration are only temporary. 21

5.3 Comparison of instruments

Figure 7 compares both instruments in the presence of migration in the model. The results confirm that a spending-based consolidation (solid lines) is more favorable than a tax-based consolidation (dashed lines) in terms of consumption, investment, and GDP effects. The fall in GDP is more abrupt and unwinds faster in the case of spending cuts as this instrument impacts directly on aggregate absorption and does not deteriorate labor market conditions as strongly as tax hikes do. A tax-based consolidation affects the incentives to work, reduces output and lowers the tax base. Regarding the real wage, tax hikes lead to a rise, while spending cuts lead to a very small fall. Consequently, we have a real exchange rate appreciation in the case of tax hikes and a depreciation in the case of spending cuts. The instrument that induces the strongest effects on migration is the labor tax hike, with a persistent increase in outflows, while spending cuts increase outflows only in the short run. Consequently, tax hikes are associated with stronger unemployment costs than spending cuts, except for the very short run.22

6 Migration of the employed

So far we have assumed that only unemployed jobseekers migrate. However, as argued in the Introduction, recent migration outflows from peripheral European countries, such as

21In Appendix A3 we show that these mechanisms are in line with the results for a standard government spending shock (see Figure 11).

22For a comparison of the instruments in the model without migration, see Figure 12 in the Appendix.
Greece, largely involved employed members of the labor force. In this section, we turn to the migration of the employed members of the labor force by modelling OTJ search abroad.

### 6.1 Extending the model with OTJ search abroad

In extending our baseline model to allow employed workers to search and take jobs abroad, we follow the setup in Krause and Lubik (2006) and Tüzemen (2017) who model OTJ search in the domestic labor market.\textsuperscript{23} Each period, workers decide how much effort $z_t$ to exert in searching for a job abroad. The higher the search intensity, the higher the probability to be matched with a job abroad in the next period. However, OTJ search is subject to a pecuniary cost per employee $\omega z_t^\xi_1$, with parameters $\omega > 0$ and $\xi_1 > 1$, measured in units of the final good.\textsuperscript{24} With OTJ search, the law of motion of employed workers in Home is given by

$$n_{t+1} = (1 - \sigma - \psi^*_H, z_t) n_t + \psi_H, s_t u_t$$

(41)

where the term $\psi^*_H, z_t$ accounts for those workers that move abroad to join the measure of employed migrants:

$$n_{c,t+1} = (1 - \sigma^*) n_{c,t} + \psi^*_H, (1 - s_t) u_t + \psi_H, z_t n_t$$

(42)

The introduction of OTJ search affects indirectly the household’s decisions regarding jobseeking or the allocation of jobseekers between Home and Foreign through the impact on the asset value of being employed in Home. This asset value is negatively affected by the pecuniary costs of OTJ search and the higher probability of leaving the job in the future, $\psi^*_H, z_{t+1}$, and positively affected by the future value of being employed abroad. This trade-off can be clearly seen from the optimality condition for the intensity of OTJ search, which is given by

$$\lambda_{c,t} \omega \xi_1 (z_t)^{\xi_1 - 1} = \psi^*_H, (\lambda_{c,t} - \lambda_{n,t})$$

(43)

Condition (43) states that, in equilibrium, the marginal costs of OTJ search intensity, in units of consumption, must be equal to the excess value of working abroad relative to working in Home, subject to the probability of finding a job in Foreign. The higher this differential, the higher the optimal level of OTJ search.\textsuperscript{25}

The possibility that workers can resign from their contracts also affects the surplus firms derive from new hires. This occurs because the average tenure of a contract depends on the

\textsuperscript{23}For simplicity, we model OTJ search only for employment abroad, in line with the recent experience of the euro-area peripheral countries where domestic employment opportunities had dramatically shrunk.

\textsuperscript{24}The added term in the budget constraint of (8) is therefore $n_t \omega z_t^\xi_1$.

\textsuperscript{25}In the scenarios we analyze below, we only consider cases where $\lambda_c > \lambda_n$ is true in the steady state.
probability of an early termination by the emigrating worker, which affects the law of motion of employment, (41). These changes in the surpluses affect the real wage, which is now given by

\[ w_{n,t} = \frac{\vartheta}{(1 - \tau^n)} \left\{ b + \frac{b}{\lambda_{c,t}} \left( 1 + \xi T \right) - z_t \left\{ \frac{\Omega (m_{c,t})^\mu}{\lambda_{c,t}} + \phi_u \left( (1 - s_t) u_t - (1 - s) u \right) \right\} \right\} \\
+ (1 - \vartheta) \left\{ (1 - \phi) \frac{p_{x,t} y_t}{n_t} + (1 - z_t) \frac{\psi_{H,T}}{\psi_{F,t}} \right\} \]

Comparing to the wage rule in the baseline model, (44) differs in three respects. First, the last term in the second line (firm’s surplus) is now multiplied by \((1 - z_t)\), which reflects the fact that the higher is OTJ search, the lower the average tenure of work contracts in Home. This reduces the continuation value of the contract and, therefore, pushes down on wages. Second, the worker’s surplus is affected by the pecuniary costs of OTJ search. Finally, because in equilibrium the asset value of jobseeking in Home and Foreign must be equal, the surplus for the worker is adjusted to reflect the utility and moving costs associated with the future value of working abroad, through the outside option opened by OJS. Without OJS, firm-worker relations do not depend on migration costs directly (see (19)). They rather depend on the outside option of workers (which refers to the value of unemployment and is equal between searching at home or abroad).

Before we turn to the results, notice that we have assumed that employed members of the household will only migrate having secured a job, which is not the case for the unemployed members who migrate to continue their job search abroad. This implies that when we introduce OTJ search abroad in the model, the household may decide to substitute migration of the unemployed with migration of the employed, since the latter is directly translated into a job match abroad. In terms of calibration, we assume that at the steady state 0.5% of workers are matched to a job abroad and that \(\xi_1 = 2\). The latter is is calibrated to govern the migration outflows in the policy simulations (see section 6.4), while \(\omega\) is pinned down in steady state.

### 6.2 Business cycle fluctuations

Figures 3 and 4 also present the impulse response functions for the two shocks in Section 4 with OTJ search abroad (see dash-dotted lines). After a positive TFP shock workers reduce substantially the intensity with which they look for jobs abroad, which reinforces the decrease in the stock of migrants and boosts aggregate demand, employment, and GDP by significantly more than in the other two versions of the model. On the other hand, the return of unemployed jobseekers is mitigated, relative to the model with migration of the unemployed
only, and consequently the negative impact of labor mobility on the unemployment rate is mitigated as well.

In the case of a shock to the risk premium, OTJ-search abroad increases in the short run, following the fall in the real wage, which reinforces the increase in the stock of migrants and the decrease in aggregate demand, employment, and GDP by significantly more than in the other two versions of the model. On the other hand, the outflows of unemployed jobseekers are mitigated, relative to the model with migration of the unemployed only, and consequently the positive impact of labor mobility on the unemployment rate. In the medium run the unemployment rate increases even more than in the model without migration due to a deeper demand contraction in the economy.

Overall, taking into account cross-border OTJ search in the model reinforces the demand effects of the previous two shocks, while it mitigates unemployment gains (costs) from migration (return migration).

6.3 Fiscal consolidation: spending cuts versus tax hikes

Figures 5 and 6 also report the responses for the fiscal consolidation shock under the two alternative instruments in the presence of OTJ search abroad (see dash-dotted lines). A tax-based consolidation significantly increases the intensity with which current workers look for jobs abroad, increasing further the stock of migrants, and tending to mitigate the migration of the unemployed jobseekers. The latter happens because the employed migrate having secured a job abroad. A higher stock of migrants abroad has a negative impact on internal demand, deepening the GDP contraction, which is also reflected in the response of the unemployment rate that excludes those jobseeking abroad. This shows that taking into account the migration of the employed can limit the short-run gains from migration in terms of reduction in unemployment. Notably, in the medium run the unemployment rate increases even more than in the model without migration due to a deeper demand contraction in the economy.

Cuts in public spending have a non-monotonic impact on the intensity with which current workers look for jobs abroad, in line with the results in Section 5.2. The intensity of the OTJ search abroad increases (decreases) in the short run (medium run) following the fall (increase) in the real wage. This is translated in a smaller increase in consumption and a higher decline in labor. As with tax hikes, taking into account the migration of the employed limits the short-run gains from migration and even reverses them in the medium run.

26 Figure ?? of the Appendix shows a similar response after a positive shock to the nominal interest rate.

In the case of a government spending shock in Figure 11 of the Appendix, the intensity of OTJ-search abroad initially falls given the boost in aggregate demand and the subsequent increase in labor demand and the real wage. However, this response is reversed in the medium run due to the fall in the wage from the increased labor supply (wealth effect).

27 The response of the OTJ search abroad becomes negative after eighteen quarters, as the instrument (tax rate) goes back to the steady state.
Overall, taking into account cross-border OTJ search in the model reinforces the demand effects of both types of consolidation, while it mitigates the short-run unemployment gains from migration and even reverses them in the medium run. A comparison of the two cases in Figure 13 of the Appendix confirms that cuts in tax hikes induce a much higher increase in the intensity of the OTJ search abroad.

6.4 Fiscal consolidation mix in Greece

So far, we have studied the interaction of migration and fiscal consolidation instruments, without considering a policy mix with both spending cuts and labor tax hikes. In this subsection, we examine the predictions of our model when looking at the actual tax-spending consolidation implemented in Greece. We obtain annual data on the non-wage component of public consumption expenditure from Eurostat.  

We construct effective taxes following the methodology of Mendoza et al. (1994) and allow lump-sum transfers to adjust to satisfy the government budget.

We solve the model under two alternative, informational assumptions about the paths of the fiscal instruments: perfect foresight and random walk. Under perfect foresight, we start the economy at its steady state and then feed in the model the actual annual values of the two (tax-spending) instruments for the period 2009-2015. Under random walk, we assume that people expect the current fiscal policy stance to remain the same in the next period, so any change is entirely unanticipated.

The model is solved in Dynare in a non-linear fashion. Changes in our calibration for the annual frequency are as follows: we set the capital depreciation rate, $\delta$, equal to 0.1, the discount factor $\beta$ equal to 0.96, and the price and wage stickiness parameters equal to 0.25. We further set the non-wage component of public expenditure in Greece equal to 10% of GDP in the steady state, the effective labor tax rate equal to 34% and the public debt-to-GDP ratio equal to 127% according to the Greek data for 2009. For the annual calibration, we also divide by 4 the parameters for pecuniary migration costs and search effort, so that the flow of migrants is roughly 4 times higher in one year compared to a quarter. The calibration of the OTJ search parameter $\xi_1 = 2$ aims to generate migration outflows of the order observed in the Greek data (see Figure 2).

Figures 8a and 8b show the results for the perfect foresight and perfectly unanticipated solutions, respectively. The actual paths of the fiscal instruments are also depicted in the two figures for the three versions of the model considered: without migration (solid lines), with migration of the unemployed (dashed lines) and with migration of both the unemployed

\footnote{An extension of our model with a public sector would allow to assess the role of the public wage bill cuts, too (see, e.g., Bandeira et al. (2018)).}
and the employed (dash-dotted lines). As can be seen in both figures, the implemented fiscal consolidation mix leads to increased migration outflows, which are higher under perfect foresight. The magnitude observed in the data falls between the cases of perfect foresight and random walk (see Figure 2). Consumption, investment, employment and GDP decline, while net exports increase, consistently with the Greek data (due to a decline in imports, see Arkolakis et al. (2017)). In the case of perfect foresight, cross-border labor mobility increases significantly the decline of consumption, investment, GDP, and employment. In the case of random walk, differences are observed in the responses of consumption and employment. As expected, in both Figures 8a and 8b migration mitigates the increase in the unemployment rate in the model without labor mobility.

The consolidation mix leads to an increase in the intensity with which current workers look for employment abroad, which increases migration outflows and exacerbates the decline of internal demand, GDP and employment relative to the model without OTJ search abroad. In the case of the perfectly unanticipated solution, the model’s prediction after 2011 seems generally in line with the finding of Labrianidis and Pratsinakis (2016) that half of Greek emigrants in the Great Recession were employed at the time. Given the annual frequency we adopt here and given also that many ex post unanticipated changes in the fiscal packages were implemented in Greece due to failure of previous plans and mid-course revisions, we believe the use of the random walk assumption here is well justified.

7 Further analysis

To gain a better insight into our results, we analyze below the role of changes in the (i) utility cost of migration and (ii) real wage in our model.

7.1 Utility cost of migration

In this subsection, we consider a positive shock to the utility cost of migration. An increase in migration costs could represent the case of anti-immigration policies implemented in the destination economy or repatriation policies implemented in the sending economy. We simulate the shock so that it induces a fall in stock of migrants of 1% (at peak) in the presence of the cross-border OTJ search (dashed-dotted lines). As can be seen in Figure 9, for the model with migration of the unemployed only (dashed lines), the economy experiences a GDP expansion, coming from an increase in consumption and investment demand. The return of migrants leads to a fall in the real wage and an increase in the unemployment rate. The boost

\[ \phi_u \left( (1 - s_t) u_t - (1 - s) u \right)^2, \]

is equal to zero at the steady state.\footnote{Notice that the other type of migration costs in the model (pecuniary costs), given by}
in demand and the fall in the real wage lead to an increase in labor demand (vacancies). As a result, employment rises. The increase in the pool of unemployed jobseekers reduces the job-finding rate in the economy. The household initially increases hours, given the increased costs of migration. However, the fall in the real wage and the job finding rate quickly reverses this response. The real exchange rate depreciates as the economy becomes more competitive with the fall in the real wage. The GDP expansion leads to an increase in the demand for imports, which is reflected in the fall of net exports.

With cross-border OTJ search (dashed-dotted lines), we observe a reduction in the OTJ search intensity and a higher return of migrants, which leads to a higher fall in the wage and a higher increase in internal demand, GDP and employment.

In sum, a higher utility cost of migration acts induces a boost in labor supply and aggregate demand, leading to a GDP expansion. At the same time, the shock tends to increase unemployment, but the effects appear very small.

7.2 Wage shock

Real wages play an important role in the migration decisions of the household. In the aftermath of the Great Recession, many peripheral countries of Europe experienced cuts in wages. For example, in Greece a 22% cut in the minimum monthly wage of 751 euros was legislated in 2012. In this subsection, we consider a fall in the domestic real wage, simulating the shock so that it induces (at peak) a 1% rise in the stock of migrants under cross-border OTJ search (dashed-dotted lines). As can be seen in Figure 10 for the model with migration of the unemployed only (dashed lines), an increase in the stock of migrants coming from a fall in the domestic wage induces an increase in vacancy posting and in employment. Consumption, investment and real GDP increase as well, while the unemployment rate is substantially reduced. Hence here emigration increases despite the fall in unemployment. The real exchange rate depreciates since labor costs are lower. With cross-border OTJ search (dashed-dotted lines), we observe negative effects on internal demand, GDP and employment relative to the model with migration of the unemployed only.

In sum, after a negative wage shock emigration increases despite the fall in unemployment.

8 Conclusions

This paper was motivated by the significant migration outflows from the periphery of Europe in search of employment, better pay and better social and economic prospects in the aftermath of the Great Recession. We endogenized migration decisions of the household both for its unemployed and employed members in a small open economy DSGE model with search
and matching frictions. Employed members migrate having secured a job abroad, while unemployed members migrate to continue their job search abroad. The government implements fiscal consolidation through cuts in public spending or labor income tax hikes.

We showed that migration reinforces business-cycle fluctuations. A TFP shock induces a return of migrant jobseekers, while an increase in the risk premium leads to an increase in migrant jobseekers abroad. Higher migration costs, which can capture the case of anti-immigration or repatriation policies, implies a higher labor supply domestically, which lowers the real wage, and a boost in aggregate demand, which induces an output expansion in the economy.

Regarding the interaction of migration with fiscal consolidation, our results indicated that a tax-based consolidation increases migration outflows, which exacerbates the induced GDP contraction. As a result, the unemployment gains from migration are only temporary. Tax hikes also lead to a persistent increase in the intensity with which current workers look for a job abroad. Taking into account the migration of the employed not only limits the short-run unemployment gains from migration but also reverses them substantially in the medium run due to a deeper demand contraction. Government spending cuts, on the other hand, have a non-monotonic impact on migration: initially outflows are higher due to the negative demand effect, while later this is reversed due to the wealth effect which decreases hours and increases the wage. As with tax hikes, taking into account the migration of the employed not only limits the short-run unemployment gains from migration but also reverses them in the medium run. However, government spending cuts, overall, have a relatively small impact on migration as this instrument impacts directly on aggregate absorption and does not deteriorate labor market conditions as strongly as tax hikes do.

This paper has compared the effects of tax-spending instruments used for debt consolidation in the presence of cross-country labor mobility. However, restrictions in new recruitment of public employees have also been important in the fiscal adjustment of peripheral countries, where the public sector is sizeable (e.g. Greece, Spain, Italy), and have led many graduates, who were previously absorbed in public sector jobs, to emigrate. Further work in this area could therefore look into the effects of public wage bill cuts in the presence of migration by adding a public sector to this model (see, e.g., Bandeira et al. (2018) and Bermperoglou et al. (2017)). Second, this paper has used a small open economy model, treating the foreign economy as exogenous. Future work could consider a two-country model, allowing to study the effect of global shocks affecting the foreign country too, as well as the effects of immigration on the host economy in line with recent empirical work (see, e.g., Furlanetto and Robstad (2017)). Third, another interesting extension could be to incorporate OTJ search and heterogenous workers in terms of skills (see e.g. Dolado et al. (2009)) in a model with
migration. Finally, even though the paper is motivated by the migration outflows of Europe’s periphery during the Great Recession, our model is general enough to study other cases too. For instance, according to recent figures from the U.K. Office for National Statistics, the highest level of EU emigration from Britain since the 2008 recession was recorded in 2017, following the Brexit referendum in 2016. We leave these topics for future research.

References


Figures

Figure 1: Net migration flows (outflows - inflows) from the periphery of Europe (in thousand persons)

Source: Eurostat

Figure 2: Emigration phases in Greek history (all ages)

Source: updated graph from Lazaretou (2016)
Figure 3: A 1% shock to TFP

Responses for interest rates and inflation are shown in annualized levels. Responses for the unemployment rate, job-finding rate, share of unemployed jobseeking abroad and net exports are in levels. All other responses are in percent deviations from steady state. OTJ denotes on the job and U rate (jbsk in H only) denotes a measure of the unemployment rate excluding the share of unemployed that look for a job abroad.
Figure 4: A shock to the risk premium (normalised to generate a 1% increase in the nominal interest rate)

Responses for interest rates and inflation are shown in annualized levels. Responses for the unemployment rate, job-finding rate, share of unemployed jobseeking abroad and net exports are in levels. All other responses are in percent deviations from steady state. OTJ denotes on the job and U rate (jbsk in H only) denotes a measure of the unemployment rate excluding the share of unemployed that look for a job abroad.
Figure 5: Tax-based consolidation

Responses for interest rates and inflation are shown in annualized levels. Responses for the unemployment rate, job-finding rate, share of unemployed jobseeking abroad and net exports are in levels. All other responses are in percent deviations from steady state. OTJ denotes on the job and U rate (jbsk in H only) denotes a measure of the unemployment rate excluding the share of unemployed that look for a job abroad. The black line in the Debt/GDP panel reports the path for the debt-to-GDP target.
Responses for interest rates and inflation are shown in annualized levels. Responses for the unemployment rate, job-finding rate, share of unemployed jobseeking abroad and net exports are in levels. All other responses are in percent deviations from steady state. OTJ denotes on the job and U rate (jbsk in H only) denotes a measure of the unemployment rate excluding the share of unemployed that look for a job abroad. The black line in the Debt/GDP panel reports the path for the debt-to-GDP target.

Figure 6: Spending-based consolidation
Figure 7: Comparison of instruments with migration

Responses for interest rates and inflation are shown in annualized levels. Responses for the unemployment rate, job-finding rate, share of unemployed jobseeking abroad and net exports are in levels. All other responses are in percent deviations from steady state. OTJ denotes on the job and U rate (jbsk in H only) denotes a measure of the unemployment rate excluding the share of unemployed that look for a job abroad. The black line in the Debt/GDP panel reports the path for the debt-to-GDP target.
Responses for the unemployment rate, net exports, and migration outflows (thousands persons) are in levels. For the fiscal instruments we show growth rates in percentage form relative to 2009. All other responses are in percent deviations from steady state. OTJ denotes on the job and U rate (jbsk in H only) denotes a measure of the unemployment rate excluding the share of unemployed that look for a job abroad.

Figure 8: Fiscal consolidation mix in Greece
Figure 9: A shock to the utility cost of migration

Responses for interest rates and inflation are shown in annualized levels. Responses for the unemployment rate, job-finding rate, share of unemployed jobseeking abroad and net exports are in levels. All other responses are in percent deviations from steady state. OTJ denotes on the job and U rate (jbsk in H only) denotes a measure of the unemployment rate excluding the share of unemployed that look for a job abroad.
Figure 10: A negative shock to the wage

Responses for interest rates and inflation are shown in annualized levels. Responses for the unemployment rate, job-finding rate, share of unemployed jobseeking abroad and net exports are in levels. All other responses are in percent deviations from steady state. OTJ denotes on the job and U rate (jbsk in H only) denotes a measure of the unemployment rate excluding the share of unemployed that look for a job abroad.
Appendix

1.1 First order conditions of the household problem

The household's Lagrangean can be written as:

\[ \mathcal{L} = \sum_{t=0}^{\infty} \left( \frac{(C_t - \zeta C_{t-1})^{1-\eta}}{1-\eta} - \Omega \left( \frac{m_{e,t}^{1+\mu}}{1+\mu} - \chi \left( \frac{h_{e,t}^{1+\xi} n_t + h_{e,t}^{1+\xi} n_{e,t}}{1+\xi} \right) \right) \right) 
\]

\[ -\lambda_{c,t} \left[ (1 + \tau^c) c_t + i_t + b_{g,t} + e_t r_{f,t-1} b_{f,t-1} + \phi_u (1 - s_t) u_t - (1 - s) u^2 \right) 
\]

\[ + (1 - \tau^n) w_t h_t n_t - b u_t - \left( r_k^k - \tau^k (r_k^k - \bar{\delta}) \right) x_t k_t - r_t b_{g,t} - \bar{e}_t b_{f,t} - \Pi^g_t - T_t 
\]

\[ + e_t \left( (1 + \tau^e) c_{e,t} - (1 - \tau^e) w_t h_{e,t} n_{e,t} \right) \]

\[ -\lambda_{k,t} \left[ k_{t+1} - \left( 1 - \frac{\omega}{2} \left( \frac{i_t}{i_{t-1}} - 1 \right) \right) i_t - \left( 1 - \bar{\delta} (x_t)^c \right) k_t \right] \]

\[ -\lambda_{n,t} \left[ n_{t+1} - (1 - \sigma) n_t - \psi_H n_t \right] \]

\[ -\lambda_{e,t} \left[ n_{e,t+1} - (1 - \sigma^*) n_{e,t} - \psi_{H,t} (1 - s_t) u_t \right] \]

We assume external habits in consumption, meaning that \( C_{t-1} \) is taken as given in period \( t \). Note that \( m_{e,t} = n_{e,t} + (1 - s_t) u_t \). The choice variables comprise \( c_t, k_{t+1}, i_t, x_t, b_{g,t}, b_{f,t}, n_{t+1}, n_{e,t+1}, h_t, \) and \( s_t \), and the corresponding first order conditions are the following:

\[ c_t : \]

\[ \lambda_{c,t} (1 + \tau^c) = \left( C_t - \zeta C_{t-1} \right)^{-\eta} \] \hspace{1cm} (45)

\[ k_{t+1} : \]

\[ \lambda_{k,t} = \beta \lambda_{c,t+1} \left[ r_{t+1}^k - \tau^k (r_{t+1}^k - \delta_{t+1}) \right] x_{t+1} + \beta \lambda_{k,t+1} (1 - \delta_{t+1}) \] \hspace{1cm} (46)

\[ i_t : \]

\[ \lambda_{c,t} - \lambda_{k,t} \left\{ 1 - \frac{\omega}{2} \left( \frac{i_t}{i_{t-1}} - 1 \right) \right\} ^2 - \omega \left( \frac{i_t}{i_{t-1}} - 1 \right) = \beta \lambda_{k,t+1} \omega \left( \frac{i_{t+1}}{i_t} \right) \left( \frac{i_{t+1}}{i_t} \right)^2 \] \hspace{1cm} (47)

\[ x_t : \]

\[ \lambda_{k,t} \tilde{\delta} (x_t)^{c-1} = \lambda_{c,t} \left\{ r_t^k - \tau^k (r_t^k - (1 + t) \delta_t) \right\} \] \hspace{1cm} (48)
\[ b_{g,t+1} : \quad 1 = \beta \frac{\lambda_{c,t+1}}{\lambda_{c,t}} r_{t} \] (49)

\[ b_{f,t+1} : \quad 1 = \beta \frac{\lambda_{c,t+1}}{\lambda_{c,t}} \frac{e_{t+1}}{e_{t}} r_{f,t} \] (50)

\[ n_{t+1} : \quad \frac{\lambda_{n,t}}{\beta} = \lambda_{c,t+1} (1 - \tau^{n}) w_{t+1} h_{t+1} - \chi \frac{h_{t+1}^{1+\xi}}{1+\xi} + \lambda_{n,t+1} (1 - \sigma) \] (51)

\[ n_{e,t+1} : \quad \frac{\lambda_{e,t}}{\beta} = \lambda_{c,t+1} (1 - \tau^{n^{*}}) e_{t} w_{t+1}^{*} h_{e,t+1} - \chi \frac{h_{e,t+1}^{1+\xi}}{1+\xi} - \Omega (m_{e,t+1})^{\mu} + \lambda_{e,t+1} (1 - \sigma^{*}) \] (52)

\[ s_{t} : \quad \lambda_{e,t} \psi_{H,t}^{*} = \lambda_{n,t} \psi_{H,t} + \lambda_{c,t} [\phi u ((1 - s_{t}) u_{t} - (1 - s) u)] \] (53)

\[ h_{t} : \quad \chi \frac{h_{t}^{\xi}}{\lambda_{c,t}} = (1 - \tau^{n}) p_{x,t} (1 - \phi) (1 - \phi) \frac{y_{t}}{n_{t} h_{t}} \] (54)

1.2 Derivation of worker’s and firm’s surpluses

The surplus for workers consists of the asset value of employment net of the outside option (value of being unemployed). The former is denoted by \( V_{e,t}^{H} \) and is given by:

\[ V_{e,t}^{H} = -\chi \frac{h_{t}^{1+\xi}}{\lambda_{c,t} 1 + \xi} + (1 - \tau^{n}) w_{n,t} h_{t} + E_{t} \beta_{t+1} \left\{ (1 - \sigma) V_{t+1}^{E} + \sigma V_{t+1}^{U} \right\} \]

where \( w_{n,t} h_{t} \) denotes the wage income as an outcome of the Nash bargaining and \( V_{u,t}^{H} \) denotes the value of being unemployed at Home and is given by:

\[ V_{u,t}^{H} = b + E_{t} \beta_{t+1} \left\{ \psi_{H,t} V_{e,t+1}^{H} + (1 - \psi_{H,t}) V_{u,t+1}^{H} \right\} \]
Hence, the worker’s surplus, $S^H_t = V^E_t - V^U_t$, is given by:

$$S^H_t = (1 - \tau^n) w_{n,t} h_t - \chi \frac{h_t^{1+\xi}}{\lambda_{c,t}} + (1 - \sigma - \psi_{H,t}) E_t \beta_{t+1} S^H_{t+1}$$

The assumption that when an emigrant loses her job she joins the pool of emigrant jobseekers is rather innocuous since in equilibrium, arbitrage implies that $V^H_{u,t} = V^F_{u,t} = V_{u,t}$ for all $t$. This arbitrage condition is derived from the optimality conditions of the household with respect to $s_t$.

For the firm, the surplus from a match is given by:

$$S_{f,t} = (1 - \phi) \frac{p_{x,t} y_t}{n_t} - w_{n,t} h_t + (1 - \sigma) E_t \beta_{t+1} S_{f,t+1}$$

which, using (18), can be written as:

$$S_{f,t} = (1 - \phi) \frac{p_{x,t} y_t}{n_t} - w_{n,t} h_t + (1 - \sigma) \frac{\kappa}{\psi_{F,t}}$$

Inserting the two surpluses into the splitting rule $(1 - \vartheta) (1 - \tau^n) S_{f,t} = \vartheta S^H_{h,t}$ and solving for $w_{n,t} h_t$ yields:

$$w_{n,t} h_t = (1 - \vartheta) \left\{ p_{x,t} (1 - \phi) \frac{y_t}{n_t} + \frac{\psi_{H,t}}{\psi_{F,t}} \kappa \right\} + \vartheta \left\{ b + \chi \frac{h_t^{1+\xi}}{\lambda_{c,t}} \right\}$$

### 1.3 Additional figures
Figure 11: A 1% shock to government spending

Responses for interest rates and inflation are shown in annualized levels. Responses for the unemployment rate, job-finding rate, share of unemployed jobseeking abroad and net exports are in levels. All other responses are in percent deviations from steady state. OTJ denotes on the job and U rate (jbsk in H only) denotes a measure of the unemployment rate excluding the share of unemployed that look for a job abroad.
Responses for interest rates and inflation are shown in annualized levels. Responses for the unemployment rate, job-finding rate, share of unemployed jobseeking abroad and net exports are in levels. All other responses are in percent deviations from steady state. OTJ denotes on the job and U rate (jbsk in H only) denotes a measure of the unemployment rate excluding the share of unemployed that look for a job abroad. The black line in the Debt/GDP panel reports the path for the debt-to-GDP target.
Figure 13: Comparison of instruments with on-the-job search abroad

Responses for interest rates and inflation are shown in annualized levels. Responses for the unemployment rate, job-finding rate, share of unemployed jobseeking abroad and net exports are in levels. All other responses are in percent deviations from steady state. OTJ denotes on the job and U rate (jbsk in H only) denotes a measure of the unemployment rate excluding the share of unemployed that look for a job abroad. The black line in the Debt/GDP panel reports the path for the debt-to-GDP target.