

**SHOULD I STAY OR SHOULD I GO?  
AUSTERITY, UNEMPLOYMENT  
AND MIGRATION**

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# SHOULD I STAY OR SHOULD I GO? AUSTERITY, UNEMPLOYMENT AND MIGRATION <sup>(\*)</sup>

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## **Abstract**

High unemployment and fiscal austerity during the Great Recession have led to significant migration outflows in those European countries that suffered a deep deterioration of their economy, Greece being the most obvious case. This paper introduces endogenous migration in a small open economy DSGE model to analyze the business cycle effects from the interaction of fiscal consolidation instruments with migration. A tax-based consolidation induces the strongest increase in emigration, leading to the highest costs in terms of aggregate GDP and unemployment in the medium run. As a result, the unemployment gains from migration are only temporary. However, in terms of per capita GDP, cuts in the components of public spending that are either productive or utility-enhancing can lead to a deeper contraction than tax hikes or wasteful spending cuts. The introduction of potential migration by the employed implies even higher unemployment costs, a deeper demand contraction, and an increase in both the tax hike and the time required to achieve the same size of fiscal consolidation.

**Keywords:** fiscal consolidation, migration, matching frictions, on-the-job search.

**JEL classification:** E32, F41.

## Resumen

La elevada tasa de paro y la austeridad fiscal durante la Gran Recesión han provocado importantes movimientos migratorios procedentes de los países europeos que sufrieron un profundo deterioro de su economía, siendo Grecia el caso más obvio. En este trabajo se introduce una decisión endógena sobre migración en un modelo DSGE aplicado a una economía abierta pequeña para así poder analizar los efectos sobre el ciclo económico que surgen de la interacción entre los instrumentos de consolidación fiscal y la migración. Una consolidación basada en impuestos sobre el trabajo genera los mayores aumentos en la emigración, lo que conlleva costes más altos en términos de PIB agregado y desempleo en el medio plazo. Así pues, las ganancias en términos de desempleo ocasionadas por la existencia de migración son solo temporales. Sin embargo, en términos del PIB per cápita, recortes en los componentes del gasto público, ya sea éstos productivos o que proporcionen utilidad directamente, pueden provocar una contracción más profunda que los aumentos de impuestos o los recortes en el gasto público no productivo o que no genere utilidad. La introducción de la posibilidad de migración por parte de los individuos empleados genera costes asociados al desempleo aún más altos, una mayor contracción de la demanda y un aumento tanto de los impuestos como del tiempo requerido para lograr el mismo volumen de consolidación fiscal.

**Palabras clave:** consolidación fiscal, migración, fricciones de emparejamiento en el mercado laboral, búsqueda de trabajo por parte de los individuos empleados.

**Códigos JEL:** E32, F41.

*Nearly half a million Greeks have become economic migrants since the crisis began, one of the biggest exoduses from any eurozone country. And they are still leaving.*

(New York Times, June 5, 2018: Greece May Be Turning a Corner. Greeks Who Flew Are Staying Put.)

## 1 Introduction

Worsening labour 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). 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.<sup>1</sup> For instance, Greece and Spain exhibited net migration outflows in 2013, representing 2.2% and 1.9% of the workforce, respectively (Lazaretou (2016)). Over the period 2010-2015, 533,000 Greek residents of working age (15-64) left the country in search of employment, better pay and better social and economic prospects (see also Figure 2).<sup>2</sup> 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 persons per year, which is, both in absolute and relative terms, the highest level of emigration in Spanish history.<sup>3</sup> The goal of this paper is twofold. First, we study the macroeconomic consequences of migration and the implications for business cycle fluctuations in the country of departure. Second, we shed light on the interaction between fiscal consolidation and endogenous migration decisions.

Although mobility in response to disparate labour 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, labour 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 hire new workers but also face a shortage of labour. For instance, Labrianidis and Pratsinakis (2016) report that half of those leaving Greece after 2010 were employed at the

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<sup>1</sup>Prior to the crisis, immigration from new member states of the EU or from outside the block contributed to migration surpluses in peripheral countries.

<sup>2</sup>In 2014, the unemployment rate in Greece rose to 28%, more than triple that of 2008, with a profound impact on the mobility decisions of the Greek people, previously considered among the least favorable Europeans towards long distance mobility (Commission (2006)). The total estimate of 612,400 emigrants in Figure 2 refers to all age groups, emigrants according to data from the Hellenic Statistical Authority (ELSTAT). Beyer and Smets (2015) have found a gradual convergence in labour mobility between Europe and the US, reflecting both a fall in interstate migration in the US and a rise in the role of migration in Europe.

<sup>3</sup>This figure is comparable to the average annual immigrant flow of 485,000 persons in Spain during the immigration boom of 2000-2006 (Bentolila et al. (2008)). The recent emigration wave 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 were 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 US and Australia seem to be the next most popular destinations, followed by several other European destinations (Labrianidis and Pratsinakis (2016)).

time of emigration.<sup>4</sup> Second, migrants take with them not only their labour 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.<sup>5</sup> 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. Farhi and Werning (2014) show that emigration can reduce labour supply to meet a demand shortfall in the non-tradable sector, leaving stayers in an unchanged situation. Emigration can also lead to an increase in external demand. However, in most typical cases with lower trade integration, the increase in external demand might not compensate for the fall in internal demand.

Notably, labour mobility also has fiscal consequences with the emigration of net payers posing a challenge to the public treasury (Borjas et al. (2018)). Out-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.

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 (SOE) 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. The model therefore features cross-border on-the-job search. Searching for foreign jobs is subject to a pecuniary cost, whereas living abroad entails a utility cost. Apart from supplying labour, migrants pay taxes, buy the foreign consumption good and send remittances to the country of origin. We calibrate our model for the Greek economy, which has exhibited significant migration outflows and has experienced the implementation of a sizeable fiscal consolidation program. It thus seems a natural choice to discipline our model.<sup>6</sup>

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<sup>4</sup>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) and Labrianidis and Pratsinakis (2016)).

<sup>5</sup>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 the Greek emigration 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)).

<sup>6</sup>Greece emerged in August 2018 from three consecutive bailouts, totalling around €290 billion in loans from its European partners and the International Monetary Fund, to tackle its debt crisis. This has been the biggest bailout in global financial history. Austerity measures, such as tax hikes and cuts in public spending, were a condition of the bailout.

We first investigate the importance of the migration channel over the business cycle through the dynamic responses of our model to a negative TFP shock and a risk premium shock. To this end, we perform a comparison to a benchmark version of the model without migration. We find that a negative TFP shock or a risk premium shock increases the search abroad of unemployed job seekers, which has a positive impact on short-run unemployment, but also reinforces the negative effects of the shock on consumption. Over time, as the impact of the shock fades out and the job-finding rate returns towards its steady-state level, we observe some return migration, which leads to higher unemployment costs in the medium run, relative to the no-migration scenario. The presence of the job search abroad of current workers in the model, and therefore the potential emigration of the employed, reinforces the fall in consumption, mitigates the short-run unemployment gains from migration and reinforces unemployment costs over time. The mitigation of the short-run unemployment gains is due to the fact that the exodus of current workers with successful matches abroad leads firms to cut vacancies by less, mitigating therefore the search abroad for unemployed job seekers, while the reinforcement of the unemployment costs over time comes from the strongest contraction in consumption and employment.

We then perform a positive analysis of the economic consequences of migration during fiscal consolidation episodes by examining the effects on output and unemployment. In particular, we study fiscal consolidations implemented via increases in labour income tax rates or cuts in public expenditures. For the latter we consider various possible roles, namely wasteful, utility-enhancing and productive. 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 induces the highest increase in the emigration of both the unemployed and employed, which implies an increase in the tax hike required to achieve a given size of debt reduction relative to the no-migration scenario and exacerbates the induced GDP contraction. As a result, the unemployment gains from migration for the stayers are only temporary. In the medium run, labour tax hikes lead to the biggest fall in aggregate GDP and increase in unemployment. However, in terms of *per capita* GDP, cuts in the components of public spending that are either productive or utility-enhancing lead to a much deeper contraction than tax hikes or wasteful spending cuts. Government spending cuts have a non-monotonic impact on migration: initially outflows increase due to the negative demand effect, while later this is reversed due to the positive wealth effect, which decreases household's labour supply and increases the wage. Both in the case of tax hikes and spending cuts, the introduction of potential migration by the employed limits further the short-run unemployment gains from migration and reinforces the unemployment increase over time. We also perform simulations for the actual fiscal consolidation mix implemented in Greece over the period 2009-2015 in a macroeconomic environment proxied by a negative investment shock and a risk premium shock. We show that the model is able to match well the size and composition of migration outflows in Greece over the period under examination.

The two main results of the paper have important policy implications. First, we show that labour income tax hikes and government spending cuts lead to different outcomes in terms of net migration. The choice of the fiscal instrument for debt consolidation therefore matters if policymakers want to avoid an exodus of workers from the country undergoing fiscal adjustment. Specifically, a tax-based consolidation increases significantly migration outflows, while the effect of spending-based consolidation is non-monotonic due to the opposite forces of the negative demand effect and the positive wealth effect. This then implies that while tax hikes are the most harmful consolidation instrument in terms of *aggregate* output, cuts in the components of public spending that are either productive or utility-enhancing may be even more detrimental for *per capita* GDP. Second, we show that unemployment gains from migration are only temporary following an adverse business-cycle shock or a fiscal consolidation shock. Moreover, these short-run gains are reversed over time, and even more so when we consider also the migration of the employed. Even though in the case of business-cycle shocks and spending consolidation there is some return migration in the medium run, as mentioned above, in the case of tax-based consolidation the situation is different. The increase, relative to the migration scenario, in the tax rate required to achieve a given size of debt reduction leads to a deeper demand contraction, which offsets the unemployment gains from the reduction in labour supply. Cross-country labour mobility is therefore a weak and temporary shock absorber in this case, hurting the economy in the long run. This result delivers a second message for policy makers, namely that if tax hikes are implemented, it is very important to provide motives so that employed workers do not flee the country.

Our paper adds to the literature on the macroeconomic effects of migration by exploring the fiscal and business-cycle implications of endogenous labour force outflows in a SOE implementing debt consolidation. We therefore depart from existing studies that examine the implications of migration for the destination economy using models with labour market frictions in a static framework (see, e.g., Ortega (2000); Liu (2010); Chassamboulli and Palivos (2014); Chassamboulli and Peri (2015); Liu et al. (2017); Battisti et al. (2018); and Iftikhar and Zaharieva (2018)) by disentangling the dynamic effects on the country of origin.<sup>7</sup> In the tradition of papers on the impact of immigrants on host labour markets, the stock of migrants is generally taken as an exogenous variable or immigration is modeled on the basis of a reduced form approach, whereas in our setup the migration of both the unemployed and the employed occurs endogenously, which allows us to explore this channel in the face of shocks and policy actions. A link can also be established with previous studies featuring on-the-job search in RBC models (see, e.g., Dolado et al. (2009); Krause and Lubik (2006) and Tüzemen (2017)) but without migration. Finally, the paper contributes to the theoret-

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<sup>7</sup>There is very little work so far on migration using macro models with labour market frictions in dynamic setting (see, e.g., Braun and Weber (2016), Kiguchi and Mountford (2018), and Lozej (2018)). For macroeconomic models of migration without labour market frictions, see among others Storesletten (2000), Canova and Ravn (2000), Mandelman and Zlate (2012), Farhi and Werning (2014), Hauser (2017), and Smith and Thoenissen (2018). For recent empirical studies, see, e.g., Dustmann and Frattini (2014), Furlanetto and Robstad (2017), d'Albis et al. (2018).

ical literature on the effects of fiscal consolidation (see, e.g., Erceg and Lindé (2012); Erceg and Lindé (2013); Pappa et al. (2015); Philippopoulos et al. (2017); Bandeira et al. (2018)), which has considered an immobile labour force, by studying the interaction between fiscal consolidation and migration.

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 contain our results. Finally, Section 6 concludes the paper.

## 2 A Small Open Economy Model with Migration

Our model introduces labour force mobility in a standard SOE model with search and matching frictions, sticky prices, and lack of monetary policy independence. The SOE is labeled Home. We consider in our calibration a scenario in which higher wages and more employment opportunities exist abroad than in Home. Hence, when we introduce endogenous migration decisions in the model, unemployed job seekers from Home will have an incentive to migrate abroad. Current workers may also have an incentive to migrate given higher wages and better fiscal conditions abroad. Apart from supplying labour, migrants pay taxes and consume part of their income abroad.

Home nationals are part of a representative household. In terms of their labour market status, household members can be employed or unemployed and participate in the domestic and the foreign labour markets.<sup>8</sup> Searching for foreign jobs is subject to a pecuniary cost, whereas living abroad entails a utility cost (see, e.g., Hauser (2017)). Together with labour supply decisions (hours), consumption and savings are defined at the household level.<sup>9</sup> On the production side, following standard practice in the literature (see, e.g., Trigari (2006) and 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 labour 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 labour market frictions occur in the sector producing intermediate goods. The government collects taxes and issues debt to finance public expenditure, lump-sum transfers, and the provision of unemployment benefits. Initially, we will treat public spending as a waste. We will then consider additional roles for public expenditure, namely productive and utility-enhancing spending, in Section 5.4. Implementation of debt consolidation occurs through labour income tax hikes or public spending cuts.

In what follows below, the asterisk  $\star$  denotes foreign variables or parameters. We treat foreign variables as exogenous and therefore omit the time subscript. All quantities in the model are in aggregate terms, but we also present responses of per capita variables in the results that follow.

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<sup>8</sup>As discussed in Section 5.5, introducing endogenous labour force participation does not alter substantially our results. The main impact is that fiscal consolidation leads to a decrease in labour force participation (positive wealth effect) and therefore in the short-run unemployment rate. Keeping this out of our analysis allows us to isolate the effect of migration on unemployment.

<sup>9</sup>See Andolfatto (1996) for an application of the big household assumption in a framework with labour-market search.

## 2.1 Home

### 2.1.1 Nationals, Residents and Migrants

We assume a continuum of identical households of mass one. In what follows we will refer to the representative household. The total number of Home *nationals* of the representative household 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* abroad, with the latter varying over time either due to new arrivals or due to returns back to Home. Denoting by  $N_t$  the resident population and by  $n_{e,t}$  the stock of emigrant workers from Home, total Home nationals are given by

$$\bar{n} = N_t + n_{e,t}. \quad (1)$$

At any point in time, Home residents are either employed  $n_t$  or unemployed job seekers  $u_t$ ,

$$N_t = n_t + u_t. \quad (2)$$

Among the unemployed job seekers  $u_t$ , a share  $1 - s_t$  are searching in the domestic labour market, while the remaining  $s_t$  are looking for jobs abroad. Those who seek jobs abroad face an individual pecuniary cost  $\varsigma(\tilde{s}_t)$ , where  $\tilde{s}_t$  is the average share of unemployed looking for jobs abroad per household and  $\varsigma'(\tilde{s}_t) > 0$ .<sup>10</sup> This endogenous cost function (see Section 3 for the specific functional form) helps to smooth out migration decisions in the model, putting a brake to the search abroad of the unemployed. In the domestic labour market, jobs are created through a matching function of the following form:

$$m_t = \mu_1 (v_t)^{\mu_2} ((1 - s_t) u_t)^{1-\mu_2}, \quad (3)$$

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.<sup>11</sup> We define the probabilities of a job seeker to be hired  $\psi_{H,t}$  and of a vacancy to be filled  $\psi_{F,t}$  as follows:

$$\psi_{H,t} \equiv \frac{m_t}{(1 - s_t) u_t} \quad \text{and} \quad \psi_{F,t} \equiv \frac{m_t}{v_t}.$$

Those currently employed in the domestic labour market  $n_t$  can exert effort  $z_t$  in searching for a job abroad where better labour market and fiscal conditions exist. The higher the search intensity, the higher the probability to be matched with a job abroad in the next

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<sup>10</sup>Superscript ' denotes first derivative.

<sup>11</sup>A natural question is whether migration precedes search or search precedes migration. Given the possibility of search for foreign jobs via the internet, we consider here the case in which the unemployed and the employed move abroad with a job in hand. However, we can obtain similar results if we assume instead that (i) unemployed first relocate and then are matched and (ii) there is contemporaneous timing in matching. For remote search and migration, see also Kaplan and Schulhofer-Wohl (2017).

period. We denote by  $\varphi(z_t)$  the productivity of on-the-job search effort measured in terms of the probability of finding a job abroad. Searching while employed is subject to a pecuniary cost  $\phi(z_t)$ , measured in units of the final good. We assume that  $\varphi'(z_t) > 0$  and  $\phi'(z_t) > 0$ , with  $\frac{\varphi'(z_t)}{\varphi(z_t)} < \frac{\phi'(z_t)}{\phi(z_t)}$  such that on-the-job search effort is effectively costly (see, e.g., Krause and Lubik (2006) and Tüzemen (2017)). The law of motion of employed workers in Home is given by

$$n_{t+1} = (1 - \sigma - \psi_H^* \varphi(z_t)) n_t + \psi_{H,t} (1 - s_t) u_t, \quad (4)$$

where  $\sigma$  denotes the exogenous separation rate and  $\psi_H^* \varphi(z_t)$  accounts for those workers that move abroad to join the measure of employed migrants.<sup>12</sup>

The law of motion for emigrant employment  $n_{e,t}$  is then given by

$$n_{e,t+1} = (1 - \sigma^*) n_{e,t} + \psi_H^* (s_t u_t + \varphi(z_t) n_t). \quad (5)$$

where for simplicity we assume that the job finding probability abroad for Home unemployed and employed is equal.

### 2.1.2 Households

The representative household consists of a continuum of infinitely lived agents. The household derives utility from a consumption bundle  $C_t$ , composed of goods purchased by Home residents  $c_t$  and by emigrants  $c_{e,t}$ ,

$$C_t = c_t + c_{e,t}, \quad (6)$$

where  $c_{e,t}$  is determined through (9) below.

To keep with the representative household framework, we assume that all agents pool consumption risk perfectly (for macro-labour models with migration and a representative agent, see, e.g., Kaplan and Schulhofer-Wohl (2017), Mandelman and Zlate (2012), Davis et al. (2014), and Binyamini and Razin (2008)). The household also suffers disutility from having members working abroad  $n_{e,t}$  and from hours worked at home and abroad,  $h_t$  and  $h_e$ , respectively. The instantaneous utility function is given by

$$U(C_t, h_t, n_t, n_{e,t}) = \frac{(C_t - \zeta \tilde{C}_t)^{1-\eta}}{1-\eta} - \chi \frac{h_t^{1+\xi} n_t + h_e^{1+\xi} n_{e,t}}{1+\xi} - \Omega \frac{(n_{e,t})^{1+\mu}}{1+\mu}, \quad (7)$$

where  $\eta$  is the inverse of the intertemporal elasticity of substitution,  $\zeta$  is the parameter determining external habits in aggregate consumption where the consumption reference is

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<sup>12</sup>Focusing on cross-country rather than within-country wage differentials, we abstract from on-the-job search domestically, which would require modeling market segmentation. We will calibrate the model below to Greece where the job-to-job transition probability is low, amounting to 5% (Garda (2016), Figure 6A), and was even lower during the Great Recession (see section 4.3 in Casado et al. (2015)).

taken as given by the household, with  $C_t = C_{t-1}$  in equilibrium. The strictly positive parameters  $\Omega$ ,  $\chi$ ,  $\mu$  and  $\xi$  are associated with the disutility from hours worked and from living abroad. The disutility from having family members abroad captures notions such as different culture, food, habits; distance from relatives and friends; less dense networks; difficulties experienced with bureaucracy and integration, as well as families ties between the migrant and the non-migrant members of the household.<sup>13</sup> Hours worked in Home  $h_t$  are determined through negotiation over the joint surplus of workers and firms (see below), while hours worked abroad  $h_e$  are taken as exogenous.

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

$$(1 + \tau^c) c_t + i_t + b_{g,t} + e_t r_{f,t-1} b_{f,t-1} + \varsigma(\tilde{s}_t) s_t u_t + \phi(z_t) n_t \leq (1 - \tau_t^n) w_t h_t n_t + [r_t^k - \tau^k (r_t^k - \delta_t)] x_t k_t + r_{t-1} b_{g,t-1} + e_t b_{f,t} + e_t \Xi_t + b u_t + \Pi_t^p + T_t, \quad (8)$$

where  $\varsigma(\tilde{s}_t) s_t u_t$  and  $\phi(z_t) n_t$  are the total costs of search for jobs abroad for the unemployed and the employed, respectively,  $w_t$  is the hourly wage,  $r_t^k$  is the return on effective capital,  $b$  denotes unemployment benefits,  $e_t$  is the real exchange rate, and  $\Pi_t^p$  are profits from monopolistic retailers. The depreciation rate of capital is  $\delta_t$  and the degree of capital utilization is  $x_t$ . Lump-sum transfers and tax rates on private consumption, private capital, and labour income are given by  $T_t$ ,  $\tau^c$ ,  $\tau^k$ ,  $\tau_t^n$ , respectively. Government bonds are denoted by  $b_{g,t}$ , and pay the return  $r_t$ , while  $b_{f,t}$  denote liabilities with the rest of the world with return  $r_{f,t}$ .<sup>14</sup> Migrants' labour income is spent on purchases of goods abroad  $c_{e,t}$  and remittances sent to Home, denoted by  $e_t \Xi_t$  (in units of the Home final good),

$$\Xi_t + (1 + \tau^{c*}) c_{e,t} = (1 - \tau^{n*}) w^* h_e n_{e,t}. \quad (9)$$

Following Mandelman and Zlate (2012), we assume a remittances rule of the following form:

$$\Xi_t = \varrho \left( \frac{(1 - \tau^{n*}) w^*}{(1 - \tau_t^n) w_t} \right)^{\rho_\Xi}. \quad (10)$$

The rationale behind (10) is that remittances represent an altruistic compensation mechanism between migrant and domestic workers. In other words, assuming  $\rho_\Xi > 0$ , a relative improvement in the net wage premium abroad leads to an increase in remittances. Purchases

<sup>13</sup>Including the utility cost of migration, in addition to the pecuniary costs of job search abroad, is useful in smoothing out migration decisions when we study the case of labour income tax hikes, which is the instrument that leads to the strongest increase in migration outflows. Without this utility cost, pecuniary costs would have to be unrealistically high in the simulations we perform in Section 5.5.

<sup>14</sup>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 peripheral countries of Europe (See Figure 1 in Brutti and Sauré (2016)), supported by the secondary market theory of Broner et al. (2010).

of goods abroad  $c_{e,t}$  is therefore modelled as the residual of the budget constraint of migrants once remittances are chosen (see also Mandelman and Zlate (2012)).<sup>15</sup>

The household owns the capital stock, which evolves according to

$$k_{t+1} = \epsilon_{i,t} \left[ 1 - \frac{\omega}{2} \left( \frac{i_t}{i_{t-1}} - 1 \right)^2 \right] i_t + (1 - \delta_t) k_t, \quad (11)$$

where  $i_t$  is private investment,  $\epsilon_{i,t}$  denotes an investment efficiency shock, which will be present in our simulations later on (see Section 5.5), 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

$$\delta_t = \bar{\delta} x_t^\iota, \quad (12)$$

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

Given that  $h_e$  is exogenous,  $c_{e,t}$  is determined through (9) and  $h_t$  is determined through negotiation over the joint surplus of workers and firms (see below), the problem of the household is to choose  $c_t$ ,  $k_{t+1}$ ,  $i_t$ ,  $x_t$ ,  $b_{g,t}$ ,  $b_{f,t}$ ,  $n_{t+1}$ ,  $n_{e,t+1}$ ,  $s_t$ ,  $z_t$  to maximize expected lifetime utility subject to the budget constraint, the laws of motion of resident and migrant employment, taking the probability of finding a job in Home and abroad 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 Online Appendix and focus here on those that determine job seeking and migration.<sup>16</sup> 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, (4) and (5), the first order conditions with respect to  $n_{t+1}$ ,  $n_{e,t+1}$ ,  $s_t$  and  $z_t$  are given by

$$\begin{aligned} \lambda_{n,t} = & \beta \left[ \lambda_{c,t+1} \left( (1 - \tau_t^n) w_{t+1} h_{t+1} - b - \phi(z_{t+1}) \right) - \chi \frac{h_{t+1}^{1+\xi}}{1+\xi} \right] \\ & + \beta \left[ \lambda_{n,t+1} (1 - \sigma - \psi_{H,t+1} - \psi_H^* \varphi(z_{t+1})) + \lambda_{e,t+1} \psi_H^* \varphi(z_{t+1}) \right], \end{aligned} \quad (13)$$

$$\begin{aligned} \lambda_{e,t} = & \beta \left[ \lambda_{c,t+1} \left( (1 - \tau^{n*}) e_{t+1} w^* h_e - b + \varsigma(\tilde{s}_{t+1}) \right) - \chi \frac{h_e^{1+\xi}}{1+\xi} - \Omega(n_{e,t+1})^\mu \right] \\ & + \beta \left[ \lambda_{e,t+1} (1 - \sigma^* - \psi_H^*) \right], \end{aligned} \quad (14)$$

<sup>15</sup>We abstract from endogenizing the allocation of 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 migrants as separate optimizing agents. Given that remittances have increased much less than recent migration outflows from Europe's periphery, as emphasized in the Introduction, endogenizing such choice is outside the scope of our paper.

<sup>16</sup>The Online Appendix is available at <http://pareto.uab.es/jcaballe/Papers/MigrationOnlineAppendix.pdf>.

$$\psi_H^* \lambda_{e,t} - \lambda_{c,t} \zeta(\tilde{s}_t) = \lambda_{n,t} \psi_{H,t}, \quad (15)$$

$$\lambda_{c,t} \frac{\phi'(z_t)}{\varphi'(z_t)} = \psi_H^* (\lambda_{e,t} - \lambda_{n,t}). \quad (16)$$

Equations (13) and (14) determine the evolution of the value of being employed in Home and abroad, 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, where the latter is adjusted for the costs of searching abroad, minus the disutility from supplying hours and, for the case of equation (14), from having members abroad, plus the continuation value of the match.<sup>17</sup> The latter is the expected value of continuing with the job without experiencing an exogenous separation, net of the value foregone because workers are not simultaneously job seeking, which is captured in equations (13) and (14) by  $\psi_{H,t+1}$  and  $\psi_H^*$  respectively. Equation (13) also accounts for the fact that with probability  $\psi_H^* \varphi(z_{t+1})$  a current worker will quit to take up a job abroad.<sup>18</sup> Equation (15) shows that, at the margin, the value of job seeking 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. Finally, condition (16) states that, in equilibrium, the marginal costs of on-the-job 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 abroad. The higher this differential, the higher is the optimal level of on-the-job search.<sup>19</sup>

### 2.1.3 Intermediate goods firms

Intermediate goods are produced with a Cobb-Douglas technology,

$$y_t = A_t (h_t n_t)^{1-\alpha} (x_t k_t)^\alpha, \quad (17)$$

where  $k_t$  and  $n_t$  are capital and labour inputs,  $x_t$  is the degree of capital utilization, and  $A_t$  is an exogenous stationary TFP process.<sup>20</sup>

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  $v_t$  posted in the current period, so as to employ the desired number of workers  $n_{t+1}$  in the next period. For firms, the law of motion of employment is given by

<sup>17</sup>Note that a new match becomes productive next period.

<sup>18</sup>The Online Appendix includes the full derivation of equations (13) and (14). It is shown that the value of being employed in Home or abroad includes the full foregone value of being unemployed, which in turn consists of the value of the unemployment benefit and the value of being matched to a job.

<sup>19</sup>In the scenarios we analyze below, we only consider cases where  $\lambda_e > \lambda_n$  is true in the steady state.

<sup>20</sup>Note that without the assumption of variable capital utilization all factors of production would be predetermined, meaning that output cannot adjust on impact in response to shocks.

$$n_{t+1} = (1 - \sigma - \psi_H^* \varphi(z_t)) n_t + \psi_{F,t} v_t,$$

which is equivalent to (4). Firms also decide the amount of effective capital  $x_t k_t$  to be rented from the household at rate  $r_t^k$ . The problem of an intermediate firm with  $n_t$  workers currently employed can be written as

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

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 effective capital and vacancies are

$$r_t^k = \alpha \frac{p_{x,t} y_t}{x_t k_t}, \quad (18)$$

and

$$\frac{\kappa}{\psi_{F,t}} = E_t \beta_{t+1} \left[ (1 - \alpha) \frac{p_{x,t+1} y_{t+1}}{n_{t+1}} - w_{t+1} h_{t+1} + (1 - \sigma - \psi_H^* \varphi(z_{t+1})) \frac{\kappa}{\psi_{F,t+1}} \right]. \quad (19)$$

According to (18) and (19), 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 labour minus the wage plus the continuation value, knowing that with probability  $\sigma$  the match can be destroyed and that a termination can also occur due to cross-border job matches captured by  $\psi_H^* \varphi(z_{t+1})$ .

#### 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  $(1 - \vartheta)(1 - \tau_t^n) S_t^F = \vartheta S_t^H$ , where  $S_t^H$  denotes the worker's surplus from a match in Home and  $S_t^F$  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 Online Appendix, the worker's surplus from a match in Home can be written as

$$\begin{aligned} S_t^H &= (1 - \tau_t^n) w_t h_t - b - \frac{\chi}{\lambda_{c,t}} \frac{h_t^{1+\xi}}{1+\xi} - \phi(z_t) + \varphi(z_t) \varsigma(\tilde{s}_t) \\ &\quad + (1 - \sigma - \psi_{H,t} - \varphi(z_t)(\psi_H^* - \psi_{H,t})) E_t \beta_{t+1} S_{t+1}^H. \end{aligned}$$

The introduction of on-the-job search affects the household's decisions regarding job seeking and regarding also the allocation of job seekers' search between Home and abroad through the

impact on the asset value of being employed in Home. This asset value is negatively affected by the pecuniary costs of on-the-job search  $\phi(z_t)$  and the higher probability of leaving the job in the future due to successful on-the-job search effort, as given by the term  $\varphi(z_t)$ , and positively affected by the fact that, by being employed in Home, the worker avoids incurring search cost looking for a job abroad when unemployed  $\varsigma(\tilde{s}_t)$ .

Using the equation above together with the equivalent expression for the value of an additional employee abroad  $S_{h,t}^F$  (see the Online Appendix), the definition of hiring rates, and the first order condition with respect to  $s_t$ , we obtain

$$\psi_{H,t} E_t(\beta_{t+1} S_{t+1}^H) = \psi_H^* E_t(\beta_{t+1} S_{h,t+1}^F) - \varsigma(\tilde{s}_t).$$

This condition shows that, in equilibrium, the expected value of searching in the two labour markets is equalized (see also equation (15) expressed in units of the consumption good). This expected value will depend not only on the probability of finding a job in each labour market, but also on the expected utility from having an additional worker at Home or abroad, which, in turn, will depend on the respective wage and separation rate.

In turn, the firm's surplus is given by

$$S_t^F = (1 - \alpha) \frac{p_{x,t} y_t}{n_t} - w_t h_t + (1 - \sigma - \psi_H^* \varphi(z_t)) \frac{\kappa}{\psi_{F,t}}.$$

Using the above expressions, the negotiated real wage income  $w_t h_t$ , determined by the splitting rule of the Nash bargaining, is given by

$$w_t h_t = (1 - \vartheta) \left\{ (1 - \alpha) \frac{p_{x,t} y_t}{n_t} + (1 - \varphi(z_t)) \frac{\psi_{H,t}}{\psi_{F,t}} \kappa \right\} + \frac{\vartheta}{(1 - \tau_t^n)} \left\{ b + \frac{\chi}{\lambda_{c,t}} \frac{h_t^{1+\xi}}{1 + \xi} + \phi(z_t) - \varphi(z_t) \varsigma(\tilde{s}_t) \right\}. \quad (20)$$

The first term, weighted by the workers' bargaining power  $(1 - \vartheta)$  includes the value of the marginal product of labour and the continuation value of the match to the firm, corrected by the continuation value of the match to the household. The presence of on-the-job search abroad affects this term through the possibility that workers can resign from their contracts. This is captured by  $(1 - \varphi(z_t))$ , which reflects the fact that the higher is on-the-job search, the lower the average tenure of work contracts in Home, pushing down on wages. The second term refers to the workers' surplus and consists of the immediate outside option of being unemployed, corrected for the disutility from hours. This term is also affected by the pecuniary cost of on-the-job search  $\phi(z_t)$ . Since, when employed, a worker incurs a cost from on-the-job search, the outside option must include the savings from not incurring this cost. Finally, the last term  $\varphi(z_t) \varsigma(\tilde{s}_t)$  appears because, in equilibrium, the worker surplus in Home and abroad must be equal taking into consideration the migration costs. The worker's

surplus from a match in Home includes an extra term to account for the fact that, by being employed in Home, the worker avoids incurring search cost looking for a job abroad when unemployed  $\varsigma(\tilde{s}_t)$ . The determination of hours in equilibrium through negotiation over the joint surplus of workers and firms is presented in the Online Appendix.

### 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  $p_{x,t}$  of intermediate goods 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

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

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  $P_{r,t} = \left( \int (P_{i,r,t})^{\epsilon-1} di \right)^{\frac{1}{\epsilon-1}}$ , where  $P_{i,r,t}$  is 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

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

subject to the respective demand schedule, where  $P_t$  is the final good price. 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

$$\frac{p_{r,t}^*}{p_{r,t}} = \frac{\epsilon}{\epsilon-1} \frac{\mathcal{N}_t}{\mathcal{D}_t} \quad (21)$$

with

$$\mathcal{N}_t = p_{x,t} y_{r,t} + \lambda_p E_t \beta_{t+1} (\pi_{r,t+1})^\epsilon \mathcal{N}_{t+1}, \quad (22)$$

$$\mathcal{D}_t = p_{r,t}y_{r,t} + \lambda_p \mathbb{E}_t \beta_{t+1} (\pi_{r,t+1})^{\epsilon-1} \mathcal{D}_{t+1}, \quad (23)$$

where  $p_{r,t} \equiv P_{r,t}/P_t$  and  $\pi_{r,t} \equiv P_{r,t}/P_{r,t-1}$  is the producer price inflation. Under the assumption of Calvo pricing, the price index in nominal terms is given by

$$(P_{r,t})^{1-\epsilon} = \lambda_p (P_{r,t-1})^{1-\epsilon} + (1 - \lambda_p) (P_{r,t}^*)^{1-\epsilon}. \quad (24)$$

The aggregate tradable good is sold domestically and abroad

$$y_{r,t} = y_{l,t} + y_m^*, \quad (25)$$

where  $y_{l,t}$  is the quantity of tradable goods sold locally and  $y_m^*$  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

$$y_{f,t} = \left[ (\varpi)^{\frac{1}{\gamma}} (y_{l,t})^{\frac{\gamma-1}{\gamma}} + (1 - \varpi)^{\frac{1}{\gamma}} (y_{m,t})^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}. \quad (26)$$

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  $y_{f,t} - p_{r,t}y_{l,t} - e_t p_{r,t}^* y_{m,t}$  each period, where  $p_{r,t}$  and  $p_{r,t}^*$  denote the real price of aggregate retail goods produced in Home and abroad, respectively, and we have assumed the law of one price holds. Solving for the optimal demand functions gives

$$y_{l,t} = \varpi (p_{r,t})^{-\gamma} y_{f,t}, \quad (27)$$

and

$$y_{m,t} = (1 - \varpi) (e_t p_{r,t}^*)^{-\gamma} y_{f,t}. \quad (28)$$

We substitute out (27) and (28) into (26) to obtain

$$1 = \varpi (p_{r,t})^{1-\gamma} + (1 - \varpi) (e_t p_{r,t}^*)^{1-\gamma}, \quad (29)$$

where  $p_{r,t} = P_{r,t}/P_t$  and  $p_r^* = P_r^*/P^*$  are the retail prices in Home and abroad, respectively, denominated in each country's numeraire. Then we define implicitly the nominal consumer price index as the value solving (29) for  $P_t$ .

Government expenditure consists of unemployment benefits, consumption expenditure modeled initially as a waste  $g_{w,t}$  and lump-sum transfers, while revenues come from consumption, capital income and labour income taxes.<sup>21</sup> The primary deficit is, therefore, defined by

$$DF_t = bu_t + g_{w,t} + T_t - \tau_t^n w_t h_t n_t - \tau^k (r_t^k - \delta_t) x_t k_t - \tau^c c_t \quad (30)$$

and the government budget constraint is given by

$$r_{t-1} b_{g,t-1} + DF_t = b_{g,t}. \quad (31)$$

The government has initially two potential fiscal instruments, labour income tax rates  $\tau_t^n$  and public expenditure  $g_{w,t}$ . The other tax rates,  $\tau^k$  and  $\tau^c$ , are treated as parameters. We will consider each instrument separately, assuming that if one is active, the other remains fixed at its steady state value. For  $\Psi \in \{\tau^n, g_w\}$ , following Erceg and Lindé (2013) and Pappa et al. (2015), we assume fiscal rules according to which the fiscal instruments depend on the discrepancy between the debt-to-GDP ratio  $\tilde{b}_{g,t} \equiv \frac{b_{g,t}}{gdp_t}$  and an exogenous target  $b_{g,t}^T$ , and also on the discrepancy between their changes, denoted by  $\Delta$ . Specifically, we assume

$$\Psi_t = \Psi^{(1-\beta_{\Psi 0})} \Psi_{t-1}^{\beta_{\Psi 0}} \left[ \left( \frac{\tilde{b}_{g,t}}{b_{g,t}^T} \right)^{\beta_{\Psi 1}} \left( \frac{\Delta \tilde{b}_{g,t+1}}{\Delta b_{g,t+1}^T} \right)^{\beta_{\Psi 2}} \right]^{(1-\beta_{\Psi 0})}, \quad (32)$$

where  $\beta_{\Psi 1}, \beta_{\Psi 2} > 0$  for  $\Psi = \tau^n$ , and  $\beta_{\Psi 1}, \beta_{\Psi 2} < 0$  for  $g_w$ . The target debt-to-GDP ratio is given by the AR(2) process

$$\log b_{g,t}^T - \log b_{g,t-1}^T = \rho_1 (\log b_{g,t-1}^T - \log b_{g,t-2}^T) + \rho_2 (\log \bar{b} - \log b_{g,t-1}^T) - \varepsilon_t^b, \quad (33)$$

where  $\bar{b}$  is the steady-state level of the debt-to-GDP ratio and  $\varepsilon_t^b$  is a white noise process representing a fiscal consolidation shock. By introducing strong inertia through the AR(2) process, 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 (32), 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.<sup>22</sup>

### 2.1.8 Resource constraint

The non-tradable final good is sold for private and public consumption,  $c_t$  and  $g_{w,t}$ , and for investment  $i_t$ . However, costs related to vacancy posting and looking for a job abroad reduce the amount of resources available

$$y_{f,t} = c_t + i_t + g_{w,t} + \kappa v_t + \phi(z_t) n_t + \varsigma(\tilde{s}_t) s_t u_t. \quad (34)$$

<sup>21</sup>We consider the role of productive and utility-enhancing public expenditure in Section 5.4.

<sup>22</sup>Note that studying the possibility of sovereign default is beyond the scope of our paper.

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

$$e_t (r_{f,t-1} b_{f,t-1} - b_{f,t}) = nx_t + e_t \Xi_t, \quad (35)$$

where  $nx_t$  are net exports defined as

$$nx_t = p_{r,t} y_{m,t}^* - e_t p_r^* y_{m,t}. \quad (36)$$

The equation for exogenous exports is given by

$$y_{m,t}^* = \left( \frac{p_{r,t}}{e_t} \right)^{\gamma_x} \bar{y}_m^*, \quad (37)$$

where  $\gamma_x$  is the price elasticity of exports and  $\bar{y}_m^*$  is the steady-state level of exports pinned down by the calibrated value of steady-state net foreign assets.

In turn, real GDP is defined as

$$gdp_t = y_{f,t} + nx_t. \quad (38)$$

Using (25) and (36), together with the equilibrium condition  $y_{f,t} = p_{r,t} y_{l,t} + e_t p_r^* y_{m,t}$ , real GDP can be equivalently expressed as

$$gdp_t = p_{r,t} y_{r,t}. \quad (39)$$

### 2.1.9 Lack of monetary policy independence

Regarding exchange rate policy, since the model is designed for peripheral countries of the euro area, such as Greece, we solve it for a case without monetary policy independence. Specifically, we assume that the nominal exchange rate  $E$  is exogenously set and, at the same time, the domestic nominal interest rate on domestic government bonds  $R_t$  becomes an endogenous variable (see, e.g., Erceg and Lindé (2012)). The real exchange rate  $e_t$  is given by

$$e_t = \frac{E \cdot P^*}{P_t}.$$

The nominal interest rate  $R_t$  is then pinned down endogenously through the Fisher equation<sup>23</sup>

$$r_t = \frac{R_t}{E_t \pi_{t+1}}. \quad (40)$$

<sup>23</sup>As noted in Philippopoulos et al. (2017), in the case of flexible or managed floating exchange rates,  $E$  and  $R$  switch positions, in the sense that the former becomes an endogenous variable  $E_t$ , while the latter is used as a policy instrument following a Taylor-type rule.

where consumer price inflation  $\pi_t$  is defined as

$$\pi_t = \frac{P_t}{P_{t-1}}. \quad (41)$$

Finally, we introduce a risk premium charged to Home households depending on the size of the deviation from its steady-state value of the net foreign liabilities to real GDP ratio,

$$r_{f,t} = r^* \exp \left\{ \Gamma \left( \frac{e_t b_{f,t+1}}{gdp_t} - \frac{\bar{e} \bar{b}_f}{\bar{gdp}} \right) + \epsilon_{r,t} \right\} \quad (42)$$

where  $\Gamma$  is the elasticity of the risk premium with respect to liabilities (see Schmitt-Grohé and Uribe (2003)),  $\bar{b}_f$  and  $\bar{e}$  refer to the steady-state values of  $b_{f,t}$  and  $e_t$ , and  $\epsilon_{r,t}$  is a risk premium shock.

### 3 Calibration strategy

We solve the model by linearizing the equilibrium conditions around a non-stochastic zero-inflation steady state in which all prices are flexible, the price of the final good is normalized to unity, and the real exchange rate is also equal to unity. We calibrate the model at an annual frequency with Greece as our primary target economy (see also the simulation exercise we perform in Section 5.5). Table 1 shows the key parameters and steady-state values we target.

In the analysis that follows after this Section, we will 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. To compare the dynamics across the different specifications, we eliminate potential steady-state differences by working with the full model specification (iii), setting all variables related to migration and on-the-job search abroad to their steady-state values when considering the model specifications (i) and (ii).

#### National accounts

Using annual data from the Eurostat from 2008 to 2015, we set the shares of private consumption, capital investment and imports in GDP equal to 62% , 18%, and 25%, respectively. We also set net foreign assets and public debt to 10% and 127% of GDP, respectively, while remittances over GDP in the steady state are fixed to 3%, in line with data from the World Bank. The ratio of wasteful public spending to GDP is set equal to around 5%, using *Government's final consumption expenditure*, taking out compensation of employees (which we do not model) and consumption expenditure in the health and education sectors, which we explore in Section 5.4 when looking at additional components of public spending.

#### Utility function

Following the literature, we set the discount factor  $\beta$  to 0.96, implying an annual interest rate of 4%. Regarding the inverse elasticity of intertemporal substitution  $\eta$ , much of the literature cites the econometric estimates of Hansen and Singleton (1983), which place it “between 0 and 2”. We fix it to unity, so that utility from consumption takes the logarithmic form. External habits are set equal to 0.75, which is a common value in the literature. In order to match the ratio of imports to GDP, we assume a degree of home bias equal to 0.75. Following Erceg and Lindé (2013), we set the elasticity between domestically produced and imported goods equal to 1.2. To match the path of GDP in the simulations, we set the price elasticity of exports  $\gamma_x$  to 0.2. The elasticity of hours worked is fixed to 1, while the relative weight in utility  $\chi$  is implicitly determined through the bargaining expression for hours (see the Online Appendix) which we normalize in the steady state to unity. In Section 5.5, we also explore a version of the model without the intensive margin.

## Production process

The capital share takes the standard value of  $1/3$  and the steady-state price markup over marginal costs is set to 10%. The annual depreciation rate is calibrated to 8.8% in order to match the ratio of capital investment to GDP above. The model's steady state is independent of the degree of price rigidities and the size of the investment adjustment costs. The latter are included to moderate the response of investment with respect to fiscal shocks. We set the degree of price stickiness  $\lambda_p$  equal to 0.25, which is a standard value on an annual basis, and the degree of investment adjustment costs  $\omega$  equal to 4.

## Labour market

We start by normalizing total Home nationals  $\bar{n}$  to unity, of which 10% reside abroad.<sup>24</sup> The unemployment rate is set equal to 12%, which matches well the figure in Greece during 2009-2010. For simplicity, we assume that the termination rates in the domestic and foreign labour markets are both equal to 7%, which is the value used in Pappa et al. (2015). We set the vacancy-filling and job-finding probabilities equal to 0.70 and 0.60 respectively, which pins down the efficiency of the matching technology  $\mu_1$ . We calibrate the job-finding probability abroad to be 60% higher than in Home, which allows us to match an unemployment rate abroad of 7%, consistent with that of Germany in the same period. Using the laws of motion of employment in Home and abroad, our calibration implies a steady-state share of unemployed looking for a job abroad of 6.5%, whereas just below 0.5% of current workers are matched to a job abroad. Our calibration also implies that, in the steady state, 34% of migration outflows (household members who are newly matched with a job abroad) are current workers in Home who obtained a job abroad through on-the-job search effort. This number will be the starting point in our simulations for Greece for the period 2009-2015 in Section 5.5, where we will show that the model matches an average share of 48% over the entire period, in line with the survey evidence in Labrianidis and Pratsinakis (2016) mentioned in the Introduction. Vacancy-posting costs  $\kappa$  represent 15% of the wage, or, in the aggregate, just under 1% of GDP. Finally, we enforce the Hosios condition by setting the elasticity of matches to vacancies equal to the bargaining power of firms,  $\mu_2 = \vartheta = 0.38$  (see below).

## Search abroad and migration

For the cost of job search abroad for the unemployed and the employed,  $\varsigma(\tilde{s}_t)$  and  $\phi(z_t)$  respectively, as well as the productivity of on-the-job search effort  $\varphi(z_t)$  we adopt the following functional forms:

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<sup>24</sup>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, 22% for Portugal, and close to 5% for Spain and Italy. All numbers were higher compared to the previous data points for 2010.

$$\begin{aligned}\varsigma(\tilde{s}_t) &= \varsigma_{s1}(\tilde{s}_t)^{\varsigma_{s2}}, \\ \phi(z_t) &= \phi_{z1}(z_t)^{\phi_{z2}}, \\ \varphi(z_t) &= \varphi_{z1}(z_t)^{\varphi_{z2}}.\end{aligned}$$

The scale parameters for search costs  $\varsigma_{s1}$  and  $\phi_{z1}$ , as well as the weight on the utility cost of migration  $\Omega$ , are implicitly determined by the first-order conditions (13) - (16) in the steady state. While ensuring realistic positive values for these parameters, we choose the remaining parameters by calibrating the net replacement rate  $b/[(1 - \tau_n)w] = 0.41$  in line with data from the OECD Benefits and Wages Statistics, the bargaining power of firms  $\vartheta = 0.38$  in line with Flinn (2006), and the wage premium abroad  $w^*/w = 1.10$ . These values imply that, per job match abroad, search costs represent 46% and 36% of the wage for the unemployed and the employed respectively. Put differently, total costs of job search abroad account for around 0.33% of GDP. We then normalize search effort  $z$  to 1 and use the parameter for the on-the-job search effort productivity  $\varphi_{z1}$  to determine the steady-state number of workers that are matched to a job abroad. The remaining parameters  $\phi_{z2}$ ,  $\varsigma_{s2}$ ,  $\varphi_{z2}$  together with the elasticity of the utility cost of living abroad  $\mu$  largely determine the magnitude of migration outflows in response to shocks. We set  $\phi_{z2}$  and  $\varsigma_{s2}$  such that the migration outflows in our simulations for Greece in Section 5.5 match (i) the magnitude of migration outflows presented in Lazaretou (2016) and (ii) the survey evidence in Labrianidis and Pratsinakis (2016) on the share of emigrants that were previously employed in Greece (close to 50%). Specifically, we calibrate  $\varphi_{z2}$  jointly with  $\phi_{z2}$  so that the total number of workers emigrating in our simulations matches the Greek data and, at the same time, on-the-job effort fluctuates to reasonable values along the simulation horizon.<sup>25</sup> Finally, the elasticity of the utility cost of living abroad  $\mu$  is normalized to 1. The higher the value of  $\mu$ , the lower the magnitude of the migration outflows. However, in the absence of costs to the number of workers abroad, the ratio of pecuniary searching costs to GDP would have to be unrealistically high for the model to reproduce the magnitude of outflows from Greece in our estimations.

## Policy

The elasticity of the spread between domestic and foreign interest rates  $\Gamma$  is set equal to 0.001. We construct effective taxes following the methodology of Mendoza et al. (1994). We calibrate the public-debt target rule (33) in such a way that the cut in the debt target  $b_{g,t}^T$  is implemented gradually over 10 years, remaining below its steady state for an arbitrarily larger number of time periods. For the fiscal rule (32), we calibrate the set of three parameters for each fiscal instrument in such a way that the actual debt-to-GDP ratio  $\tilde{b}_{g,t}$  meets the new,

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<sup>25</sup>For instance, with  $\varphi_{z2} = 1$ ,  $z_t$  could more than triple in our simulation just to generate the same number of workers moving abroad. Krause and Lubik (2006) look at on-the-job search in the domestic market and set  $\varphi_{z1} = \varphi_{z2} = 1$ , while letting the steady-state value of search effort  $\bar{z}$  determine the number of low paid workers moving to a better job. They calibrate the job-to-job transition rate to be 6%, whereas here the comparative measure would be below 0.45%. This difference in magnitudes explains why we opt for  $\varphi_{z2} > 1$ .

lower target at the same time across the different instruments and at around 10 years after the decision to consolidate is taken. Finally, we assume that all exogenous shock processes follow an auto-regressive form with one lag and coefficient  $\rho = 0.75$ .

Table 1: Calibration

<i>National accounts:</i>		
per capita real GDP	$gdp$	1.00
private consumption / GDP	$C/gdp$	0.62
private investment / GDP	$i/gdp$	0.018
imports / GDP	$y_m/gdp$	0.25
public debt / GDP	$\bar{b}$	1.27
net foreign assets / GDP	$b_f/gdp$	0.10
wasteful gov. spending / GDP	$g_w/gdp$	0.0533
remittances / GDP	$\Xi/gdp$	0.03
<i>Utility:</i>		
discount factor	$\beta$	0.96
intertemporal elasticity	$\eta$	1.01
external habits in consumption	$\zeta$	0.75
home bias in consumption	$\varpi$	0.75
elasticity home/imported goods	$\gamma$	1.20
elasticity exports	$\gamma_x$	0.20
elasticity hours worked	$\xi$	1.00
weight hours worked	$\chi$	1.68
<i>Production:</i>		
capital share in production	$\alpha$	0.33
capital depreciation rate	$\bar{\delta}$	0.0088
investment adjustment costs	$\omega$	4.00
price monopolistic elasticity	$\epsilon$	11
price Calvo lottery	$\lambda_p$	0.25
<i>Labour market:</i>		
unemployment rate	$u/(u+n)$	0.12
stock of migrants	$m_e/\bar{n}$	0.10
vacancy-filling probability	$\psi_F$	0.70
job-finding probability	$\psi_H$	0.60
job-finding probability abroad	$\psi_H^*/\psi_H$	1.60
wage premium abroad	$w^*/w$	1.10
firm's bargaining power	$\vartheta$	0.38
vacancies matching elasticity	$\mu_2$	$\vartheta$
vacancy posting costs	$\kappa v/w$	0.15
net replacement rate	$b/[(1-\tau_n)w]$	0.41
termination rates	$\sigma, \sigma^*$	0.072

Table 1: Calibration (continued)

<i>Migration and search abroad:</i>		
on-the-job search effort	$\bar{z}$	1.00
on-the-job search abroad cost	$\phi_{z1}, \phi_{z2}$	0.0017, 3.40
on-the-job effort productivity	$\varphi_{z1}, \varphi_{z2}$	0.0047, 3.00
unemployed's search abroad cost	$\varsigma_{s1}, \varsigma_{s2}$	0.6485, 0.15
disutility of migration	$\Omega, \mu$	0.64, 1.00
<i>Policy:</i>		
elasticity country premium	$\Gamma$	0.001
labour income tax	$\tau_n$	0.30
capital income tax	$\tau_k$	0.20
consumption tax	$\tau_c$	0.10
debt target parameters	$\rho_1, \rho_2$	0.6, 0.000001
fiscal rule parameters: $\tau_n$	$\beta_{n0}, \beta_{n1}, \beta_{n2}$	0.75, -3.3, -6
fiscal rule parameters: $g_w$	$\beta_{gw0}, \beta_{gw1}, \beta_{gw2}$	0.35, 5.5, 7

## 4 Migration Over the Business Cycle

We begin our analysis by showing responses to standard business cycle shocks, namely a negative productivity shock and a risk premium shock. The goal is to examine the behaviour of migration variables and the impact of migration on economic aggregates in comparison to a counterfactual scenario of labour force immobility.

### 4.1 TFP shock

Figure 3 reports the responses of the model for a negative TFP shock. Panel 3a shows the migration and labour market variables, while panel 3b refers to the main aggregates in the economy. The solid lines for the model without migration confirm that a negative TFP shock leads to a decrease in vacancies and the real wage, given the drop in the marginal product of labour. The job finding rate falls and pushes down on employment. As a result, the unemployment rate rises. Due to sticky prices, markups decrease and so the drop in profits becomes larger than the decrease in wages. Because the labour-increasing income effect of lower profits dominates the labour-reducing effect of lower wages, hours rise. We also observe a decrease in consumption, investment and GDP in the economy. Given the negative supply shock, prices go up. On the other hand, the decrease in demand leads to a decrease in imports and therefore a rise in net exports.

When we allow for cross-border job search of the unemployed, the dashed lines demonstrate that the household increases the share of searchers for jobs abroad, which raises the stock of migrants. The resulting decrease of labour supply in the domestic labour market attenuates the decrease in the real wage and in the job-finding rate relative to the model without migration. At the same time, the bigger reduction in the household's income from employment in Home intensifies the decrease in consumption and investment. Consequently, firms post even fewer vacancies in the short run in order to decrease production capacity. The reduction in labour supply and labour demand reinforce the decrease in employment. For the unemployment rate we examine two measures: "Unempl. rate: all" refers to all the Home residents who are unemployed, including those who look for jobs abroad while receiving the domestic unemployment benefit. As we can see, migration mitigates the increase of unemployment in the short run as it helps to reduce the total number of job seekers through successful job matches abroad. However, this is reversed in the medium run as the effect from the contraction in domestic employment dominates the reduction in job seekers mentioned previously. Moreover, as the impact of the shock fades out and the job-finding rate returns towards its steady-state level, we observe some return migration. The second measure "Unempl. rate: H searchers" includes only the unemployed who look for domestic jobs, therefore excluding those who seek a job in the foreign labour market. As expected, this measure reveals a decrease of unemployment in the short run for those who aim to stay in the country. In aggregate terms, consumption, investment and GDP fall by more than in

the case without migration. However, a closer look at per capita measures shows that per capita GDP actually falls by less, while the response of per capita investment hardly differs between the two models. The higher fall in consumption in the model with migration relative to the specification without migration is preserved in per capita terms, but is smaller in magnitude, as expected. On the other hand, the positive response of net exports is significantly reinforced in per capita terms. The latter outcome explains the fact that per capita GDP falls by less with migration relative to the benchmark model of immobility.

The dash-dotted lines present the impulse response functions when we introduce in the model on-the-job search abroad. After a negative TFP shock, workers increase substantially the intensity with which they look for jobs abroad, which reinforces the increase in the stock of migrants and the reduction employment relative to the previous two versions of the model. At the same time, the search abroad of unemployed job seekers is mitigated, since the exodus of workers due to successful matches abroad leads firms to cut vacancies by less, attenuating the decrease in the domestic job finding rate. Consequently, the positive impact of labour mobility on the short-run unemployment rate is mitigated. However, over time, these unemployment gains from migration are reversed due to the stronger contraction in employment. We also observe a decrease in the intensity of on-the-job search abroad below its steady-state level. In aggregate terms, internal demand and GDP fall by more than in the previous two versions of the model. Again, looking at per capita measures, we see that actually per capita GDP falls by less than in the previous two versions of the model due to the stronger increase in per capita net exports. The negative impact of labour mobility on consumption is preserved but weakened in per capita terms.

In sum, a negative TFP shock increases the search abroad of unemployed job seekers for many periods, which has a positive impact on short-run unemployment, but also reinforces the negative effects of the shock on consumption and leads to higher unemployment costs over time. Taking into account also the job search abroad of current workers reinforces the fall in consumption, mitigates the short-run unemployment gains from migration and reinforces unemployment costs over time.

## 4.2 Risk premium shock

Next, in Figure 4 we examine a risk premium shock, normalized to generate a 1% increase in the nominal interest rate. This risk premium shock could come, from instance, from an exogenous change in the country's credit rating. Panel 4a shows the migration and labour market variables, while panel 4b refers to the main aggregates in the economy. An increase in the risk premium reduces domestic demand, pushing down on domestic prices and, therefore, causing the real exchange rate to depreciate and net exports to increase. The fall in domestic demand from the increase in the nominal interest rate leads firms to reduce vacancies and to lower wages and markups. All other responses are in line with the results presented in Section 4.1 for a negative TFP shock. Specifically, an increase in the risk premium induces a higher

fraction of unemployed searching for foreign jobs in the short run, which has a positive impact on short-run unemployment, but also reinforces the negative effects on consumption. Taking into account also the job search abroad of current workers reinforces the fall in consumption, mitigates the short-run unemployment gains from migration and reinforces unemployment costs over time.

Note that the main variables react similarly to the TFP and risk premium shocks, including all the labour market variables and emigration in particular. This suggests that the primitive cause of the recession does not seem to be crucial for these results. However, the two shocks differ with respect to the response of inflation, which increases after a TFP shock, while it decreases after a risk premium shock. For that reason, we prefer to base our simulation exercise in section 5.5 on risk premium shocks.

## 5 Migration and Fiscal Consolidation

In this section, we consider a shock that drives the debt-to-GDP target  $b_{g,t}^T$ , determined by (33), 5% below its steady state. We simulate the responses to this shock with labour income taxes or government spending adjusting through (32) so that the actual debt-to-GDP ratio  $\tilde{b}_{g,t}$  meets the new lower target after 10 quarters in the benchmark specification without migration. In this way, we can ensure comparability for the tax-spending instruments, given the same size and timing of fiscal consolidation in the baseline economy. When we introduce subsequently migration decisions for the unemployed and the employed, we maintain the same fiscal rule parameters  $\beta_{\Psi_0}, \beta_{\Psi_1}, \beta_{\Psi_2}$  (see Table 1).

### 5.1 Labour tax hikes

We begin with the case of tax-based consolidation, depicted in Figure 5 where panel 5a shows the migration and labour market variables, while panel 5b refers to the main aggregates in the economy. Starting with the model without migration (see solid lines), we can see that 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, and employment, while unemployment rises. The labour tax hike also decreases hours by affecting negatively the incentives to work. The fall in internal demand leads to a fall in the demand for imports, reflected in the increase of net exports, but the contraction in internal demand is stronger and so real GDP falls.

When we introduce job search abroad for the unemployed (see dashed lines), the significant fall in the job-finding probability induces the household to increase the share of foreign-job seekers, leading to a higher stock of migrants. Vacancies and employment fall substantially more, given the stronger contraction in demand. Due to the fact that more unemployed job seekers are now directed abroad, both the conventional measure for unemployment (“Unempl. rate: all”) and the measure for those searching domestically (“U rate: H searchers”) fall in the short run, with the fall being more significant in the latter case, while they subsequently rise, due to the more negative response of vacancies and employment in the presence of migration. The unemployment gains from migration are therefore only temporary. In aggregate terms, migration induces a stronger fall in consumption, investment and GDP relative to the model without migration. The debt-to-GDP ratio therefore falls more slowly, implying that it will take more time for the new debt target to be met, and the increase in the labour income tax rate is higher than in the model without migration, hurting the economy further. A look at per capita measures reveals that per capita consumption and investment still fall by more than in the case without migration. This is explained by the higher tax hikes required in the presence of migration, which gives rise to stronger distortions. On the other hand, per capita GDP actually falls by less, in line with the fact that the rise in net exports is significantly reinforced in per capita terms.

In the presence of on-the-job search abroad (see dash-dotted lines), a tax-based consolidation significantly increases the intensity with which current workers look for employment

abroad, raising further the stock of migrants, while mitigating the search abroad of the unemployed. A higher stock of migrants abroad has a negative impact on internal demand, both in aggregate and per capita terms. However, as before, for per capita GDP the fall is mitigated from a reinforced increase in per capita net exports. Taking into account the migration of the employed impacts negatively both measures of the unemployment rate, therefore limiting the short-run unemployment gains from migration and increasing unemployment costs over time due to a deeper demand contraction in the economy. On the fiscal side, the tax hike and the time required to achieve fiscal consolidation is higher than in the other two versions of the model.

In sum, labour tax hikes increase the search abroad of unemployed job seekers. On the one hand, this has a positive impact on short-run unemployment, but, on the other hand, it reinforces the negative effects on consumption and investment and leads to higher unemployment costs over time. Taking into account also the job search abroad of current workers reinforces the fall in consumption and investment, mitigates the short-run unemployment gains from migration and reinforces unemployment costs over time. The migration of the employed leads to a tax revenue leakage, since the migrants become tax payers abroad. Due to this leakage, migration increases the required tax hike and time to achieve the same size of fiscal consolidation. In other words, a higher tax hike hurts employment and demand, leading to a second-order leakage from the tax revenue.

## 5.2 Public spending cuts

The case of cuts in wasteful government spending is displayed in Figure 6. The solid lines for the baseline model without migration confirm the negative demand effect, which induces vacancies, and consequently the job finding rate, to fall. This leads to a fall in employment and an increase in unemployment. The real wage goes down, given the drop in labour demand, but then increases slightly in the medium run, given the reduction in labour supply. The latter comes from the well-known positive wealth effect for the household that reduces hours, while it increases consumption and investment in expectation of lower taxes in the future. Real GDP falls since the cut in government spending directly reduces aggregate demand in the economy. The increase in net exports comes from a decrease in the demand for imports.

When job search abroad is allowed for the unemployed (see dashed lines), the negative demand shock induces the household to initially increase the share of unemployed who look for jobs abroad, which raises the stock of migrants. This mitigates the increase in consumption, both in aggregate and per capita terms, and deteriorates the response of employment. However, the share of foreign-job searchers falls in the medium run as the job-finding rate and the real wage increase above the steady-state levels. Due to the fact that more unemployed job seekers are directed abroad in the short run, both the conventional measure for unemployment (“Unempl. rate: all”) and the measure for those searching domestically (“U rate: H searchers”) are impacted positively in the short run, with the latter falling below

its steady-state level, while the medium-run impact is negative, due to the more negative response of employment in the presence of migration. As with labour tax hikes, the unemployment gains from migration are therefore only temporary. The response of real GDP with and without migration hardly differs, as its main driver is the reduction of aggregate demand from the government spending cut itself rather than the mobility channel.

Cuts in public spending also have a non-monotonic impact on the intensity with which current workers look for jobs abroad (see dash-dotted lines). The on-the-job search effort increases (decreases) in the short run (medium run) following the fall (increase) in the real wage. This is translated in a smaller increase in aggregate consumption and investment, as well as a higher decline in labour, relative to the previous two specifications. Taking into account the migration of the employed affects unemployment little relative to the model with migration of the unemployed only.

In sum, a spending-based consolidation has a non-monotonic effect on the search abroad of the unemployed. Migration leads to weaker positive effects on consumption and stronger negative effects on employment. As with labour tax hikes, the unemployment gains from migration are only temporary since unemployment costs become higher over time. Taking into account cross-border on-the-job search in the model weakens the internal demand effects of consolidation, in aggregate terms, while it affects unemployment little.

### 5.3 Comparison: tax-based versus spending-based consolidation

Figure 7 compares labour tax hikes and spending cuts in the full model (with cross-border search of both the unemployed and the employed). A similar comparison in the other two model specifications is provided in the Online Appendix. As can be seen in Figure 7a, tax hikes lead to a bigger fall in vacancies, hours, the job-finding rate, the real after-tax wage, and employment. Due to the stronger contraction in labour, a tax-based consolidation takes longer to be achieved in the presence of migration, while the required time for a spending-based consolidation is not altered. As can be seen in Figure 7b, due to adverse effects on consumption and investment, labour tax hikes (dashed lines) lead to higher output and unemployment costs than spending cuts (solid lines), except for the very short run when the direct negative demand impact of spending cuts prevails, accompanied by higher unemployment costs. In per capita terms, however, the horizon over which spending cuts appear more harmful to per capita GDP and the unemployment rate for those searching domestically (“U rate: H searchers”) is significantly extended. Why tax hikes have a more favourable impact on per capita GDP and unemployment for stayers for so many periods? The answer is that by inducing stronger migration outflows than spending cuts, they reduce the resident population by significantly more and, as a result, the drop in per capita GDP becomes much less pronounced. At the same time, the rise in per capita net exports after a tax-based consolidation appears to be quite important.

## 5.4 Expanding the role of government spending

We have considered so far cuts in wasteful government spending (see, e.g., Erceg and Lindé (2013)). We now extend our analysis to also consider the role of utility-enhancing and productive public expenditure,  $g_{c,t}$  and  $g_{y,t}$  respectively. To this end, we modify the utility function as follows:

$$U(C_t, g_{c,t}, h_t, n_{e,t}) = \frac{\Phi_t^{1-\eta}}{1-\eta} - \chi \frac{(h_t^{1+\xi} n_t + h_e^{1+\xi} n_{e,t})}{1+\xi} - \Omega \frac{(n_{e,t})^{1+\mu}}{1+\mu}, \quad (43)$$

where  $\Phi_t \equiv \left[ (1-\alpha_1) (C_t - \zeta \tilde{C}_{t-1})^{\alpha_2} + \alpha_1 (g_{c,t})^{\alpha_2} \right]^{\frac{1}{\alpha_2}}$ . The elasticity of substitution between private and public consumption is given by  $\frac{1-\eta}{\alpha_2}$ . When this elasticity is greater than one, private and public consumption are substitutes, while when it is below one, they are complements (see also Bermpferoglou et al. (2017)). The Cobb-Douglas specification is obtained when the elasticity is equal to zero.

We also modify the production function to account for the role of productive public expenditure as follows:

$$y_t = A_t (n_t h_t)^{1-\alpha} (x_t k_t)^\alpha (g_{y,t})^\nu, \quad (44)$$

where the parameter  $\nu$  regulates how the public input affects private production: when  $\nu$  is zero, government spending is unproductive.

The composition of total government spending is therefore given by

$$g_t = g_{w,t} + g_{c,t} + g_{y,t}. \quad (45)$$

As before, we consider each of the expanded set of instruments  $\Psi \in \{\tau^n, g_w, g_c, g_y\}$  separately, assuming that if one is active, the other remains fixed at its steady state value. For the steady-state output shares of the additional government spending components, we use  $g_c/GDP = 0.1048$  and  $g_y/GDP = 0.0512$ , based on annual Greek data from Eurostat.<sup>26</sup> For the fiscal rule parameters we use the following values:  $\{\beta_{gc0}, \beta_{gc1}, \beta_{gc2}\} = \{0.35, 3.35, 5\}$  and  $\{\beta_{gy0}, \beta_{gy1}, \beta_{gy2}\} = \{0.35, 9, 10\}$ . Using the FOCs of the firm and of the household with respect to  $g_{y,t}$  and  $g_{c,t}$  in the steady state, and simplifying further by using the FOC with respect to  $c_t$ , allows us to pin down the following parameter values

$$\nu = \frac{g_y}{y} = 0.05$$

<sup>26</sup>Specifically, for  $g_y$  we use *Government's Gross Capital Formation* and for  $g_c$  we use *Government's Expenditure in Health and Education*, taking out the amount used in these sectors for *Gross Capital Formation* to avoid double counting with the previous item.

$$\alpha_1 = \left( 1 + (1 + \tau^c) \left( \frac{C(1 - \zeta)}{g_c} \right)^{1 - \alpha_2} \right)^{-1} = 0.2925.$$

Following the literature on Edgeworth complementarity between private and public consumption goods (see, e.g., Bouakez and Rebei (2007), Fève et al. (2013)), we set  $\alpha_2 = -0.75 < 0$  so that private consumption and  $g_{c,t}$  are complements.<sup>27</sup>

Figure 8 compares the three spending instruments and labour tax hikes in the full model (with job search abroad for both the unemployed and the employed).<sup>28</sup> Regarding the migration and labour market variables shown in panel 8a, labour tax hikes lead to the highest increase in the search for jobs abroad both for the employed and the unemployed, and therefore induce the biggest rise in the stock of migrants, as well as the biggest increase in the medium-run unemployment (“U rate: all”), followed by cuts in productive, utility-enhancing and wasteful spending. This is in line with the ranking of responses of vacancies, after-tax wages and employment for the four instruments. The same conclusion is obtained if we look at the time required for the new debt target to be met. Considering the unemployment rate for those searching domestically (“U rate: H searchers”), we see that this ranking of instruments is reversed in the short run due to the decrease in unemployment from the exodus of the labour force members. Turning to the main aggregates in panel 8b, in the medium run labour tax hikes lead to the strongest fall in consumption, investment and output, whereas over the short run cuts in the components of public spending that are either productive or utility-enhancing lead to a much higher contraction in output than wasteful spending cuts or labour tax hikes. In per capita terms, the latter result holds almost over the entire time horizon. For per-capita consumption, the most detrimental fiscal consolidation instrument seems to be cuts in utility-enhancing spending, given the complementarity with private consumption, followed by labour tax hikes. For investment, both in per capita and aggregate terms, the highest decrease is observed for tax hikes, followed by cuts in productive public expenditure.

In sum, labour tax hikes induce the highest increase in migration outflows, leading in the short run to the biggest decrease in unemployment for stayers, but in the medium run to the biggest fall in aggregate GDP and increase in unemployment, followed by cuts in productive, utility-enhancing and wasteful spending. However, in terms of per capita GDP, cuts in the components of public spending that are either productive or utility-enhancing lead to a much higher contraction than labour tax hikes or wasteful spending cuts.

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<sup>27</sup>Note that the productive and utility-enhancing public goods are provided for free. However, to find their optimal levels, we equate the marginal productivity of each of the public goods to its price, which is equal to that of the private consumption good (our numeraire).

<sup>28</sup>In the Online Appendix we include the responses to a spending-based consolidation when public expenditure is utility-enhancing or productive for the three versions of the model: without migration, with migration of the unemployed and with migration of both the unemployed and the employed. Extending the model with a public sector would allow to also assess the role of the public wage bill cuts (see, e.g., Bandeira et al. (2018)).

## 5.5 Fiscal consolidation mix in Greece

We have studied so far the interaction of migration and various fiscal consolidation instruments separately, without considering a policy mix with both spending cuts and labour tax hikes. In this subsection, we examine the predictions of our model when looking at the actual tax-spending consolidation implemented in Greece, which stands out as an example of public debt crisis and implementation of fiscal austerity policies. In 2010 Greece began the implementation of such measures in order to receive conditional bailout packages from international institutions.

We obtain annual data on the various components of public expenditure components from Eurostat (see Section 5.4). All paths are inputted into the simulation as shares of 2009 GDP. We allow lump-sum transfers to adjust to satisfy the government budget. As mentioned in Section 3, our calibration targets the magnitude and composition of the recent migration outflows in Greece. Specifically, we aim to match (i) a total outflow of half a million until 2015 and (ii) a share of around 50% of emigrants that had a job before departure (Labrianidis and Pratsinakis (2016)). Figure 9a shows the number of emigrants by previous employment status, as generated by our simulations, and calculates the total amount of emigrants that left Greece until 2015. According to the results displayed, our simulations do a fairly good job in matching both (i) and (ii) above. Specifically, the model generates total migration outflows of 536,000 persons. This number matches very accurately the figure obtained through the Hellenic Statistic Authority (ELSTAT) for emigrants aged 15-64 during the period 2010-2015, which is 533,188. The share of previously employed predicted by the model is 49%.

We start the economy at its steady state and then feed in the model the actual annual values of the four fiscal consolidation instruments considered in the previous section for the period 2009-2015 (see Figure 9b). Under the informational assumption of random walk, the labour force expects the current fiscal policy stance to remain the same in the next period, so any change is entirely unanticipated. Given the annual frequency adopted 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 is well justified. We proxy the macroeconomic environment in which the fiscal consolidation package was implemented through a combination of a risk premium shock and a negative investment shock. We include a table presenting information about the shocks used in the simulation exercise as well as the results of the exercise without the investment and risk premium shocks in the Online Appendix.

Results are reported in Figure 10. Panel 10a shows the simulation results for migration, unemployment, consumption, investment and GDP for all three versions of the model: without migration (solid lines), with migration of the unemployed (dashed lines) and with migration of both the unemployed and the employed (dash-dotted lines). As can be seen, the increase in migration outflows in the full model (dash-dotted lines) is of the magnitude observed in the data. The model also generates a significant increase in the intensity with

which current workers look for employment abroad during the period 2010-2015. Consumption, investment, and GDP decline following closely the actual path of the data, which is depicted by the dotted lines for comparison. Regarding unemployment, the model also predicts a steady increase from 2010 onwards, even though its magnitude falls short of the data, according to which between 2010 and 2015 the unemployment rate in Greece almost doubled (from 13% to 25%). Yet, it is well known that in models with search and matching frictions the volatility of unemployment is somehow limited. However, as panel 10b illustrates, if we raise the firms' bargaining power to a higher value (equal to 0.70), we do get a much larger increase in unemployment (of around 70% higher than the steady-state level). This happens because when the bargaining power of firms increases, the equilibrium wage level is closer to the outside option of households, given that the firm is able to extract a bigger share of the surplus of the match. When this is the case, the wage moves by less, given that the outside option of households is mostly determined by the unemployment benefit, which is fixed. This then makes firms decide to use the quantity margin (vacancies) by more since the wage is now less sensitive to shocks. As a result, there will be more unemployed. At the same time, wages moving by less means that on-the-job search effort for employment abroad increases by less. Finally, looking at the measure of the unemployment rate only for those searching domestically ("U rate: H searchers") we see that the unemployment gains from emigration for the stayers are limited when both the unemployed and employed can migrate. Note that with a longer time horizon we would likely observe in the medium run higher unemployment costs relative to the no-migration scenario, as discussed previously.

Finally, it is worth exploring in this exercise the role of the intensive versus the extensive margin. Recall that we have chosen to leave the latter out of our modeling specification so as not to blur the effects of migration on unemployment with the effects of labour force participation. Moreover, Greece exhibits very low probabilities of changing labour market status from inactivity to employment and vice versa (see Figure 5 in Garda (2016)). Panel 10c reports our simulations for the full model (with migration of both the unemployed and the employed) for three specifications: the dashed lines now repeat the results shown in panel 10a for the model with hours, the solid lines show the results when we remove hours from the model, and the dashed-dotted lines report the responses when we include endogenous labour force participation, instead of hours, in the model.<sup>29</sup> As can be seen, the main differences appear in the response of the unemployment rate. When we remove hours from the model, we tend to obtain a bigger increase in medium-run unemployment but a smaller increase

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<sup>29</sup>We modify equation (43) as follows

$$U(C_t, g_{c,t}, h_t, n_{e,t}) = \frac{\Phi^{1-\eta}}{1-\eta} - \chi \frac{(h_t^{1+\xi} n_t + h_e^{1+\xi} n_{e,t})}{1+\xi} - \Omega \frac{(n_{e,t})^{1+\mu}}{1+\mu} + X \frac{l_t^{1-\varphi_l}}{1-\varphi_l}, \quad (46)$$

where  $X > 0$  is the relative preference for leisure, which is pinned down in steady state by the first-order condition with respect to unemployment (see the Online Appendix), setting in steady state  $l = 1/3$ , and  $\varphi_l$  is the inverse of the Frisch elasticity of labour supply, which takes the standard value 4 in our calibration.

in migration outflows, while with endogenous labour force participation, the increase in the conventional measure of unemployment (“U rate: all”) occurs faster. At the same time, the unemployment rate for those searching domestically (“U rate: H searchers”) increases, rather than decreases, in the short run, driven by the increase in labour force participation following the risk-premium and the negative investment-specific shocks.<sup>30</sup>

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<sup>30</sup>In additional results included in the Online Appendix for simulations without the investment and risk premium shocks, we show that in the model without hours both consumption and investment rise due to a (i) stronger wealth effect after a spending-based consolidation and (ii) weaker migration and labour market effects after a tax-based consolidation. In the model with extensive margin in the place of intensive margin, the unemployment rate decreases due to the positive wealth effect of the fiscal consolidation mix that decreases labour force participation.

## 6 Conclusions

This paper has been motivated by the significant increase in 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. The government implements fiscal consolidation through labour income tax hikes or cuts in public spending. For the latter we consider various possible roles, namely wasteful, utility-enhancing and productive.

We showed that migration can reinforce business-cycle fluctuations. A negative TFP shock or a risk premium shock increases the search abroad of unemployed job seekers, which has a positive impact on short-run unemployment, but also reinforces the negative effects of the shock on consumption. Over time, as the impact of the shock fades out and the job-finding rate returns towards its steady-state level, we observe some return migration, which leads to higher unemployment costs in the medium run, relative to the no-migration scenario. Taking into account also the job search abroad of current workers reinforces the fall in consumption, mitigates the short-run unemployment gains from migration and reinforces unemployment costs over time. The mitigation of the short-run unemployment gains is due to the fact that the exodus of current workers with successful matches abroad leads firms to cut vacancies by less, mitigating therefore the search abroad for unemployed job seekers, while the reinforcement of the unemployment costs over time comes from the strongest contraction in consumption and employment.

Regarding the interaction of migration with fiscal consolidation, our results indicated that a tax-based consolidation induces the highest increase in emigration of both the unemployed and employed, which implies an increase in the tax hike required to achieve a given size of fiscal consolidation relative to the no-migration scenario and exacerbates the induced GDP contraction. As a result, the unemployment gains from migration for the stayers are only temporary. In the medium run, labour tax hikes lead to the biggest fall in aggregate GDP and increase in unemployment. However, in terms of *per capita* GDP, cuts in the components of public spending that are either productive or utility-enhancing lead to a much deeper contraction than tax hikes or wasteful spending cuts. Government spending cuts 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. Both in the case of tax hikes and spending cuts, the introduction of potential migration by the employed limits further the short-run unemployment gains from migration and reinforces the unemployment increase over time. Our simulations for the actual fiscal consolidation mix implemented in Greece in a macroeconomic environment proxied by a negative investment shock and a risk premium shock match well the size and composition of migration outflows. Our analysis has therefore offered important policy recommendations on the choice of fiscal consolidation instruments in the presence of migration and has stressed the

need of measures to provide motives for employed workers not to flee the country especially if a tax-based consolidation is implemented.

This paper has compared the effects of tax-spending instruments used for debt consolidation in the presence of cross-country labour 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), Bradley et al. (2017), 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, our results about the unemployment costs in the presence of migration and fiscal consolidation may well be considered as the lowest bound, since there is important evidence that a significant proportion of the recent emigrants were young and highly skilled. Another interesting extension could therefore be to incorporate on-the-job search and heterogeneous workers in terms of skills (see, e.g., Dolado et al. (2009)) in a model with migration. The long-run costs from the emigration of the employed would be also amplified if we considered (post-match) training costs. 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. Our model can also speak to episodes such as when eastern European countries joined the EU and saw a surge in migration outflows to other EU countries. We leave these topics for future research.

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# Figures

Figure 1: Net migration flows, defined as outflows minus inflows (in thousand persons), from Europe's periphery, Source: Eurostat

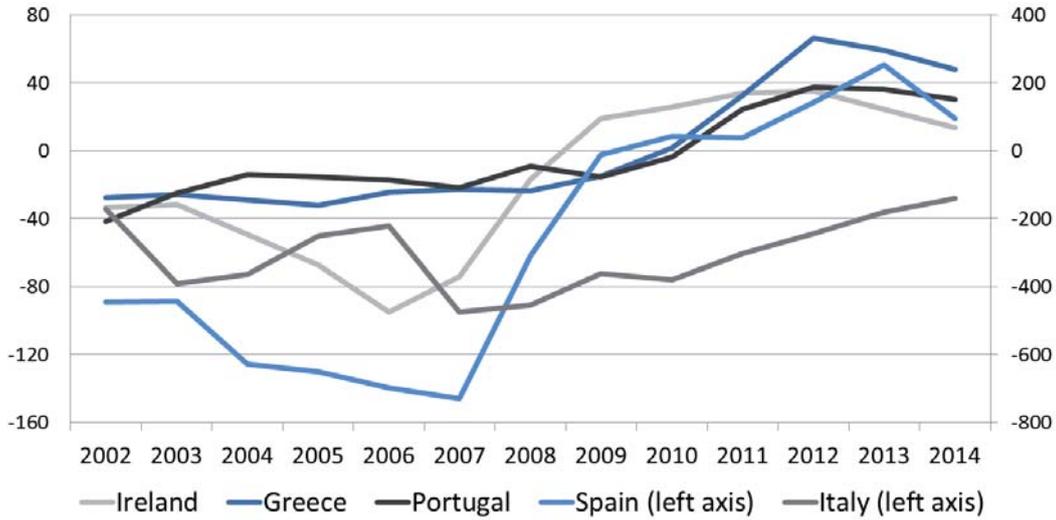
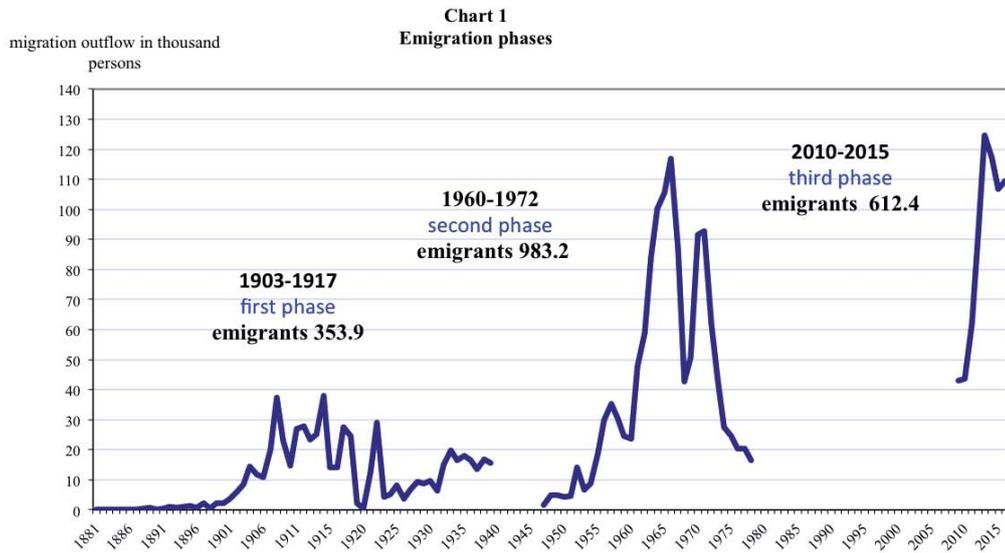


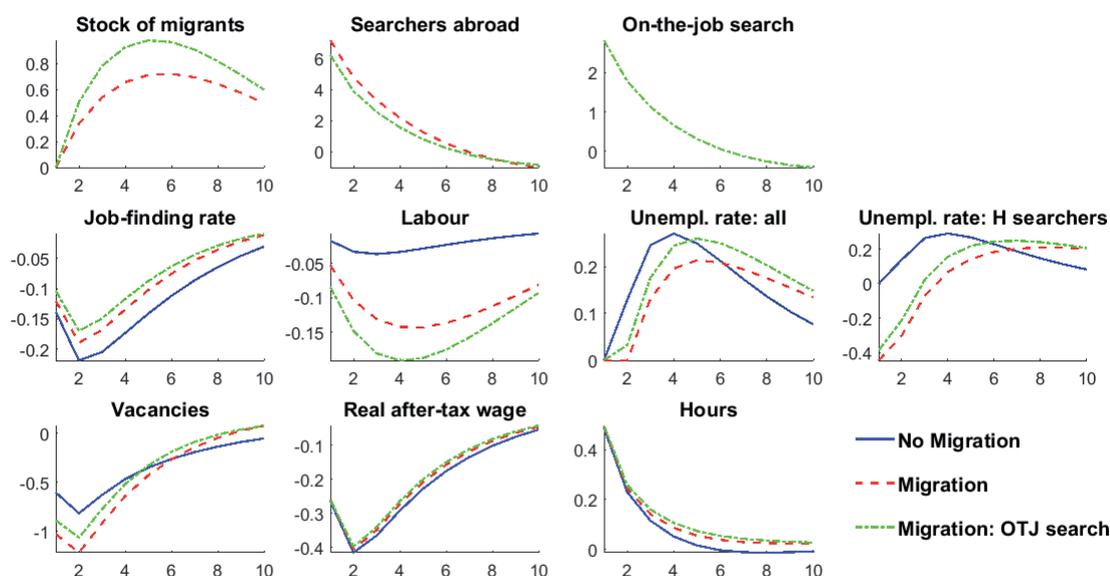
Figure 2: Emigration phases in Greek history (all age groups)



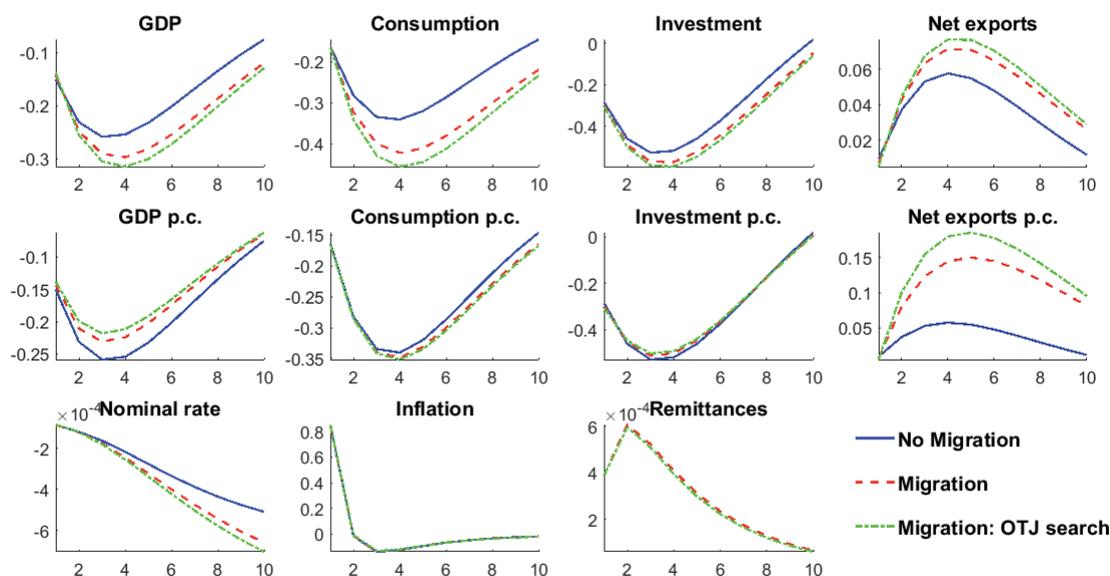
Source: updated graph from Lazaretou (2016)

Figure 3: A 1% negative shock to TFP

(a) Migration and Labour Market



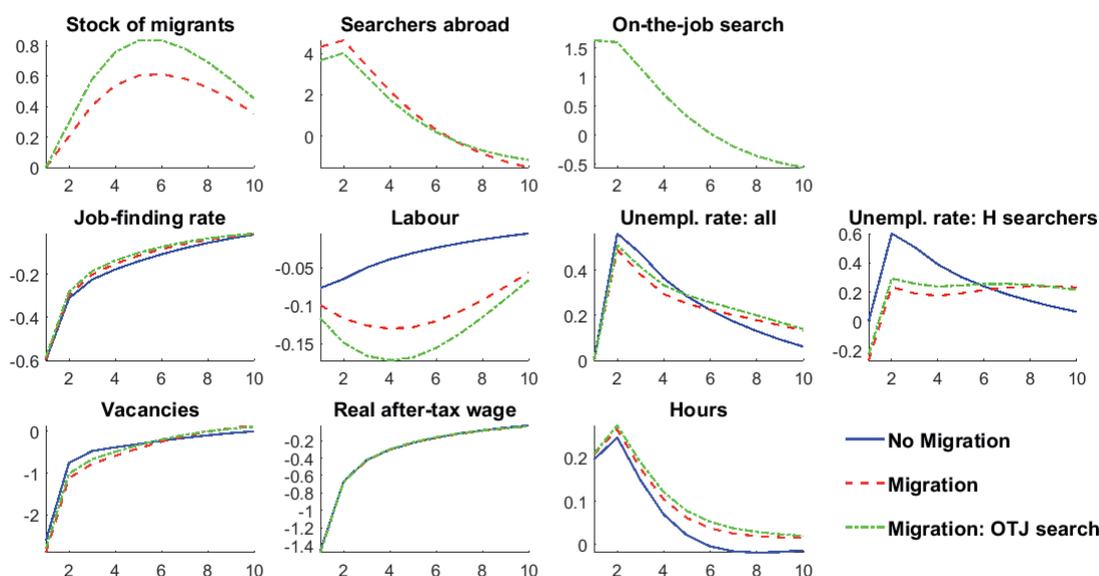
(b) Aggregates



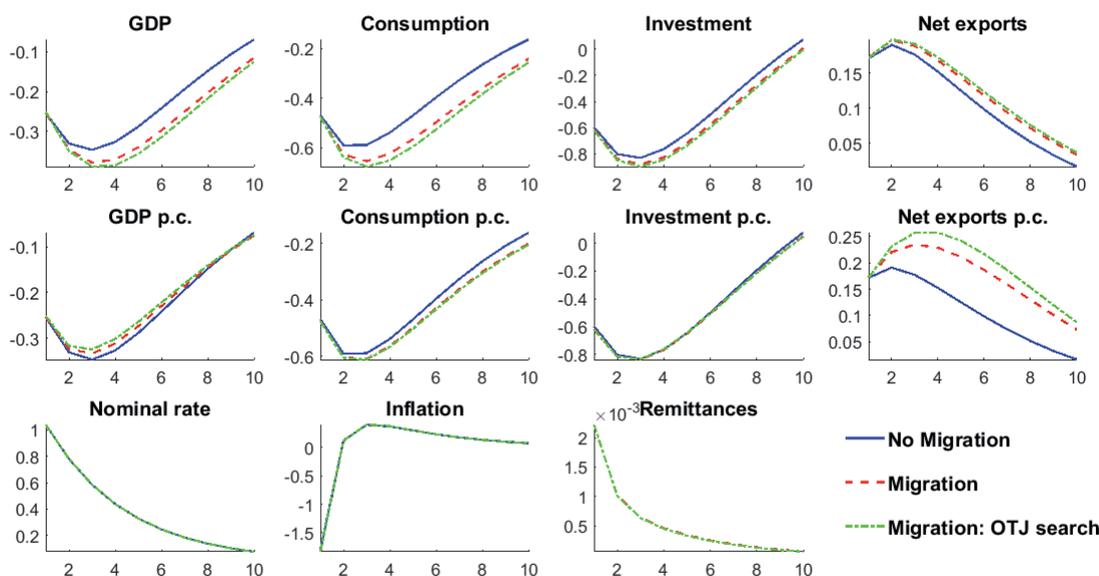
Responses for interest rates and inflation are shown in annualized levels. Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to consumption of the domestic good. OTJ denotes on the job and p.c. denotes per capita. Unempl. rate: all and Unempl. rate: H searchers denote measures of the unemployment rate including and excluding, respectively, the share of unemployed that look for a job abroad.

Figure 4: A risk premium shock inducing a 1% increase in the nominal interest rate

(a) Migration and Labour Market



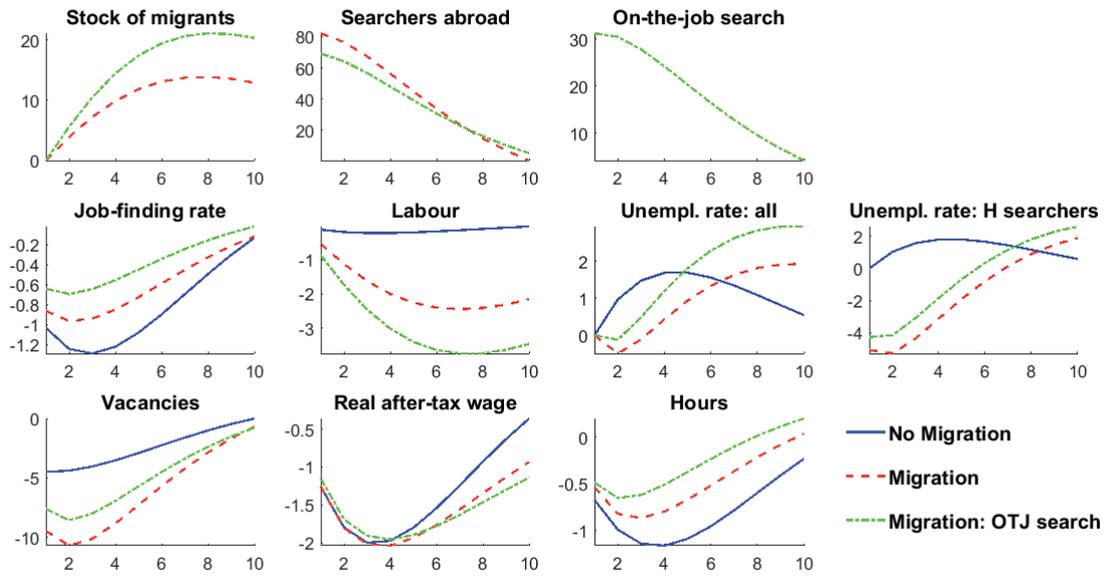
(b) Aggregates



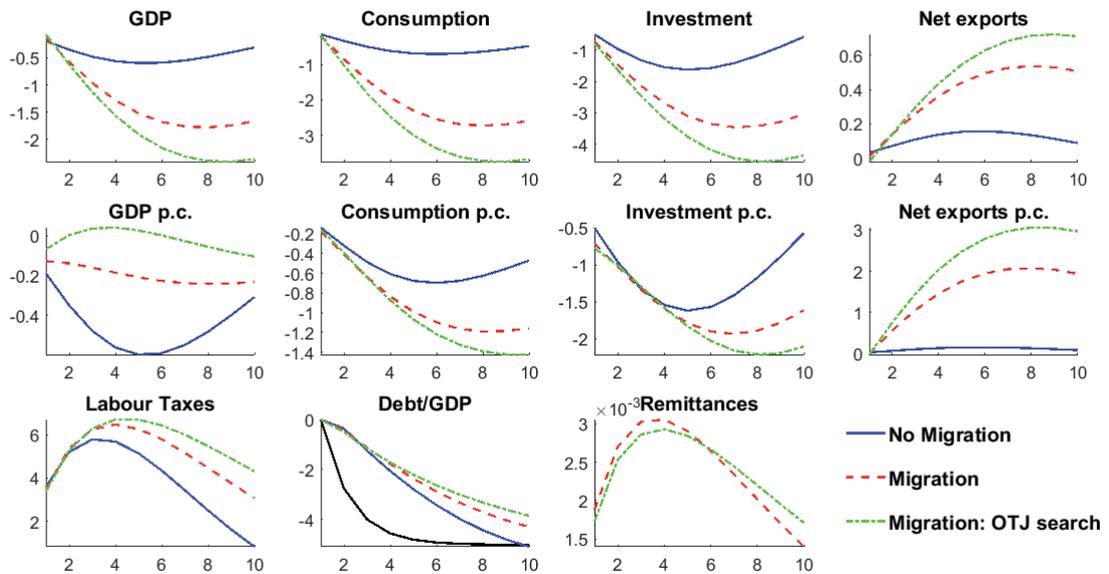
Responses for interest rates and inflation are shown in annualized levels. Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to consumption of the domestic good. OTJ denotes on the job and p.c. denotes per capita. Unempl. rate: all and Unempl. rate: H searchers denote measures of the unemployment rate including and excluding, respectively, the share of unemployed that look for a job abroad.

Figure 5: Tax-based consolidation

(a) Migration and Labour Market



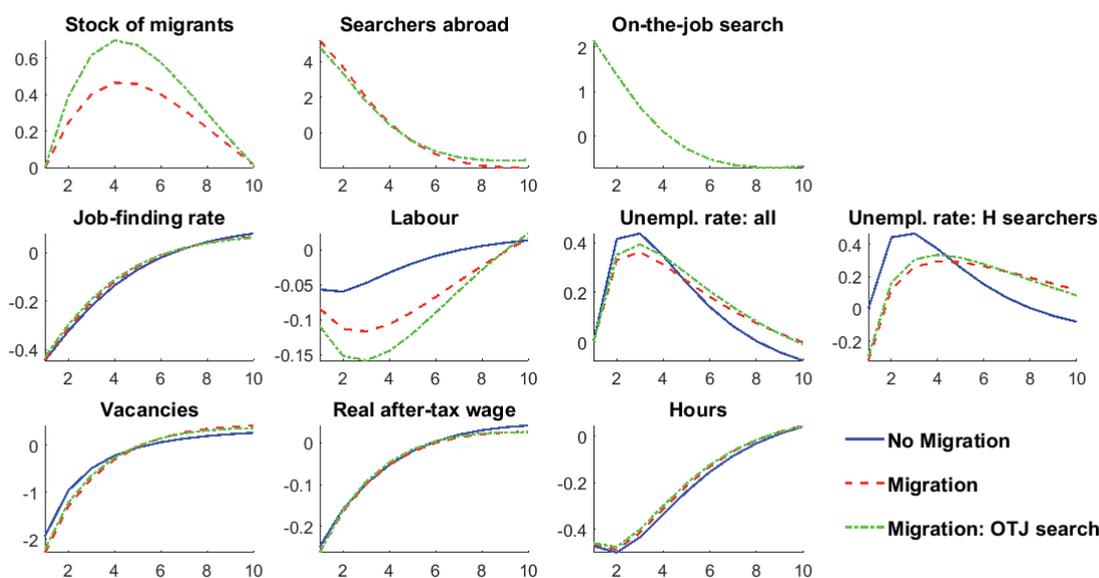
(b) Aggregates



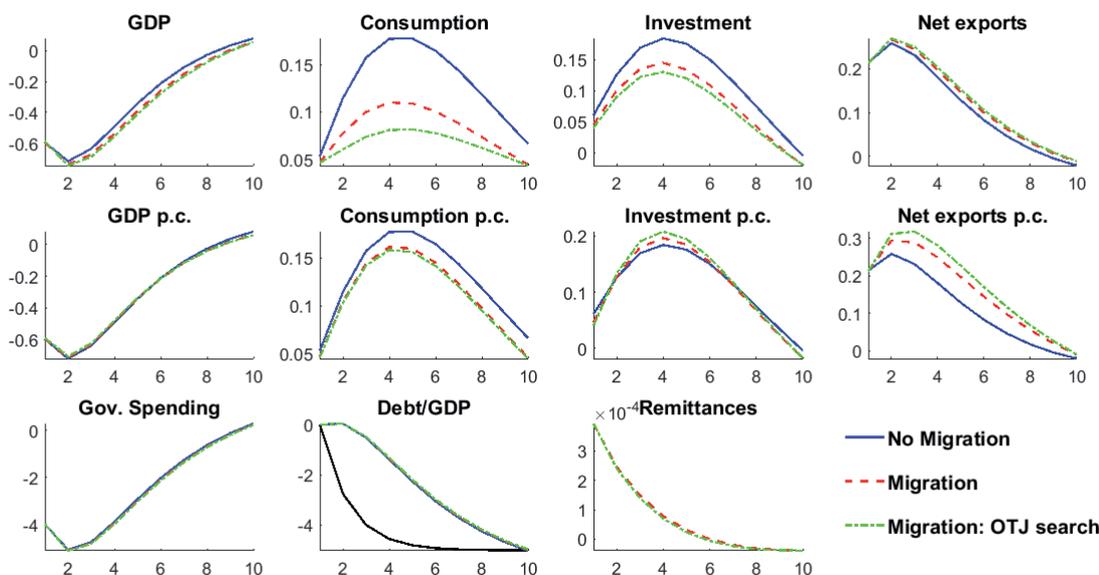
Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to consumption of the domestic good. OTJ denotes on the job and p.c. denotes per capita. Unempl. rate: all and Unempl. rate: H searchers denote measures of the unemployment rate including and excluding, respectively, 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

(a) Migration and Labour Market



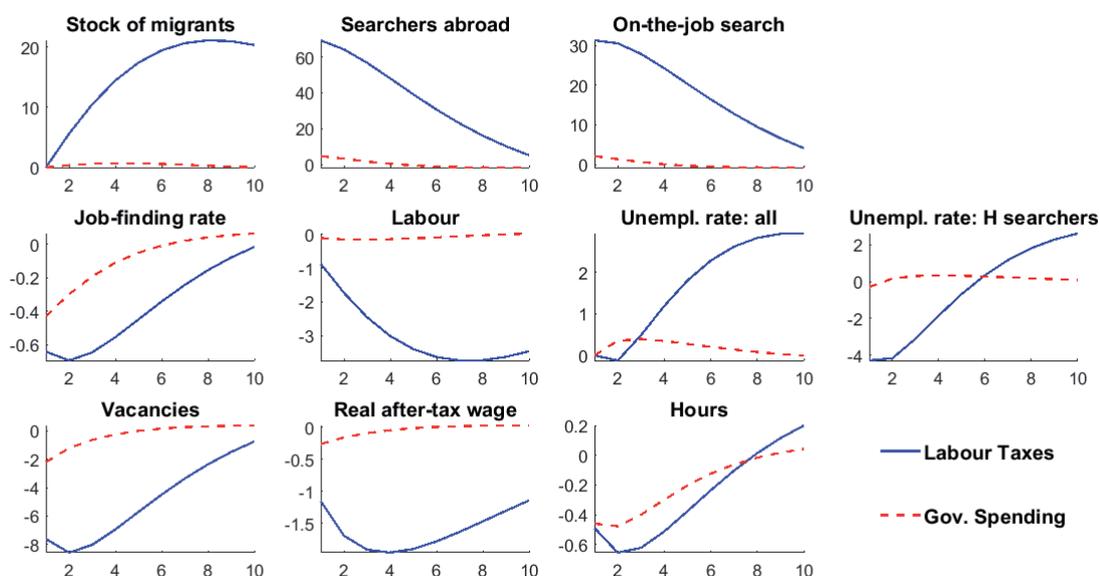
(b) Aggregates



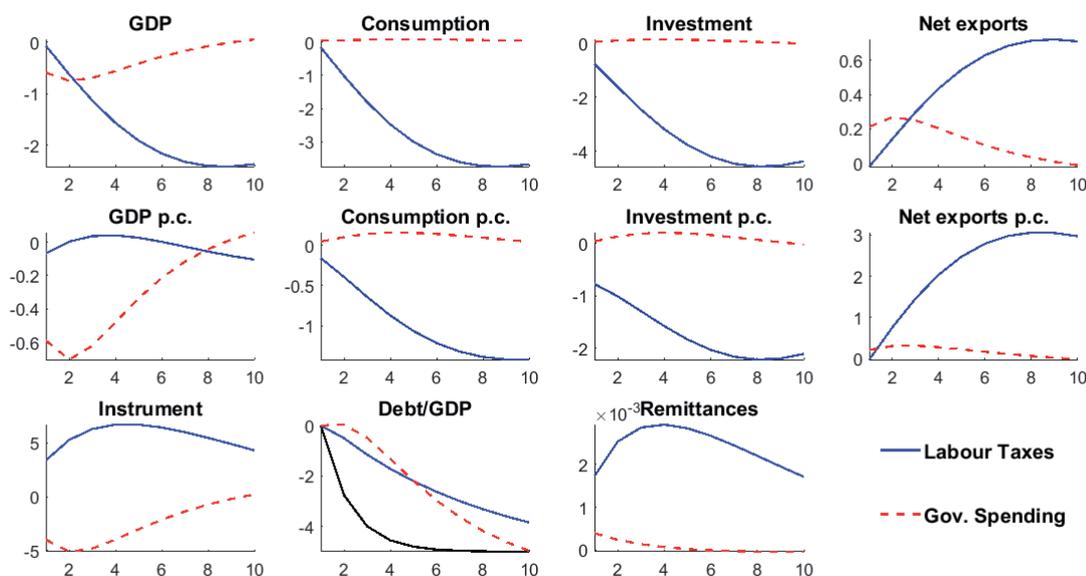
Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to consumption of the domestic good. OTJ denotes on the job and p.c. denotes per capita. Unempl. rate: all and Unempl. rate: H searchers denote measures of the unemployment rate including and excluding, respectively, 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 7: Comparison of instruments with labour force mobility

(a) Migration and Labour Market

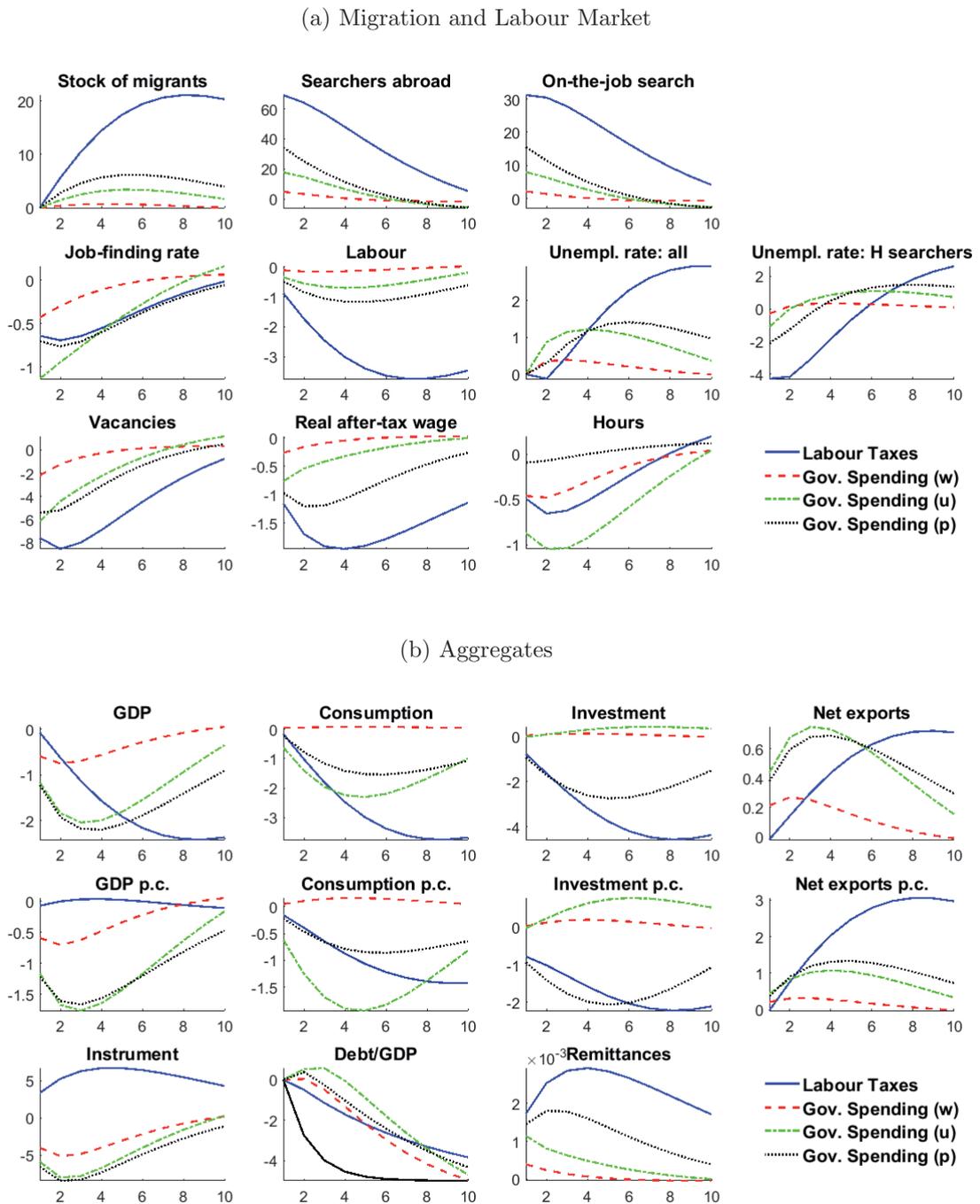


(b) Aggregates



Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to consumption of the domestic good. OTJ denotes on the job and p.c. denotes per capita. Unempl. rate: all and Unempl. rate: H searchers denote measures of the unemployment rate including and excluding, respectively, 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.

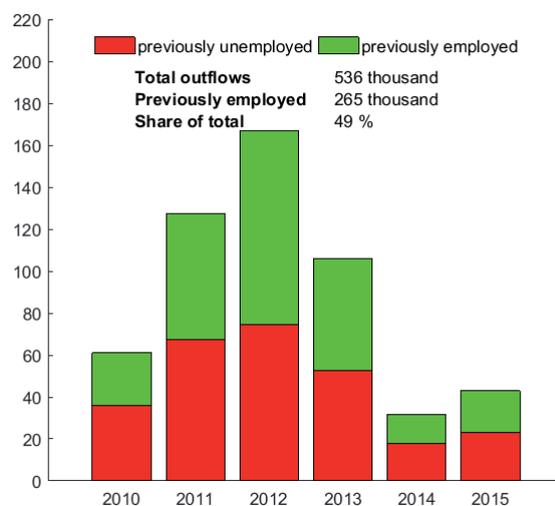
Figure 8: Comparison of additional instruments with labour force mobility



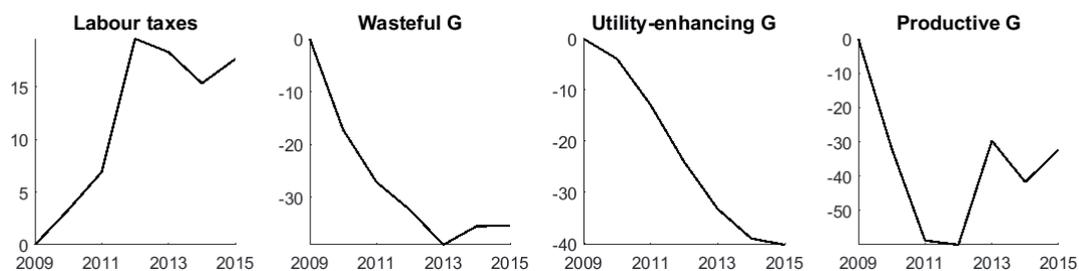
Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to consumption of the domestic good. OTJ denotes on the job and p.c. denotes per capita. Unempl. rate: all and Unempl. rate: H searchers denote measures of the unemployment rate including and excluding, respectively, 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. Regarding the role of government spending, (w), (u), (p) denote wasteful, utility-enhancing, productive, respectively.

Figure 9: Simulation exercise

(a) Composition and size of migration outflows



(b) Paths of tax-spending instruments



For the fiscal instruments we show growth rates in percentages relative to 2009. G denotes government spending.

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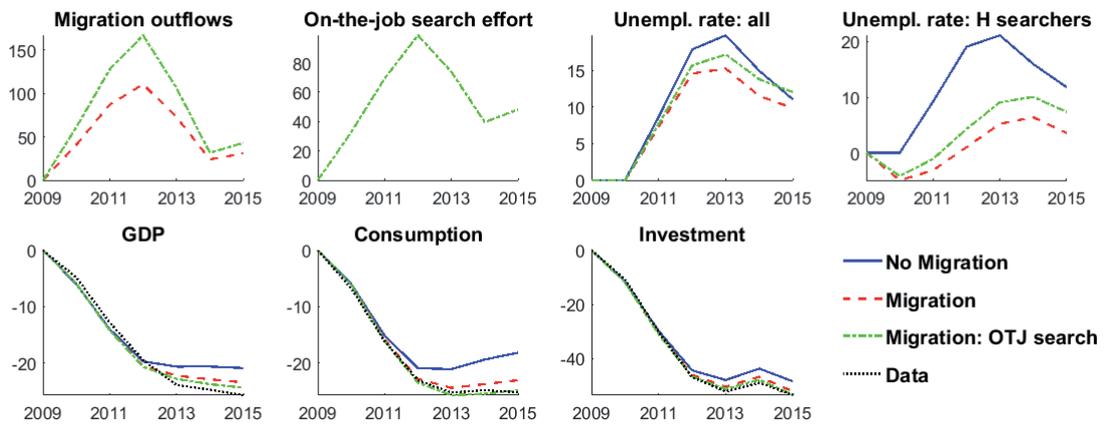
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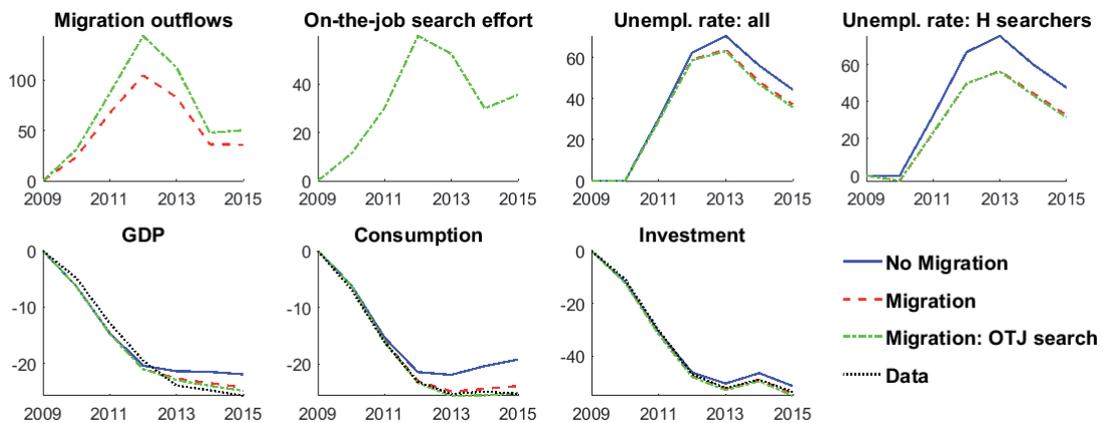
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Figure 10: Fiscal consolidation mix in Greece during the Great Recession: simulation results

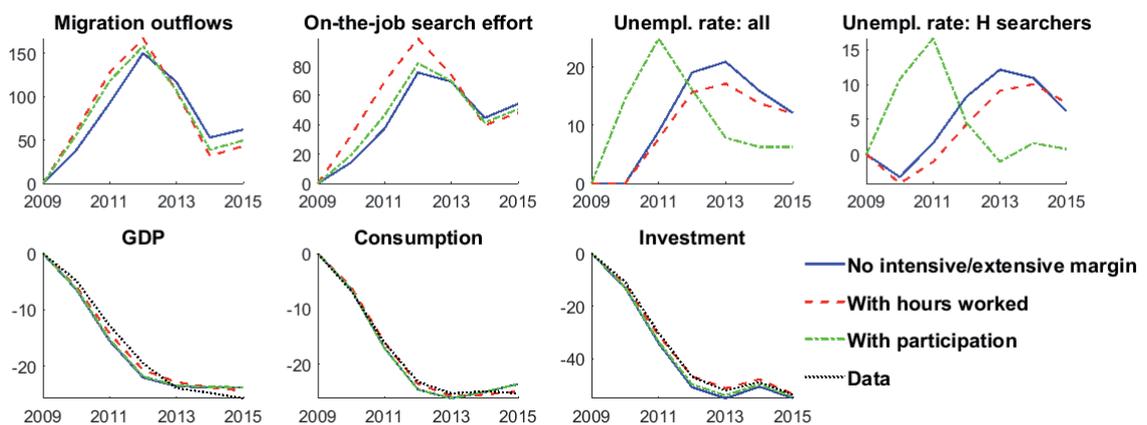
(a) Baseline calibration



(b) Higher bargaining power of firms



(c) Intensive and extensive margins (full model)



Responses for migration outflows are in levels (thousands persons). All other responses are in percent deviations from steady state. Consumption refers to consumption of the domestic good. OTJ denotes on the job. Unempl. rate: all and Unempl. rate: H searchers denote measures of the unemployment rate including and excluding, respectively, the share of unemployed that look for a job abroad.