Fiscal Austerity and Migration: A Missing Link*

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Abstract

In this paper we propose a new channel through which fiscal austerity affects the macroeconomy. To this end, we introduce endogenous migration both for the unemployed and the employed members of the household in a small open economy New Keynesian model with labour market frictions. Our model-based simulations for the austerity mix implemented in Greece over the period 2010-2015 show that the model is able to match the total size of half a million emigrants and output drop of 25%, while the model without migration generates an output drop of 20%. Having established that the model delivers empirically plausible results, we then use it to investigate (i) the two-way relation between migration and austerity, and (ii) the role of migration as shock absorber. We find that tax hikes induce prolonged migration outflows, while the effect of spending cuts is hump-shaped. In turn, emigration implies an increase in both the tax hike and time required to achieve a given size of debt reduction. As a result of the labour-reducing effect of these higher tax hikes, the unemployment gains from migration are only temporary in the presence of austerity and are substantially reversed over time.

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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 Fled Are Staying Put.)

1 Introduction

Worsening labour market conditions and fiscal tightness during the Great Recession have led to increased migration outflows from countries of Europe that suffered a deep deterioration of their economy (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, with Greece being the most obvious case.[1] 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 Figure 2).[2] This total outflow exceeds 7% of the working-age population.[3] Over the same period, the unemployment rate rose from 13% to 25%. On the fiscal front, Greece experienced the biggest bailout in global financial history, with austerity measures being a condition of the bailout. This paper studies the macro-dynamic effects of emigration, and its interaction with austerity, in the country of departure.

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 time of emigration. Second, migrants take with them not only their labour supply,

[1] Prior to the crisis, immigration from new member states of the EU or from outside the block contributed to migration surpluses in peripheral countries. Beyer and Smets (2015) have found a gradual convergence in labour mobility between Europe and the US recently, reflecting both a fall in interstate migration in the US and a rise in the role of migration in Europe.

[2] The total estimate of 612,400 emigrants in Figure 2 refers to all age groups, according to data from the Hellenic Statistical Authority (ELSTAT).

[3] In the case of Spain, outflows have exceeded 400,000 persons per year since 2010, which is, both in absolute and relative terms, the highest level of emigration in Spanish history. This figure is comparable to the average annual immigrant flow of 485,000 persons during the immigration boom of 2000-2006 (Bentolila et al. (2008)). Data for 2012 in (Izquierdo et al. (2016)) reveal that 39% of those outflows were directed to other EU countries and 31% to South America. In the case of Greece, Germany and the UK concentrate together more than half of the post 2010 emigration (Labrianidis and Pratsinakis (2016)).

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.[4] 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 (see e.g. Farhi and Werning (2014)). In most typical cases with relatively low 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. Since the recent evidence suggests that the majority of emigrants from Greece were highly skilled (see, e.g, Triandafyllidou and Gropas (2014), Labrianidis and Pratsinakis (2016)), we abstract from modeling different skill types.

The paper consists of two parts. In the first part, we perform model-based 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.[5] We show that the model is able to match the size and composition of migration out-

[4]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%. A *Hellenic Observatory* survey 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)).

[5]According to Gourinchas et al. (2016), who analyze the Greek crisis through the lens of a DSGE model,

flows in Greece over the period under examination. Moreover, the model without migration generates a fall in Greek output after 2012 close to 20%, whereas the model with labour force mobility matches much more closely the actual fall in output of 25%.

In the second part, we use this model to explore the mechanisms at play. We initially investigate the importance of the migration channel over the business cycle through the dynamic responses of the 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 such shocks increase 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 happens because 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,implemented via increases in labour income tax rates or cuts in public expenditures, by examing the effects on output and unemployment. For public spending 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 hump-shaped 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

fiscal consolidation accounted for half of the Greek output drop.

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.

Our paper adds to the migration literature by exploring the macro-dynamic effects of endogenous labour force mobility, and its interaction with austerity, in the country of departure. We therefore depart from previous work that examines the implications of migration for the destination economy using static models with labour market frictions (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)). There is very little work so far using macro-migration models with labour market frictions in a dynamic setting, but none of it studies the interaction of austerity with migration (see, e.g., House et al. (2018), Kiguchi and Mountford (2018), and Lozej (2018)).[6] 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 theoretical 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), House et al. (2017)), which has so far considered an immobile labour force.

The results of the paper have novel policy implications. First, we shed light on the impact of austerity measures on emigration and output. Specifically, we show that labour income tax hikes and government spending cuts affect migration outflows differently. A tax-based consolidation induces significant and prolonged migration outflows, while the effect of a spending-based consolidation is hump-shaped due to the opposite forces of the negative demand effect and the positive wealth effect. Given the different impact on emigration, our results then underscore 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 highlight the implications of migration outflows for austerity. In particular, we find that emigration implies an increase both in the tax hike and time required to achieve a given size of fiscal consolidation. This is because emigrants become tax payers abroad, which leads

[6] For models without labour market frictions, see e.g. Storesletten (2000), Canova and Ravn (2000), Mandelman and Zlate (2012), Farhi and Werning (2014), and Hauser (2017). For recent empirical studies, see, e.g., Dustmann and Frattini (2014), Furlanetto and Robstad (2017), d'Albis et al. (2018).

to a “leakage” in tax revenues in the country of origin. A higher tax hike has then to be imposed, which increases the negative impact in the labour market and further reduces the tax base in the economy. In other words, austerity shocks become more contractionary in the presence of migration reinforcing the increase in the debt-to-GDP ratio as a consequence of endogenous reductions in economic activity and tax revenue. Third, we shed light on the role of migration as shock absorber. We demonstrate that unemployment gains from migration are only temporary following 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. Especially in the case of tax-based consolidation, 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.

The rest of the paper is organized as follows. Section 2 lays out our DSGE model and Section 3 discusses the calibration strategy. Sections 4 presents our simulations for the fiscal consolidation mix implemented in Greece, while Sections 5 and 6 analyze the dynamic responses to business-cycle and consolidation shocks. Finally, Section 7 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.[7] 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

[7]As discussed in Section 4.2 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.

supply decisions (hours), consumption and savings are defined at the household level.[8] 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. In order to do this, we assume that 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. For public spending we consider various roles, namely wasteful, productive and utility-enhancing spending. Implementation of debt consolidation occurs through labour income tax hikes or public spending cuts.

Finally, we note that the model features habit formation and investment adjustment costs, which are critical to generating smooth responses with reasonable degrees of nominal rigidities. 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.

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

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

[8]See Andolfatto (1996) for an application of the big household assumption in a framework with labour-market search.

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

$$N_t = n_t + u_t \,. \tag{2}$$

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 $\varsigma(\tilde{s}_t \tilde{u}_t)$, where $\tilde{s}_t$ and $\tilde{u}_t$ are the average shares of s_t and u_t per household and the function $\varsigma(\tilde{s}_t \tilde{u}_t)$ is increasing in both arguments. This endogenous cost function (see Section 3 for the specific functional form) links positively the cost of search abroad with the number of unemployed who search for foreign jobs, helping 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:

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

where m_t denotes matches, υ_t denotes vacancies posted by firms, μ_1 measures the efficiency of the matching process and μ_2 denotes the elasticity of the matching technology with respect to vacancies.[9] 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:

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

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 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

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

[9] 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).

where σ denotes the exogenous separation rate and $\psi_H^\star \varphi(z_t)$ accounts for those workers that move abroad to join the measure of employed migrants.[10]

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

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

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 $c_{e,t}$,

$$C_t = c_t + c_{e,t} , \tag{6}$$

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

$$U\left(C_t, g_t^c, h_t, n_{e,t}\right) = \frac{\Phi_t^{1-\eta}}{1-\eta} - \chi \frac{\left(h_t^{1+\xi} n_t + h_e^{1+\xi} n_{e,t}\right)}{1+\xi} - \Omega \frac{(n_{e,t})^{1+\mu}}{1+\mu} , \tag{7}$$

where $\Phi_t \equiv \left[(1-\alpha_1)\left(C_t - \zeta \tilde{C}_{t-1}\right)^{\alpha_2} + \alpha_1 \left(g_t^c,\right)^{\alpha_2}\right]^{\frac{1}{\alpha_2}}$, g_t^c, denotes utility-enhancing public expenditure, η is the inverse of the intertemporal elasticity of substitution, ζ is the parameter determining external habits in aggregate consumption where the consumption reference is taken as given by the household, with $\tilde{C}_t = C_{t-1}$ in equilibrium. The strictly positive parameters $\mathit{\Omega}$, χ, μ and ξ 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;

[10] 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)).

difficulties experienced with bureaucracy and integration, as well as families ties between the migrant and the non-migrant members of the household.[11] 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 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 Bermperoglou et al. (2017)). The Cobb-Douglas specification is obtained when the elasticity is equal to zero.

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

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

where $\varsigma\,(\tilde{s}_t \tilde{u}_t)\, s_t u_t$ 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 Π_t^p are profits from monopolistic retailers. The depreciation rate of capital is δ_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, τ^c, τ^k, τ_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 $r_{f,t}$.[12] 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),

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

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

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

The rationale behind (10) is that remittances represent an altruistic compensation mechanism between migrant and domestic workers. Note that we do not include cross-country

[11] 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 4.

[12] 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).

differentials in unemployment benefits as we do not intend to study those as drivers of the migration decisions of the household. In other words, assuming $\rho_\Xi > 0$, a relative improvement in the net wage premium abroad leads to an increase in remittances. Purchases 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)).[13] As argued in the Introduction (see footnote 4), evidence from World Bank data and from recent surveys suggests that the role of remittances has been very small in the recent emigration wave from Greece. This is captured in our calibration (see below).

The household owns the capital stock, which evolves according to

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

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 4), and ω dictates the size of investment adjustment costs. Following Neiss and Pappa (2005), the depreciation rate δ_t depends on the degree x_t, of capital utilization according to

$$\delta_t = \bar{\delta} x_t^{\iota} \,, \tag{12}$$

where $\bar{\delta}$ and ι 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. 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

[13] 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.

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

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

$$\psi_H^\star\lambda_{e,t} - \lambda_{c,t}\varsigma\left(\tilde{s}_t\tilde{u}_t\right) = \lambda_{n,t}\psi_{H,t}, \tag{15}$$

$$\lambda_{c,t}\frac{\phi'\left(z_t\right)}{\varphi'\left(z_t\right)} = \psi_H^\star\left(\lambda_{e,t}-\lambda_{n,t}\right). \tag{16}$$

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.[14] 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 $\psi_H^\star$ respectively. Equation (13) also accounts for the fact that with probability $\psi_H^\star\varphi\left(z_{t+1}\right)$ a current worker will quit to take up a job abroad.[15] 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.[16]

[14] Note that a new match becomes productive next period.

[15] 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.

[16] In the scenarios we analyze below, we only consider cases where $\lambda_e > \lambda_n$ is true in the steady state.

2.1.3 Intermediate goods firms

Intermediate goods are produced with a Cobb-Douglas technology,

$$y_t \;\; = \;\; A_t \left(n_t h_t\right)^{1-\alpha} \left(x_t k_t\right)^{\alpha} \left(g_t^y,\right)^{\nu}, \tag{17}$$

where k_t and n_t are capital and labour inputs, x_t is the degree of capital utilization, A_t is an exogenous stationary TFP process and g_t^c, denotes the productive component of public expenditure. The parameter ν regulates how the public input affects private production: when ν is zero, government spending is unproductive.[17]

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 υ_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

$$n_{t+1} = \left(1 - \sigma - \psi_H^{\star} \varphi\left(z_t\right)\right) n_t + \psi_{F,t} \upsilon_t \,,$$

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

$$Q(n_t) = \max_{x_t k_t, \upsilon_t} \left\{ p_{x,t} y_t - w_t h_t n_t - r_t^k x_t k_t - \kappa \upsilon_t + \mathrm{E}_t \beta_{t+1} Q(n_{t+1}) \right\} \,,$$

where $p_{x,t}$ is the relative price of intermediate goods with the final good being the numeraire, κ 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

$$r_t^k \;\; = \;\; \alpha \frac{p_{x,t} y_t}{x_t k_t} \,, \tag{18}$$

and

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

[17]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.

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 σ the match can be destroyed and that a termination can also occur due to cross-border job matches captured by $\psi_H^{\star}\varphi(z_{t+1})$.

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

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

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 $\varsigma(\tilde{s}_t \tilde{u}_t)$.

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

$$\psi_{H,t} \mathrm{E}_t \left(\beta_{t+1} S_{t+1}^H\right) = \psi_H^{\star} \mathrm{E}_t \left(\beta_{t+1} S_{h,t+1}^F\right) - \varsigma(\tilde{s}_t \tilde{u}_t) .$$

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

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

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

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

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 $\varphi(z_t)\varsigma(\tilde{s}_t\tilde{u}_t)$ 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 $\varsigma(\tilde{s}_t\tilde{u}_t)$. 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

Following standard practice in the DSGE literature with New Keynesian models, we introduce price stickiness through monopolistic competition. 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

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

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 $p^*_{r,t} \equiv P^*_r/P_t$ is

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

with

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

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

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

$$(P_{r,t})^{1-\epsilon} = \lambda_p (P_{r,t-1})^{1-\epsilon} + (1-\lambda_p) \left(P^*_{r,t}\right)^{1-\epsilon} . \tag{24}$$

The aggregate tradable good is sold domestically and abroad

$$y_{r,t} \quad = \quad y_{l,t} + y_m^\star \,, \tag{25}$$

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

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

The home bias parameter ϖ denotes the fraction of the final good that is produced locally. The elasticity of substitution between home-produced and imported goods is given by γ. Final good producers maximize profits $y_{f,t} - p_{r,t} y_{l,t} - e_t p^\star_{r,t} y_{m,t}$ each period, where $p_{r,t}$ and $p^\star_{r,t}$ 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

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

and

$$y_{m,t} \quad = \quad (1-\varpi) \left(e_t p^\star_{r,t}\right)^{-\gamma} y_{f,t}. \tag{28}$$

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

$$1 \quad = \quad \varpi \left(p_{r,t}\right)^{1-\gamma} + (1-\varpi) \left(e_t p_r^\star\right)^{1-\gamma} , \tag{29}$$

where $p_r^\star = P_r^\star / P^\star$ 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. A graphical illustration of the model for the households and firms is presented in Figure 3.

2.1.7 Government

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

$$DF_t = \mathrm{b}u_t + g_t + T_t - \tau_t^n w_t h_t n_t - \tau^k (r_t^k - \delta_t) x_t k_t - \tau^c c_t \tag{30}$$

and the government budget constraint is given by

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

The composition of total government spending is given by

$$g_t \;\; = \;\; g_t^w + g_t^c + g_t^y\,, \tag{32}$$

where g_t^w, g_t^c, g_t^y denote the wasteful, utility-enhancing and productive components of public expenditure, respectively.

2.1.8 Resource constraint

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

$$y_{f,t} \;\; = \;\; c_t + i_t + g_t^w + \kappa \upsilon_t + \phi\left(z_t\right) n_t + \varsigma\left(\tilde{s}_t \tilde{u}_t\right) s_t u_t. \tag{33}$$

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

$$e_t\left(r_{f,t-1} b_{f,t-1} - b_{f,t}\right) \;\; = \;\; nx_t + e_t \Xi_t\,, \tag{34}$$

where nx_t are net exports defined as

$$nx_t \;\; = \;\; p_{r,t} y_{m,t}^{\star} - e_t p_r^{\star} y_{m,t}\,. \tag{35}$$

The equation for exogenous exports is given by

$$y^{\star}_{m,t} \;=\; \left(\frac{p_{r,t}}{e_t}\right)^{\gamma_x} \overline{y^{\star}_m}\,, \tag{36}$$

where γ_x is the price elasticity of exports and $\overline{y^{\star}_m}$ 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

$$gdp_t \;=\; y_{f,t} + nx_t\,. \tag{37}$$

Using (25) and (35), together with the equilibrium condition $y_{f,t} = p_{r,t}y_{l,t} + e_t p^{\star}_r y_{m,t}$, real GDP can be equivalently expressed as

$$gdp_t = p_{r,t}y_{r,t}\,. \tag{38}$$

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

$$e_t \;=\; \frac{E \cdot P^{\star}}{P_t}\,.$$

The nominal interest rate R_t is then pinned down endogenously through the Fisher equation[18]

$$r_t \;=\; \frac{R_t}{\mathrm{E}_t \pi_{t+1}}\,. \tag{39}$$

where consumer price inflation π_t is defined as

$$\pi_t \;=\; \frac{P_t}{P_{t-1}}\,. \tag{40}$$

[18] 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.

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,

$$r_{f,t} \quad = \quad r^{\star} exp\left\{\Gamma\left(\frac{e_t b_{f,t+1}}{gdp_t} - \frac{\overline{e}\overline{b_f}}{\overline{gdp}}\right) + \epsilon_{r,t}\right\} \tag{41}$$

where Γ is the elasticity of the risk premium with respect to liabilities (see Schmitt-Grohé and Uribe (2003)), $\overline{b_f}$ and $\overline{e}$ 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. Table 1 shows the key parameters and steady-state values we target.

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 World Bank data.

Utility function

Following the literature, we set the discount factor β to 0.96, implying an annual interest rate of 4%. Regarding the inverse elasticity of intertemporal substitution η, 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 γ_x to 0.2. The elasticity of hours worked is fixed to 1, while the relative weight in utility χ is implicitly determined through the bargaining expression for hours (see the Online Appendix) which we normalize in the steady state to unity. In Section 4.2, we also explore a version of the model without the intensive margin. Using the FOC of the household with respect to $g_{c,t}$ in the steady state, and simplifying further by using the FOC with respect to c_t, allows us to pin down the following parameter value

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

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.[19]

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 λ_p equal to 0.25, which is a standard value on an annual basis, and the degree of investment adjustment costs ω equal to 4. Using the FOC of the firm with respect to $g_{y,t}$ in the steady state allows us to pin down the following parameter value:

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

Labour market

We start by normalizing total Home nationals $\bar{n}$ to unity, of which 10% reside abroad.[20] 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 μ_1. We calibrate the job-finding probability

[19]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).

[20]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.

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 4, 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 κ 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, $\varsigma(\tilde{s}_t \tilde{u}_t)$ 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:

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

The scale parameters for search costs ς_{s1} and ϕ_{z1}, as well as the weight on the utility cost of migration Ω, 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 $w^\star/w = 1.10$. 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. Note that the choice of a not very high wage premium abroad is driven by trying not to assume extremely high migration costs. We then normalize search effort z to 1 and use the parameter for the on-the-job search effort productivity φ_{z1} to determine the steady-state number of workers that are matched to a job abroad. The remaining parameters ϕ_{z2}, ς_{s2}, φ_{z2} together with the elasticity of the utility cost of living abroad μ largely determine the magnitude of migration outflows in response to shocks. We set ϕ_{z2} and ς_{s2} such that the migration outflows in our simulations for Greece in Section 4 match (i) the total magnitude of migration outflows (equal to half a million people) 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 φ_{z2} jointly with ϕ_{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.[21] Finally, the elasticity of the utility cost of living abroad μ is normalized to 1. The higher the value of μ, 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. As presented below, the disutility of living abroad is associated with realistic results in the model about return migration over time after negative business-cycle shocks or a spending-based consolidation.

Policy

The elasticity of the spread between domestic and foreign interest rates Γ is set equal to 0.001. For the steady-state output shares of the government spending components, we use $g^w/GDP = 0.0533$, $g^c/GDP = 0.1048$ and $g^y/GDP = 0.0512$, based on annual Greek data from Eurostat. Specifically, for g^w we use *Government's Final Consumption Expenditure*, taking out compensation of employees (which we do not model) and consumption expenditure in the health and education sectors; 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.

4 Simulations for the Fiscal Policy Mix in Greece

We start by examining 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.

[21] 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 $\overline{z}$ 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 $\varphi_{z2} > 1$.

In the analysis that follows, we present 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).

4.1 Baseline simulations

We obtain annual data on the various components of public expenditure components from Eurostat. 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 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)). We construct effective taxes following the methodology of Mendoza et al. (1994). Figure 4a 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 531,000 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 51%.

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 4b). 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 5. Panel 5a 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. Specifically, the model without migration generates a fall in Greek output close to 20% after 2012, whereas the model with labour force mobility matches much more closely the actual fall in output of 25%. 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%). Note that 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 medium run. 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 bigger difference in unemployment with and without labour mobility. We further investigate the unemployment response in the sensitivity analysis that follows.

4.2 Sensitivity analysis

In models with search and matching frictions the volatility of unemployment is somehow limited. However, as Panel 5b illustrates, if we raise the firms' bargaining power to a higher value (equal to 0.7), we do get a much larger increase in unemployment (of around 60% higher than the steady-state level), as captured by the conventional measure .[22] 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

[22]See the evidence presented in ILO (2014).

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 5c 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 5a 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.[23] 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 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 due to the negative income effect of the risk-premium shock.[24]

5 Migration Over the Business Cycle

In this section we examine the responses of the main macroeconomic and labour market variables to standard business cycle shocks, namely a negative productivity shock and a risk premium shock, which we assume follow an auto-regressive form with one lag and coefficient $\rho = 0.75$. The goal is to examine the behaviour of migration variables and the impact of

[23] We modify the utility function as follows

$$U\left(C_t, g_t^c, h_t, n_{e,t}\right) = \frac{\Phi^{1-\eta}}{1-\eta} - \chi \frac{\left(h_t^{1+\xi} n_t + h_e^{1+\xi} n_{e,t}\right)}{1+\xi} - \Omega \frac{\left(n_{e,t}\right)^{1+\mu}}{1+\mu} + X \frac{l_t^{1-\varphi_l}}{1-\varphi_l}, \tag{42}$$

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 φ_l is the inverse of the Frisch elasticity of labour supply, which takes the standard value 4 in our calibration.

[24] 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.

migration on economic aggregates in comparison to a counterfactual scenario of labour force immobility.

5.1 TFP shock

Figure 6 reports the responses of the model for a negative TFP shock. Panel 6a shows the migration and labour market variables, while Panel 6b 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.

5.2 Risk premium shock

Next, in Figure 7 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 7a shows the migration and labour market variables, while Panel 7b 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 5.1 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.

6 Migration and Fiscal Consolidation

In this section, we compare the effects of tax hikes versus spending cuts by considering one fiscal consolidation instrument at a time.

6.1 Adding fiscal consolidation in the model

Let us assume that government has two potential fiscal instruments, labour income tax rates τ_t^n and public expenditure g_t^f where $f = w, c, y$ for the different components of spending (i.e. wasteful, consumption, productive). The other tax rates, τ^k and τ^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 $\Psi \in \{\tau^n, g^f\}$, 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 Δ. Specifically, we assume

$$\Psi_t = \Psi^{(1-\beta_{\Psi 0})}\ \Psi_{t-1}^{\beta_{\Psi 0}} \left[\left(\frac{\tilde{b}_{g,t}}{b_{g,t}^T} \right)^{\beta_{\Psi 1}} \left(\frac{\Delta \tilde{b}_{g,t+1}}{\Delta b_{g,t+1}^T} \right)^{\beta_{\Psi 2}} \right]^{(1-\beta_{\Psi 0})}, \tag{43}$$

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

$$\log b_{g,t}^T - \log b_{g,t-1}^T = \rho_1(\log b_{g,t-1}^T - \log b_{g,t-2}^T) + \rho_2(\log \bar{b} - \log b_{g,t-1}^T) - \varepsilon_t^b\,, \tag{44}$$

where $\bar{b}$ is the steady-state level of the debt-to-GDP ratio, ε_t^b is a white noise process representing a fiscal consolidation shock, $0 \leq \rho_1 < 1$ and $\rho_2 > 0$. 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)).[25]

Below we consider a shock that drives the debt-to-GDP target $b_{g,t}^T$, determined by (44), 5% below its steady state. We simulate the responses to this shock with labour income taxes or government spending adjusting through (43) so that the actual debt-to-GDP ratio $\tilde{b}_{g,t}$ meets the new lower target after 10 years 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 without migration. 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 2). We calibrate the debt target rule (44) setting $\rho_1 = 0.6$ and $\rho_2 = 0.000001$ so that about half of the convergence to the new long-run debt target is achieved after five years, and that the debt target is fully implemented after 10 years (see Erceg and Lindé (2013)).[26] For the fiscal rule (43), 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, lower target at the same time across the different instruments and at 10 years after the decision to consolidate is taken.

6.2 Labour tax hikes

We begin with the case of tax-based consolidation, depicted in Figure 8 where Panel 8a shows the migration and labour market variables, while Panel 8b 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

[25] Note that studying the possibility of sovereign default is beyond the scope of our paper.

[26] In line with Erceg and Lindé (2013), the debt target is eventually assumed to converge back to the steady state level $\bar{b}$, as we are considering a stationary model, but by setting $\rho_2 = 0.000001$, the convergence is very slow and irrelevant for the analysis in the short- and medium-term.

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.

6.3 Public spending cuts

We turn next in Figure 9 to the case of cuts in wasteful government spending, which is usually the type of public expenditure analyzed in the literature (see, e.g., Erceg and Lindé (2013)). 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 hump-shaped effect 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.

6.4 Comparison of all instruments

We have considered so far cuts in wasteful government spending. We now extend our analysis to also consider the role of utility-enhancing and productive public expenditure, g_t^c and g_t^y respectively. 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 remain fixed at its steady state value.

Figure 10 compares the three spending instruments and labour tax hikes in the full model (with job search abroad for both the unemployed and the employed).[27] Regarding the migration and labour market variables shown in Panel 10a, 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 10b, 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-enhacing 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.

Why tax hikes have a more favourable impact on per capita GDP and unemployment for stayers for so many periods than wasteful spending cuts? The answer is that by inducing stronger migration outflows than spending cuts, they reduce the resident population by sig-

[27]In the Online Appendix we include the responses to a spending-based consolidation when public expenditure is utility-enancing 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.

nificantly 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. 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.

7 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 first showed that 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. Moreover, the model without migration generates a fall in Greek output after 2012 close to 20%, whereas the model with labour force mobility matches much more closely the actual fall in output of 25%.

We then 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.

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 countries with a sizeable public sector (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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Tables

Table 1: Calibration

National accounts:		
per capita real GDP	gdp	1.00
private consumption / GDP	C/gdp	0.62
private investment / GDP	i/gdp	0.18
imports / GDP	y_m/gdp	0.25
public debt / GDP	$\bar{b}$	1.27
net foreign assets / GDP	b_f/gdp	0.10
remittances / GDP	Ξ/gdp	0.03
Utility:		
discount factor	β	0.96
intertemporal elasticity	η	1.01
external habits in consumption	ζ	0.75
home bias in consumption	ϖ	0.75
elasticity home/imported goods	γ	1.20
elasticity exports	γ_x	0.20
elasticity hours worked	ξ	1.00
weight hours worked	χ	1.68
Production:		
capital share in production	α	0.33
capital depreciation rate	$\bar{\delta}$	0.088
investment adjustment costs	ω	4.00
price monopolistic elasticity	ϵ	11
price Calvo lottery	λ_p	0.25
Labour market:		
unemployment rate	$u/(u+n)$	0.12
stock of migrants	$m_e/\bar{n}$	0.10
vacancy-filling probability	ψ_F	0.70
job-finding probability	ψ_H	0.60
job-finding probability abroad	$\psi_H^\star/\psi_H$	1.60
wage premium abroad	$w^\star/w$	1.10
firm's bargaining power	ϑ	0.38
vacancies matching elasticity	μ_2	ϑ
vacancy posting costs	$\kappa v/w$	0.15
net replacement rate	$\mathrm{b}/\left[(1-\tau_n)\,w\right]$	0.41
termination rates	σ, $\sigma^\star$	0.072

Table 1: Calibration (continued)

Migration and search abroad:		
on-the-job search effort	$\bar{z}$	1.00
on-the-job search abroad cost	ϕ_{z1}, ϕ_{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	Ω, μ	0.64, 1.00
Policy:		
elasticity country premium	Γ	0.001
wasteful gov. spending / GDP	g^w/gdp	0.0533
utility-enhanching gov. spending / GDP	g^c/gdp	0.1048
productive gov. spending / GDP	g^y/gdp	0.0512
labour income tax	τ^n	0.30
capital income tax	τ^k	0.20
consumption tax	τ^c	0.10

Table 2: Parameterization of the debt-target and fiscal rules

debt target parameters	ρ_1, ρ_2	0.6, 0.000001
fiscal rule parameters: τ^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
fiscal rule parameters: g^c	$\beta_{gc0}, \beta_{gc1}, \beta_{gc2}$	0.35, -3.35, -5
fiscal rule parameters: g^y	$\beta_{gy0}, \beta_{gy1}, \beta_{gy2}$	0.35, -9, -10

Figures

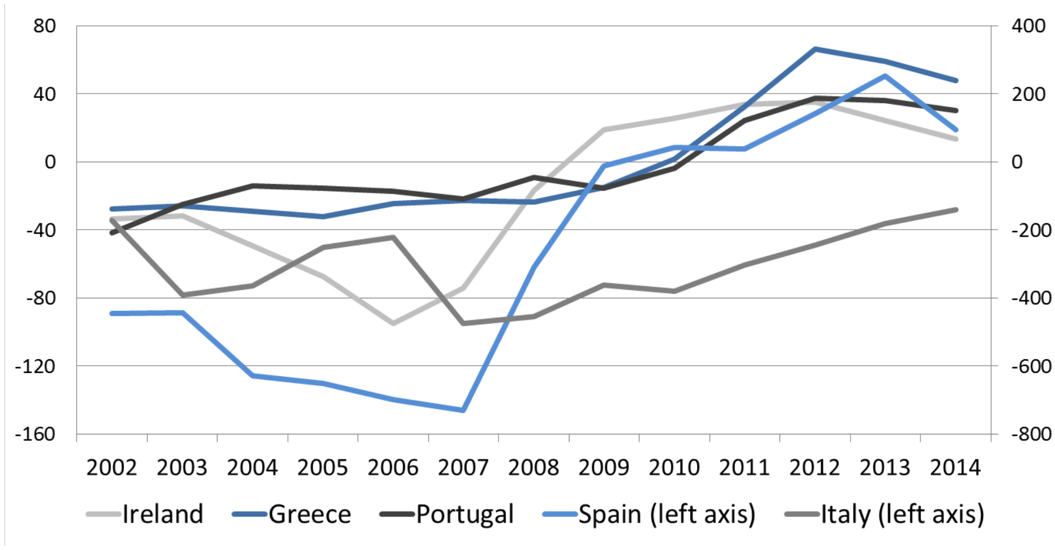


Figure 1: Net migration flows, defined as outflows minus inflows (in thousand persons), from Europe's periphery, Source: Eurostat

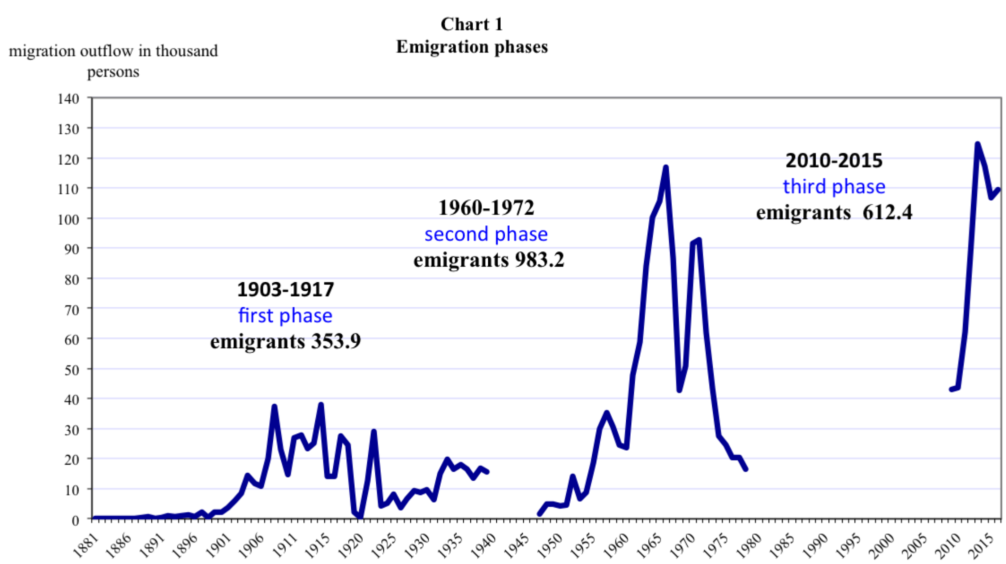
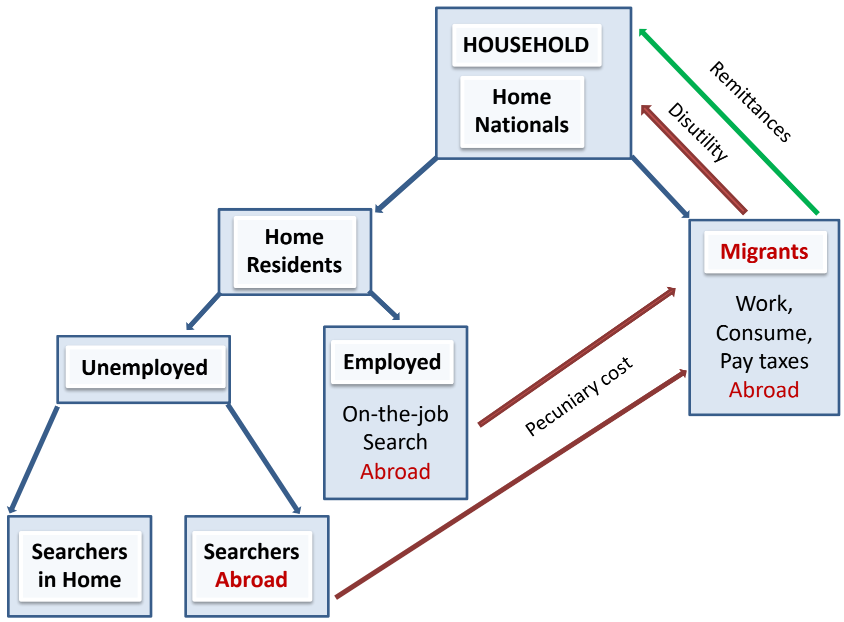


Figure 2: Emigration phases in Greek history (all age groups)

Source: updated graph from Lazaretou (2016)

Figure 3: Graphical illustration of the model

(a) Household in Home and Migrants



(b) Firms

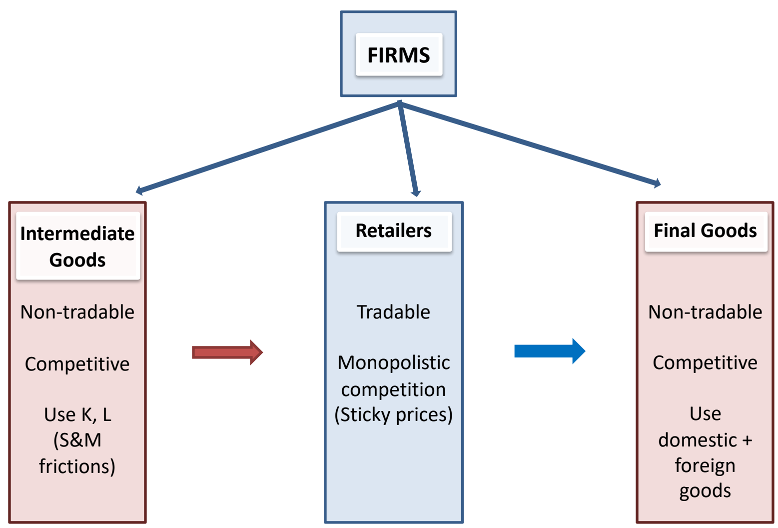
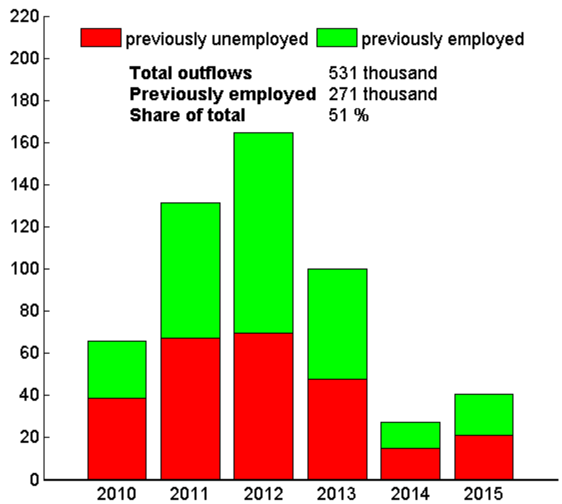
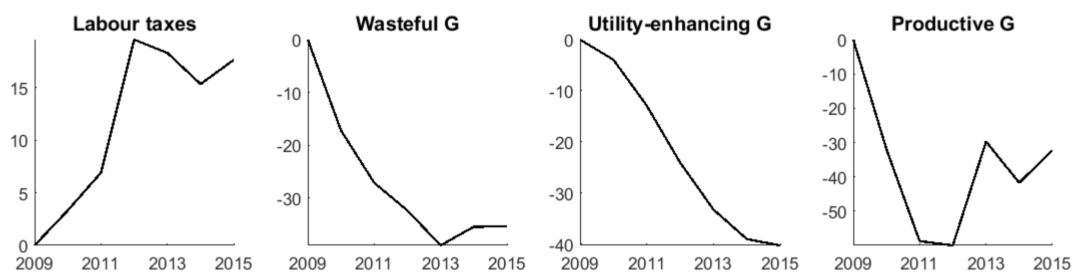


Figure 4: Simulation exercise

(a) Composition and size of migration outflows



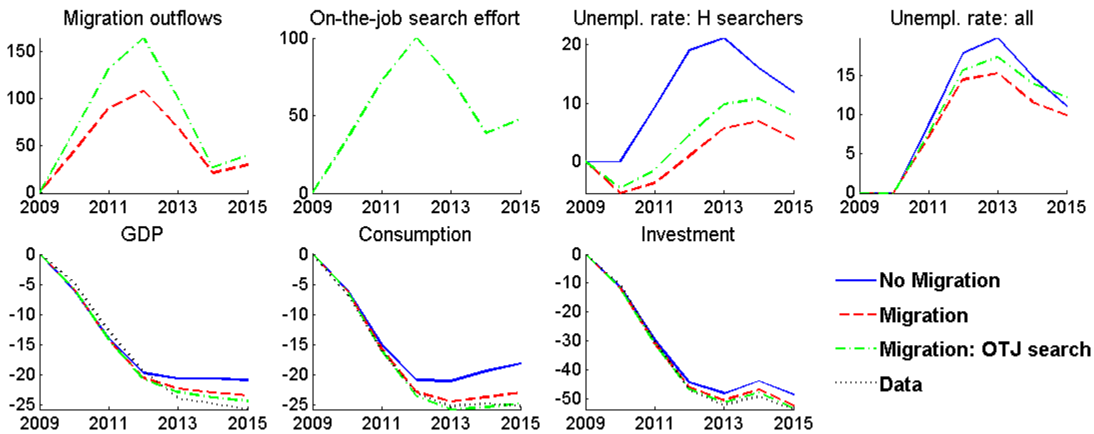
(b) Paths of tax-spending instruments



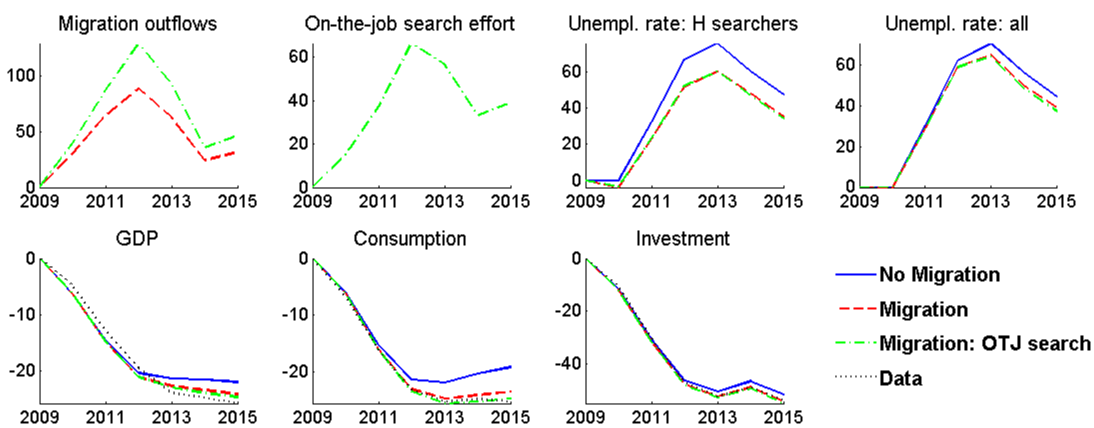
For the fiscal instruments we show growth rates in percentages relative to 2009. G denotes government spending.

Figure 5: Fiscal consolidation mix in Greece during the Great Recession: simulation results

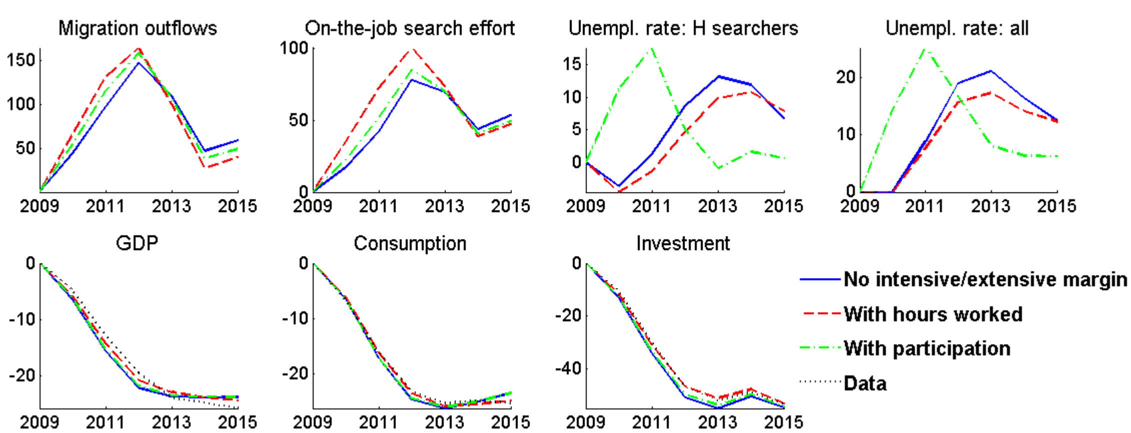
(a) Baseline calibration



(b) Sensitivity analysis: Higher bargaining power of firms



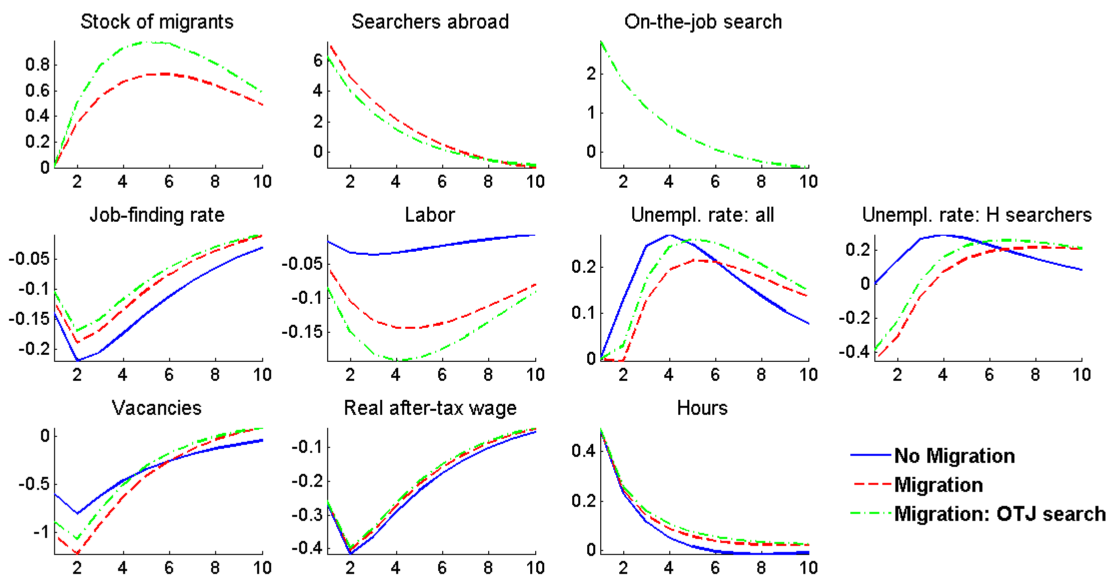
(c) Sensitivity analysis: Intensive and extensive margins (full model)



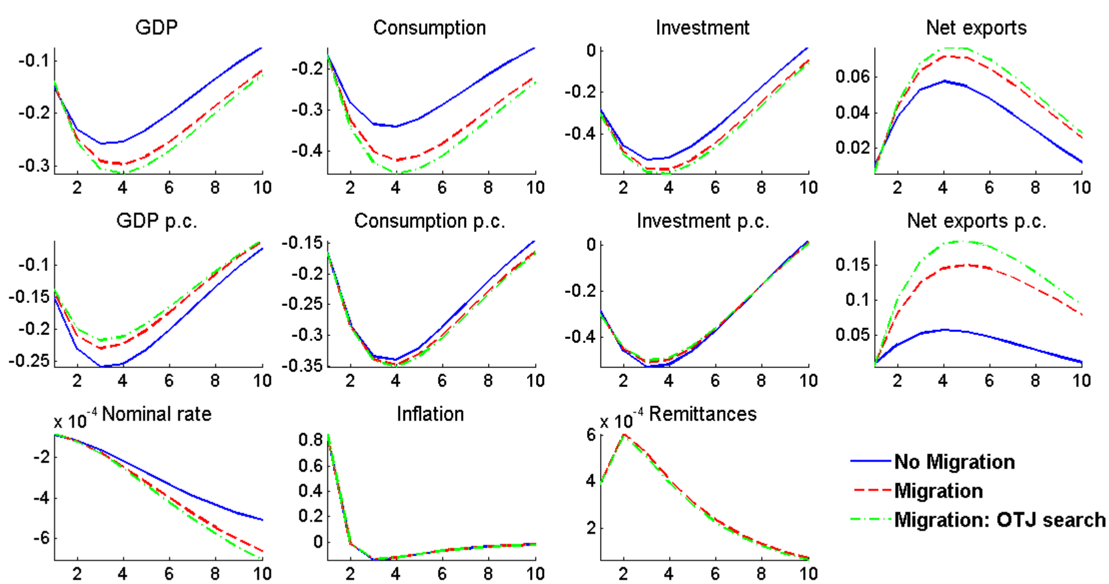
Responses for migration outflows are in levels (thousands persons). All other responses are in percent deviations from steady state. Consumption refers to consumption of the domestic good. OTJ denotes on the job. Unempl. rate: all and Unempl. rate: H searchers denote measures of the unemployment rate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

Figure 6: A 1% negative shock to TFP

(a) Migration and Labour Market



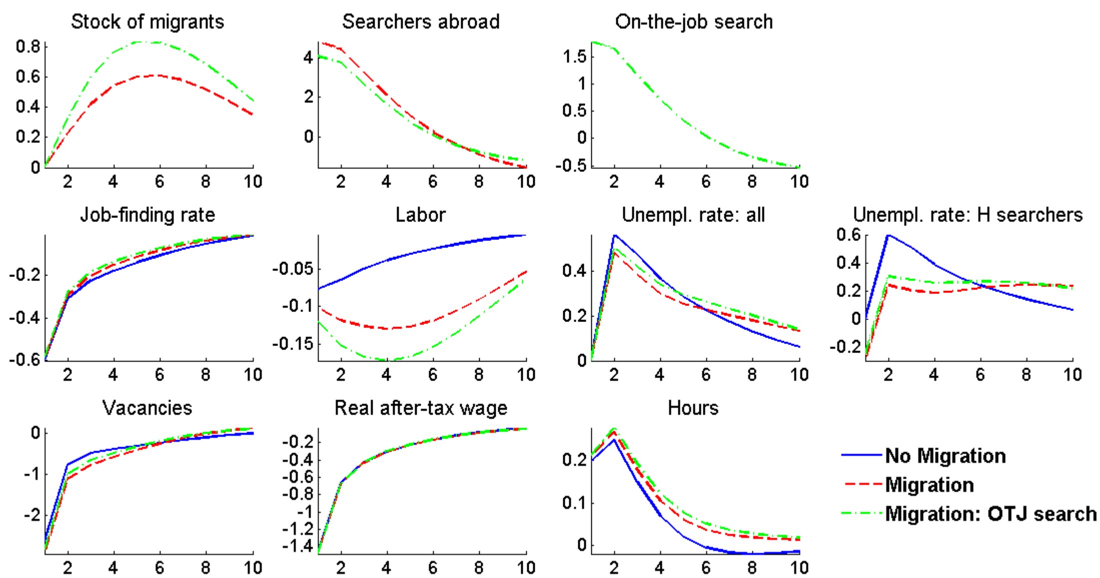
(b) Aggregates



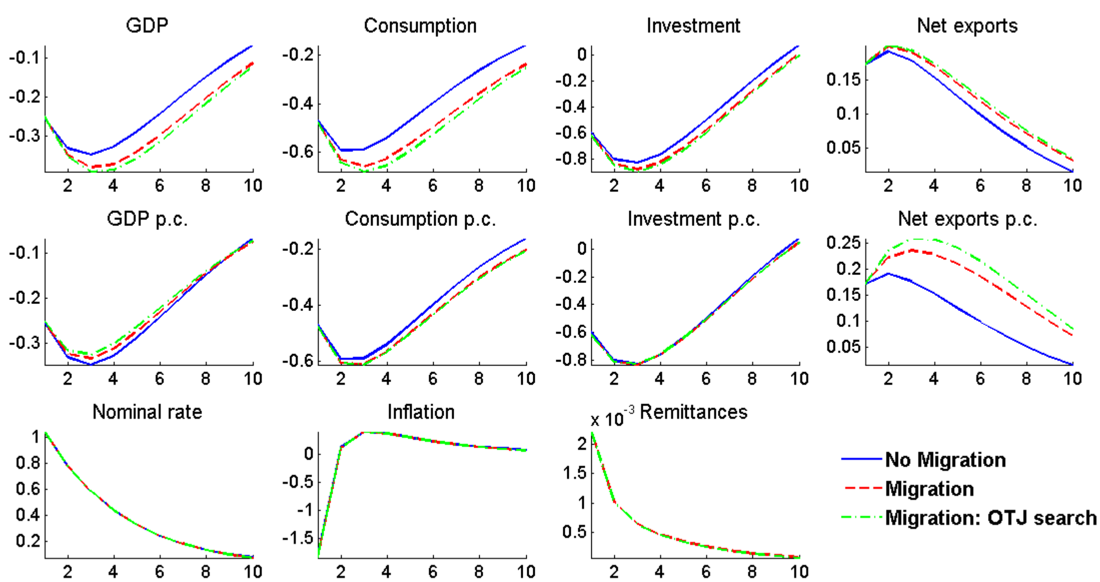
Responses for interest rates and inflation are shown in annualized levels. Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to consumption of the domestic good. OTJ denotes on the job and p.c. denotes 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 7: A risk premium shock inducing a 1% increase in the nominal interest rate

(a) Migration and Labour Market



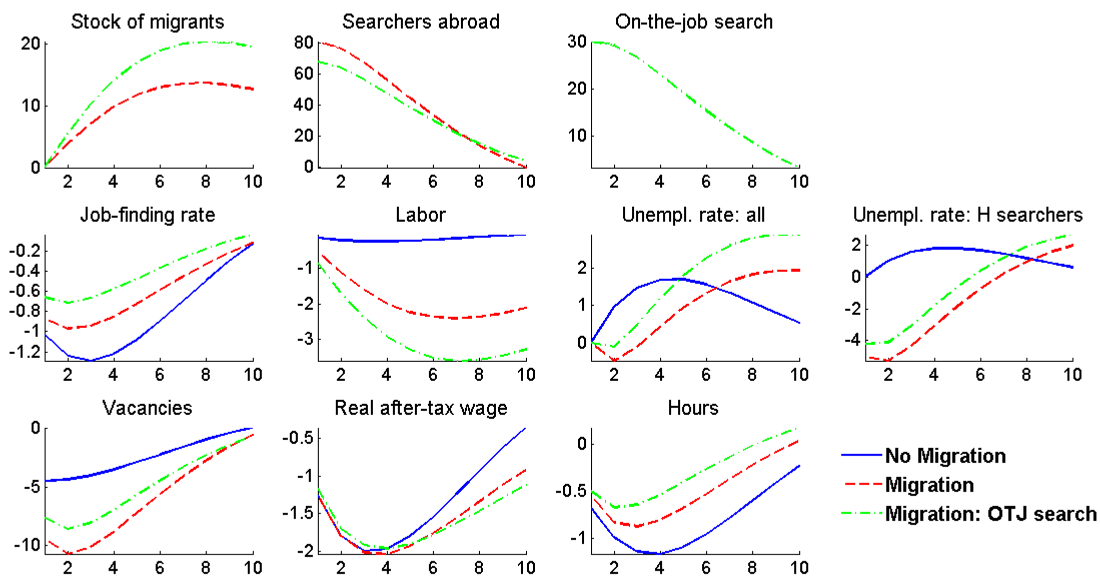
(b) Aggregates



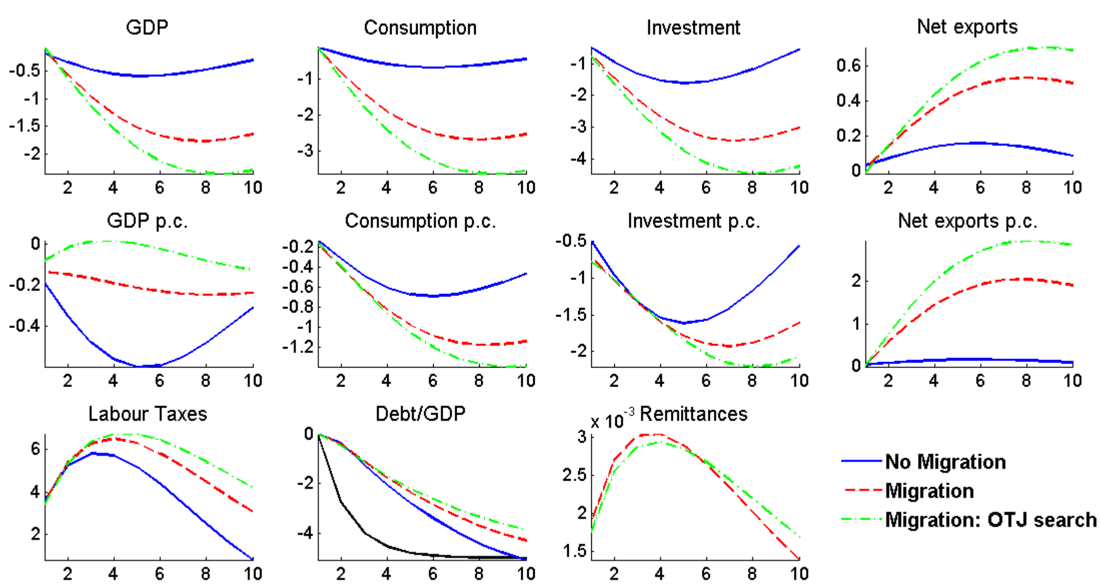
Responses for interest rates and inflation are shown in annualized levels. Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to consumption of the domestic good. OTJ denotes on the job and p.c. denotes 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 8: Tax-based consolidation

(a) Migration and Labour Market



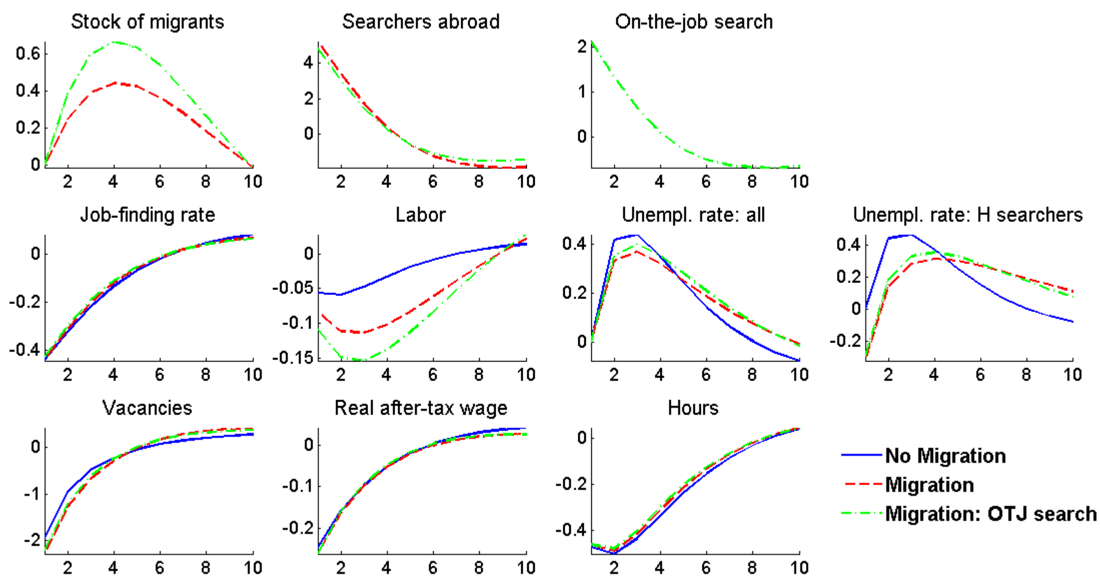
(b) Aggregates



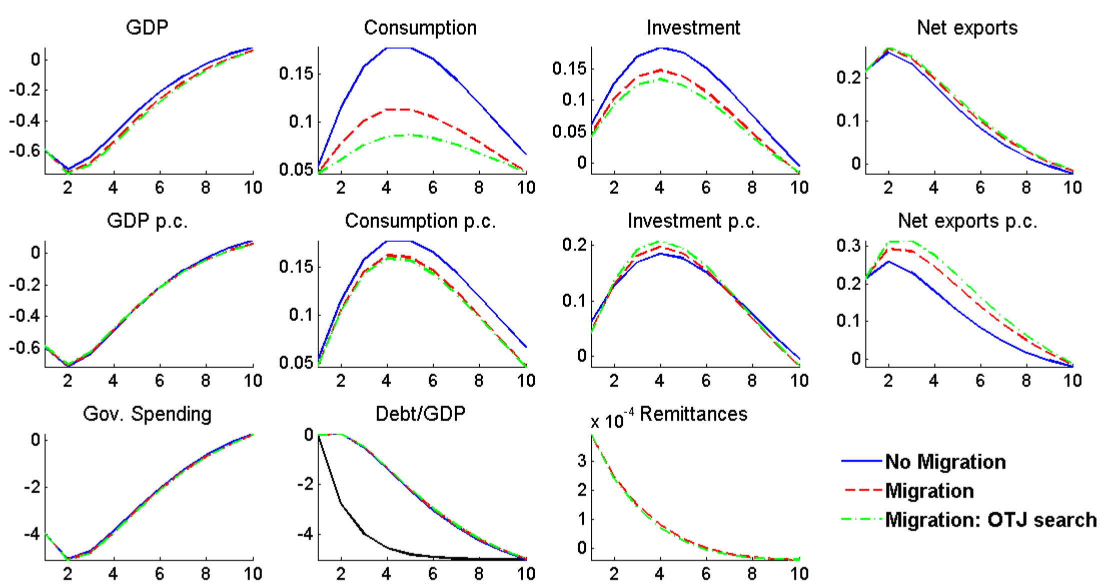
Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to consumption of the domestic good. OTJ denotes on the job and p.c. denotes per capita. Unempl. rate: all and Unempl. rate: H searchers denote measures 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 9: Spending-based consolidation (wasteful expenditure)

(a) Migration and Labour Market



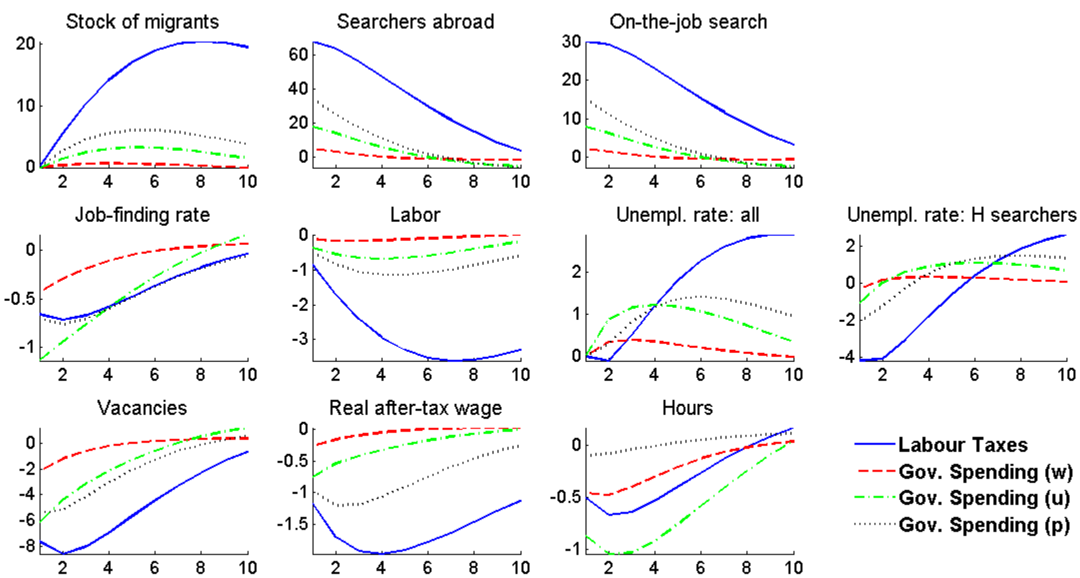
(b) Aggregates



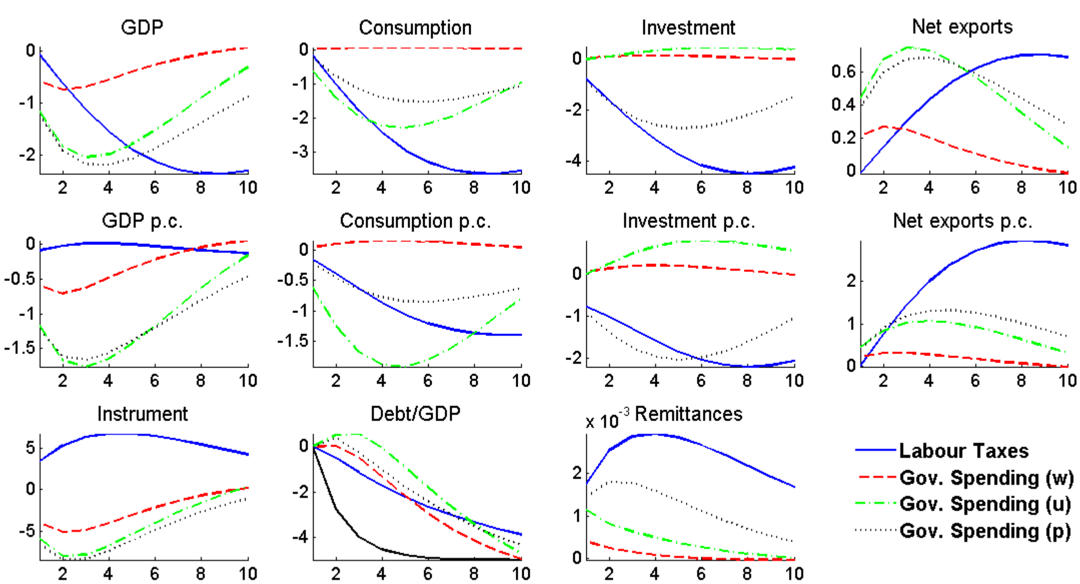
Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to consumption of the domestic good. OTJ denotes on the job and p.c. denotes per capita. Unempl. rate: all and Unempl. rate: H searchers denote measures 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 10: 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. Regarding the role of government spending, (w), (u), (p) denote wasteful, utility-enhancing, productive, respectively.