Fiscal Austerity and Greek Migration: A Missing Link

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Fiscal Austerity and Greek Emigration: A Missing Link*

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Abstract

This paper proposes a new channel through which fiscal austerity affects the macroeconomy. We introduce endogenous migration for both the unemployed and the employed members of the labour force in a small open economy New Keynesian model with labour market frictions exposed to a rich fiscal policy. Our model-based simulations for the austerity mix during the Greek Depression match both the total number and the composition in terms of labour market status of emigrants. Fiscal austerity accounts for one third of the output drop and 11% of migration outflows, whereas the rest is attributed to the macroeconomic environment. A counterfactual without migration underestimates the fall in output by one fifth. Using this model, we also shed light on the two-way relation between emigration and austerity, and the role of migration as austerity shock absorber. On the one hand, fiscal austerity increases emigration with labour income tax hikes inducing prolonged outflows, while spending cuts exerting a hump-shaped effect due to the opposite demand and wealth effects. On the other hand, emigration leads to an increase in both the tax hike and time required for a given debt reduction due to an endogenous leakage in tax revenue. Unemployment gains from emigration during fiscal consolidation may be reversed over time due to the labour-reducing effect of the higher tax hikes needed and of the higher wages sustained by emigration.

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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

Adverse labour market conditions and fiscal tightness during the Great Recession led to net emigration from many European countries 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, have contributed to this notable increase in migration outflows, with Greece being the most obvious case. Over the period 2010-2015, half a million of working-age Greek residents left the country in search of employment, better pay and better social and economic prospects (see also Figure 2). This total outflow exceeds 7% of the active population.[1] Over the same period, the unemployment rate reached 25% and the economy shrank by one quarter. On the fiscal front, Greece experienced the biggest bailout in global financial history, with austerity measures being a condition of the bailout.

In this paper we ask two sets of questions. First, did the mass exodus of Greek workers made the recession worse? Second, does fiscal austerity contribute more strongly to the depth of recession in the presence of emigration?

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, emigration puts upward pressure on wages and hamper 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, but also their purchasing power, reinforcing the 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.[2]

[1] Massive emigration is increasingly recognised as a phenomenon in Southern and Eastern EU countries. For instance, in Spain annual outflows since 2010 have exceeded 400K, which is historically the highest level and is also comparable to the average annual inflow of 485K during the immigration boom of 2000-2006 (Bentolila et al. (2008)). Around 40% of these outflows were directed to other EU countries and 30% to South America (Izquierdo et al. (2016)). In the case of Greece, Germany and the UK concentrate more than half of the post 2010 emigration (Labrianidis and Pratsinakis (2016)).

[2] World Bank data on remittances over GDP 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*

The impact on aggregate demand depends also on the degree of openness and the importance of home bias in the demand for tradable goods (see e.g., Farhi and Werning (2014)). Typically, with relatively low trade integration the increase in external demand might not compensate for the fall in internal demand.

Interestingly, the relation of fiscal austerity and emigration is bi-directional. Fiscal policy affects migration decisions in the current period and also through migrants' expectations regarding the domestic fiscal stance and the perception of future austerity. On the flip side, emigration has fiscal implications for the source economy. Emigration shifts the tax base, by affecting private demand and taxable income. The emigration of net payers thus poses a challenge to the public treasury (Borjas et al. (2019)). Yet, migration can act as a fiscal stabilizer, mitigating increases in unemployment and lifting fiscal pressure off governments by reducing the payments of unemployment benefits. The emigration of unemployed and employed workers therefore entails different implications for the public treasury. The outflow of employed workers leads to a reduction in the labour income tax base, while the outflow of unemployed acts as a fiscal stabilizer. In addition, the emigration of employed members of the labour force may mitigate the exodus abroad of the unemployed by freeing up jobs. In this paper, we focus on the composition of emigrants in terms of their labour market status before departing, while abstracting from different skill types to keep the model tractable (see the discussion in Section 4.3).[3]

We study the macroeconomic interaction between fiscal austerity and emigration by introducing endogenous migration decisions 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 (through on-the-job search) and the unemployed have an incentive to migrate abroad where better wage and employment opportunities exist. Apart from supplying labour, migrants pay taxes, buy the foreign consumption good and send remittances to the source country.

In the first part of the paper, we offer a model-based anatomy of the Greek crisis, studying jointly the impact of the implemented fiscal austerity mix and the amplification through the emigration channel.[4] Model-based simulations match the total number and composition in terms of labour market status of emigrants. Fiscal austerity accounts for one third of the output decrease and close to 11% of the migration outflows during the Greek Depression, whereas the rest is attributed to the macroeconomic environment, proxied by negative demand shocks. The benchmark model without migration under-predicts the fall in output by one fifth.

After establishing that the model delivers empirically plausible results, we use it in the second part to explore the mechanisms at play through a positive analysis of the output and unemploy-

themselves and not of the household" (Labrianidis and Pratsinakis (2016)).

[3]Recent evidence suggests that around two thirds of Greek emigrants were highly skilled (see, e.g, Triandafyllidou and Gropas (2014), Labrianidis and Pratsinakis (2016)).

[4]Gourinchas et al. (2016) analyze the Greek crisis through the lens of a DSGE model without migration and find that fiscal consolidation accounted for half of the output drop.

ment effects of migration during fiscal consolidation shocks (see Erceg and Lindé (2013)). Our results have novel policy implications. First, we shed light on the impact of austerity measures on emigration. Labour tax hikes induce significant and persistent emigration due to the distortionary effects in the labour market, while the effect of spending cuts is hump-shaped due to the opposite forces of the negative demand, Keynesian effect from sticky prices, and the positive wealth effect from the expectation of lower future taxes.

Second, we study the implications of emigration for fiscal austerity. We find that emigration implies an increase both in the tax hike and time required to achieve a given debt reduction. Intuitively, when people can "vote with their feet", austerity policies face a more elastic tax base and can potentially lead to higher public debt as the tax base erodes. The endogenous leakage in tax revenue from the loss of taxpayers is translated into a reduction in consumption-tax receipts and the labour-income tax base (first-order effect on tax revenue). A higher tax hike is then required for debt reduction, which implies stronger increase in emigration and further reduces consumption-tax receipts (second-order effect on tax revenue). Despite the higher tax hikes, the migration model implies a smaller fall in the debt-to-GDP ratio even when those who migrate are only the unemployed. For spending cuts, a similar result is obtained for sufficiently strong price rigidities (see Section 5.5). Our results are in line with Storesletten (2000) who has shown that an inflow of working-age immigrants in the U.S. increases tax revenues per capita, reduces government debt, and might serve as an alternative to tax hikes or spending cuts for financing future fiscal deficits.

Third, we examine the role of labour mobility as fiscal austerity shock absorber. We find that emigration mitigates the costs of fiscal consolidation in terms of GDP per capita, through the reduction of resident population, which is much more substantial in the case of labour tax hikes. However, the unemployment gains from migration may be reversed over time. Emigration offers an extra outside option for workers in wage negotiations and therefore sustains higher wages. Emigration also implies an increase in the tax hike required for a given debt reduction, hurting demand and employment, which together with the higher wages sustained by emigration, can offset the unemployment gains from the reduction in labour supply. Both for tax hikes and for spending cuts, the migration of the employed reduces the short-run unemployment gains from migration and reinforces the unemployment costs over time.

To the best of our knowledge, the effect of fiscal policies on emigration as well as the implications of emigration for the macroeconomic impact of fiscal policy remain unexplored topics so far. Our paper thus contributes to the literature on the macroeconomic effects of fiscal consolidation with an immobile labour force (see, e.g., Erceg and Lindé (2012); Erceg and Lindé (2013); Pappa et al. (2015); Philippopoulos et al. (2017); House et al. (2017); Bandeira et al. (2018)). While existing work has examined the consequences of migration for the destination economy using

static or dynamic models with labour market frictions (see, e.g., Chassamboulli and Palivos (2014); Chassamboulli and Peri (2015); Battisti et al. (2018); Iftikhar and Zaharieva (2019); Lozej (2019)), the use of the search and matching, DSGE framework is novel in the literature on the fiscal implications of emigration in source countries. The latter is either empirical, focusing on developing countries, or based on a neo-classical framework (see, e.g., Desai et al. (2009); Wilson (2008)).[5] The modelling of cross-border on-the-job search in a search and matching framework is also novel and adds to the studies featuring on-the-job search in RBC models without migration (see, e.g., Dolado et al. (2009); Krause and Lubik (2006); Tüzemen (2017)). Notably, our analysis distinguishes between RBC supply-side effects (the loss of labour force which leads to a loss of aggregate demand) and New Keynesian demand-side effects (the feedback from this loss to general equilibrium and to government tax revenue).

The rest of the paper is organized as follows. Section 2 lays out the DSGE model and Section 3 discusses the calibration strategy. Sections 4 presents our simulations for the fiscal austerity mix during the Greek Depression, while Section 5 studies the transmission of fiscal austerity shocks in the presence of labour mobility. Finally, Section 6 concludes the paper.

2 A SOE Model with Migration of the Labour Force

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. The household's members can be employed or unemployed and they participate in the domestic or foreign labour markets.[6] Unemployed job seekers and current workers have an incentive to migrate abroad where higher wages and more employment opportunities exist. Apart from supplying labour, migrants pay taxes and consume part of their income abroad. Searching for foreign jobs is subject to a pecuniary cost, whereas living abroad entails a utility cost. Together with supply decisions for worked hours, job search in Home and abroad, consumption and savings are defined at the household level, in line with evidence about strong family ties in Southern European countries (see e.g., Alesina and Giuliano (2014); Giuliano (2007)).

On the production side, following standard practice in the literature (see, e.g., Trigari (2006); Erceg and Lindé (2013)), we separate the decisions regarding factor demands from price setting to

[5]For labour market effects of emigration see, e.g., Docquier et al. (2013), Mishra (2007) and the survey in Kapur and McHale (2012). For two-country migration models without labour market frictions see e.g., Canova and Ravn (2000), Mandelman and Zlate (2012) and Farhi and Werning (2014), and with matching frictions see Hauser and Seneca (2019). For recent empirical work, see, e.g., Smith and Thoenissen (2019), Furlanetto and Robstad (2019), and d'Albis et al. (2019).

[6]As discussed in Section 4.3, 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 the analysis allows us to isolate the effect of migration on unemployment.

simplify the description of the model. To this end, 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. Price rigidities arise at the retail level, while labour market frictions occur in the intermediate goods sector. A graphical illustration of the model for the households and firms is presented in the Online Appendix.[7]

The government collects taxes and issues debt to finance public expenditure, lump-sum transfers, and unemployment benefits. For public spending we consider various roles, namely wasteful, productive and utility-enhancing. Implementation of debt consolidation occurs through labour income tax hikes or spending cuts.

The model features habit formation and investment adjustment costs, which are critical to obtain smooth responses with reasonable degrees of nominal rigidities. Since employment is a state variable in a search and matching framework, variable capital utilization and hours in the model allow output to react on impact to macroeconomic shocks.

In what follows, the asterisk $\star$ denotes foreign variables or parameters. As we model a small open economy, we take foreign demands for goods and labour as given. We therefore treat foreign variables as exogenous and omit the time subscript. All quantities in the model are in aggregate terms. Responses of per capita variables are included in the results below.

2.1 Nationals, Residents and Migrants

We assume a continuum of identical households of mass one. The number of Home nationals of the household is equal to $\hat{n}$, which is constant. The number of Home residents N_t varies depending on changes in the stock of Home migrants abroad $n_{e,t}$, with the latter varying over time either due to new arrivals or returns. It then follows

$$\hat{n} \;=\; N_t + n_{e,t}\,. \tag{1}$$

Residents are employed n_t or unemployed u_t,

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

An endogenous share $1 - s_t$ of the unemployed u_t search in the domestic labour market, while the remaining s_t look for jobs abroad, facing an individual pecuniary cost $\varsigma\left(\tilde{s}_t\tilde{u}_t\right)$, where $\tilde{s}_t$ and $\tilde{u}_t$ are the average shares of s_t and u_t per household and the function $\varsigma\left(\tilde{s}_t\tilde{u}_t\right)$ is increasing. This cost

[7]The Online Appendix is available at http://pareto.uab.es/jcaballe/Papers/MigrationOnlineAppendix.pdf.

function (see Section 3 for the specific functional form) links positively the cost of search abroad with the number of corresponding job seekers, helping to smooth out migration decisions in the model by putting a brake to the search abroad.

Jobs in Home are created through a matching function,

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

where m_t denotes matches, v_t denotes vacancies, μ_1 measures the efficiency of the matching process and μ_2 denotes the elasticity of the matching technology with respect to vacancies.[8] We define the probabilities of a job seeker to be hired $\psi_{H,t}$ and of a vacancy to be filled $\psi_{F,t}$,

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

The employed n_t can exert effort z_t searching for a job abroad, where better fiscal and employment conditions exist. We denote by $\varphi\left(z_t\right)$ the productivity of on-the-job search effort measured by the probability of finding a job abroad. The higher the search intensity, the higher is this probability. Searching while employed is subject to a pecuniary cost $\phi\left(z_t\right)$, measured in units of the final good. We assume that $\varphi'\left(z_t\right) > 0$ and $\phi'\left(z_t\right) > 0$, with $\varphi'\left(z_t\right)/\varphi\left(z_t\right) < \phi'\left(z_t\right)/\phi\left(z_t\right)$ such that the on-the-job search effort is effectively costly (see, e.g., Krause and Lubik (2006); Tüzemen (2017)). The evolution of Home employed workers is given by

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

where σ denotes the exogenous separation rate and $\psi_H^{\star} \varphi\left(z_t\right)$ captures emigrant workers.[9]

The evolution of emigrant employment $n_{e,t}$ is given by

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

where we assume equal job finding probabilities abroad for Home unemployed and employed.

[8] A natural question is whether migration precedes search or search precedes migration. Given the possibility of search online for jobs abroad and the positive relation of available data to OECD migration data (see e.g. Mamertino and Sinclair (2019)), we assume that household members emigrate with a job in hand. We can obtain similar results if we assume instead that (i) the unemployed relocate before being matched and (ii) there is contemporaneous timing in matching. For remote search and migration, see also Kaplan and Schulhofer-Wohl (2017).

[9] 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 calibrate the model 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)).

2.2 Households

Keeping with the representative household framework, we assume that all agents pool consumption risk perfectly (for macro-migration models with a representative agent, see, e.g., Kaplan and Schulhofer-Wohl (2017); Mandelman and Zlate (2012), Davis et al. (2014); Binyamini and Razin (2008)). The big family setup is in line with evidence about strong family ties in Southern European countries (see e.g., Alesina and Giuliano (2014); Giuliano (2007)). The household derives utility from a consumption bundle C_t, composed of goods purchased by residents c_t and emigrants $c_{e,t}$,

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

where $c_{e,t}$ is determined through (9) below. The household suffers disutility from hours worked in Home h_t, which are determined through negotiation over the joint surplus of workers and firms (see below), and from the exogenous hours abroad h_e. Disutility is also derived from having members abroad $n_{e,t}$, which captures notions such as different culture, food, habits; distance from relatives and friends; less dense networks; difficulties experienced with bureaucracy and integration, as well as families ties.[10] The instantaneous utility function is given by

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

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, and ζ is a parameter determining external habits in aggregate consumption, where the consumption reference is taken as given with $\tilde{C}_t = C_{t-1}$ in equilibrium. The elasticity of substitution between private and public consumption is given by $(1-\eta)/\alpha_2$. The strictly positive parameters Ω, χ, μ, ξ refer to the disutility from hours worked and living abroad.

The budget constraint, in real terms (i.e. in units of the final good), is given by

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

where $\varsigma\left(\tilde{s}_t\tilde{u}_t\right) s_t u_t$ and $\phi\left(z_t\right) n_t$ 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 T_t denotes lump-sum transfers.

[10] Including the utility cost of migration is useful in smoothing out migration decisions when we study labour income tax hikes, which is the instrument that leads to the strongest increase in emigration. Without this utility cost, pecuniary costs of job search abroad would have to be unrealistically high in our simulations (see Section 4).

The capital depreciation rate is δ_t and the degree of capital utilization is x_t. Profits Π_t^r from monopolistic retailers enter the budget constraint in a lump-sum fashion. Given that the household does not optimize over profits, we abstain from taxes on profits. Since the focus of the paper is on the labour mobility channel, we consider as fiscal instrument the labour income tax rate τ_t^n and treat the capital and consumption taxes τ^k and τ^c as constant. Government bonds $b_{g,t}$ pay the return r_t, while $b_{f,t}$ denotes liabilities with the rest of the world with return $r_{f,t}$.[11]

Migrants' labour income is spent on purchases of goods abroad $c_{e,t}$ and remittances Ξ_t,

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

We follow the approach of Mandelman and Zlate (2012), in which the migrant labour income is part of a unified budget constraint, allowing to model migration as an inter-temporal decision of the household in the source economy. Since the household maximizes utility as a single entity, one cannot treat emigrants and residents as separate agents that choose consumption, labour and remittances independently. Without further assumptions, the consumption allocation between the migrant and non-migrant members of the household would remain undetermined. To avoid this problem, we use an insurance mechanism of remittances parameterized to fit the data, similarly to Mandelman and Zlate (2012)[12],

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

Assuming $\rho_\Xi > 0$, improvements in the net wage premium abroad increase remittances, which represents an altruistic compensation mechanism between migrant and domestic workers. Note that we do not include cross-country differentials in unemployment benefits as we do not intend to study those as drivers of the migration decisions. 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)). Evidence from World Bank data and recent surveys suggests that the role of remittances has been very small in the recent emigration wave from Greece (see footnote 2), which is captured in our calibration.

[11] 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).

[12] 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 our scope.

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

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

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 (21) 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

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

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

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

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

where β is the household's discount factor.

Equations (13) and (14) determine the evolution of the value for the household of being employed in Home and abroad, respectively. This value equates to the utility value of the net wage, adjusted for the costs of searching abroad, minus the disutility from supplying hours and from having members abroad in (14), plus the continuation value of the match. The latter is the expected value of continuing with the job without an exogenous separation, net of the value foregone because workers are not simultaneously job seeking, which is captured by $\psi_{H,t+1}$ and $\psi_H^\star$ in (13) and (14), respectively. Equation (13) also accounts for the fact that with probability $\psi_H^\star \varphi(z_{t+1})$ a current worker will quit to take up a job abroad.[13]

Equation (15) shows that equality needs to hold for the values of job seeking at home and abroad, with the latter including the utility-adjusted cost of moving. 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 the marginal costs of on-the-job search intensity, in units of consumption, must be equal to the excess relative value of working abroad, subject to the job-finding probability. The higher this differential, the higher is the optimal level of on-the-job search.[14]

2.3 Intermediate Goods Firms

Intermediate goods are produced with a Cobb-Douglas technology,

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

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^y denotes the productive component of public expenditure. The parameter ν regulates how the public input affects private production.

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

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

which is equivalent to equation (4). Firms also decide the amount of effective capital $x_t k_t$ to be

[13] The Online Appendix includes the full derivation of (13) and (14). 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.

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

rented from the household at rate r_t^k. The problem of an intermediate firm can be written as

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

where $p_{y,t}$ 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 vacancy-filling probability as given. The first order conditions with respect to effective capital and vacancies are

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

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

In (18), the value of the marginal product of capital equals the rental rate. In (19), the marginal cost of hiring is set equal to the expected marginal benefit, given by the marginal productivity of labour minus the wage plus the continuation value. Termination of the match occurs exogenously with probability σ and also endogenously due to cross-border matches $\psi_H^\star \varphi(z_{t+1})$.

2.4 Wage Bargaining

Wages are determined by splitting the surplus of a match between the worker and the firm. 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 and S_t^F denotes the firm's surplus. As shown in the Online Appendix, the surplus for workers consists of the asset value of employment net of the value of the outside option which refers to unemployment,

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

On-the-job search affects negatively S_t^H through (i) the pecuniary costs $\phi(z_t)$, net of the benefit, thanks to a successful match abroad, of not incurring the cross-border search cost as unemployed $\varphi(z_t)\varsigma(\tilde{s}_t\tilde{u}_t)$; (ii) the probability of leaving the job due to successful on-the-job search $\varphi(z_t)(\psi_H^\star - \psi_{H,t})$.

Combining the equation above 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

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

The equilibrium expected values of searching in the two labour markets are equalized (see also (15) in units of the consumption good). These values depend on the respective job-finding probability and the expected utility from having an additional worker in the respective labour market.

Next, the firm's surplus is given by

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

where the probability that workers resign $\psi_H^\star\varphi(z_t)$ affects the continuation value.

The resulting equilibrium wage income $w_t h_t$, from the splitting rule of the Nash bargaining, is

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

The term weighted by the workers' bargaining power $(1-\vartheta)$ includes the value of the marginal product of labour and the continuation value to the firm. The higher is on-the-job search, the higher is the probability that workers resign $\varphi(z_t)$, pushing down on wages. The term weighted by the firm's bargaining power ϑ includes the outside option of the unemployment benefit b, the disutility from hours, and the costs of on-the-job search $\phi(z_t)$, net of the benefit from a match abroad of not incurring the cross-border search cost as unemployed $\varphi(z_t)\varsigma\left(\tilde{s}_t\tilde{u}_t\right)$.

As shown in the Online Appendix, the determination of hours yields in equilibrium,

$$\chi\frac{h_t^{1+\xi}}{\lambda_{c,t}} = (1-\tau^n)(1-\alpha)^2\frac{p_{y,t}y_t}{n_t}. \tag{21}$$

2.5 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 who buy domestic intermediate goods and differentiate them with a technology that transforms one unit of intermediate goods into one unit of retail goods. Since this part is quite

standard, we present the corresponding equations in the Appendix for economy of space.

2.6 Final Goods Producers

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

$$y_{f,t} = \left[(\varpi)^{\frac{1}{\gamma}} (y_{l,t})^{\frac{\gamma-1}{\gamma}} + (1-\varpi)^{\frac{1}{\gamma}} (y_{m,t})^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}}, \tag{22}$$

where ϖ denotes home bias and γ is the elasticity of substitution. Final good producers maximize profits $y_{f,t} - p_{r,t} y_{l,t} - e_t p_r^\star y_{m,t}$, where $p_{r,t} \equiv P_{r,t}/P_t$ and $p_r^\star \equiv P_r^\star / P^\star$ denote the real price of $y_{l,t}$ and $y_{m,t}$, respectively, denominated in each country's numeraire. We assume the law of one price holds, i.e. $p_{r,t} = e_t p_r^\star$. Solving for the optimal demand functions gives

$$y_{l,t} = \varpi (p_{r,t})^{-\gamma} y_{f,t}, \tag{23}$$

$$y_{m,t} = (1-\varpi) (e_t p_r^\star)^{-\gamma} y_{f,t}. \tag{24}$$

We substitute out (23) and (24) into (22) to obtain

$$1 = \varpi (p_{r,t})^{1-\gamma} + (1-\varpi) (e_t p_r^\star)^{1-\gamma}, \tag{25}$$

Then we define implicitly the nominal consumer price index as the value solving (25) for P_t.

2.7 Government

The composition of total government spending is given by

$$g_t = g_t^w + g_t^c + g_t^y, \tag{26}$$

where g_t^w denotes the wasteful component, g_t^c denotes the utility-enhancing component (see equation (7)), and g_t^y denotes the productive component for the intermediate goods sector (see equation (17)).

The primary deficit and the government budget constraint is are given by

$$DF_t = \mathrm{b} u_t + g_t + T_t - \tau_t^n w_t h_t n_t - \tau^k (r_t^k - \delta_t) x_t k_t - \tau^c c_t, \tag{27}$$

$$r_{t-1}b_{g,t-1} + DF_t = b_{g,t}\,. \tag{28}$$

2.8 Resource Constraint

The non-tradable final output must equal private and public demand (i.e., the government uses final goods to produce public goods and services). Costs related to vacancy posting and search for jobs abroad reduce the amount of resources available,

$$y_{f,t} \;=\; c_t + i_t + g_t + \kappa\upsilon_t + \phi\left(z_t\right)n_t + \varsigma\left(\tilde{s}_t\tilde{u}_t\right)s_t u_t\,. \tag{29}$$

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

$$e_t\left(r_{f,t-1}b_{f,t-1} - b_{f,t}\right) \;=\; nx_t + e_t\Xi_t\,, \tag{30}$$

where net exports nx_t are defined as

$$nx_t \;\equiv\; p_{r,t}y^{\star}_{m,t} - e_t p^{\star}_r y_{m,t}\,. \tag{31}$$

Exports depend on the price faced by foreigners, which is the domestic price divided by the real exchange rate

$$y^{\star}_{m,t} \;=\; \left(\frac{p_{r,t}}{e_t}\right)^{\gamma_x}\overline{y^{\star}_m}\,, \tag{32}$$

where γ_x is the price elasticity 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

$$gdp_t \;=\; y_{f,t} + nx_t\,. \tag{33}$$

2.9 Lack of Monetary Policy Independence

The nominal exchange rate E is exogenously set and the nominal interest rate on domestic government bonds R_t is 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[15],

$$r_t = \frac{R_t}{\mathrm{E}_t \pi_{t+1}}. \tag{34}$$

where consumer price inflation π_t is defined as

$$\pi_t = \frac{P_t}{P_{t-1}}. \tag{35}$$

The risk premium depends on the deviation of the net foreign liabilities to GDP ratio from its steady state (see Schmitt-Grohé and Uribe (2003)),

$$r_{f,t} = r^{\star} exp\left\{\Gamma\left(\frac{e_t b_{f,t+1}}{gdp_t} - \frac{\overline{e}\overline{b_f}}{\overline{gdp}}\right) + \epsilon_{r,t}\right\}, \tag{36}$$

where Γ is the elasticity, $\epsilon_{r,t}$ is a risk premium shock, and a bar above variables denotes steady state values.

3 Calibration

We solve the model by linearizing the equilibrium conditions around a non-stochastic zero-inflation steady state with flexible prices, and the price of the final good and the real exchange rate normalized to unity. We calibrate the model annually with Greece at the onset of the crisis (2008-2009) as our target economy. Table 1 shows the key parameters and steady-state values we target.

National Accounts. The annual depreciation rate is calibrated to 8.8% to match the ratio of capital investment to GDP, which is 18% according to Eurostat data. Setting net foreign assets to 10% of GDP and remittances to 3% of GDP, in line with Greek data, pins down the net exports to GDP ratio. In order to match the ratio of imports to GDP, which is 25%, we assume a degree of home bias equal to 0.75. Together with the net exports to GDP ratio, this pins down the ratio of exports to GDP. In the policy section below we refer to the calibration of government spending (% GDP). The share of private consumption in GDP is then obtained as a residual. We also set public debt to 127% of GDP, in line with Greek data.

Utility Function. Following the DSGE literature, we set the discount factor β to 0.96, implying an annual interest rate of 4%. For the inverse elasticity of intertemporal substitution η, much of the literature cites the econometric estimates of Hansen and Singleton (1983), which place it "between

[15] In the case of flexible or managed floating exchange rates, E and R switch positions: the former becomes an endogenous variable E_t, while the latter follows a policy (Taylor-type) rule (Philippopoulos et al. (2017)).

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. 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). Hours are normalized in the steady state to unity. In Section 4.3, we also explore a version of the model without the intensive margin. Using the household's first order conditions with respect to $g_{c,t}$ and c_t, allows us to pin down α_1,

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

Following the literature on Edgeworth complementarity between private and public consumption (see, e.g., Bouakez and Rebei (2007); Fève et al. (2013)), we set $\alpha_2 = -0.75 < 0$.[16]

Production. The capital share takes the standard value of one third and the steady-state price markup over marginal costs is set to 10%. Using the first order condition of the firm with respect to $g_{y,t}$ in the steady state allows us to pin down ν,

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

Following Erceg and Lindé (2013), we set the elasticity between domestically produced and imported goods equal to 1.2. To match the path of Greek GDP in the simulations of Section 4, we set the price elasticity of exports γ_x to 0.2 and the degree of investment adjustment costs ω to 4. In addition to the size of investment adjustment costs, the model's steady state is independent of the degree of price rigidities, which takes a standard value annually ($\lambda_p = 0.25$).[17]

Labour Market. We normalize Home nationals $\hat{n}$ to unity, of which 10% reside abroad.[18] The unemployment rate is set equal to 12% according to the Greek figure during 2009-2010. We target an unemployment rate abroad which is lower almost by half (7%) by calibrating the job-finding probability abroad to be 60% higher than in Home. Assuming a relatively mild wage premium abroad, i.e. $w^\star/w = 1.12$, helps us to moderate migration costs. Specifically, our calibration implies

[16]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).

[17]We abstract from wage rigidities, as we have found very little impact with annual calibration.

[18]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.

that per job match abroad, search costs represent 54.9% and 46.9% of the wage for the unemployed and the employed respectively, or total costs of search abroad correspond to 0.4% of GDP. For simplicity, we assume that the termination rates in the two labour markets are equal amounting to 7% (see also Pappa et al. (2015)). The efficiency of the matching technology μ_1 is pinned down by setting the vacancy-filling and job-finding probabilities equal to 0.7 and 0.6 respectively, which, using the laws of motion of employment in Home and abroad, implies a reasonable steady-state share of unemployed looking for jobs abroad of 6.5%. Our calibration also implies that 34.5% of migration outflows (household members newly matched to a job abroad) are current workers. This number will be the starting point in Section 4, where the model matches over the simulation horizon an average share of 51% previously employed Greek emigrants, in line with the survey evidence in Labrianidis and Pratsinakis (2016). We calibrate the net replacement rate $b/\left[\left(1-\tau_n\right)w\right] = 0.41$ in line with data from the OECD Benefits and Wages Statistics. The vacancy cost parameter κ is set such that total vacancy posting costs represent just under 1% of GDP. We enforce the Hosios condition by setting the elasticity of matches to vacancies equal to the bargaining power of firms, $\mu_2 = \vartheta = 0.38$. The implied value for workers' bargaining power is therefore $1-\vartheta = 0.62$, which is close to the 0.72 estimate for unions' bargaining power in Greece over the period 1980-2012 in Beqiraj and Tancioni (2014). For firms' bargaining power we also investigate results for a higher value (equal to 0.7) in Section 4.

Search Abroad and Migration. We adopt the following functional forms for the costs of job search abroad $\varsigma\left(\tilde{s}_t\tilde{u}_t\right)$ and $\phi\left(z_t\right)$, and for the productivity of on-the-job search effort $\varphi\left(z_t\right)$,

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

We normalize z to 1 and use φ_{z1} to determine the steady-state number of workers that are matched to a job abroad. The scale parameters ς_{s1} and ϕ_{z1}, and the weight on the utility cost of migration Ω, are implicitly determined by (13)-(16) in the steady state. We set φ_{z2}, ϕ_{z2}, ς_{s2} such that in our simulations in Section 4 (a) migration outflows match the total magnitude of Greek emigration (equal to half a million people), (b) the average share along the simulation horizon of emigrants that were previously employed matches the survey evidence in Labrianidis and Pratsinakis (2016) reporting a share of 50, and (c) on-the-job effort fluctuates within reasonable values.[19] The elas-

[19]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 $\varphi_{z2} > 1$.

ticity of the utility cost of living abroad μ is then normalized to 1. In the absence of this utility cost, the ratio of pecuniary searching costs to GDP would have to be unrealistically high for the model to reproduce the magnitude of Greek emigration.

Policy. The elasticity of the spread between domestic and foreign interest rates Γ is set equal to 0.001 (Schmitt-Grohé and Uribe (2003)). 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 the 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. The consumption, capital and labour tax rates are set to 13.9%, 17.2% and 28.9% respectively, corresponding to the values of the effective tax rates in Greece for 2009 in Table 1 of Papageorgiou et al. (2012).

4 Austerity and Emigration in the Greek Depression

In this section, we offer a model-based anatomy of the Greek crisis, which stands out as an example of public debt crisis and implementation of fiscal austerity policies. We study jointly the impact of the fiscal austerity mix implemented and the amplification through the emigration channel.

4.1 Methodology

Our calibration targets the magnitude and composition of the recent emigration wave in Greece by aiming to match (a) a total outflow of half a million during the period 2010-2015 and (b) a share of around 50% of emigrants that had a job before departure (Labrianidis and Pratsinakis (2016)). As shown in the Online Appendix, migration inflows throughout this period remained constant, below their pre-crisis level, at around 60K and started to pick up again after 2015.

Starting the economy at its steady state, we feed in the model the actual annual values of the four fiscal consolidation instruments for the period 2009-2015 and we allow lump-sum transfers to adjust to satisfy the government budget. All public expenditure paths are inputted as shares of 2009 GDP. Figure 3a normalizes 2009 data to zero and plots deviations (%) of each fiscal variable. 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. This assumption is justified 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 proxy the macroeconomic environment through a combination of a risk premium shock and a negative investment-efficiency shock (see equations (36) and (11)), which follow an auto-regressive form with one lag and coefficient $\rho = 0.75$. The Online Appendix includes a table with information about the shocks in the simulation exercise, as well as the results of the model to each of the two shocks, when fiscal policy instruments are held constant at their steady-state levels.

We compare results for three model variants: (i) without migration, (ii) with migration of the unemployed, and (iii) with migration of both the unemployed and employed. We eliminate potential steady-state differences by working with the full model (iii), setting all variables related to migration and on-the-job search abroad to their steady-state values for models (i) and (ii).

4.2 Results of Quantitative Analysis

Figure 3b shows the predicted number of emigrants by employment status before departure and calculates the total emigration wave in Greece until 2015. Our simulations do a fairly good job in matching (a) and (b) in Section 4.1. The model generates total migration outflows of 533K, which matches exactly the data from the Hellenic Statistic Authority for emigrants aged 15-64 during the period 2010-2015. The share of employed emigrants from our simulations is 50%.

Figure 4a shows the simulation results for migration, unemployment, consumption, investment and GDP for the three model variants mentioned above, using solid lines for model (i), dashed lines for model (ii), and dash-dotted lines for model (iii). The increase in migration outflows in the full model (iii) 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. Consumption, investment, and GDP decline following closely the actual path of the data depicted by the dotted lines for comparison. The model without migration generates a fall in Greek output close to 20% after 2012, which underestimates the actual contraction of one quarter.[20]

The model also predicts a steady increase in unemployment after 2010, even though the magnitude falls short of the data, since the unemployment rate in Greece almost doubled between 2010 and 2015. Note that we examine two measures: *Unempl. rate: all* refers to all unemployed residents, including those who look for jobs abroad while receiving the domestic unemployment benefit. As can be seen, emigration helps to mitigate the increase of unemployment in the medium run. Note than in the model without migration, unemployment rate in the first year of fiscal policy changes (2010) does not move, given that employment is a state variable in a search and

[20]In the absence of demographic trends (net of migration), our simulations target the path of aggregate GDP. We highlight the impact of emigration on per resident output costs of fiscal austerity in Section 5 where we explore the mechanisms of the model.

matching framework. The second measure *Unempl. rate: stayers* includes only the unemployed who target domestic jobs, and therefore is shown to vary from 2010. As expected, this measure reveals stronger differentials in the response of unemployment between the models with and without migration. In the early periods, unemployment for stayers decreases due to emigration. We further investigate the unemployment response in the next subsection.

4.3 Robustness

Bargaining Power. In models with search and matching frictions the volatility of unemployment is somehow limited.[21] However, 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 70% higher than the steady-state level) in Figure 4b.[22] With higher ϑ the equilibrium wage level moves closer to the outside option of households, which is largely determined by the fixed unemployment benefit, b (see equation (20)). Consequently, the wage response becomes more sluggish. This makes firms use the quantity margin (cut vacancies) by more, following adverse demand shocks. As a result, there will be more unemployed. Wages moving by less also implies that on-the-job search effort for employment abroad increases by less.

Intensive and Extensive Margin. So far we have not included the extensive margin in our model 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)). However, in order to explore the role of the intensive versus the extensive margin, we now modify the utility function as follows

$$U\left(C_t, g_t^c, h_t, n_{e,t}\right) = \frac{\Phi^{1-\eta}}{1-\eta} - \chi \frac{\left(h_t^{1+\xi} n_t + h_e^{1+\xi} n_{e,t}\right)}{1+\xi} - \Omega \frac{\left(n_{e,t}\right)^{1+\mu}}{1+\mu} + X \frac{l_t^{1-\varphi_l}}{1-\varphi_l}, \tag{37}$$

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. Figure 4c reports our simulations for the full model (with migration of the unemployed and the employed). When we remove hours (solid lines), we tend to obtain a bigger increase in unemployment, but a smaller increase in migration outflows. With endogenous labour force participation instead of hours (dashed-dotted lines), the increase in the conventional

[21] See the Shimer critique (Shimer (2005)) and the answers to this critique (e.g., Hagedorn and Manovskii (2008)).
[22] See the evidence presented in ILO (2014).

measure of unemployment (*U rate: all*) occurs too early, and the unemployment rate for those searching domestically (*U rate: stayers*) increases, rather than decreases, in the short run. Both these are driven by the increase in labour force participation due to the negative income effect of the risk premium shock.

Counterfactuals. In the two counterfactual exercises, we present the simulation results without the fiscal policy paths of Figure 3a (see Figure 5) and without the risk premium and investment-specific shocks (see Figure 6). The main finding is that fiscal austerity alone accounts roughly for one third of the output decrease and close to 11% of migration outflowse during the Greek Depression, while the rest is attributed to the macroeconomic environment.

Skill Heterogeneity. Finally, a potential concern is that skill heterogeneity would also matter for the effect of emigration on the taxable income base, given that the high skilled contribute more to tax revenues than the low skilled. Yet, it should be stressed that in the Greek case emigrants with low skill level were mostly unemployed and therefore not labour income taxpayers, prior to departure. Labrianidis and Pratsinakis (2016) survey results reveal that *"[...] half of the emigrants were employed in Greece at the time of emigration. [...] for a sizeable share of the higher educated emigrants it was not absolute exclusion from the labor market per se that drove their decision to migrate but the insecurity for their future in Greece and the quest for a better socioeconomic and political environment abroad."* According to the Greek evidence, about 70% of emigrants were high skilled (see footnote 2). In our quantitative analysis, 50% of the total emigrants were employed before departing. The rest of high-skilled emigrants, together with the low-skilled, may therefore be viewed as unemployed (and therefore not labour income taxpayers). We thus feel confident that our analysis does not overestimate the effect of emigration on the taxable income base.

5 Fiscal Consolidation Shocks and Emigration

After establishing that the model delivers empirically plausible results, we use it to investigate the two-way relation between migration and austerity, and the role of migration as shock absorber. In this section, we shed light on the main mechanisms in the transmission of fiscal consolidation shocks in the presence of migration.

5.1 Modelling Fiscal Consolidation

Following Erceg and Lindé (2013) and Pappa et al. (2015), the government has two potential fiscal instruments, labour income tax rates τ_t^n and public expenditure g_t^f where $f = w, c, y$ refers to wasteful, consumption, productive, respectively. The other tax rates, τ^k and τ^c, are kept fixed at

their steady state levels. We consider each instrument separately, assuming that if one is active, the other remains fixed at its steady state value. The fiscal instruments evolve depending on the discrepancy between the debt-to-GDP ratio $\tilde{b}_{g,t} \equiv \frac{b_{g,t}}{gdp_t}$ and an exogenous target $b^T_{g,t}$, and the discrepancy between their changes, denoted by Δ,

$$\Psi_t = \Psi^{(1-\beta_{\Psi 0})}\ \Psi_{t-1}^{\beta_{\Psi 0}} \left[\left(\frac{\tilde{b}_{g,t}}{b^T_{g,t}} \right)^{\beta_{\Psi 1}} \left(\frac{\Delta \tilde{b}_{g,t+1}}{\Delta b^T_{g,t+1}} \right)^{\beta_{\Psi 2}} \right]^{(1-\beta_{\Psi 0})}, \tag{38}$$

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

$$\log b^T_{g,t} - \log b^T_{g,t-1} = \rho_1 (\log b^T_{g,t-1} - \log b^T_{g,t-2}) + \rho_2 (\log \bar{b} - \log b^T_{g,t-1}) - \varepsilon^b_t\,, \tag{39}$$

where $\bar{b}$ is the steady-state level of the debt-to-GDP ratio, ε^b_t 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 model a gradual (effectively permanent) reduction in the debt target (see also Erceg and Lindé (2013), Pappa et al. (2015), Bandeira et al. (2018)).[23]

We consider a shock that drives the debt-to-GDP target $b^T_{g,t}$ in (39), 5% below its steady state. We calibrate the debt target rule (39) 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 5 years, and the debt target is fully implemented after 10 years (see Erceg and Lindé (2013)).[24] We simulate the responses to this shock with labour income taxes or government spending adjusting through (38). We calibrate the set of three parameters $\beta_{\Psi 0}, \beta_{\Psi 1}, \beta_{\Psi 2}$ for each fiscal instrument (see Table 2) so that the actual debt-to-GDP ratio $\tilde{b}_{g,t}$ meets the new lower target at 10 years after the decision to consolidate is taken, in the model without migration (shown in Figure 7 of the Online Appendix). This ensures comparability across instruments. To investigate the implications of labour mobility for the achievement of debt reduction, we maintain the initial $\beta_{\Psi 0}, \beta_{\Psi 1}, \beta_{\Psi 2}$ when we introduce emigration in the model.[25]

5.2 Labour Tax Hikes

We examine the case of tax-based consolidation in Figure 7.

[23] Studying the possibility of sovereign default is beyond the scope of our paper.

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

[25] We also present in the Online Appendix impulse responses for standard AR(1) fiscal shocks. In this case, lump-sum transfers need to adjust to stabilize debt and ensure stationarity.

No Migration. Following the solid lines, we see that consumption and investment fall, given the drop in after-tax income, and so VAT and capital tax revenue fall too. The drop in demand leads to a fall in vacancies, the job finding probability, and employment, and so unemployment rises, leading to an increase in payments of unemployment benefits. The tax hike also decreases hours by reducing 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, and a fall in real GDP.

Migration of Unemployed. When we introduce job search abroad for the unemployed (dashed lines), the decrease in the job-finding probability, coming from the distortionary effects of the tax hikes in the labour market, induces the household to increase the share of foreign-job seekers, leading to a higher stock of migrants. Emigration offers an extra outside option for workers in wage negotiations and therefore sustains higher wages than without labour mobility. As a result, the fall in vacancies and employment is now more pronounced. Due to the exodus of job seekers with successful matches abroad, the unemployment rate falls in the short run, but it subsequently rises, due to the more negative response of employment and the fact that the labour force is shrinking. The unemployment gains from migration are therefore temporary. Emigration affects positively the government budget through a reduction in unemployment benefits and negatively through a leakage in VAT revenue. The negative impact prevails and deficit falls by less than without labour mobility, which coupled with a higher fall in aggregate GDP implies that the debt-to-GDP ratio falls more slowly, requiring more time to meet the new target and a higher tax hike. However, due to the stronger contraction in employment, the higher tax hike is able to yield higher tax revenue than in the no mobility scenario only in the second half of the time horizon. It also leads to a higher fall in consumption and investment per capita. However, per capita GDP actually falls by less, given that the reduction of resident population implies a reinforced increase of per capita net exports.

Migration of Unemployed and Employed. In the presence of on-the-job search abroad (dash-dotted lines), tax hikes significantly increase 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. As before, for GDP per capita the fall is mitigated by a reinforced increase in net exports per capita. Taking into account the migration of the employed reduces the short-run unemployment gains from emigration and increases unemployment costs over time due to the deeper demand contraction. On the fiscal side, the tax hike and the time required to achieve the debt reduction is higher than in the other two versions of the model. The drop in VAT revenue becomes more pronounced, deficit

falls by less, and the required labour tax hike is even higher than in the previous model.[26] Note that the long-run costs from the emigration of the employed would be amplified by considering, for instance, (post-match) training costs.

5.3 Spending Cuts

Next, we turn in Figure 8 to the typical case of cuts in wasteful government spending (see, e.g., Erceg and Lindé (2013)).

No Migration. The solid lines confirm the well-known negative demand effect with sticky prices, which induces vacancies and the job finding rate to fall. This leads to a fall in employment and labour tax revenue, and a rise 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 future taxes. In line with the increase in consumption, VAT revenue rises which aids the fiscal consolidation effort. Real GDP falls since the cut in government spending directly reduces aggregate demand (see the resource constraint (29)). The increase in net exports comes from the drop in wages, leading to lower marginal costs, which makes the economy more competive, given fixed foreign prices and demand.

Migration of Unemployed. Contrary to the case of labour tax hikes that directly generate distortions in the labour market, it is the negative demand, Keynesian effect of the spending cuts that now induces the household to increase the share of unemployed who look for jobs abroad (see the dashed lines). However, the increase in emigration under spending cuts is characterized by both lower magnitude and lower persistence than under labour tax hikes due to the different strength of the corresponding driving forces. The exodus of unemployed abroad mitigates the increase in consumption and reinforces the decline of employment relative to the no-migration scenario. However, the share of foreign-job searchers falls below its steady-state level in the medium run as the job-finding rate and the real wage increase above the steady-state levels. In the short run, due to the fact that more unemployed job seekers are directed abroad, unemployment increases by less than in the model without migration, while the opposite is true in the medium-run, due to the stronger contraction of employment in the presence of emigration. Therefore, unemployment gains from emigration are short-lived. Due to the small increase in emigration, the response of GDP per capita hardly differs from the no-migration scenario, and is mainly driven by the reduction of aggregate demand from the government spending cuts. Emigration weakens, to some extent,

[26] Due to full insurance, employed and unemployed members of the household have the same consumption and departure of either causes a reduction in consumption tax-receipts.

the positive wealth effect of spending cuts on consumption but without impacting significantly the debt-to-GDP ratio. The negative impact of emigration on tax revenue (i.e., VAT revenue rises by less and labour tax revenue declines by more) seems to be counterbalanced by the lower payments of unemployment benefits. In Section 5.5 we show how these results may be altered in the presence of stronger price rigidities.

Migration of Unemployed and Employed. Cuts in public spending exert a hump-shaped effect on the intensity with which workers look for jobs abroad (see dash-dotted lines). Their on-the-job search effort increases (decreases) in the short run (medium run) following the fall (rise) in the real wage. This is translated in a higher decline in labour relative to models (i) and (ii). Introducing the potential migration of the employed alters little the response of unemployment and the debt-to-GDP ratio.

5.4 Mechanisms and Policy Implications

The mechanisms and policy implications for our main results so far are summarized below.

The Effect of Fiscal Austerity on Emigration. Labour tax hikes induce significant and prolonged emigration, while the effect of spending cuts is hump-shaped. The latter is attributed to the opposite forces of the negative demand effect due to sticky prices, and the positive wealth effect from the expectation of lower future taxes.

Implications of Emigration for Fiscal Consolidation. Emigration implies an increase in the tax hike and time required to achieve a given debt reduction. Intuitively, when people can "vote with their feet", austerity policies face a more elastic tax base and can potentially lead to higher public debt as the tax base erodes. The endogenous leakage in tax revenue comes from the loss of taxpayers, which implies a reduction both in consumption-tax receipts and the labour-income tax base (first-order effect on tax revenue). Despite the reduction in payments of unemployment benefits, a higher tax hike is required for debt reduction, which depresses economic activity and erodes the tax base even more (second-order effect on tax revenue). Despite the higher tax hikes, our migration model implies a smaller fall in the debt-to-GDP ratio even when those who migrate are only the unemployed. The migration of the employed then reinforces the tax revenue leakage. Our results are in line with Storesletten (2000) showing that an inflow of working-age immigrants in the U.S. increases tax revenues per capita and reduces government debt, and might serve as an alternative to tax hikes or spending cuts for financing future fiscal deficits.

Emigration as Absorber of Fiscal Austerity Shocks. Unemployment gains from emigration can be reversed over time. Emigration offers an extra outside option for workers in wage negotiations and therefore sustains higher wages. Emigration also implies an increase in the tax hike required for a given debt reduction, hurting internal demand and employment, which together with the higher wages sustained by emigration, offset the unemployment gains from the reduction in labour supply. The migration of the employed reduces the short-run unemployment gains from migration and reinforces the unemployment costs over time. At the same time, emigration mitigates the costs of fiscal consolidation in terms of GDP per capita, through the reduction of resident population, much more substantially in the case of labour tax hikes.

5.5 The Effect of Price Rigidities

The intensity of the effect of fiscal austerity on emigration depends on the degree of price rigidities. We thus investigate the impact of raising the latter from $\lambda_p = 0.25$ (annual value) to $\lambda_p = 0.75$ (quarterly value) in the full model. The larger the share of firms that cannot change prices on impact, the weaker the negative effects of tax-based consolidation on inflation and the milder the necessary consolidation (see equations (28) and (34)), meaning that a lower tax hike is required (Figure 9). In turn, this implies milder effects on the labour market, and therefore on emigration and output.

This result is reversed in the case of spending cuts (Figure 10). The fact that a higher fraction of firms cannot reset their price after the fiscal cut, which induces a negative demand effect, implies that they will react by cutting vacancies more. As a result, the increase in unemployment and emigration become stronger. A stronger response of emigration leads to non-trivial differences in the responses of per capita GDP and the debt-to-GDP ratio between the no migration model and the model with migration of the unemployed and the employed. The required spending cut is larger in the latter case. Interestingly, in results not shown here for economy of space, we observe that the positive response of consumption to the spending-based consolidation, which arises from the positive wealth effect, can be reversed in the presence of emigration when price rigidities are sufficiently strong, which is the case here.

5.6 Extending the Role of Public Spending

Last, we consider the role of utility-enhancing and productive public expenditure, g_t^c and g_t^y respectively. Figure 11 compares in the full model (iii) the various instruments $\Psi \in \{\tau^n, g^w, g^c, g^y\}$, assuming that if one is active, the others remain fixed at their steady-state value.[27]

[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 model variants.

Firstly, labour tax hikes exert the strongest impact on emigration, and thus both on the required time for a given debt reduction (see the strong reduction in VAT revenue) and on unemployment (reducing payments of unemployment benefits). They are followed by cuts in productive, utility-enhancing and wasteful spending. This ranking also holds for the responses of vacancies, after-tax wages and employment.

Secondly, cuts in productive or utility-enhancing spending induce a stronger contraction in GDP per capita than labour tax hikes or wasteful spending cuts. By inducing the strongest emigration, tax hikes reduce the resident population substantially and, as a result, in their case the drop in GDP becomes less pronounced in per capita terms. For the same reason, tax hikes increase net exports per capita more significantly than spending cuts. For consumption per capita, the most detrimental fiscal consolidation tools seem to be the cuts in utility-enhacing spending, given the complementarity with private consumption, and labour tax hikes. For investment per capita, the highest fall is observed with tax hikes and productive spending cuts.

6 Conclusions

Most of the literature until now has focused on the issues raised by migration in receiving countries. This paper, instead, takes the point of view of the economies that are left behind. Our model-based simulations for the fiscal consolidation mix during the Greek Depression match the number and composition in terms of labour market status of emigrants. Fiscal austerity accounts for one third of the output decrease and close to 11% of the emigration increase, whereas the rest is attributed to the macroeconomic environment. A model variant without migration under-predicts the fall in Greek output by one fifth.

Regarding the interaction of migration with fiscal consolidation, our results indicated that a tax-based consolidation induces the highest increase in emigration, which implies an increase in the tax hike required to achieve a given debt reduction relative to the no-migration scenario. The unemployment gains from migration for the stayers can be temporary. In the medium run, labour tax hikes lead to the biggest increase in unemployment. However, cuts in productive or utility-enhancing public spending lead to a much deeper contraction in *per capita* GDP 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 with sticky prices, while later this is reversed due to the positive wealth effect, which decreases hours and increases the wage. The migration of the employed limits further the short-run unemployment gains from migration during fiscal consolidation and reinforces the unemployment costs over time.

In addition to the government spending instruments considered in this paper, restrictions in new recruitment of public employees have been important in the fiscal adjustment of countries with

a sizeable public sector (e.g., Greece, Spain, and Italy) and have led many graduates, who were previously absorbed in public sector jobs, to emigrate. Further work 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, future work could consider a two-country model, allowing to study the effect of global shocks, as well as the effects of immigration on the foreign economy. Another interesting extension could be to incorporate on-the-job search and skills heterogeneity (see, e.g., Dolado et al. (2009)) in a model with migration. Finally, our model is general enough to study other cases, such as the rise in emigration from Britain following the Brexit referendum or from eastern European countries following their EU ascension. We leave these topics for future research.

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Tables

Table 1: Calibration

Description	Symbol	Value	Source or Target
National accounts			
per capita GDP	gdp	1.00	normalization
private consumption / GDP	C/gdp	0.62	equation (29)
private investment / GDP	i/gdp	0.18	Eurostat data
imports / GDP	y_m/gdp	0.25	Eurostat data
public debt / GDP	$\bar{b}$	1.27	Eurostat data
net foreign assets / GDP	b_f/gdp	0.10	Eurostat data
remittances / GDP	Ξ/gdp	0.03	World Bank data
Utility			
discount factor	β	0.96	4% interest rate
intertemporal elasticity	η	1.01	Hansen and Simgleton (1982)
external habits in consumption	ζ	0.75	standard value
home bias in consumption	ϖ	0.75	imports / GDP
elasticity hours worked	ξ	1.00	normalization
weight hours worked	χ	1.8221	equation (21)
Production			
capital share in production	α	0.33	standard value
capital depreciation rate	$\bar{\delta}$	0.088	investment / GDP
elasticity home/imported goods	γ	1.20	Erceg and Lindé (2013)
elasticity exports	γ_x	0.20	path of GDP in simulations
price monopolistic elasticity	ϵ	11	10% price markup
price Calvo lottery	λ_p	0.25	standard value
Labour market			
unemployment rate	$u/(u+n)$	0.12	Eurostat data
stock of migrants	$m_e/\bar{n}$	0.10	UN data
vacancy-filling probability	ψ_F	0.70	share of searchers abroad
job-finding probability	ψ_H	0.60	share of quitters
job-finding probability abroad	$\psi_H^\star/\psi_H$	1.60	7% foreign unemployment rate
firm's bargaining power	ϑ	0.383	Beqiraj and Tancioni (2014)
vacancies matching elasticity	μ_2	ϑ	Hosios condition
vacancy posting cost	κ	0.16	1% GDP total vacancy costs
net replacement rate	$\mathrm{b}/\left[(1-\tau_n)\,w\right]$	0.41	OECD data
termination rates	σ, $\sigma^\star$	0.072	Pappa et al. (2015)

Table 1: Calibration (continued)

Migration			
on-the-job search effort	$\bar{z}$	1.00	normalization
on-the-job search productivity	φ_{z1}	0.0047	workers matched abroad
on-the-job search productivity	φ_{z2}	2.95	simulation targets
on-the-job search cost	ϕ_{z2}	3.2	simulation targets
unemployed's search cost	ς_{s2}	1.1	simulation targets
unemployed's search cost	ς_{s1}	0.7350	equations (13)-(16)
on-the-job search cost	ϕ_{z1}	0.0023	equations (13)-(16)
weight of migration in utility	Ω	1.0186	equations (13)-(16)
elasticity of migrants stock	μ	1.00	normalization
Policy			
elasticity risk premium	Γ	0.001	Schmitt-Grohé and Uribe (2003)
wasteful gov. spending / GDP	g^w/gdp	0.0533	Eurostat data
utility gov. spending / GDP	g^c/gdp	0.1048	Eurostat data
productive gov. spending / GDP	g^y/gdp	0.0512	Eurostat data
labour income tax	τ^n	0.289	Papageorgiou et al. (2012)
capital income tax	τ^k	0.172	Papageorgiou et al. (2012)
consumption tax (VAT)	τ^c	0.139	Papageorgiou et al. (2012)

Note: Simulation targets refer to the quantitative analysis in Section 4 where (a) migration outflows match the total magnitude of Greek emigration (equal to half a million people), (b) the average share along the simulation horizon of emigrants that were previously employed matches the survey evidence in Labriandis and Pratsinakis (2016) reporting a share of 50 percent, and (c) on-the-job effort fluctuates within reasonable values.

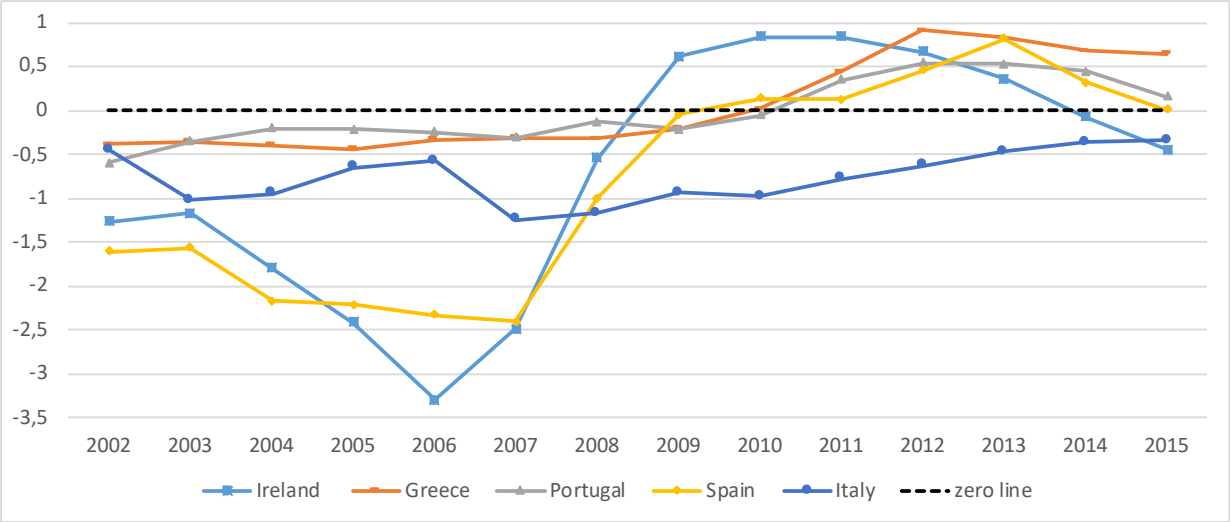
Table 2: Parameterization of the fiscal and debt-target rules

Rules	**Parameters**	**Values**	**Target(s)**
debt target	ρ_1, ρ_2	0.6, 0.000001	5% below SS in 10 yrs, half convergence in 5 yrs
τ^n	$\beta_{n0}, \beta_{n1}, \beta_{n2}$	0.75, 3.3, 6	debt / GDP meets new target in 10 yrs
g^w	$\beta_{gw0}, \beta_{gw1}, \beta_{gw2}$	0.35, -5.5, -7	debt / GDP meets new target in 10 yrs
g^c	$\beta_{gc0}, \beta_{gc1}, \beta_{gc2}$	0.35, -3.35, -5	debt / GDP meets new target in 10 yrs
g^y	$\beta_{gy0}, \beta_{gy1}, \beta_{gy2}$	0.35, -9, -10	debt / GDP meets new target in 10 yrs

Note: SS denotes steady state, yrs denotes years, and g^w, g^c, g^y refer to wasteful, utility-enhancing, productive spending, respectively. For each fiscal consolidation instrument, the actual debt to GDP ratio meets the new lower target in 10 years in the baseline model without migration.

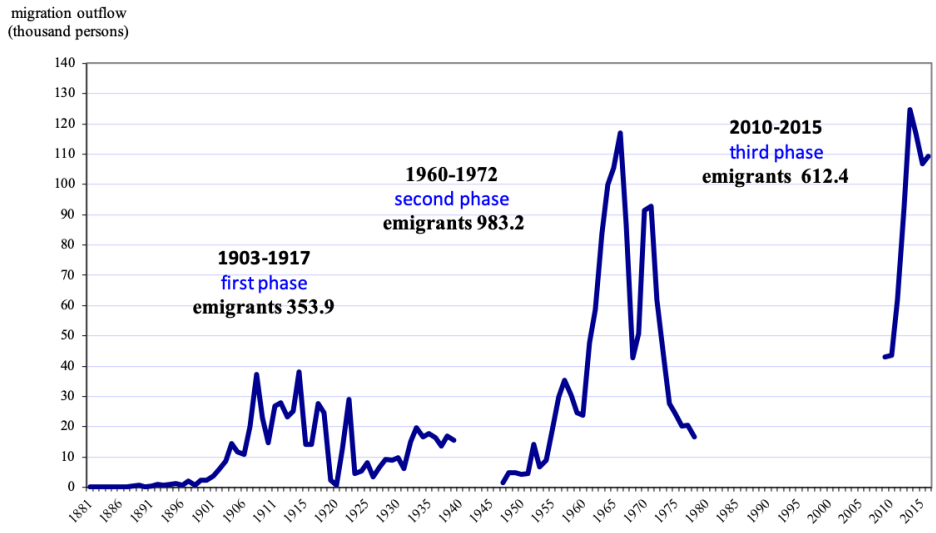
Figures

Figure 1: Net migration flows, defined as outflows minus inflows (% active population)



Source: Eurostat

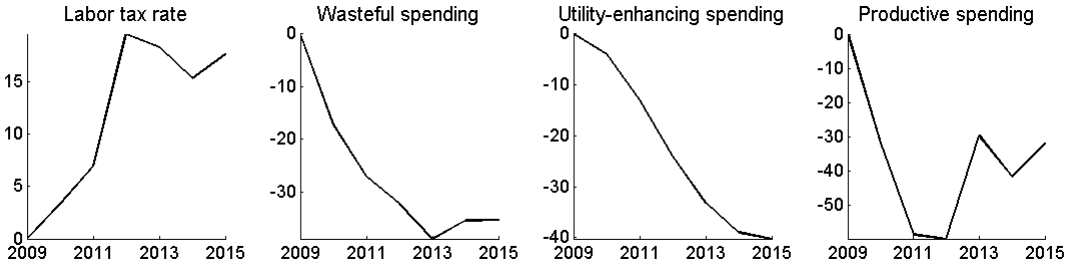
Figure 2: Emigration phases in Greek history (all age groups)



Source: updated graph from Lazaretou (2016)

Figure 3: Quantitative Analysis

(a) Paths of fiscal instruments (growth rates in percentages relative to 2009)



(b) Composition and size of emigration (thousand persons) predicted by the model

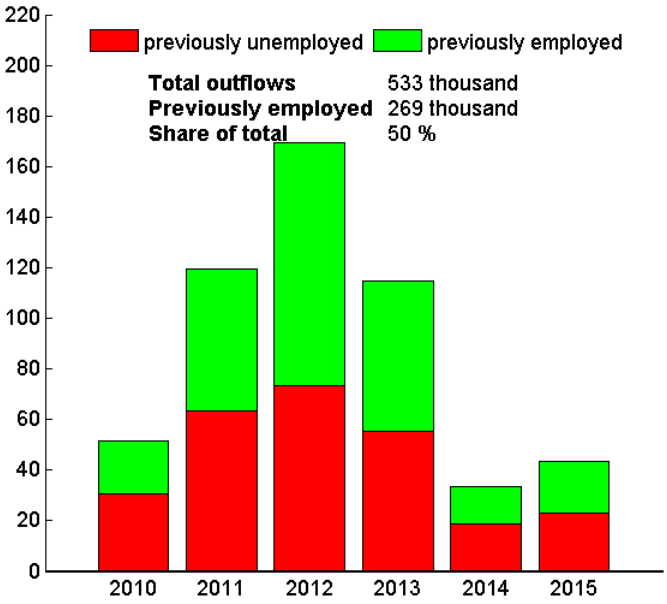
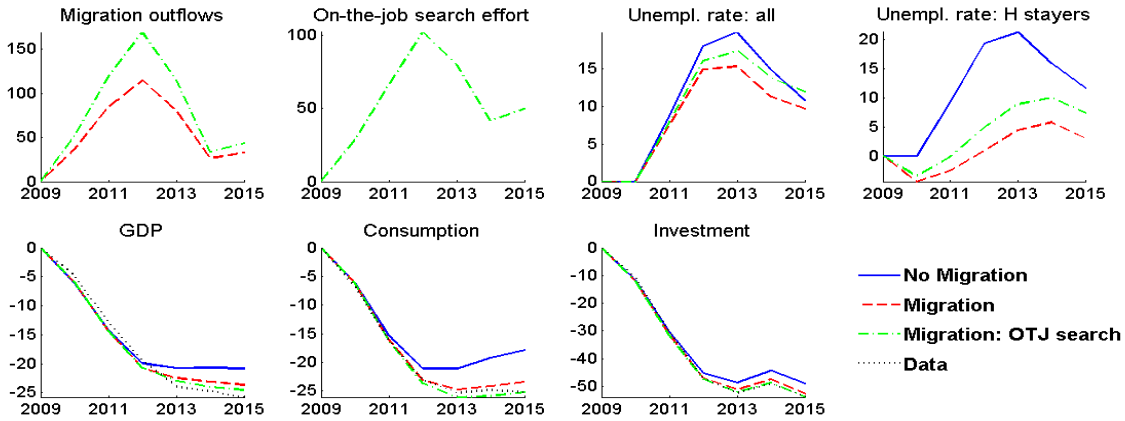
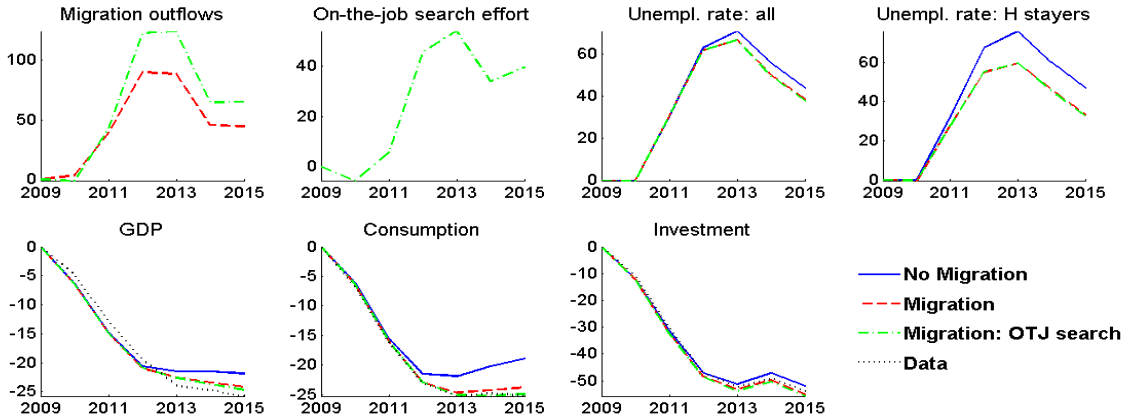


Figure 4: Austerity and Emigration in the Greek Depression: Simulation Results

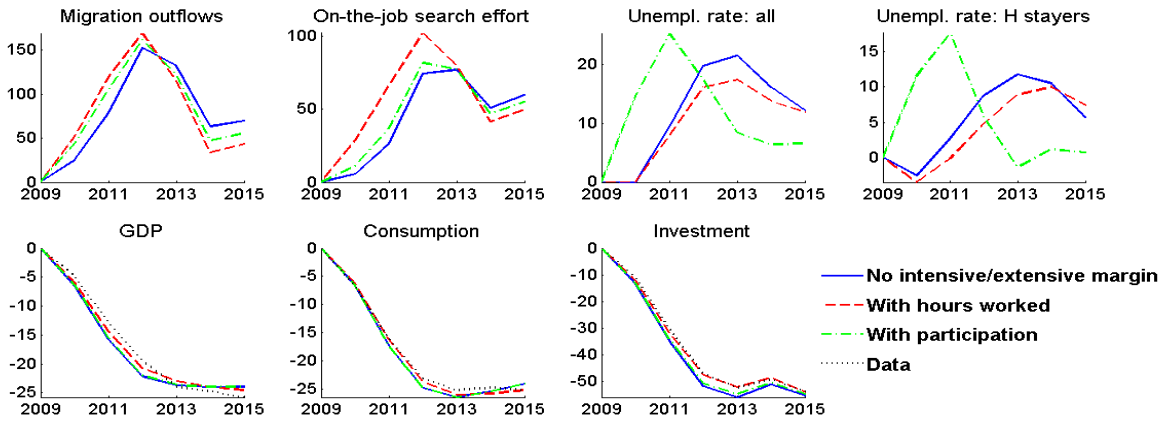
(a) Baseline calibration



(b) Sensitivity analysis: Higher bargaining power of firms



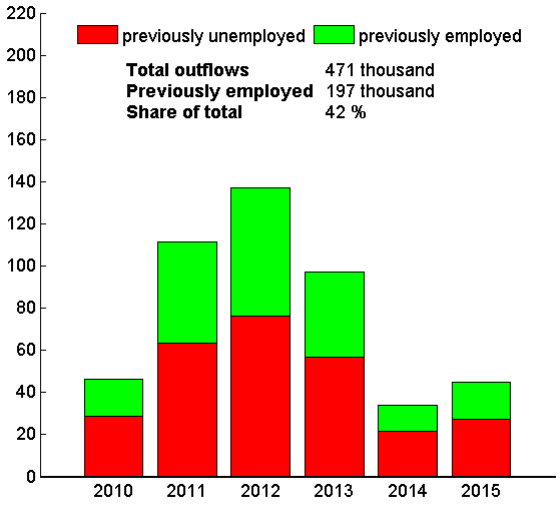
(c) Sensitivity analysis: Intensive and extensive margins (full model)



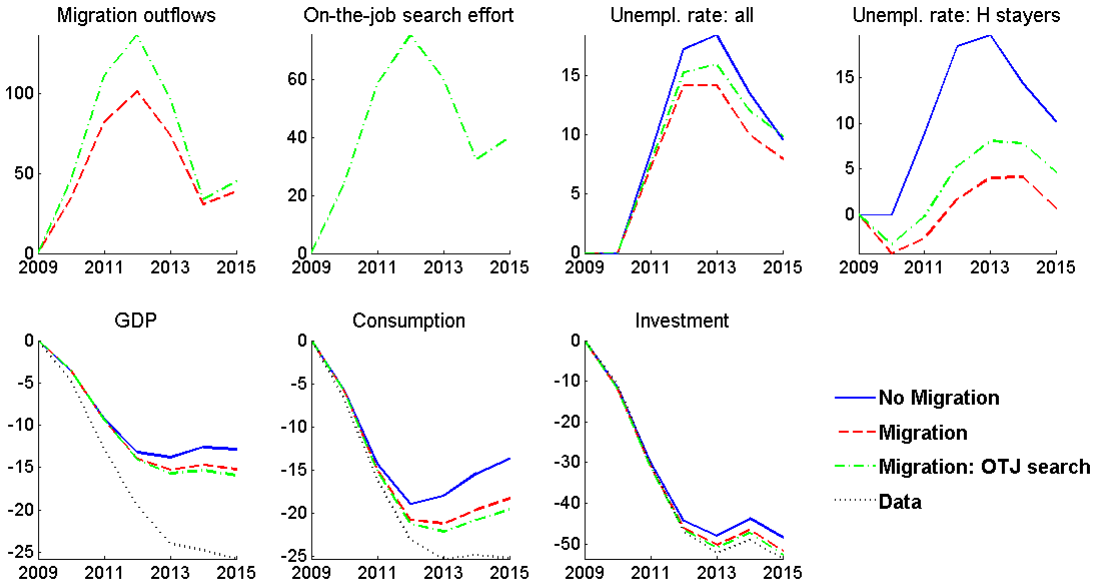
Responses for migration outflows are in levels (thousand persons). All other responses are in percent deviations from steady state. Consumption refers to the domestic good. OTJ denotes on the job. Unempl. rate: all and Unempl. rate: stayers include and exclude, respectively, the share of unemployed that target a job abroad.

Figure 5: Counterfactuals: The Role of Risk Premium and Investment Efficiency Shocks

(a) Composition and size of emigration predicted by the model (vertical axis: thousand persons)



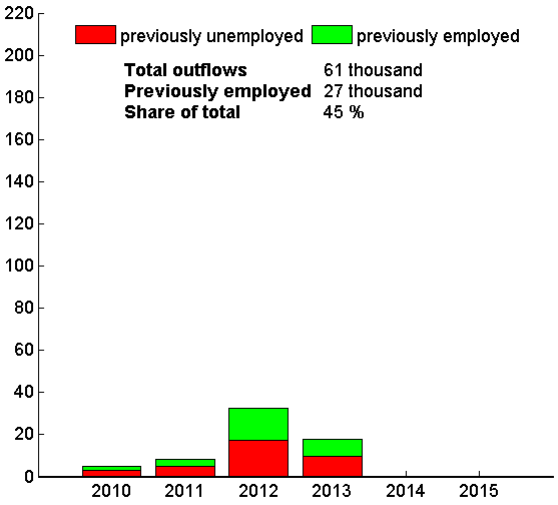
(b) Other Simulation Results



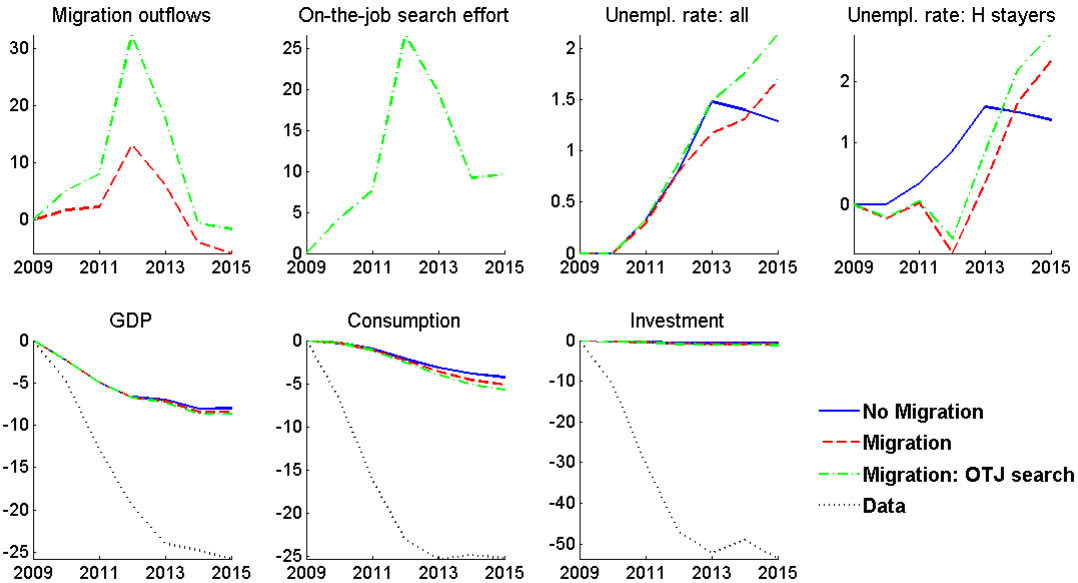
Responses for migration outflows are in levels (thousand persons). All other responses are in percent deviations from steady state. Consumption refers to the domestic good. OTJ denotes on the job. Unempl. rate: all and Unempl. rate: stayers include and exclude, respectively, the share of unemployed that target jobs abroad.

Figure 6: Counterfactuals: The Role of Fiscal Austerity

(a) Composition and size of emigration predicted by the model (vertical axis: thousand persons)



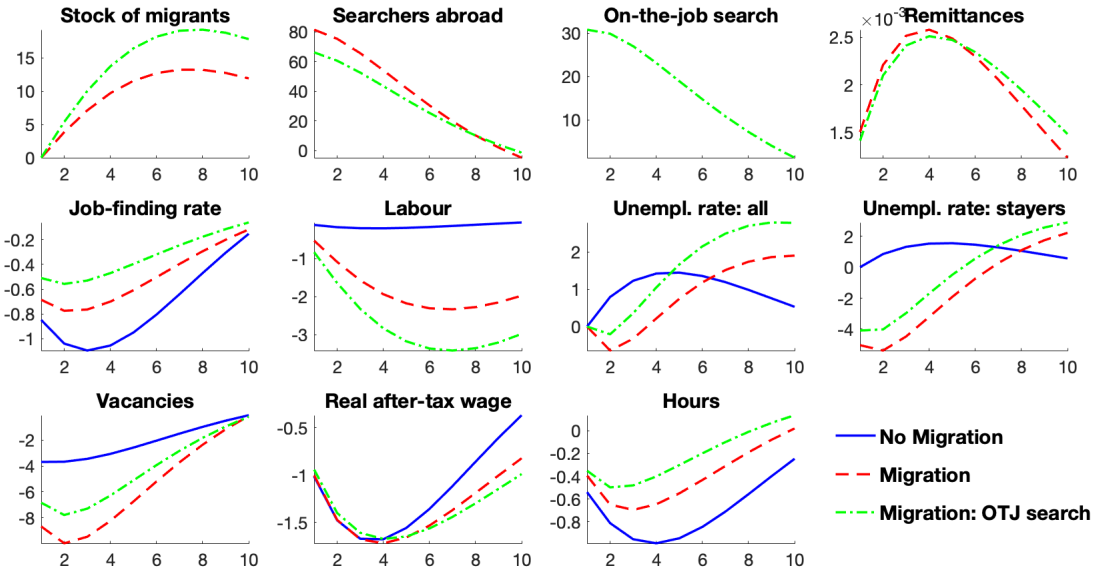
(b) Other Simulation Results



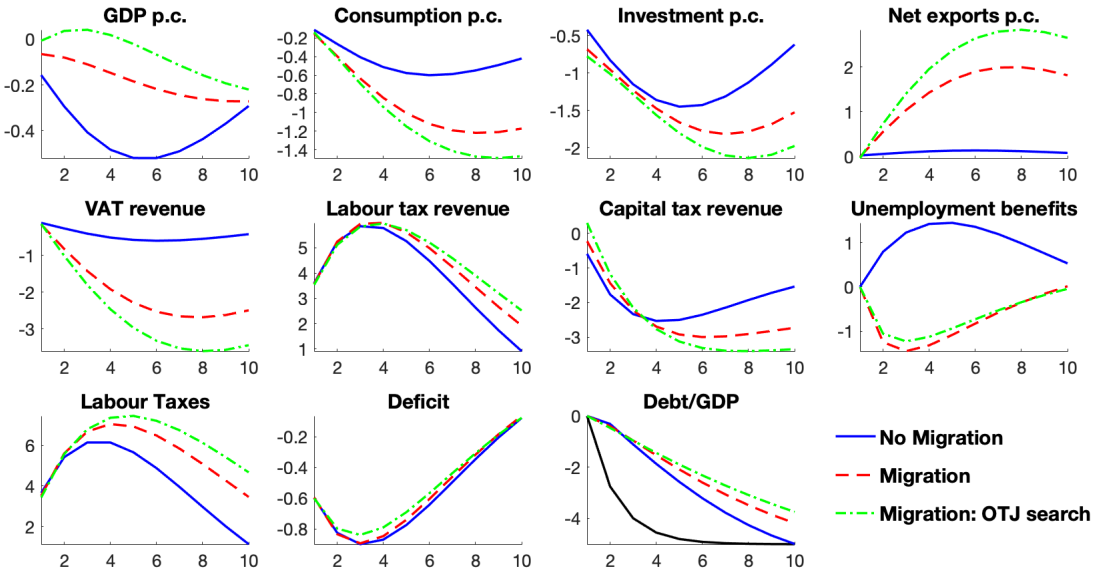
Responses for migration outflows are in levels (thousand persons). All other responses are in percent deviations from steady state. Consumption refers to the domestic good. OTJ denotes on the job. Unempl. rate: all and Unempl. rate: stayers include and exclude, respectively, the share of unemployed that target jobs abroad.

Figure 7: Labour Tax Hikes and Migration

(a) Migration and Labour Market Variables



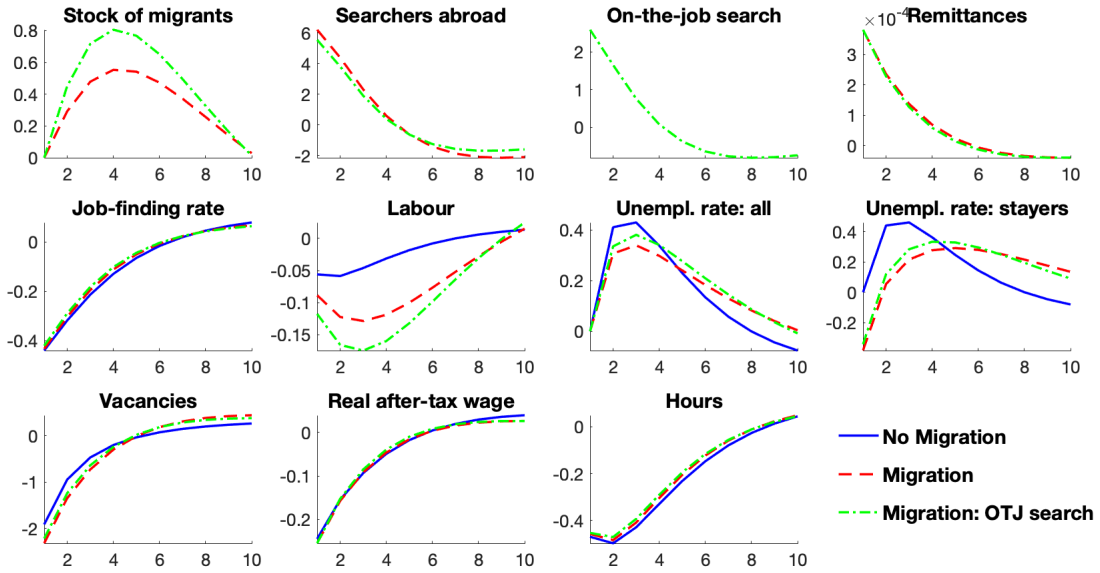
(b) Output and Fiscal Variables



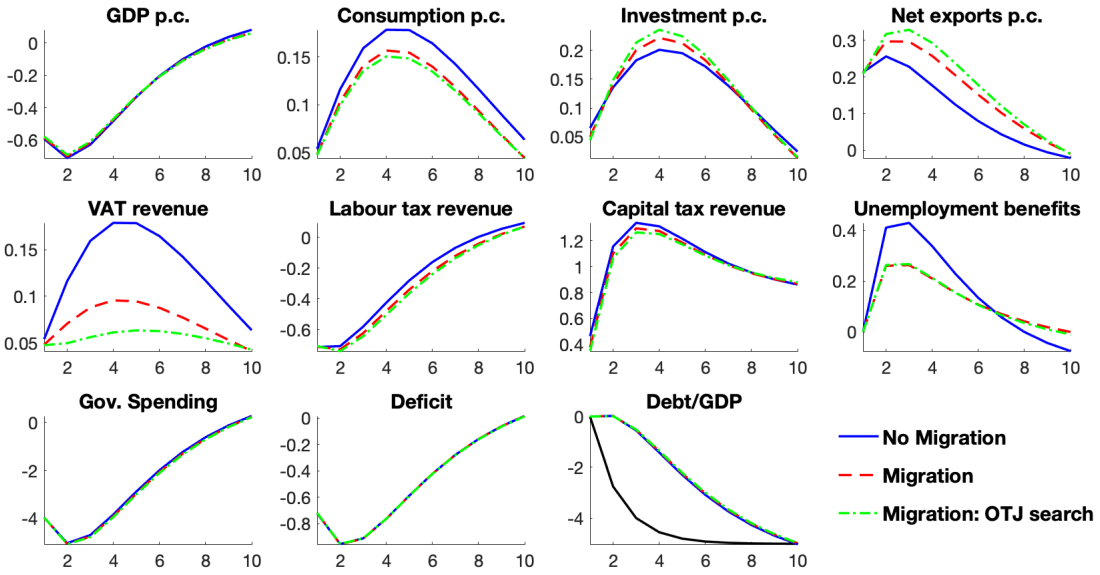
Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to the domestic good. OTJ denotes on the job and p.c. denotes per capita. Unempl. rate: all and Unempl. rate: stayers include and exclude, respectively, the share of unemployed that target jobs abroad. The black line in the Debt/GDP panel reports the path for the debt-to-GDP target.

Figure 8: (Wasteful) Spending Cuts and Migration

(a) Migration and Labour Market Variables



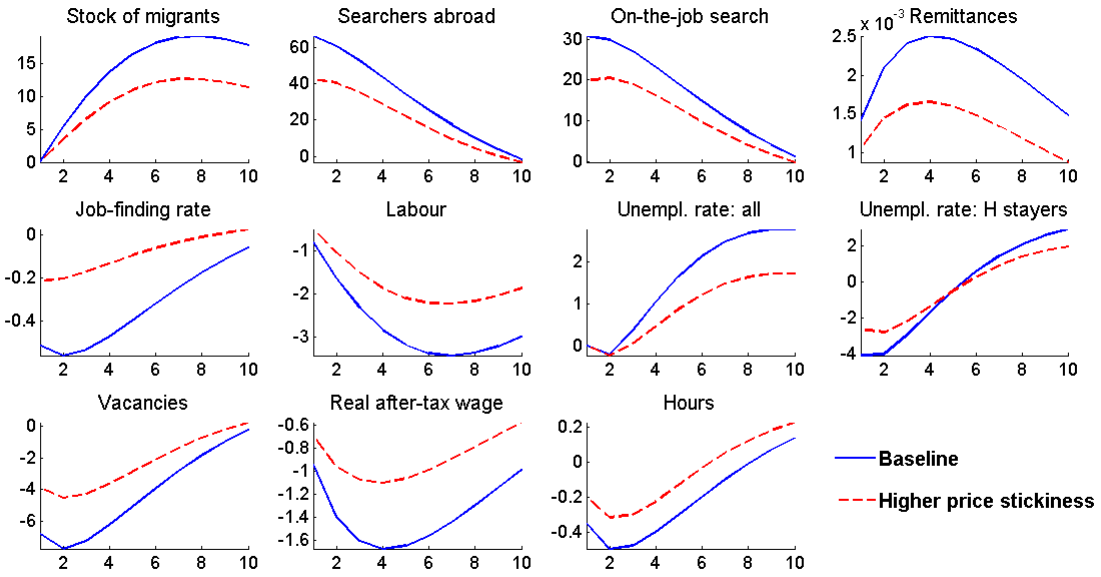
(b) Output and Fiscal Variables



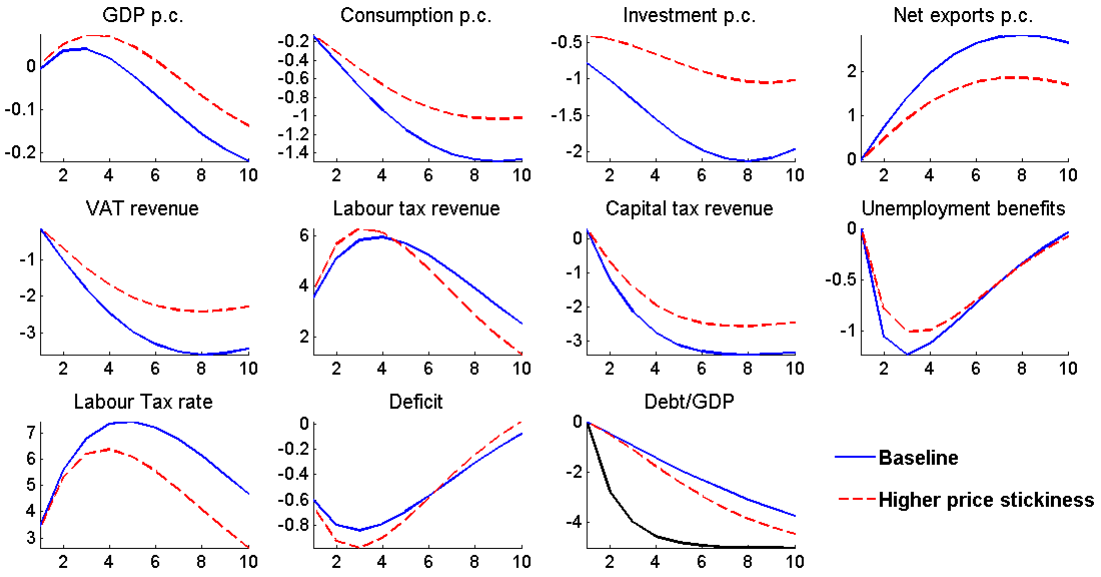
Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to the domestic good. OTJ denotes on the job and p.c. denotes per capita. Unempl. rate: all and Unempl. rate: stayers include and exclude, respectively, the share of unemployed that target jobs abroad. The black line in the Debt/GDP panel reports the path for the debt-to-GDP target.

Figure 9: Labour Tax Hikes: The Role of Price Stickiness

(a) Migration and Labour Market Variables



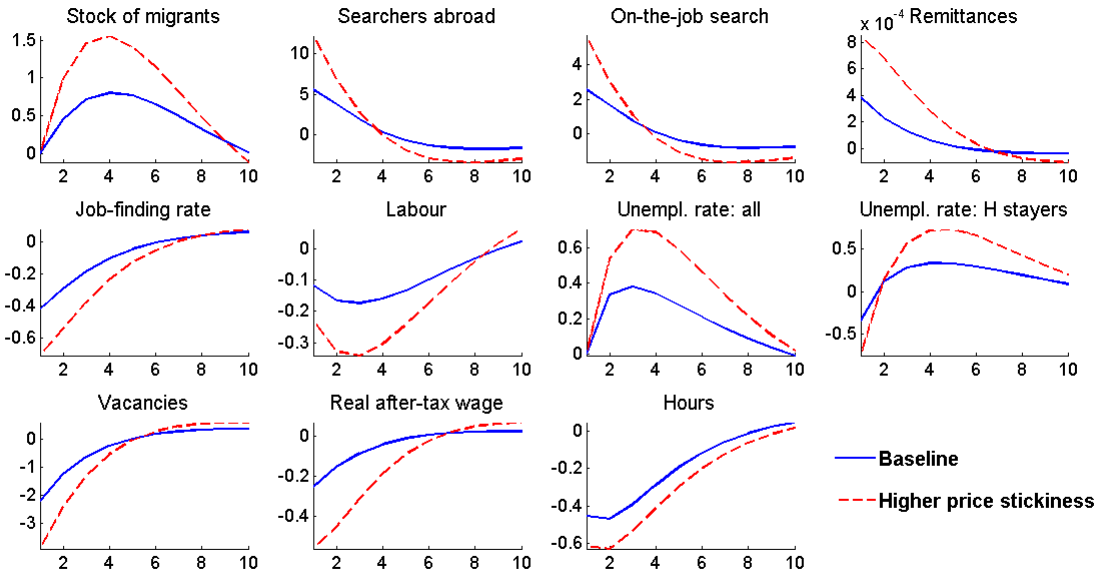
(b) Output and Fiscal Variables



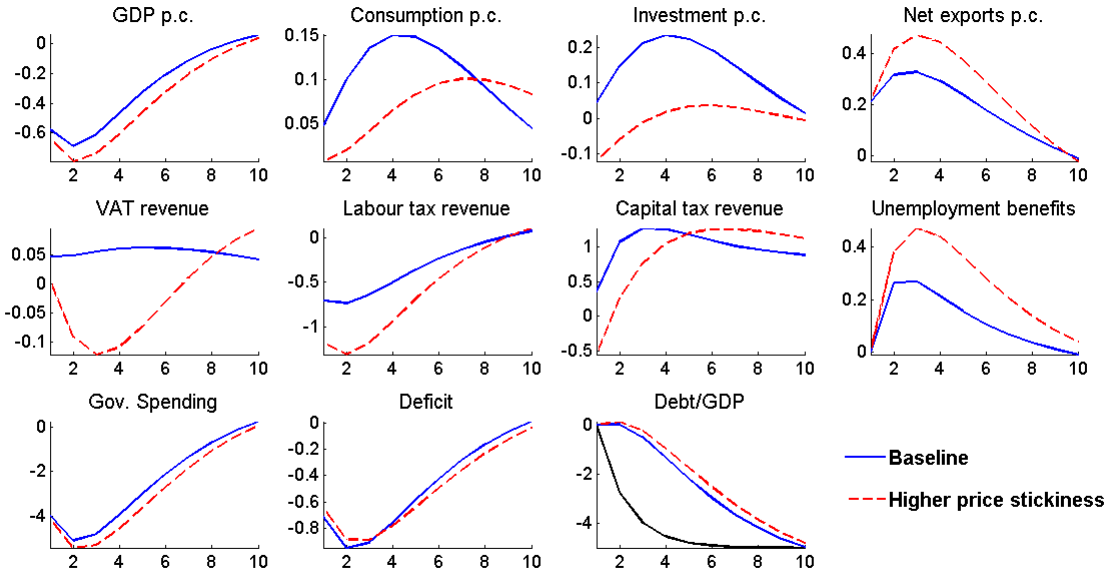
The baseline calibration refers to the model with emigration of the unemployed and the employed. Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to the domestic good. p.c. denotes per capita. Unempl. rate: all and Unempl. rate: stayers include and exclude respectively, the share of unemployed that target jobs abroad. The black line in the Debt/GDP panel reports the path for the debt-to-GDP target.

Figure 10: (Wasteful) Spending Cuts: The Role of Price Stickiness

(a) Migration and Labour Market Variables



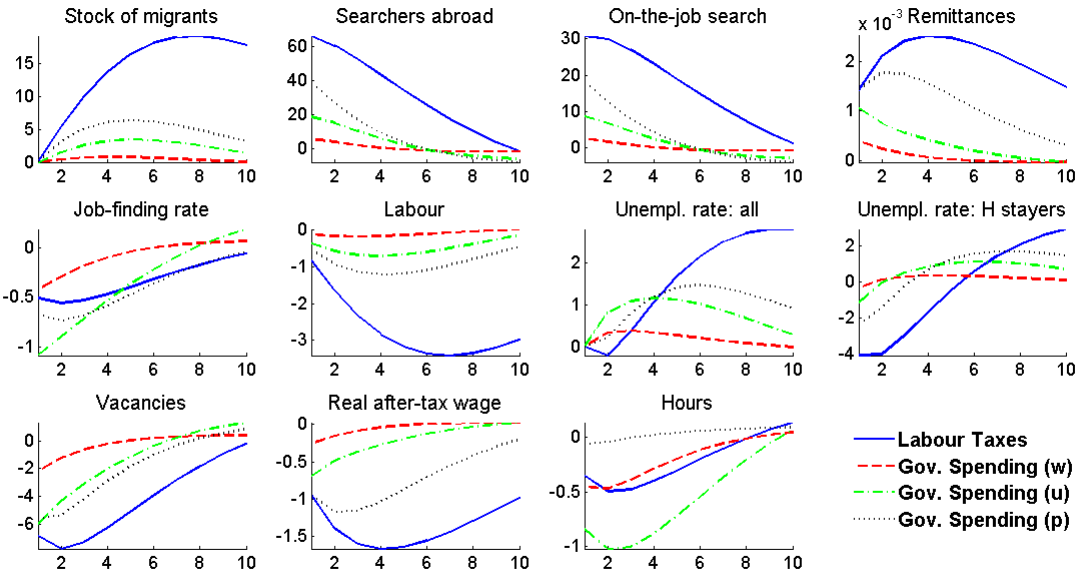
(b) Output and Fiscal Variables



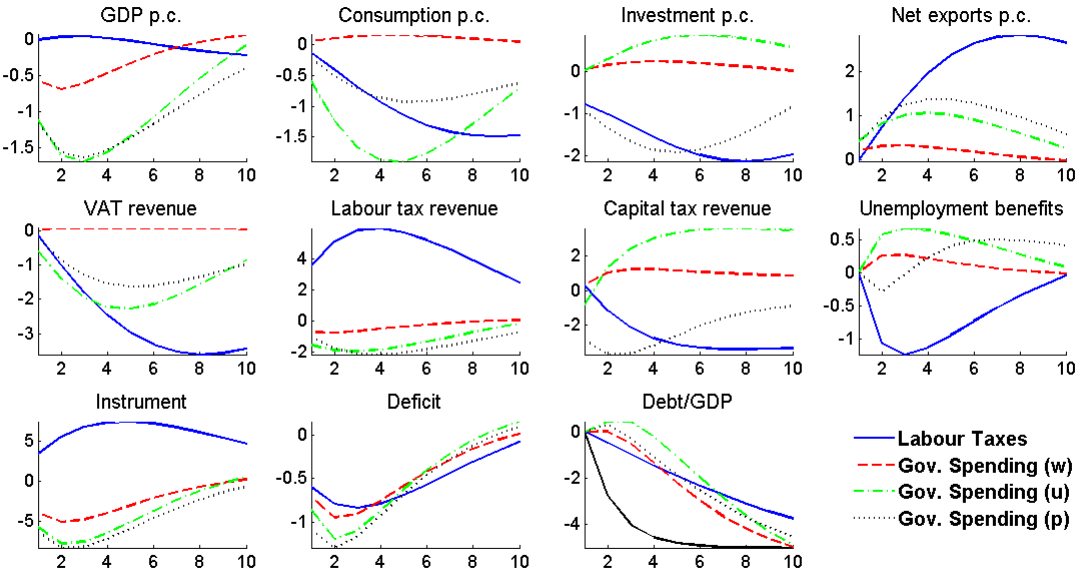
The baseline calibration refers to the model with emigration of the unemployed and the employed. Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to the domestic good. p.c. denotes per capita. Unempl. rate: all and Unempl. rate: stayers include and exclude, respectively, the share of unemployed that target jobs abroad. The black line in the Debt/GDP panel reports the path for the debt-to-GDP target.

Figure 11: Comparison of All Instruments with Migration

(a) Migration and Labour Market Variables



(b) Output and Fiscal Variables



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 the domestic good. OTJ denotes on the job and p.c. denotes per capita. Unempl. rate: all and Unempl. rate: stayers include and exclude, respectively, the share of unemployed that target jobs 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.

Appendix: The Problem of Retailers

There is a continuum of monopolistically competitive retailers indexed by i on the unit interval. Retailers transform one unit of intermediate goods into one unit of retail goods. The real marginal cost they face is the relative price $p_{y,t}$ of intermediate goods. Let $y_{i,t}$ be the quantity of output produced by retailer i. These goods are aggregated into a tradable good,

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

where $\epsilon > 1$ is the constant elasticity of demand for each variety. The aggregate tradable good is sold at the nominal price $P_{r,t} = \left(\int (P_{i,t})^{\epsilon-1} di\right)^{\frac{1}{\epsilon-1}}$, where $P_{i,t}$ is the price of variety i. The demand for each intermediate good depends on its relative price and on aggregate demand,

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

In any period each retailer can reset its price with a probability $1-\lambda_p$, choosing $P^*_{i,t}$ to maximize expected real profits,

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

subject to the demand schedule, where P_t is the final good price. Since all firms are ex-ante identical (except for the variety they produce), $P^*_{i,t} = P^*_{r,t}$ for all i. Taking into account $p_{r,t} \equiv P_{r,t}/P_t$, the resulting expression for the real reset price $p^*_{r,t} \equiv P^*_{r,t}/P_t$ is

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

with

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

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

where $\pi_{r,t} \equiv P_{r,t}/P_{r,t-1}$ is the producer price inflation. Calvo pricing implies

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

The aggregate tradable good is sold domestically and abroad

$$y_{r,t} = y_{l,t} + y^{\star}_{m,t}\,,$$

where $y_{l,t}$ and $y^{\star}_{m,t}$ are the quantities sold locally and abroad. Note that $y^{\star}_{m,t}$ is the only variable with an asterisk $\star$ that is time dependent (see equation (32)).