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**EMIGRATION AND FISCAL AUSTERITY
IN A DEPRESSION**

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Emigration and Fiscal Austerity in a Depression*

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Abstract

This paper studies the role of emigration in a deep recession when the government implements fiscal consolidation. We build a small open economy New Keynesian model with search and matching frictions, emigration of the labour force, and fiscal details. Our simulations for the austerity mix during the Greek Depression show that fiscal austerity accounts for one third of the output drop and more than 10% of migration outflows, whereas the rest is attributed to the macroeconomic environment. A counterfactual without migration underestimates the fall in output by one fifth. The model also sheds light on the two-way relation between emigration and austerity. Labour income tax hikes induce prolonged migration outflows, while spending cuts exert only a small effect on emigration which can be positive or negative depending on opposite demand and wealth effects. On the flip side, emigration increases the required tax hike and time to meet a given debt target due to endogenous revenue leakage. For tax hikes, emigration acts as an absorber of the austerity shock by diluting the output costs per resident through shrinking population. Yet, in terms of unemployment, temporary gains are reversed over time due to the distortionary effects of taxes on employment.

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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

What is the role of emigration in a deep recession when the government implements fiscal consolidation? Over the period 2010-2015, half a million of working-age Greek residents, amounting to 7% of the active population, left the country in search of employment, better pay and better social and economic prospects (see Figure 1).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 it. In this paper, we investigate, firstly, whether the mass exodus of Greek workers exacerbated the recession and, secondly, whether fiscal austerity contributes 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 hampers firms' marginal costs. Additionally, and insofar as employed workers also 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 before emigrating. Second, migrants take with them not only their labour supply, but also their purchasing power, reinforcing the fall in demand during bad times. Although this impact can be mitigated if emigrants send some of their earnings back home, remittances inflows have not increased at the same rate as emigration and amount only to a small portion of GDP.² The impact on aggregate demand depends also on openness and the importance of home bias in the demand for tradable goods. Typically, with relatively low trade integration the increase in external demand might not compensate for the fall in internal demand.

¹Adverse 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 2). In Spain annual outflows exceeded 400K, which was historically the highest level and comparable to the average inflow of 485K during the immigration boom of 2000-2006. 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 concentrated more than half of the post 2010 emigration (Labrianidis and Pratsinakis (2016)).

²World 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 themselves and not of the household”* (Labrianidis and Pratsinakis (2016)).

Interestingly, the relation of fiscal austerity and emigration is bi-directional. Fiscal policy affects migration decisions in the current period and also through emigrants' expectations regarding the domestic fiscal stance and the perception of future austerity. On the flip side, emigration has fiscal implications for the source economy. It 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 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 the employed 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 also Section 4.2.3).³

We build a Dynamic Stochastic General Equilibrium (DGSE) model of a small open economy (SOE) with sticky prices, fiscal details 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. Our simulations reveal that fiscal austerity accounts for one third of the output decrease and more than 10% of the migration outflows, whereas the rest is attributed to the macroeconomic environment, proxied by negative demand shocks. The benchmark model without migration underpredicts the fall in output by one fifth. Emigration amplifies the decline in consumption, investment, vacancies and employment. Tax hikes and spending cuts have very different effects on emigration. Overall, the effects are more attenuated for spending-based consolidations, as agents expect lower taxes in the future (positive wealth effect), and this not only curbs emigration but also helps sustain aggregate demand and therefore GDP and government revenues.

Since the link between emigration and austerity is bi-directional, we then consider simple feedback rules for fiscal policy which allow us to study the opposite direction of the relation. Specifically, we focus on the implications of emigration for (a) the success of fiscal consolidations in meeting a given debt target, and (b) the output and unemployment costs of consolidations. Through a positive analysis, we compare labour income taxes hikes and cuts in different types of government spending (wasteful, utility-enhancing, productivity-enhancing) when they are all designed to achieve the same reduction in the debt-to-GDP ratio. Labour tax hikes induce significant and

³Around two thirds of Greek emigrants were highly skilled (see, e.g., Triandafyllidou and Gropas (2014), Labrianidis and Pratsinakis (2016)).

persistent emigration, as before, while the effect of spending cuts can be positive or negative along the time horizon resulting from the opposite forces of the negative demand, Keynesian effect and the positive wealth effect.

Emigration implies an increase both in the tax hike and time required to meet a given debt target. 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 revenue leakage from the loss of taxpayers is translated into a reduction in consumption-tax receipts and the labour-income tax base (first-order effect). A higher tax hike is then required to reach a given debt target, which depresses economic activity and generates a second-order negative effect on the tax base. Despite the higher tax hikes, our model implies a smaller fall in the debt-to-GDP ratio, relative to no migration, even when only the unemployed emigrate. For spending cuts, a similar result is obtained for sufficiently strong price rigidities. Our results are in line with Storesletten (2000), who shows that an U.S. immigration inflow increases tax revenues per capita and reduces government debt, serving as a deficit-financing alternative to tax hikes or spending cuts.

Finally, we show that emigration mitigates the costs of fiscal consolidation in terms of GDP per capita, through reduction of resident population, which is much more substantial for tax hikes. Yet, the unemployment gains from emigration may be reversed over time. Emigration offers an extra outside option for workers in negotiations and therefore sustains higher wages. It 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, can offset the unemployment gains from the reduction in labour supply. Both for tax hikes and spending cuts, the emigration of the employed reduces further the short-run unemployment gains and reinforces the costs over time. Cuts in productive or utility-enhancing spending induce the deepest contraction in per capita GDP and are also the most detrimental tools, in addition to tax hikes, for per capita consumption (complementarity effect) and per capita investment, respectively.

Related Literature. Our paper contributes to the macroeconomics literature on fiscal consolidation and on migration. To the best of our knowledge, the effect of fiscal policies on emigration as well as the implications of emigration for the success and the costs of fiscal consolidations remain unexplored topics so far. Our paper adds 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. (2019); Bandeira et al. (2018)). Our results also offer new theoretical underpinnings, through highlighting the role of emigration, to the empirical literature on fiscal consolidation, pioneered by Alberto Alesina (see, e.g., Alesina et al. (2015); Alesina et al. (2019)). This literature shows that adjustments through spending cuts are less recessionary than through tax increases and, from the point of view of debt

sustainability, spending reductions are more potent means for improving the fiscal position and restraining debt growth than tax increases.

While existing work has examined the macroeconomic 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)).⁴ 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).

Structure. Section 2 lays out the DSGE model and Section 3 discusses the calibration strategy. Sections 4 presents our simulations for the Greek Depression, while Sections 5 and 6 study the role of emigration after fiscal austerity shocks and negative demand shocks, respectively. Finally, Section 7 offers concluding remarks.

2 A Small Open Economy with Labour Force Emigration

In this section, we build a small open economy New Keynesian DSGE model to assess the role of emigration in a deep recession when the government implements fiscal consolidation. Most of the model is a standard SOE NK model in the style of Gali and Monacelli (2008), taking foreign demand for goods and labour as given. There are two non-standard features that we consider: (i) labour market frictions and (ii) emigration of the labour force. We delegate the presentation of the formal model, along with a graphical illustration, to the Online Appendix and provide here an informal description as well as the key equations pertaining to unemployment and emigration.⁵

2.1 Informal Description of the Model

Labour Market. The labour market is governed by a standard search and matching mechanism.

⁴For 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) and Mandelman and Zlate (2012), 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).

⁵The Online Appendix is available at <http://pareto.uab.es/jcaballe/Papers/MigrationOnlineAppendix.pdf>.

Goods. The economy contains firms that operate at different stages of production. In the first stage, we have competitive firms that combine resident worker hours with effective capital and productive government expenditure to produce intermediate goods.⁶ These firms post vacancies at a cost. Wages and hours for resident workers are then determined by combining the firm’s demand for labour, the household’s supply of labour, and a simple Nash bargaining protocol that splits match surplus between the two parties. In the second stage, intermediate goods are sold to monopolistic retailers who are subject to price-setting frictions. In the third stage, these retail goods are combined with an imported good to generate final goods.

Price Setting. All prices are flexible except for the retail goods that are subject to the standard Calvo pricing friction.

Asset Markets. The household can hold foreign currency bonds that are associated with a risk premium, over the exogenous world interest rate. The risk premium is a function of actual relative to steady-state holdings. Firms are owned by households.

Monetary Policy. The exchange rate is fixed and we assume lack of monetary policy independence. The nominal interest rate is pinned down endogenously through the Fisher equation.

Public Finances. The government engages in three types of spending: wasteful, utility-enhancing, and production-enhancing. Additionally, the government pays a fixed unemployment benefit to unemployed workers and lump-sum transfers to the household. All this expenditure is financed via public debt and taxes on consumption, capital income, and labour income.

Households and Emigration. We assume a continuum of identical households of mass one. In each household, there is a fixed number of nationals who can be residents or emigrate to work abroad. Emigrated workers can return to the source country via exogenous separation. Residents can be employed or unemployed.⁷ Unemployed residents look for a job at home or abroad. Employed residents can continue working, become unemployed with an exogenous probability, or exert costly effort to find a job abroad with a certain probability. Residents and emigrants belong to a family, or representative household, that (imperfectly) pools income and takes consumption, savings, labour, and job search decisions, in line with evidence about strong family ties in Southern

⁶Variable capital utilization and hours allow output to react on impact to shocks given that employment is a state variable in our search and matching framework. Results without hours are included in the Online Appendix.

⁷Introducing a labour participation choice does not alter substantially our results (see the Online Appendix). 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 emigration on unemployment.

European countries (see, e.g., Alesina and Giuliano (2014); Giuliano (2007)).⁸ Consumption is a CES aggregate of public expenditures, resident consumption, and emigrant consumption. Utility is defined over consumption, an aggregate of hours worked (by residents and emigrants), and a utility penalty of emigration. Emigrants earn labour income abroad, which is split according to an exogenous rule between purchases of the foreign consumption good and remittances. The latter enter directly the representative household's budget constraint. Hours worked and wages abroad are exogenous and this effectively pins down emigrant consumption. The margin of adjustment comes from the number of emigrants, which is controlled by choosing employed's search effort for jobs abroad and the share of unemployed looking for domestic versus foreign jobs, effectively choosing the employment composition. The model features habit formation and investment adjustment costs, which are critical to obtain smooth responses with reasonable degrees of nominal rigidities.

2.2 Key Equations of the Model

We use the asterisk $\star$ to denote foreign variables or parameters. Treating foreign variables as exogenous, we omit the time subscript. All quantities are in aggregate terms. Responses of per capita variables are shown in the results that follow.

Household Composition. We assume a continuum of identical households of mass one. The number of nationals of each household is equal to constant $\hat{n}$ and comprises residents, who are employed n_t or unemployed u_t , and the stock of emigrants $n_{e,t}$,

$$\hat{n} = n_t + u_t + n_{e,t}. \quad (1)$$

Search and Matching. An endogenous share $1 - s_t$ of the unemployed u_t search in the domestic labour market, while the remaining s_t look remotely for jobs abroad, facing an individual pecuniary cost given by an increasing function $\varsigma(\tilde{s}_t \tilde{u}_t)$, where $\tilde{s}_t$ and $\tilde{u}_t$ are the average shares of s_t and u_t per household.⁹ This cost function (see Section 3 for the specific functional form) links positively the cost of search abroad with the measure of corresponding job seekers, helping to smooth out migration decisions by putting a brake to the search abroad. New matches m_t are given by

$$m_t = \mu_1 (v_t)^{\mu_2} ((1 - s_t) u_t)^{1-\mu_2}, \quad (2)$$

⁸For macro-migration models with a representative agent, see, e.g., Kaplan and Schulhofer-Wohl (2017); Mandelman and Zlate (2012), Binyamini and Razin (2008).

⁹A 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 emigrants depart 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).

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

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

The employed n_t can exert effort z_t searching for a job abroad, where better fiscal and employment conditions exist. We denote by $\varphi(z_t)$ the productivity of on-the-job search effort, measured by the probability of finding a job abroad. Searching while employed is subject to a pecuniary cost $\phi(z_t)$, measured in units of the final good. We assume that $\varphi'(z_t) > 0$ and $\phi'(z_t) > 0$, with $\varphi'(z_t)/\varphi(z_t) < \phi'(z_t)/\phi(z_t)$ such that the on-the-job search effort is effectively costly (see, e.g., Krause and Lubik (2006); Tüzemen (2017)). Domestic and emigrant employment, n_t and $n_{e,t}$, evolve according to

$$n_{t+1} = (1 - \sigma - \psi_H^* \varphi(z_t)) n_t + \psi_{H,t} (1 - s_t) u_t, \quad (3)$$

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

where σ is the exogenous separation rate and $\psi_H^* \varphi(z_t)$ captures endogenous separation for those who quit to take up a job abroad.¹⁰ For simplicity, we assume equal hiring probabilities abroad for unemployed and employed of the representative household. Equation (3) is equivalent to

$$n_{t+1} = (1 - \sigma) n_t + \psi_{F,t} v_t, \quad (5)$$

which is convenient to use in the vacancy-posting decision of firms below.

Consumption Bundle. The representative household derives utility from a consumption bundle Φ_t , composed of private consumption C_t and public consumption g_t^c ,

$$\Phi_t \equiv \left[(1 - \alpha_1) \left(C_t - \zeta \tilde{C}_{t-1} \right)^{\alpha_2} + \alpha_1 (g_t^c)^{\alpha_2} \right]^{\frac{1}{\alpha_2}}, \quad (6)$$

where the elasticity of substitution is given by $1/(1 - \alpha_2)$ 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. In turn, C_t is composed of purchases by residents c_t and emigrants $c_{e,t}$,

$$C_t \equiv c_t + c_{e,t}. \quad (7)$$

¹⁰Focusing on cross-country rather than within-country wage differentials, we abstract from domestic on-the-job search, 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)).

Migrants' purchases of goods abroad $c_{e,t}$ are equal to their labour income minus remittances Ξ_t ,

$$(1 + \tau^{c*}) c_{e,t} = (1 - \tau^{n*}) w^* h_e n_{e,t} - \Xi_t. \quad (8)$$

We follow Mandelman and Zlate (2012) by assuming that the migrant labour income is part of a unified budget constraint, which allows 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. To avoid the problem of undetermined consumption allocation between the migrant and non-migrant members of the household, we use an insurance mechanism of remittances, similarly to Mandelman and Zlate (2012)¹¹,

$$\Xi_t = \varrho \left(\frac{(1 - \tau^{n*}) w^*}{(1 - \tau_t^n) w_t} \right)^{\rho_\Xi}. \quad (9)$$

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. Evidence from World Bank data suggests that the role of remittances has been very small in the recent emigration wave from Europe's periphery, which is captured in our calibration.

Household Utility, Budget and Assets. The household suffers disutility from hours worked h_t , exogenous hours worked abroad h_e , and having family members abroad $n_{e,t}$. The latter captures different culture, food, and habits, distance from relatives and friends, less dense networks, and difficult integration.¹² The per period utility function is given by

$$U(C_t, g_t^c, h_t, n_{e,t}) = \frac{\Phi_t^{1-\eta}}{1-\eta} - \chi \frac{(h_t^{1+\xi} n_t + h_e^{1+\xi} n_{e,t})}{1+\xi} - \Omega \frac{(n_{e,t})^{1+\mu}}{1+\mu}, \quad (10)$$

where η is the inverse of the intertemporal elasticity of substitution and the strictly positive parameters Ω , χ , μ , ξ refer to the disutility from hours worked and living abroad. The budget

¹¹We abstract from endogenizing the allocation of immigrant income between remittances and consumption of the foreign good, which would require to assume that the household in the source country makes this decision or to model migrants as separate optimizing agents. Given that remittances increased much less than migration outflows from Europe's periphery in the aftermath of the Great Recession, such an endogenous choice is outside our scope.

¹²The utility cost of migration is useful in smoothing out migration decisions without assuming unrealistically high pecuniary costs of job search abroad when we study labour income tax hikes.

constraint in units of the final good is given by

$$(1 + \tau^c) c_t + i_t + \frac{b_{g,t+1}}{r_t} - \frac{e_t b_{f,t+1}}{r_{f,t}} + \varsigma(\tilde{s}_t \tilde{u}_t) s_t u_t + \phi(z_t) n_t \leq (1 - \tau_t^n) w_t h_t n_t + [r_t^k - \tau^k (r_t^k - \delta_t)] x_t k_t + b_{g,t} - e_t b_{f,t} + e_t \Xi_t + b u_t + \Pi_t^r + T, \quad (11)$$

where $\phi(z_t) n_t$ and $\varsigma(\tilde{s}_t \tilde{u}_t) s_t u_t$ are the total costs of search for jobs abroad incurred by the employed and the unemployed, w_t is the hourly wage, r_t^k is the return on effective capital, b denotes unemployment benefits, and e_t is the real exchange rate. Government bonds $b_{g,t}$ pay the return r_t , while $b_{f,t}$ denotes liabilities with the rest of the world with return $r_{f,t}$.¹³ 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. Also, since our focus 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 well as the lump-sum transfers T as constant. The capital depreciation rate is δ_t and the degree of capital utilization is x_t . The household owns the capital stock, which evolves according to

$$k_{t+1} = \epsilon_{i,t} \left[1 - \frac{\omega}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 \right] i_t + (1 - \delta_t) k_t, \quad (12)$$

where i_t is private investment, $\epsilon_{i,t}$ denotes an investment efficiency shock, and ω dictates the size of investment adjustment costs. The depreciation rate δ_t depends on capital utilization x_t ,

$$\delta_t = \bar{\delta} x_t^\iota, \quad (13)$$

where $\bar{\delta}$ and ι are positive constants. The risk premium depends on the actual relative to steady-state deviation of the net foreign liabilities to GDP ratio,

$$r_{f,t} = r^* \exp \left\{ \Gamma \left(\frac{e_t b_{f,t+1}}{gdp_t} - \frac{\bar{e} \bar{b}_f}{\bar{gdp}} \right) + \epsilon_{r,t} \right\}, \quad (14)$$

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

Household's Optimality Conditions. We report the full set of first order conditions of the household's problem in the Online Appendix and focus here on those that determine the values of

¹³Assuming 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).

employment in the two labour markets as well as the search for jobs abroad for the unemployed and the employed. Denoting by $\lambda_{n,t}$, $\lambda_{e,t}$, and $\lambda_{c,t}$ the Lagrange multipliers on equations (3), (4), and (11), the optimality conditions with respect to s_t and z_t are given by

$$\begin{aligned} \lambda_{n,t} = & \beta \left[E_t \lambda_{c,t+1} ((1 - \tau_t^n) w_{t+1} h_{t+1} - b - \phi(z_{t+1})) - \chi \frac{h_{t+1}^{1+\xi}}{1+\xi} \right] \\ & + \beta [E_t \lambda_{n,t+1} (1 - \sigma - \psi_{H,t+1} - \psi_H^* \varphi(z_{t+1})) + E_t \lambda_{e,t+1} \psi_H^* \varphi(z_{t+1})] , \end{aligned} \quad (15)$$

$$\begin{aligned} \lambda_{e,t} = & \beta \left[E_t \lambda_{c,t+1} ((1 - \tau^{n*}) e_{t+1} w^* h_e - b + \varsigma(\tilde{s}_{t+1} \tilde{u}_{t+1})) - \chi \frac{h_e^{1+\xi}}{1+\xi} - \Omega(n_{e,t+1})^\mu \right] \\ & + \beta [E_t \lambda_{e,t+1} (1 - \sigma^* - \psi_H^*)] , \end{aligned} \quad (16)$$

where β is the household's discount factor. According to the two equations, the value of having a member employed in either labour market equates to the utility value of the net wage income, adjusted for the costs of search abroad, minus the disutility from supplying hours and in (16) of having members abroad, plus the continuation value of the match. This includes the expected value of continuing with the job without an exogenous separation, net of the value foregone because workers are not job seeking, captured by $\psi_{H,t+1}$ and ψ_H^* in (15) and (16). Equation (15) also accounts for the fact that with probability $\psi_H^* \varphi(z_{t+1})$ a current worker will quit to take up a job abroad.¹⁴ Next, the optimality conditions with respect to s_t and z_t are given by

$$\psi_{H,t} \lambda_{n,t} = \psi_H^* \lambda_{e,t} - \lambda_{c,t} \varsigma(\tilde{s}_t \tilde{u}_t) , \quad (17)$$

$$\lambda_{c,t} \frac{\phi'(z_t)}{\varphi'(z_t)} = \psi_H^* (\lambda_{e,t} - \lambda_{n,t}) . \quad (18)$$

Equation (17) states that the values of job seeking in the domestic and foreign labour markets should be equal, where the latter is expressed net of the utility-adjusted moving cost. Finally, condition (18) 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.¹⁵

¹⁴The Online Appendix includes the full derivation of equations (15) and (16). The value of being employed 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.

¹⁵In the scenarios we analyze below, we only consider cases where $\lambda_e > \lambda_n$ is true in the steady state.

Vacancy Posting. Intermediate goods are produced with a Cobb-Douglas technology,

$$y_t = (n_t h_t)^{1-\alpha} (x_t k_t)^\alpha (g_t^y)^\nu, \quad (19)$$

where g_t^y denotes productive public expenditure. Firms maximize the discounted value of future profits taking as given the number of workers currently employed n_t . They decide the number of vacancies posted v_t so as to employ in the next period the desired number of workers n_{t+1} . Firms also decide the amount of effective capital $x_t k_t$ to rent at rate r_t^k from the household. The optimization problem can be written as

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

where $p_{y,t}$ is the relative price of intermediate goods with the final good being the numeraire, κ is the vacancy cost, 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 (5), with $\psi_{F,t}$ taken as given. As shown below, the optimality condition with respect to vacancies states that the marginal cost of hiring should equal the expected marginal benefit, given by the marginal productivity of labour minus the wage income plus the continuation value. The termination of the match occurs exogenously with probability σ and also endogenously due to cross-border matches $\psi_H^* \varphi(z_{t+1})$.

$$\frac{\kappa}{\psi_{F,t}} = E_t \beta_{t+1} \left[(1 - \alpha) \frac{p_{y,t+1} y_{t+1}}{n_{t+1}} - w_{t+1} h_{t+1} + (1 - \sigma - \psi_H^* \varphi(z_{t+1})) \frac{\kappa}{\psi_{F,t+1}} \right]. \quad (20)$$

The first order condition with respect to effective capital is standard (see the Online Appendix).

Wage-Hours 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 equilibrium wage income $w_t h_t$ is given by

$$\begin{aligned} w_t h_t = & (1 - \vartheta) \left\{ (1 - \alpha) \frac{p_{y,t} y_t}{n_t} + (1 - \varphi(z_t)) \frac{\psi_{H,t}}{\psi_{F,t}} \kappa \right\} \\ & + \frac{\vartheta}{(1 - \tau^n)} \left\{ b + \frac{\chi}{\lambda_{c,t}} \frac{h_t^{1+\xi}}{1 + \xi} + \phi(z_t) - \varphi(z_t) \varsigma(\tilde{s}_t \tilde{u}_t) \right\}. \end{aligned} \quad (21)$$

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, 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 $\varphi(z_t)\varsigma(\tilde{s}_t\tilde{u}_t)$. Finally, the determination of hours in equilibrium is shown in the Online Appendix.

Government. Total government spending is given by

$$g_t = g_t^w + g_t^c + g_t^y, \quad (22)$$

where g_t^w is the wasteful component, g_t^c is the utility-enhancing component and g_t^y is the productive component. The primary deficit and the government budget constraint are given by

$$DF_t = bu_t + g_t + T - \tau_t^n w_t h_t n_t - \tau^k (r_t^k - \delta_t) x_t k_t - \tau^c c_t, \quad (23)$$

$$r_{t-1} b_{g,t-1} + DF_t = b_{g,t}. \quad (24)$$

3 Calibration

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 uses econometric estimates which place it between 0 and 2. We fix it to unity, so that utility from consumption takes the logarithmic form. External habits are set equal to 0.75, which is a common value in the literature. 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 4.2.3, we also

explore a version of the model without the intensive margin. Following the literature on Edgeworth complementarity between private and public consumption (see, e.g., Bouakez and Rebei (2007); Fève et al. (2013)), we set $\alpha_2 = -0.75$. Using the household's first order conditions with respect to $g_{c,t}$ and c_t , allows us to pin down, $\alpha_1 = (1 + (1 + \tau^c)(C(1 - \zeta)/g_c)^{1-\alpha_2})^{-1} = 0.2925$.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, $\nu = g_y/y = 0.05$. 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 the measure of 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. Assuming a relatively mild wage premium abroad, i.e. $w^*/w = 1.12$, helps us to moderate migration costs. Specifically, our calibration implies that per job match abroad, search costs as a share of the wage amount to 55% and 47% 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 the two labour markets, 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 $b/[(1 - \tau_n)w] = 0.41$ in line with data from the OECD Benefits and Wages Statistics. The

¹⁶The 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).

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

¹⁸Data 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.

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. For the costs of job search abroad and the productivity of on-the-job search effort, we adopt the following functional forms, $\varsigma(\tilde{s}_t \tilde{u}_t) = \varsigma_{s1} (\tilde{s}_t \tilde{u}_t)^{\varsigma_{s2}}$, $\phi(z_t) = \phi_{z1} (z_t)^{\phi_{z2}}$, $\varphi(z_t) = \varphi_{z1} (z_t)^{\varphi_{z2}}$. 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 conditions (15)-(18) in the steady state. We set φ_{z2} , ϕ_{z2} , ς_{s2} such that in our simulations (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 elasticity 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 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 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).

¹⁹For instance, with $\varphi_{z2} = 1$, z_t could more than triple in our simulations to generate the same number of workers moving abroad. Krause and Lubik (2006) look at on-the-job search in the domestic market and set $\varphi_{z1} = \varphi_{z2} = 1$, while letting the steady-state value of search effort $\bar{z}$ determine the number of low paid workers moving to a better job. They calibrate the job-to-job transition rate to be 6%, whereas here the comparative measure would be below 0.45%. This difference in magnitudes explains why we opt for $\varphi_{z2} > 1$.

4 Quantitative Analysis

In this section, we offer a model-based anatomy of the Greek Depression, which stands out as an example of public debt crisis and implementation of fiscal austerity policies. We study jointly the impact of the fiscal 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 graphically in the Online Appendix, migration inflows throughout this period remained constant at around 60K, below their pre-crisis level, 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. 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 household 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.

The model is solved non-linearly in Dynare. We proxy the macroeconomic environment through a combination of a risk premium shock and a negative investment-efficiency shock (see equations (14) and (12)), which follow an auto-regressive form with one lag and coefficient $\rho = 0.75$ (see also the table about the shocks in the Online Appendix). Note that we have also tried negative supply side (TFP) shocks as an alternative to risk premium shocks. The results (available upon request) are very similar except mainly for the fact that negative TFP shocks are inflationary, which is not a desirable outcome for the context of our exercise. Furthermore, the impulse response functions to a risk premium shock and an investment-specific shock when lump-sum transfers react to public debt through a simple rule and all other fiscal instruments are held constant at their steady-state are discussed in Section 5, where we solve the model by linearizing the equilibrium conditions around a non-stochastic zero-inflation steady state with flexible prices.

4.2 Results

We now turn to our findings, followed by a set of counterfactual exercises and robustness checks. We compare results for three variants, with: (i) no emigration, (ii) emigration of the unemployed,

(iii) emigration of the unemployed and employed.²⁰

4.2.1 Baseline Calibration

Figure 3b shows the predicted number of emigrants by employment status before departure and calculates the total emigration wave in Greece until 2015. As targeted, 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% as evidenced in Labrianidis and Pratsinakis (2016).

Figure 4a shows the simulation results for migration, unemployment, vacancies, employment, real wage, hours, consumption, investment and GDP, using solid lines for model (i), dashed lines for model (ii), and dash-dotted lines for the full model (iii). Given that this has been targeted, the increase in migration outflows in the full model is of the magnitude observed in the data. The model 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.²¹ Both consumption and investment, and as a result labor demand (vacancies) and employment, fall by more in the presence of emigration. The decline in vacancies is more pronounced when only the unemployed emigrate than when both the unemployed and the employed emigrate, as in the latter case the departure of employed frees up positions for the stayers.

The model 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. We return to this issue in Section 4.2.3. Emigration helps to mitigate the increase of residents' unemployment (*Unempl. rate: all*) in the medium run. In the no-migration model, the unemployment rate in the first year of fiscal changes (2010) does not move, given that employment is a state variable. A second measure including only the unemployed who target domestic jobs (*Unempl. rate: stayers*) is shown to vary from 2010 and, as expected, this measure reveals stronger differentials between the models with and without emigration. In the early period, unemployment for stayers decreases due to emigration. In addition to this, we also observe differences between the no-migration and migration models from the early period 2009-2011 for vacancies.

²⁰We 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).

²¹We highlight the impact of emigration on per resident output costs of fiscal austerity in Section 6.

4.2.2 Counterfactuals

Next, we present simulation results without the fiscal austerity mix (see Figure 5a) and without the negative demand shocks (see Figure 5b). The macroeconomic environment, as proxied by the demand shocks, accounts for two thirds of the output decrease and close to 90% of migration outflows during the Greek Depression. It then follows that fiscal austerity alone accounts roughly for one third of the output decrease and slightly more than 10% of migration outflows. The inclusion of tax hikes alone in the model leads to similar, but larger responses than in Figure 5b, which underlines the distortionary effects of tax-based consolidations, while spending cuts have overall milder effects which tend to mitigate the adverse effects of tax hikes (see the Online Appendix). Spending cuts generate a very small reduction in migration outflows relative to the steady state of the model, driven by the standard, positive wealth effect which induces the household to work less and to consume more (expectation of lower future taxes).²²

4.2.3 Robustness

Bargaining Power. In models with search and matching frictions the volatility of unemployment is somehow limited.²³ 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.²⁴ With higher ϑ the wage moves closer to the household's outside option, which is largely determined by the fixed unemployment benefit, b (see equation (21)). Consequently, the wage response becomes more sluggish. This leads firms facing adverse demand shocks to use the quantity margin (cut vacancies) by more. As a result, there will be more unemployed. Wages moving by less also implies that on-the-job search effort increases by less.

Intensive and Extensive Margin. So far the extensive margin was absent from 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 status from inactivity to employment and vice versa (see Figure 5 in Garda (2016)). As shown in the Online Appendix, with endogenous labour force participation instead of hours, the increase in unemployment occurs too early and the unemployment rate for stayers increases, rather than decreases, in the short run, driven by the

²²As shown in the Online Appendix, for each spending component, the small reduction in outflows follows in shape the path of the instrument. The magnitude is larger for the component with the largest output share, which is utility-enhancing spending (see Table 1). Vacancies and the real wage increase except for productive spending cuts, which imply a fall in firms' productive capacity and the marginal product of labour. After cuts in utility-enhancing expenditure, consumption falls due to the complementarity effect. Finally, after wasteful spending cuts, the real wage falls initially, driven by a short-lived negative demand effect, but then rises, driven by the positive wealth effect which increases consumption and investment.

²³See the Shimer critique (Shimer (2005)) and the answers to this critique (e.g., Hagedorn and Manovskii (2008)).

²⁴See the evidence presented in ILO (2014).

increase in participation (negative income effect of demand shocks). Finally, if we remove hours, there is a smaller increase in emigration and hence a bigger increase in unemployment initially.

Skill Heterogeneity. Finally, a potential concern is that skill heterogeneity would also matter for the effect of emigration on taxable income, given that the high skilled contribute more to tax revenues than the low skilled. Yet, 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.”* About 70% of emigrants were high skilled (footnote 3). In our quantitative analysis, 50% of total emigrants were employed before departing. The rest of high-skilled emigrants, along with the low-skilled, may therefore be viewed as unemployed (not labour income taxpayers). We thus feel confident that our analysis does not overestimate the emigration effect on the taxable income base.

5 The Role of Emigration after Fiscal Austerity Shocks

What are the implications of labour mobility for the success of fiscal consolidations in meeting a given debt target? In the quantitative analysis of Section 4, using the actual austerity mix implemented in Greece in a model with emigration, we showed starking differences between tax hikes and spending cuts in their effects on emigration. Overall, the effects are more attenuated for spending-based consolidations, as agents expect lower taxes in the future, and this not only curbs emigration but also helps sustain aggregate demand and therefore GDP (and also government revenues). Since the link between emigration and fiscal austerity is bi-directional, in this section we consider simple feedback rules for fiscal policy which allow us to study the opposite direction of the relation. We also compare, in the presence of emigration, the output and unemployment effects of the various fiscal consolidation policies when they are all designed to achieve the same reduction in the debt-to-GDP ratio after a given period of time.

5.1 Feedback Policy Rules and Fiscal Consolidation

Following Erceg and Lindé (2013) and Pappa et al. (2015), we focus on consolidation through labour income taxes and different types of government spending, and study how the economy reacts to shocks to the target ratio of debt-to-GDP (so that a consolidation is a reduction in this target ratio), when the relevant instrument follows an autoregressive rule that adjusts at a given speed to ensure that the target ratio is hit in the long-run. Specifically, the active fiscal instrument

evolves 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 $b_{g,t}^T$, and the discrepancy between their changes, denoted by Δ ,

$$\Psi_t = \Psi^{(1-\beta_{\Psi 0})} \Psi_{t-1}^{\beta_{\Psi 0}} \left[\left(\frac{\tilde{b}_{g,t}}{b_{g,t}^T} \right)^{\beta_{\Psi 1}} \left(\frac{\Delta \tilde{b}_{g,t+1}}{\Delta b_{g,t+1}^T} \right)^{\beta_{\Psi 2}} \right]^{(1-\beta_{\Psi 0})}, \quad (25)$$

where $\beta_{\Psi 1}, \beta_{\Psi 2} > 0$ for $\Psi = \tau^n$ and $\beta_{\Psi 1}, \beta_{\Psi 2} < 0$ for $\Psi = g^f$, where $f = w, c, y$. We consider each instrument separately, assuming that if one is active, the others are fixed at the steady-state. The target debt-to-GDP ratio is given by the AR(2) process,

$$\log b_{g,t}^T - \log b_{g,t-1}^T = \rho_1(\log b_{g,t-1}^T - \log b_{g,t-2}^T) + \rho_2(\log \bar{b} - \log b_{g,t-1}^T) - \varepsilon_t^b, \quad (26)$$

where $\bar{b}$ is the steady-state level of the debt-to-GDP ratio, ε_t^b is a white noise process representing a fiscal consolidation shock, $0 \leq \rho_1 < 1$ and $\rho_2 > 0$. By introducing strong inertia through the AR(2) process, we model a gradual (effectively permanent) reduction in the debt target (see also Erceg and Lindé (2013), Pappa et al. (2015), Bandeira et al. (2018)).²⁵ We solve the model by linearizing the equilibrium conditions around a non-stochastic zero-inflation steady state with flexible prices. The price of the final good and the real exchange rate normalized to unity.

5.2 Labour Tax Hikes

We first consider $\Psi = \tau^n$ in the feedback policy rule (25). Figure 6 depicts impulse response functions to a tax-based consolidation.

No Emigration (solid lines). Given the drop in after-tax income, consumption and investment, followed by VAT and capital tax revenue, fall. The fall in demand reduces vacancies, the job finding probability and employment, and so unemployment and payments of benefits rise. Tax hikes decrease hours by disincentivizing work. The fall in demand leads to a fall in imports, reflected in the increase of net exports, and a fall in GDP.

Emigration of Unemployed (dashed lines). Relative to the previous, there are four main findings from the fact that the household raises the share of foreign-job seekers. First, emigration offers an extra outside option for workers in negotiations and therefore sustains higher wages, which in turn leads to a more pronounced fall in vacancies and employment. Second, the unemployment gains from the exodus of job seekers with successful matches abroad are temporary as the unemployment rate rises over time more strongly, due to the more pronounced fall in employment and

²⁵Studying the possibility of sovereign default is beyond the scope of our paper.

the shrinking labour force. Third, emigration affects positively the government budget through a reduction in unemployment benefits and negatively through a leakage in VAT revenue. The negative impact prevails, which implies that the debt-to-GDP ratio falls more slowly, requiring more time to meet the new target and a higher tax hike. Due to the more pronounced fall 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. Fourth, the higher tax hike 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.

Emigration of Unemployed and Employed (dash-dotted lines). Tax hikes significantly increase the intensity with which workers look for employment abroad, raising further the stock of migrants, while mitigating the search abroad of the unemployed. The exodus of the employed reduces (increases) the short-run (medium-run) unemployment gains (costs) from emigration due to the deeper demand contraction. As before, for GDP per capita the fall is mitigated by a reinforced increase in net exports per capita. On the fiscal side, the drop in VAT revenue becomes more pronounced, and a higher tax hike for a longer time is required to achieve the debt reduction.

5.3 Spending Cuts

Next, we consider $\Psi = g^w$ in the feedback policy rule (25). Figure 7 depicts impulse response functions to cuts in wasteful government spending.

No Emigration (solid lines). Due to the negative aggregate demand effect with sticky prices (see the resource constraint in the Online Appendix), vacancies, the job finding rate, employment, labour tax revenue and real GDP fall, while unemployment rises. The real wage initially goes down, given the drop in labour demand, but then increases slightly, given a reduction in labour supply. The latter comes from the standard positive wealth effect (expectation of lower future taxes) for the household which reduces hours and increases consumption and investment. VAT revenue rises aiding the fiscal consolidation effort. The drop in wages and marginal costs increases the competitiveness of the economy and net exports.

Emigration of Unemployed (dashed lines). The household initially increases the share of searchers for jobs abroad due to the negative demand, Keynesian effect of spending cuts, but the increase is of significantly lower magnitude and persistence than under tax hikes which directly distort labour incentives. Emigration mitigates the increase in consumption and reinforces the decline of employment. Relative to the no-migration model, aggregate investment rises by less

but the reduction in the resident population drives a higher rise of per resident investment. Unemployment gains from the unemployed’s exodus are short-lived and turn later to higher costs due to the reinforced employment decline. After the fourth period when the size of the cuts decreases relative to the impact period, the share of foreign-job searchers falls below its steady-state level while vacancies, the job finding rate and the wage rise above the steady state. The positive wealth effect therefore becomes dominant. By implying some persistence in spending cuts, the feedback policy rule matters for the turning point of the emigration response. In results shown in the Online Appendix for a 1% cut in public spending, when the latter follows alternatively a simple autoregressive rule, the emigration response turns negative even earlier (second period). Finally, due to the small emigration response overall, the fall in per capita GDP from the drag in aggregate demand hardly differs from the no-migration scenario. The same holds for the debt-to-GDP ratio: the negative emigration impact on tax revenue is offset by lower unemployment benefits expenditure. In Section 6.4, we show that a higher degree of price stickiness can lead to more pronounced differences between the no-migration and migration models through a stronger response of emigration.

Emigration of Unemployed and Employed (dash-dotted lines). Spending cuts exert a small and non-monotonic effect on the intensity with which workers look for jobs abroad: on-the-job search effort increases (decreases) until (after) the fourth period, in line with the fall (rise) in the real wage. The emigration of the employed leads to a higher decline in employment from job quits but alters little the response of unemployment and the debt-to-GDP ratio.

5.4 Policy Implications and Discussion

The mechanisms and policy implications of our main results are summarized below.

Effects of Fiscal Austerity on Emigration. Labour tax hikes induce significant and prolonged emigration, while the effect of spending cuts is much smaller and depends on the combination of opposite forces arising from a negative demand effect (sticky prices) and a positive wealth effect (expectation of lower taxes).

Effects of Emigration on Fiscal Austerity Success. Emigration influences the size of fiscal consolidations and time needed to reach a given debt target. Intuitively, when people can “vote with their feet”, austerity policies face a more elastic tax base and may lead to higher public debt as the tax base erodes. The endogenous leakage in revenue comes from the loss of taxpayers, generating a reduction both in consumption-tax receipts and the labour-income tax base (first-order effect). A higher tax hike is then required to reach a given debt target, which depresses

economic activity and generates a second-order negative effect on the tax base. Despite the higher tax hikes, our model implies a smaller fall in the debt-to-GDP ratio, relative to the no-migration benchmark, even when only the unemployed emigrate. The emigration of the employed then reinforces the revenue leakage. Our results are in line with Storesletten (2000) who shows that an U.S. immigration inflow increases tax revenues per capita and reduces government debt, serving as a deficit-financing alternative to tax hikes or spending cuts.

Effects of Emigration on Fiscal Austerity Costs. Emigration sustains higher wages by offering an extra outside option for workers. It 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, offset over time the unemployment gains from the reduction in labour supply. The emigration of the employed reduces the short-run unemployment gains from unemployed emigration and reinforces the unemployment costs over time. Emigration dilutes the costs of fiscal consolidation in terms of GDP per capita, through a reduction of residents, much more substantially for tax hikes.

The Role of Price Rigidities. As shown in the Online Appendix, when more firms cannot reset prices, they react to the negative demand effect of spending cuts by cutting vacancies more. This reinforces the increase in unemployment and emigration, differentiating more strongly the responses of per capita GDP and debt-to-GDP ratio between the no migration and migration models. Consequently, the required spending cut does become larger with emigration. These results are reversed in the case of tax hikes: a larger share of firms with fixed prices implies weaker negative effects on inflation and milder consolidation needed (through the debt law of motion and the Fisher equation), with milder effects on labour market variables, emigration and output.

Extending the Role of Public Spending. Comparing all instruments $\Psi \in \{\tau^n, g^w, g^c, g^y\}$ in Figure 8, we see that labour tax hikes exert the strongest impact on emigration, vacancies, after-tax wages, employment, unemployment and required consolidation time, followed by cuts in productive, utility-enhancing and wasteful spending. By inducing the strongest effects on emigration, tax hikes reduce the resident population substantially which has a diluting effect on per capita GDP costs. For the same reason, tax hikes increase per capita net exports more significantly than spending cuts. Finally, cuts in productive or utility-enhancing spending induce the deepest contraction in per capita GDP. These are also the most harmful tools, in addition to tax hikes, for per capita consumption (complementarity effect) and per capita investment, respectively.²⁶

²⁶In the Online Appendix we study cuts in utility-enhancing or productive spending in all three model variants.

6 The Role of Emigration after Negative Demand Shocks

The quantitative analysis of Section 4 showed that the combination of demand shocks considered accounts for two thirds of the output contraction and close to 90% of migration outflows during the Greek Depression. In this section, we study in more detail the role of emigration after an unexpected one-period shock to the risk premium (say from an exogenous change in the country's credit rating). As in the previous section, we solve the model by linearizing the equilibrium conditions around a non-stochastic steady state. To ensure determinacy of equilibrium and a non-explosive solution for debt, we assume that lump-sum transfers react to the debt-to-GDP ratio $\tilde{b}_{g,t}$ through a standard rule $T_t = \bar{T} \exp(\zeta_b(\tilde{b}_{g,t} - \bar{b}))$, where $\bar{b}$ is the steady-state level of $\tilde{b}_{g,t}$ and $\zeta_b < 0$. All other fiscal instruments are held constant at their steady-state levels.

Figure 9 presents impulse response functions to a risk premium shock that generates a 1% increase in the nominal interest rate. The responses to a negative investment shock, which is the second type of negative demand shock considered in Section 4, are very similar (except for inflation and the interest rate, which are though very small in magnitude) and are presented in the Online Appendix. As we explain below, most of the previous findings in Figure 5a continue to hold. Under an unexpected one-period shock, a new insight in Figure 9 is that the response of the on-the-job search for employment abroad may be non-monotonic, initially increasing but then falling below the steady state. Given that over time the emigration effort of the employed is reduced, the unemployment increase due to the negative demand shock can be higher than in the no-migration model.

No Emigration (solid lines). Given the fall in demand, vacancies, wages and employment decline, while unemployment rises. To overcome the fall in labour income, the household increases hours. The contraction of demand pushes down on domestic prices and net exports increase. Yet, the fall in internal demand reduces GDP.

Emigration of Unemployed (dashed lines). The negative demand effect of the shock increases the share of searchers for jobs abroad. The reduction in domestic labour supply reinforces the contraction in vacancies and employment relative to the no-migration model. Stayers experience a short-run reduction of unemployment, but the stronger decline of employment renders unemployment gains from emigration short-lived and leads to higher unemployment costs over time. Emigration reinforces the contraction in consumption, but also the rise in net exports. In per resident terms, GDP falls by less due to the shrinking resident population (diluting effect).

Emigration of Unemployed and Employed (dash-dotted lines). The response of the on-the-job search abroad is non-monotonic: it initially increases, since wages drop, reinforcing the

response of (un)employment, but, in later periods, it falls below its steady-state level as wages and vacancies return to the steady state faster. This is because the emigration of workers frees up vacancies, which mitigates the unemployed’s search abroad. As before, the decline in resident population dilutes per resident output costs.

7 Concluding Remarks

Most of the literature 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 by investigating the role of emigration in a deep recession when the government implements fiscal consolidation. To this end, we build a small open economy New Keynesian DSGE model with labour market frictions and emigration of the labour force.

We show that the mass exodus of Greek workers during the period 2010-2015 exacerbated the recession by amplifying the drag in consumption and investment. We also investigate the bi-directional relation between fiscal austerity and emigration, highlighting the heterogeneous effects of spending cuts and tax hikes on emigration in line with the findings in the literature about the more adverse effects of tax-based consolidations (see, e.g., Alesina et al. (2015) and Alesina et al. (2019)). In addition, we study the impact of emigration on fiscal austerity success and find that labour mobility increases the size and time of required consolidations due to an endogenous leakage in revenue. Finally, we investigate the effects of emigration on the output and unemployment costs of fiscal austerity in order to answer whether fiscal austerity contributes more strongly to the depth of recession in the presence of emigration. Our analysis suggests that when fiscal austerity induces a strong response of emigration, such as with labour tax hikes, emigration acts as an absorber of the austerity shock by diluting the output costs per resident through a population reduction. However, in terms of unemployment, gains are only temporary and are reversed over time due to the distortionary effects of taxes on employment.

In the aftermath of the Great Recession, restrictions in recruitment of public employees were part of the fiscal adjustment of countries with a sizeable public sector (e.g., Greece, Spain, Italy) and led graduates, previously absorbed in public sector jobs, to emigrate. Further work could therefore look into the interaction of public wage bill cuts (see, e.g., Bandeira et al. (2018) and Bermperoglou et al. (2017)) with emigration by adding a public sector to our model. Second, future work could consider a two-country model to study global shocks and the effects of immigration in 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 emigration.

The current Covid-19 crisis raises profound challenges for public finances and the macroeconomy. Government deficits are rising while the experience of fiscal austerity measures during the

previous recession is still fresh for many countries in Europe. The experience of these countries can offer valuable lessons for policymakers. Financing rising deficits by tax hikes can trigger future labour flows within the euro area from countries worst hit to core countries, like Germany. This will reduce the national tax base, forcing the governments to hike the tax rate even more, which will exacerbate the Covid-19 recession in worst-hit economies.

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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 Singleton (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	ψ_H^*/ψ_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	$b/[(1-\tau_n)w]$	0.41	OECD data
termination rates	σ, σ^*	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.

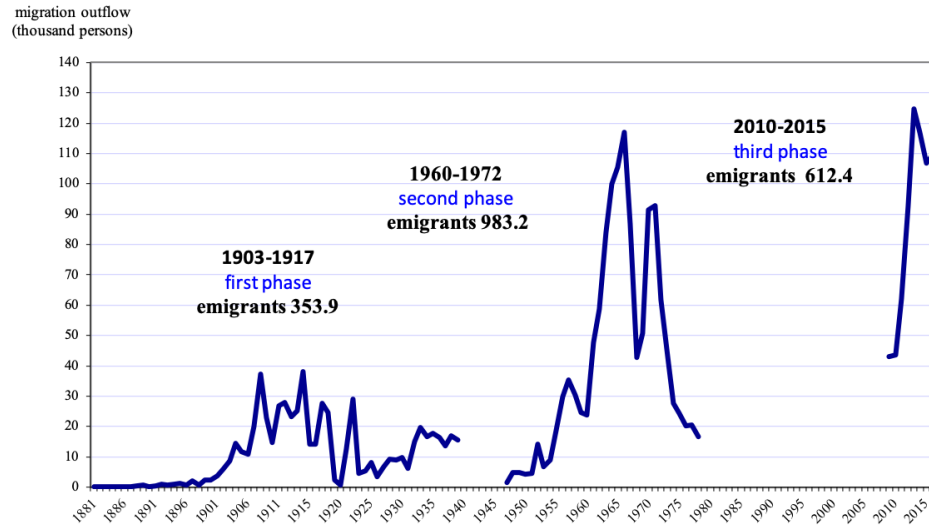
Table 2: Parameterization of the fiscal and debt-target rules

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.

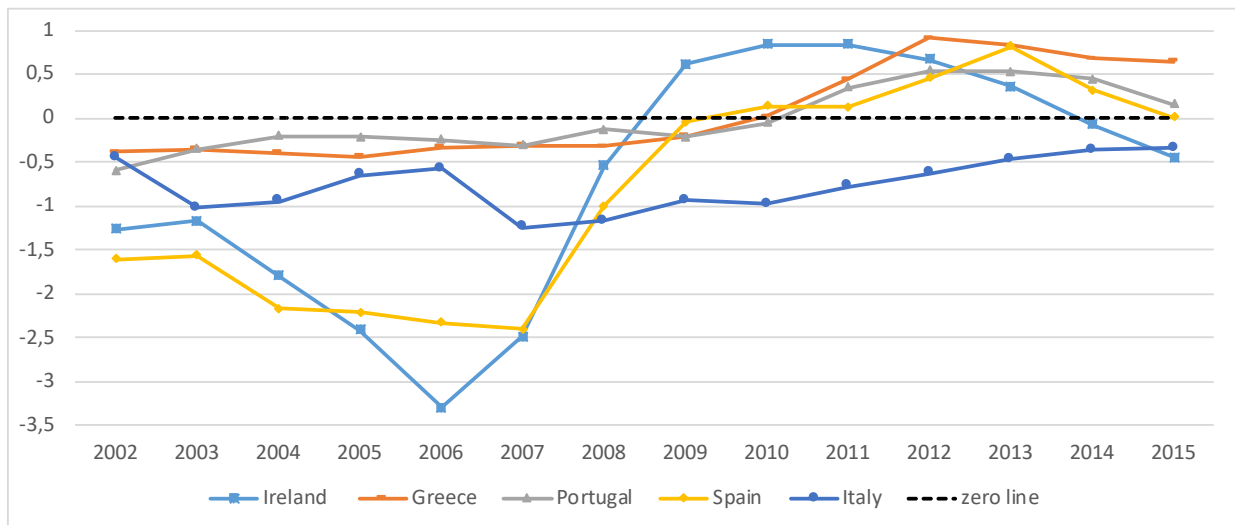
Figures

Figure 1: Emigration phases in Greek history (all age groups)



Source: updated graph from Lazaretou (2016)

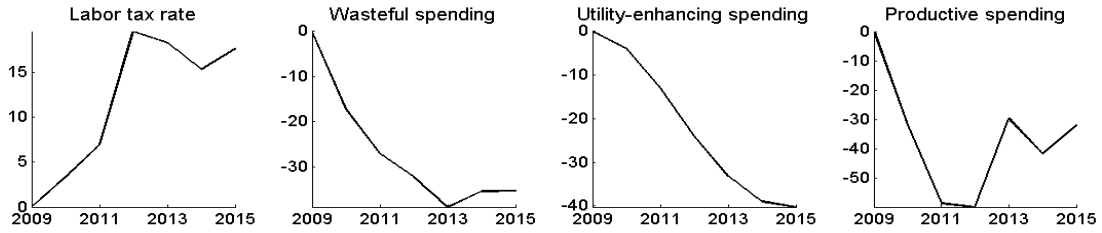
Figure 2: Net migration flows, defined as outflows minus inflows (% active population)



Source: Eurostat

Figure 3: Quantitative Analysis: Fiscal Instruments and Migration Outflows

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



(b) Labour market status and number of emigrants (thousand persons)

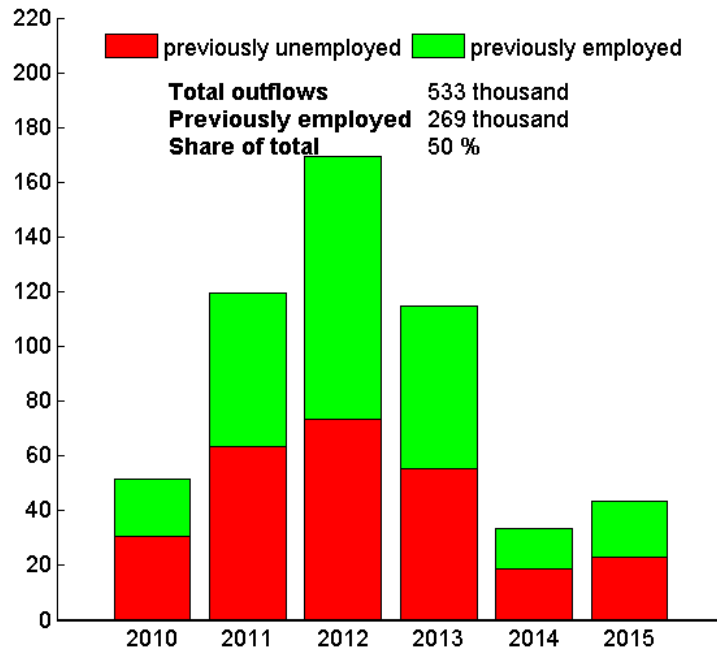
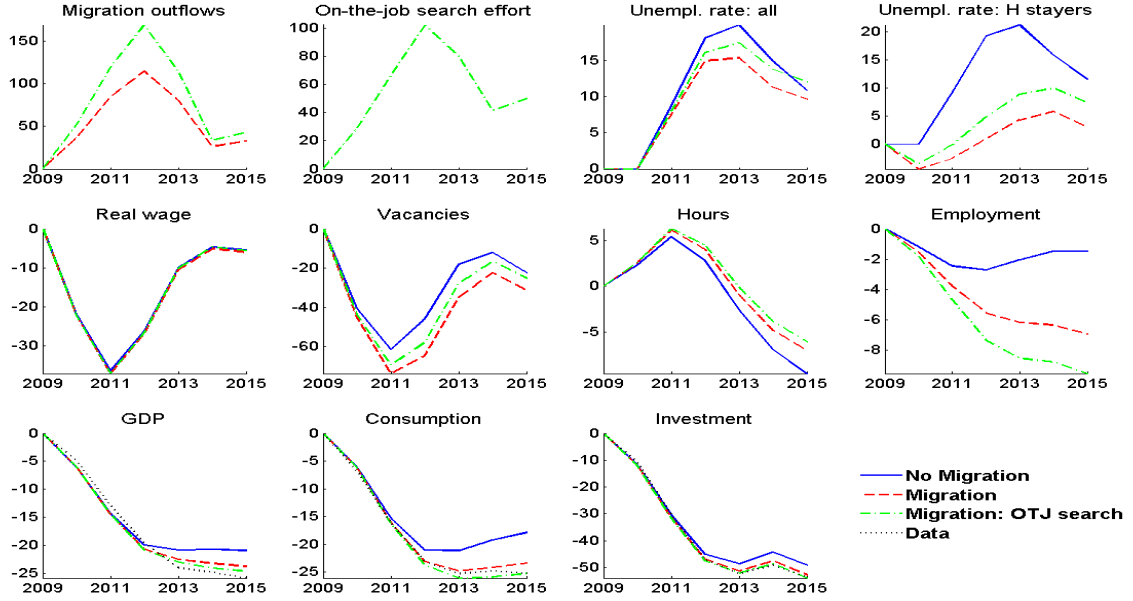
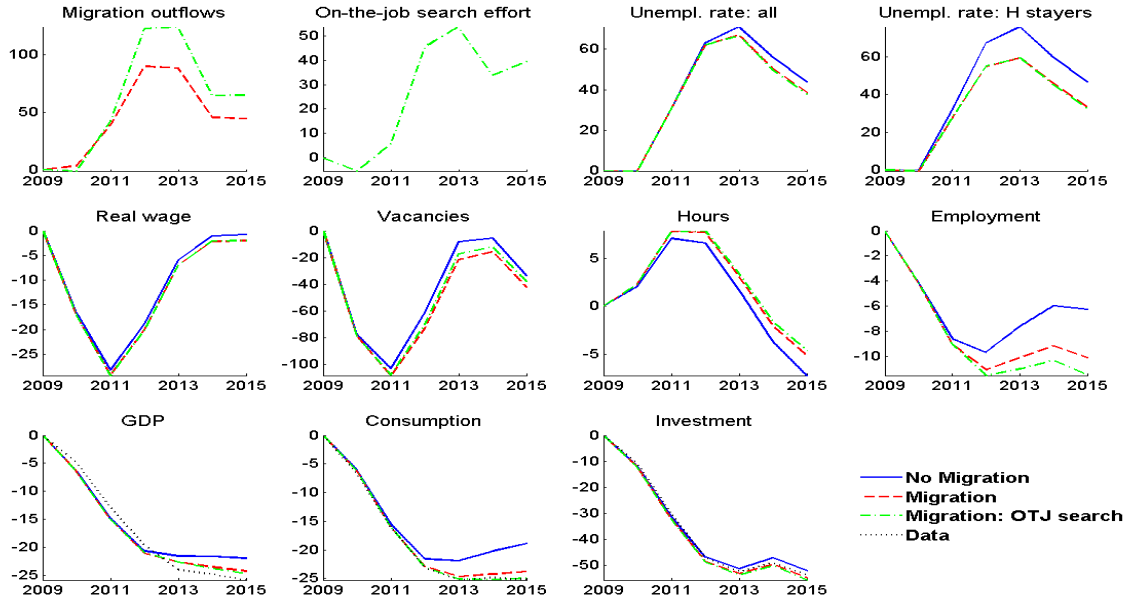


Figure 4: Quantitative Analysis: Results

(a) Baseline calibration



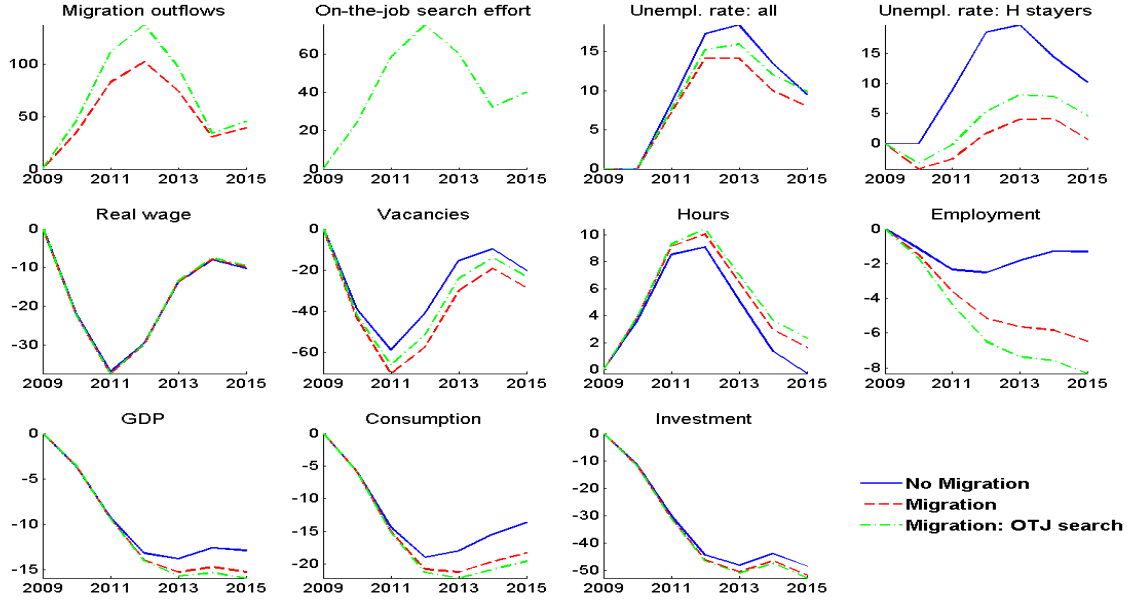
(b) Higher bargaining power of firms



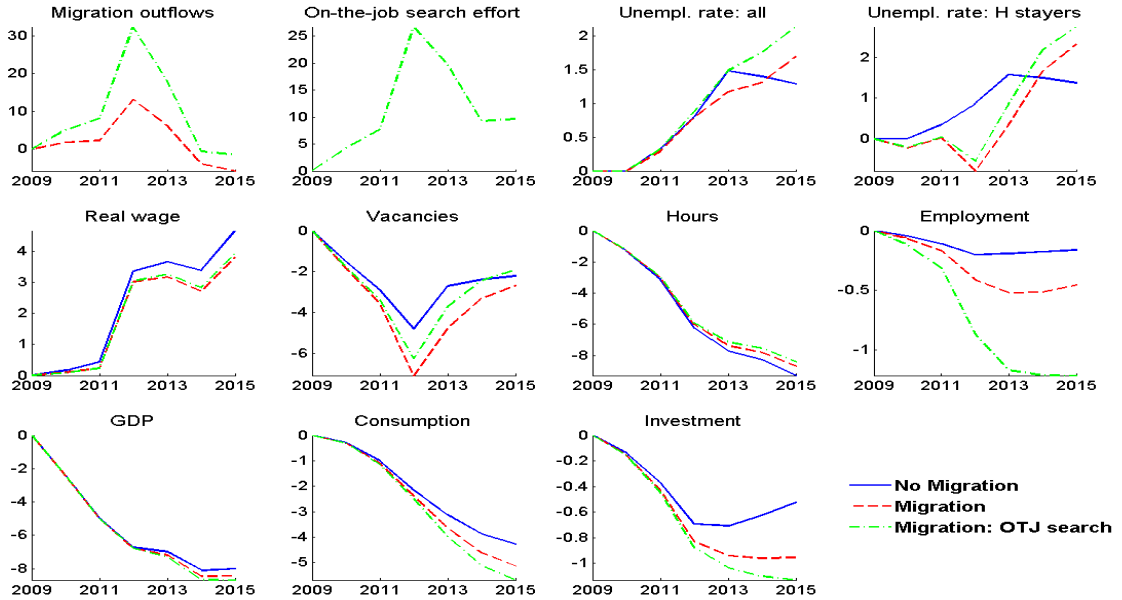
Notes: Responses for migration outflows are in levels (thousand persons). All other responses are in percent deviations from steady state. Consumption refers to the domestic good. Unempl. rate: H stayers excludes the unemployed targeting a job abroad. OTJ denotes on the job.

Figure 5: Quantitative Analysis: Counterfactual Exercises

(a) The role of negative demand shocks (risk premium and investment efficiency)



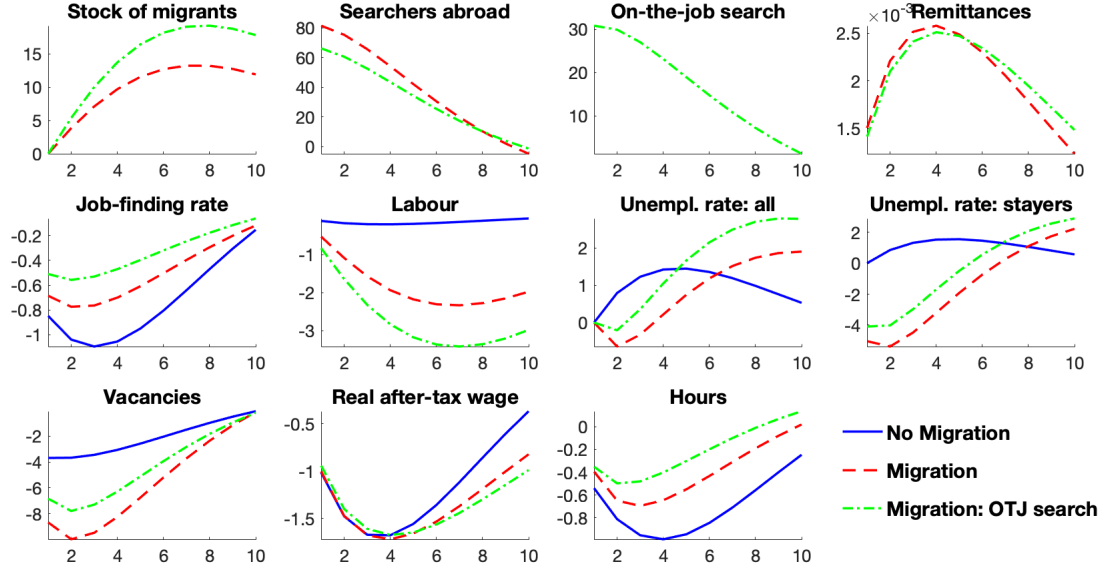
(b) The role of fiscal austerity mix



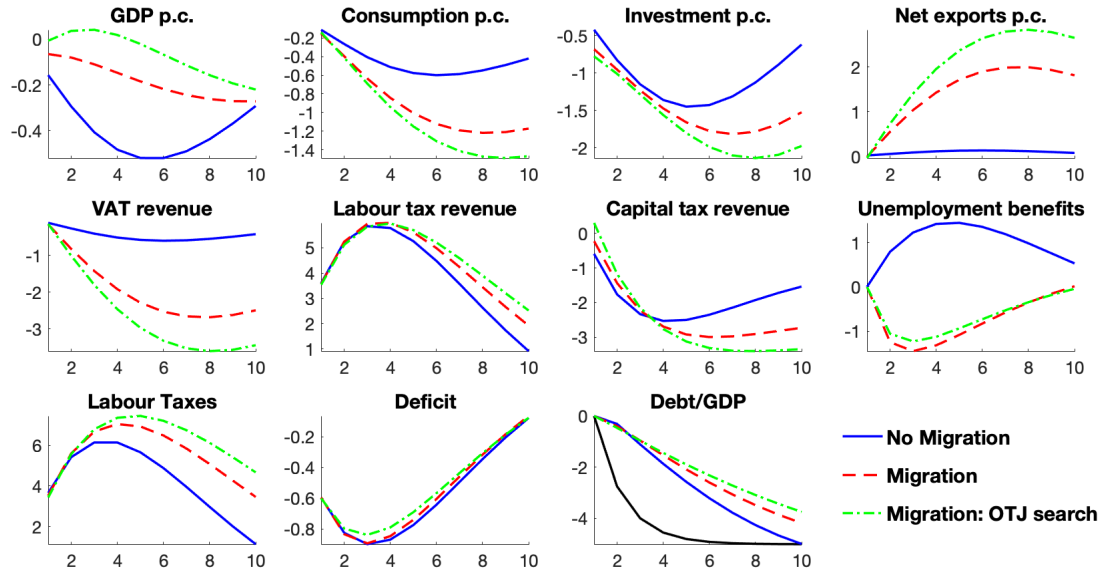
Notes: See also notes in Figure 4.

Figure 6: Labour Tax Hikes and Emigration

(a) Migration and Labour Market Variables



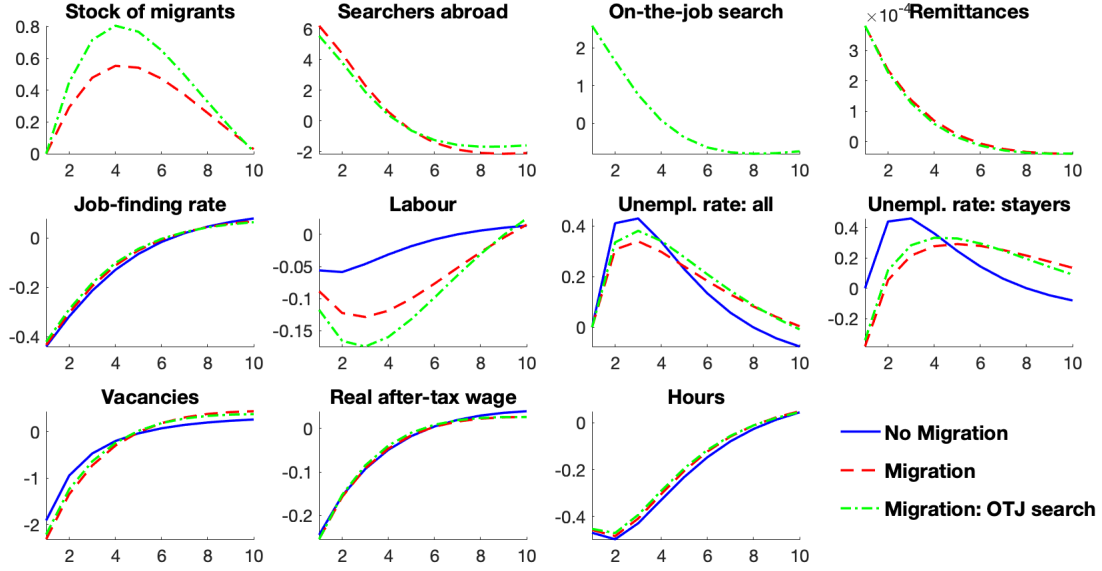
(b) Output and Fiscal Variables



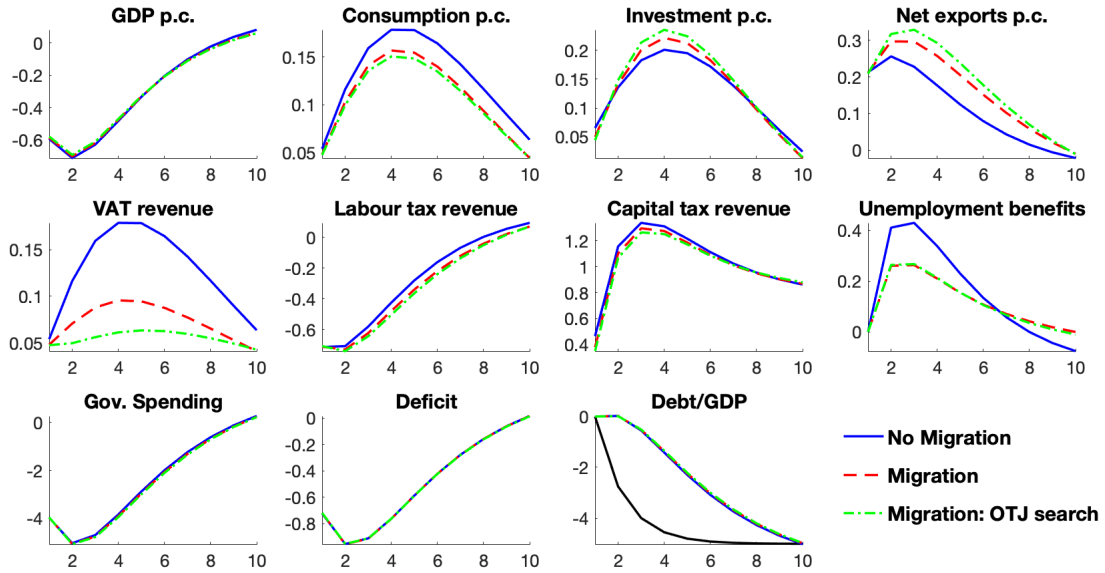
Notes: Responses for the job-finding rate and net exports are in levels. All other responses are in percent deviations from steady state. Consumption refers to consumption of the domestic good. Unempl. rate: stayers excludes the unemployed targeting jobs abroad. OTJ denotes on the job and p.c. denotes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

Figure 7: (Wasteful) Spending Cuts and Emigration

(a) Migration and Labour Market Variables



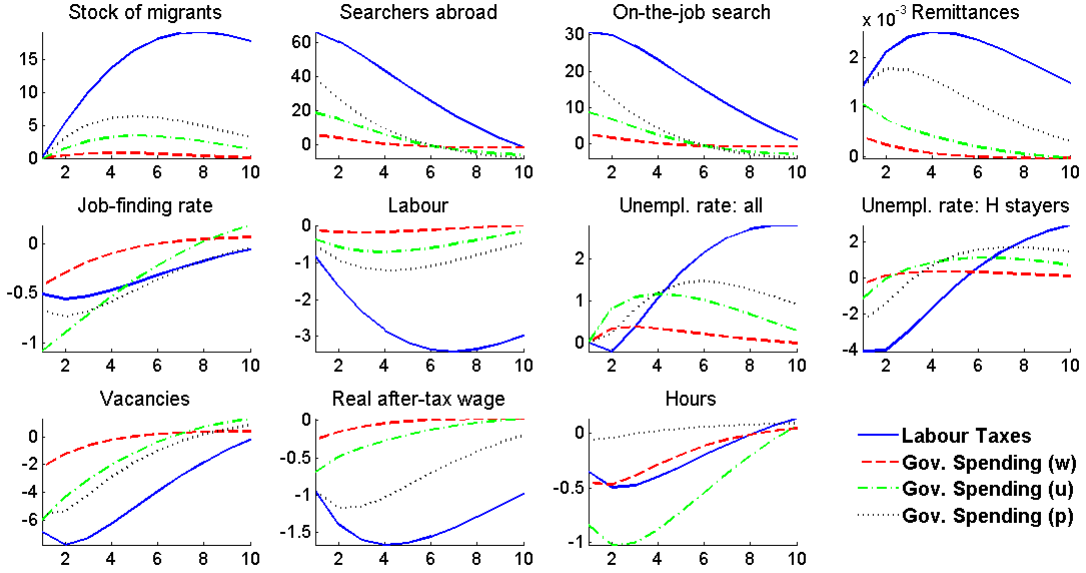
(b) Output and Fiscal Variables



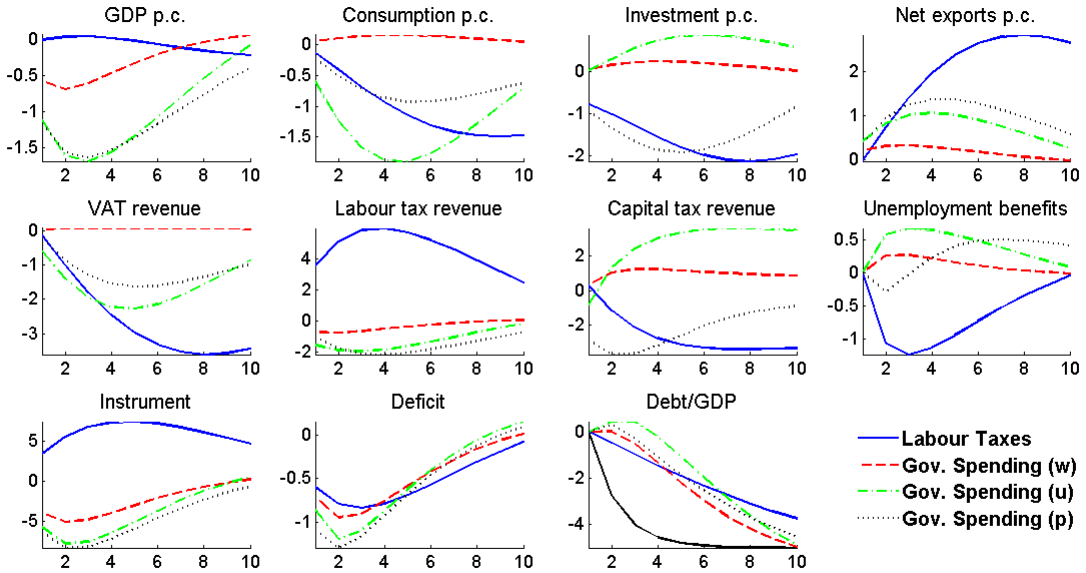
Notes: See also Figure 6.

Figure 8: All Instruments with Emigration of the Unemployed and Employed

(a) Migration and Labour Market Variables



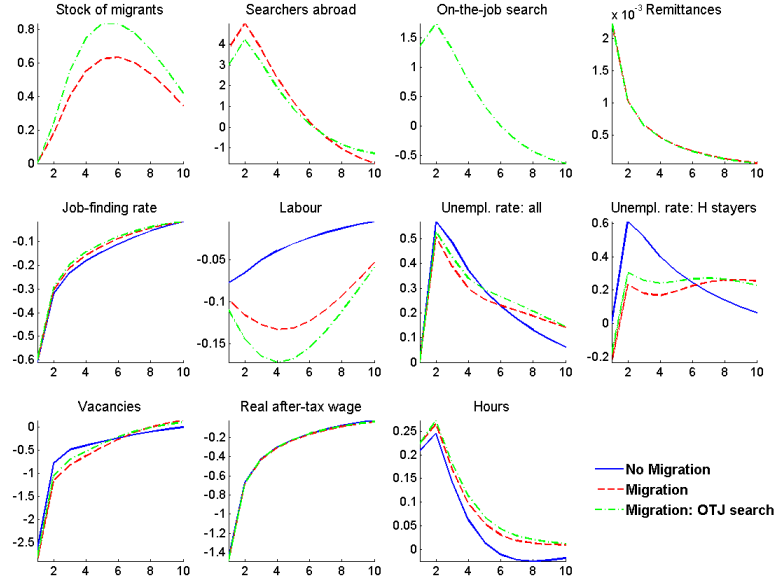
(b) Output and Fiscal Variables



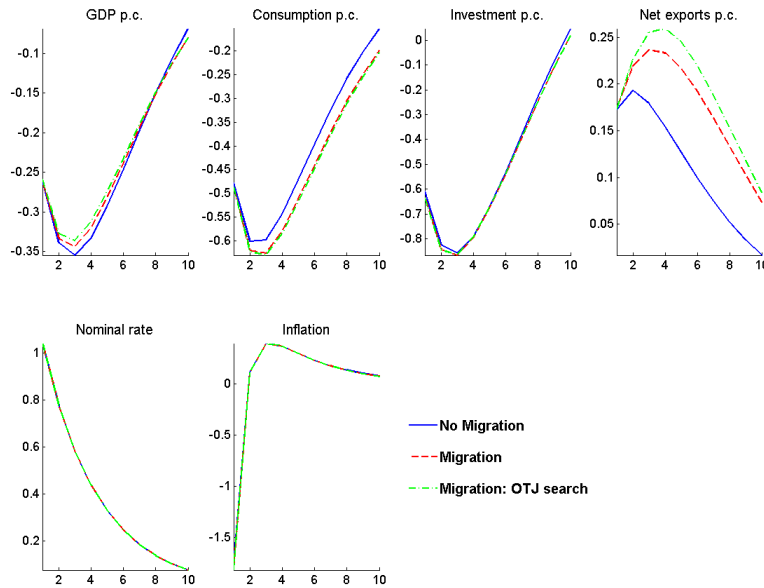
Notes: (w), (u), (p) denote wasteful, utility-enhancing, productive, respectively. See also Figure 6.

Figure 9: A Risk Premium Shock Generating a 1% Increase in the Nominal Interest Rate

(a) Migration and Labour Market Variables



(b) Output and Monetary Variables



Notes: Responses for inflation and the interest rate are shown in annualized levels. See also Figure 6.