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De-globalisation, welfare state reforms and labour market outcomes

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De-Globalisation, Welfare State Reforms and Labour Market Outcomes

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Abstract:

Within an open economy framework characterised by vertical linkages in production and search frictions and two-sided heterogeneity in the labour market, raising trade barriers is shown to increase unemployment across skill levels, and to reduce labour market participation and aggregate income. These effects are not necessarily moderated by maintaining frictionless mobility of capital across borders. We find that a *flexicurity* reform of a *liberal* welfare state can dampen the adverse effects of de-globalisation.

Keywords: Flexicurity; Welfare State; Globalisation; Participation; Unemployment.

JEL Codes: F16, F6

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1. Introduction

The perception that international trade has been a source of economic dislocations with adverse effects on labour market outcomes, above all in industrial economies, is arguably one of the causes of the backlash against globalisation and the emergence of protectionist stances in recent years. However, particularly in the light of the growing complexity of the global production chain, raising trade barriers can have multifaceted effects on labour markets – not least via their impact on aggregate productivity, a theme that has been central to debates about the potential implications of Brexit for the UK.

In this paper our goal is to first examine the labour market effects of raising trade barriers, considering not only its impact on unemployment but also on labour market participation and job-skill mismatch, in an environment characterised by inter-sectoral linkages and the tradability of intermediate inputs. The analysis will be cast in terms of raising trade costs and throughout we shall note its relevance to the protectionist tendencies that are currently being observed. However, in so doing, the paper also clearly sheds light on the opposite case of trade liberalisation. We shall then ask how welfare state and labour market reforms can influence the effects of raising trade frictions. Here, our focus will be on *flexicurity* policies which are central to the European 2020 employment strategy and have, more broadly, been supported by international institutions such as the IMF (see, e.g., Blanchard *et al.*, 2014). Given that our aim is to examine the implications of trade shocks and policy reforms on key aggregate and labour market outcomes, we shall not be concerned about the welfare implications of the reforms. Consequently, our policy analysis will consist of selected experiments informed by real world tendencies, such as the EU2020 employment strategy recommendations, and will not consider optimal policies.

To examine these issues, we construct a general equilibrium model of an open economy that is characterised by vertical linkages in production and search frictions with two-sided heterogeneity in the labour market. Firms exhibit different productivity levels and use skilled and unskilled labour and capital to produce varieties of an intermediate input sold both domestically and internationally. Three key features of this model distinguish it from those used in the existing studies that focus on the labour market effects of economic integration – and result in a richer characterisation of labour market dynamics.

The first is to capture both the transition from unemployment to employment, as arising from the search and matching process, and the move out of mismatched employment. Specifically, we assume that workers are endowed with different skill levels and can be employed in high- and low-tech jobs as in, e.g., Albretch and Vroman (2002); whilst high-tech jobs can only be performed by high-skill workers, low-tech jobs can be performed by both high-skill and low-skill workers. Consequently, skill mismatch arises in the model[1] (as in the

[1] Albeit with differences between workers' characteristics and across countries, data suggest that skill mismatch affects between 20% and 50% of the employed population in Europe (ILO, 2014).

notable contribution of Davidson *et al*., 2008), reflecting the trade-off that high-skill individuals face between not working and being employed in low-tech jobs and receiving a lower wage. Clearly, high-skill workers can then generate an externality for low-skill workers by increasing the competition for low-tech jobs. However, as in Dolado *et al*. (2009), we also allow for on-to-job-search (OTJS) whereby mismatched workers search for high-tech jobs while working, thus characterising the potentially transitory nature of mismatch.[2] As shown by Arseneau and Epstein (2014), the possibility of OTJS adds complexity to the externality generated by mismatch, as high-skill workers' search does not only affect the job prospects of low-skill workers but also of other high-skill ones.

The second important feature of the model is that it introduces endogenous participation and thus captures the transition in and out of the labour force, hence reflecting the trade-off the household faces between leisure and consumption. This aspect, to our knowledge, has been ignored in the papers studying the labour market effects of economic integration. There are reasons why addressing this omission is important: as documented by, e.g., Elsby *et al.* (2015, 2019), movements in and out of the labour force contribute significantly to the variations in unemployment over the long-run and play a key role in driving aggregate labour market outcomes. In addition, recent empirical evidence – e.g., Gaddis and Pieters (2012), Autor *et al*. (2013) and Cooray *et al*. (2017) – shows that economic integration has had a significant effect on labour force participation decisions. Furthermore, as we demonstrate in this paper, these adjustments prove to be crucial when assessing the impact of both shocks (such as raising trade costs) and policies on equilibrium solutions.[3]

The third key feature of the model is to allow for a relatively broad menu of active and passive labour market policy instruments so as to characterise the main dimensions of flexicurity and to capture the complex interaction between them in affecting labour market outcomes.

We start by calibrating the benchmark solution of the model to reflect the main characteristics of the UK economy, which can be thought of as a *liberal* welfare state regime. The UK offers an interesting benchmark, considering the potential increase in trade costs with its main and geographically closer trading partners that might result from Brexit.[4] Moreover, its labour market policies and institutions are among the most deregulated in mature industrial

[2] Evidence suggests that OTJS is an important factor that contributes to labour market dynamics (e.g., Eeckhout and Lindenlaub, 2019), especially in the context of over-education which increasingly characterises mismatch in industrial economies. This type of mismatch, in particular, has been found to be transitory in nature (see, e.g., Green and Henseke, 2016).

[3] In models with full and exogenous participation (see e.g., Cacciatore *et al*., 2016; Cacciatore, 2014; Felbermayr *et al*., 2011a; Helpman and Itskhoki, 2010), changes in unemployment following a shock occur primarily through movements in vacancy creation activities that shape market tightness and workers' job finding probabilities. Making participation endogenous, e.g. by allowing the household to decide on participation level of its members, renders unemployment sensitive to fluctuations in both labour force and vacancies.

[4] Clearly, Brexit involves much more complex and multifaceted issues. However, as recently noted by Carrère *et al.* (2019), a lot of the debate about the effects of Brexit on the UK economy has focused on the international trade channel.

economies and ought to offer, according to received wisdom, the best supporting framework to the economy's ability to adjust to and withstand the effects of adverse shocks.

Our baseline analysis considers the impact of a permanent increase in trade cost and examines the transitional dynamics of the economy from the initial to the new equilibrium. We find that higher trade frictions can have adverse consequences for the level of economic activity and labour market outcomes due to their negative effects on firms' profitability and labour demand in the long-run.

We then show that reforms of the labour market in the direction of flexicurity can mitigate these effects. Our aim is to assess the labour market implications for a country such as the UK of adopting a reform package that reflects some of the recommendations central to the EU employment strategy – which include improvements in the design of active labour market policies (ALMPs) such as the provision of public employment services and adequate income support to all jobseekers (European Commission, 2014). To this end, we implement a labour market reform package in the direction of flexicurity that targets unemployment benefit, firing and vacancy creation costs, and investment in employment services. As a reference welfare system, we use Denmark (a pioneer of the flexicurity concept) and change the values used for individual policy instruments in the direction of and by a proportion consistent with their corresponding Danish counterparts. We wish to stress that our objective is not to obtain an intercountry comparison between welfare state regimes, but to study the effects of reforms *within* a country. Clearly, from a methodological standpoint, since changes in individual policy instruments may have opposite effects on the equilibrium values of the variables, the extent to which they are altered relative to each other is an important determinant of the net impact of a given reform package. Notably, applying such a reform package to the UK's liberal regime would entail increasing employment protection, expenditure on unemployment insurance as well as that on ALMPs such as employment services – a policy that has received growing attention as a cost-effective means to reduce labour market frictions.[5] but which has arguably become less prominent in the UK in recent years (Davies, 2018).

As conjectured above, the endogeneity of labour market participation turns out to be a crucial factor in determining the effects of both the trade shock and the policy reform. By reducing the demand facing firms, higher trade costs reduce vacancy creation, which implies greater unemployment and skill mismatch due to an intensification of workers' competition for jobs. With endogenous participation, in the short-run these effects are dampened by an outflow from the labour force into inactivity as a result of worsening job prospects. As the economy transitions to a new long-run equilibrium, however, the pool of unemployed increases and so does aggregate mismatch as high-skill workers seek low-tech employment as a means to escape unemployment. In the presence of mark-up pricing, the resulting downward pressure on wages

[5] See, e.g. Lehman and Kluve (2010). The OECD (2015) has endorsed polices that improve matching processes as the most cost-effective form of ALMPs consistent with the evidence documented in Riley *et al*. (2011).

provides the only recovery channel for firms' sales and employment. However, this channel is not sufficiently strong to overcome the negative impact of the rise in trade costs: domestic and foreign absorption both fall, reducing GDP, labour force and employment both shrink while the incidence of skill mismatch increases. The endogeneity of participation also shapes the effects of policy. For instance, increases in unemployment benefits (a typical passive labour market policy) can perform as an activation measure and have expansionary effects, contrary to conventional views that portray it as a distortionary policy that harms employment via higher labour costs. More generally, our model suggests that despite involving stronger firing restrictions, a reform package that involves higher expenditure on active and passive labour market policies can increase the level of economic activity via aggregate supply and demand effects that stimulate both labour market participation and job creation. These effects result in higher transition rates from unemployment to employment and from low- to high-tech jobs (reducing skill mismatch), and in a reduction in unemployment rates across the skill spectrum.

We carry out two experiments to examine the robustness of the results. The first considers changes to the degree of capital mobility frictions. In so doing, we demonstrate the importance of the interaction between the latter and the degree of trade openness. In particular, we find that higher capital mobility frictions, by increasing the cost of capital, trigger a substitution in factors of production away from capital and towards labour – and hence lead to higher wages and employment. Thus, maintaining frictionless mobility of capital across borders does not necessarily moderate the negative impact of higher trade costs. The second experiment concerns the nature of taxation. Our main results are obtained using a neutral taxation where a lump-sum tax imposed on households adjusts to cancel the difference between government's revenue and expenditure resulting from shocks. On the one hand, this simplification facilitates the isolation and hence understanding of the effects of labour market policies. On the other hand, it prevents us from capturing the effects of distortionary income taxation on labour market decisions. We therefore later introduce direct taxation of labour and non-labour income, at different rates. We find that the presence of distortionary taxation enhances the impact of trade shocks. Albeit to a lesser extent, however, reforms continue to remain effective in countering the negative impacts of the shock.

The extant literature on the effects of international economic integration on the labour market is vast and varied. A strand of this literature, to which this study is closely related, focuses on the productivity and unemployment effects of economic integration but does not reach a clear consensus. For instance, Felbermayr *et al*. (2011a) and Cacciatore (2014), amongst others, show that higher trade integration reduces unemployment by inducing a reallocation of resources towards more productive firms. By contrast, Helpman and Itskhoki (2010) and Helpman *et al*. (2010) find that trade openness can potentially result in higher unemployment despite leading to higher firms' profitability. Moore and Ranjan (2005) argue that trade liberalisation can lead to a higher unemployment rate of the unskilled, whereas its effect on aggregate unemployment is ambiguous. A major advancement of our paper in relation to these studies is to allow for the emergence of labour market mismatch with endogenous participation.

The effects of openness on mismatch has received relatively little attention in the literature. At an empirical level, Davidson *et al*. (2014) and Krishna *et al*. (2014) find evidence of improved match quality as a result of globalisation. At a theoretical level, building on the partial equilibrium framework with two-sided heterogeneity developed by Albrecht and Vroman (2002), Davidson *et al*. (2008) study the effects of trade liberalisation but focus on firms' export decisions. A similar approach is found in Arseneau and Epstein (2017) who study the effects of openness on labour market outcomes and argue that mismatched employment helps moderate the higher aggregate unemployment consequences of offshoring. In addition to allowing for the job-search decisions of the unemployed to reside with the household, our paper differs from these studies in that it considers the transitory nature of mismatch by allowing for job-to-job flows via OTJS that we show to play a key role in driving the extent of mismatch. Moore and Ranjan (2005) also study the impact of globalisation on the unemployment outcomes of workers with different skills but focus on a labour market in which only perfect job matches exist in equilibrium.

Finally, by considering the interaction between labour market policies and institutions and the degree of international trade openness, our work is also closely related to, e.g., Helpman and Itskhoki (2010) and Coşar *et al*. (2016) but is distinguished from them by its use of an explicit definition of workers' heterogeneity and by focusing on how (de-) globalisation interacts with a multiplicity of labour market policies to drive unemployment of different categories of workers and mismatch.

The rest of the paper is organised as follows. Section 2 sets up the model and Section 3 describes its calibration. The effects of de-globalisation and reforms are discussed in Sections 4 and 5 respectively. Section 6 considers the effects of capital mobility frictions and the nature of taxation. Section 7 concludes the paper.

2. The model

We construct a dynamic model of a small open economy in which a representative household's members are endowed with and supply high-skill and low-skill labour. Capital serves the dual purpose of wealth accumulation and factor of production and is allowed to be internationally mobile. In an upstream sector, monopolistically competitive firms with firm-specific productivities use capital and high- and low-skill labour to produce varieties of an intermediate input which they export as well as sell domestically to a downstream sector. The latter combines the domestic and imported varieties to produce a homogenous final good under competitive conditions. The labour market is subject to search and matching frictions. The government implements labour market policies and uses a lump-sum tax levied on the household to balance its budget.

2.1. The household

There is a representative household with a continuum of infinitely-lived members whose measure is normalised to unity. Household members are either skilled or unskilled with their respective mass treated as exogenous and denoted by Z and 1 − Z. At any point in time *t*, each type is assumed to be economically active (participating in the labour force) or inactive. Denoting the latter states by *X* and *L* respectively, $X + L = 1$, and using the superscripts *s* and *u* to refer to high- and low-skill workers, it follows that $X_t^s + L_t^s = Z$ and $X_t^u + L_t^u = 1 - Z$. Those participating in the labour force are either unemployed and searching for a job or employed, denoted by *S* and *N*, respectively. On the demand side, there are two types of tasks, low-tech and high-tech. The low-skill individuals can only search for and be employed in low-tech task jobs, hence $X_t^u = S_t^{ul} + N_t^{ul}$, where the superscripts *ul* refers to low-skill in low-tech task jobs. The high-skill individuals can search for and be employed in either task. Hence, respectively denoting by superscripts *sl* and *sh* those who go for the low- and high-tech task jobs, $X_t^s = X_t^{sl} + X_t^{sh}$. X_t^{sl} are assumed to have opted for low-tech task jobs in order to exit from the unemployment pool, but will engage in OTJS for the high-tech task jobs.[6] Therefore, we also use $X_t^{sh} = N_t^{sh} + S_t^{sh}$ and $X_t^{sl} = N_t^{sl} + S_t^{sl}$ to partition participation of high-skill workers into employed and searching, noting that OTJS involves N_t^{sl}.

All newly-formed job matches at any time *t* are assumed to start working at the beginning of the following period. Thus, as far as the household is concerned, the three employment types evolve as follows[7]

$$N_{t+1}^{ul} = \left(1 - \eta^l\right) N_t^{ul} + q_t^l S_t^{ul}, \tag{1}$$

$$N_{t+1}^{sh} = \left(1 - \eta^h\right) N_t^{sh} + q_t^h S_t^{sh} + e\left(1 - \eta^l\right) q_t^h N_t^{sl}, \tag{2}$$

$$N_{t+1}^{sl} = \left(1 - e q_t^h\right)\left(1 - \eta^l\right) N_t^{sl} + q_t^l S_t^{sl}, \tag{3}$$

where η^j and q^j are, respectively, the exogenous job destruction (or match separation) rate and the endogenous probability of a job match (job-finding rate), with the superscript $j = h, l$ referring to low- and high-tech task jobs; $e \in [0,1]$ is the efficiency measure of OTJS. Denoting the high-tech and low-tech matched jobs by $\mathcal{M}_t^h$ and $\mathcal{M}_t^l$, respectively, it follows that $q_t^h = \mathcal{M}_t^h \big/ \left(S_t^{sh} + e\left(1 - \eta^l\right) N_t^{sl}\right)$ and $q_t^l = \mathcal{M}_t^l \big/ \left(S_t^{ul} + S_t^{sl}\right)$. Equation (1) shows that the mass of low-skill workers who are employed at the beginning of *t* +1 consists of those who survived their ‘match separation’, i.e. $\left(1 - \eta^l\right) N_t^{ul}$, and the new matches $q_t^l S_t^{ul}$. Equation (2) states that the mass of high-skill workers employed in high-tech jobs consists of those who

[6] This is a form of competitive search similar to that in Arseneau and Epstein (2014).
[7] For simplicity, we abstract from the intensive margin of employment decision.

survived their match separation in high-tech jobs, $\left(1-\eta^{h}\right)N_{t}^{sh}$, the new job matches through direct search, $q_{t}^{h}S_{t}^{sh}$, and the previously mismatched high-skill workers who found high-tech jobs through OTJS, $e\left(1-\eta^{l}\right)q_{t}^{h}N_{t}^{sl}$. Equation (3) shows that mismatched employed high-skill workers consist of those who are unable to find high-tech job matches through OTJS with probability $\left(1-eq_{t}^{h}\right)$ but have survived their match separation in their existing mismatched low-tech job with a probability $\left(1-\eta^{l}\right)$, and the new mismatched job matches, $q_{t}^{l}S_{t}^{sl}$.

The household pools income from all sources and faces the budget constraint,[8]

$$C_{t}+I_{t}+T_{t}=w_{t}^{ul}N_{t}^{ul}+w_{t}^{sl}N_{t}^{sl}+w_{t}^{sh}N_{t}^{sh}+b_{t}S_{t}+\Pi_{t}+r_{t}K_{t}^{D}+r_{t}^{*}\left(K_{t}-K_{t}^{D}\right), \tag{4}$$

where: C is consumption; I is gross investment; T is the lump-sum tax paid to the government; $w^{j}, j=ul,sl,sh,$ is the negotiated wage rate received respectively by unskilled workers in low-tech job, skilled workers in mismatched low-tech jobs, and skilled workers in high-tech jobs; b is the unemployment benefit received by those who are actively searching for jobs, $S=S^{ul}+S^{sh}+S^{sl}$; Π is the profits from firms' which is distributed to households (to be clarified later); K is the capital stock held by the household sector; K^{D} is firms' demand for capital stock; and r and r^{*} are the domestic and foreign rate of return on capital, respectively. The budget constraint above reflects the economy's international borrowing/lending of capital with an inflow (outflow) of corresponding to $K_{t}-K_{t}^{D}<0(>0)$. The stock of capital depreciates at a constant rate δ leading to the capital accumulation process

$$K_{t+1}=I_{t}+\left(1-\delta\right)K_{t} . \tag{5}$$

The instantaneous utility function of the household is assumed to be

$$U_{t}=U\left(C_{t}\right)-A^{u}\left(X_{t}^{u}\right)-A^{sl}\left(X_{t}^{sl}\right)-A^{sh}\left(X_{t}^{sh}\right), \tag{6}$$

where $U\left(C_{t}\right)$ is the utility from consumption and $A^{j}\left(X_{t}^{j}\right)$ represents the disutility of participation (not enjoying leisure) of the relevant worker type. Treating the paths for $\left\{w_{t}^{j},b_{t},r_{t},r_{t}^{*},q_{t}^{l},q_{t}^{h},K_{t}^{D},\Pi_{t},T_{t}\mid t\geq 0\right\}$ and the initial condition $\left\{K_{0},N_{0}^{ul},N_{0}^{sl},N_{0}^{sh}\right\}$ as given, the household chooses the optimal paths for $\left\{C_{t},K_{t+1},X_{t}^{j}\mid t\geq 0\right\}$ to maximise the expected value of $\sum_{t=0}^{\infty}\beta^{-t}U_{t}$ subject to (1)-(6), where $\beta\in\left(0,1\right)$ is the subjective time preference discount factor. The first order conditions for the intertemporal maximisation problem can be shown to imply the standard Euler equation governing the path of consumption

[8] We follow Merz (1995), Andolfatto (1996) and many others (e.g., Arseneau and Chigh, 2012; Cacciatore *et al.*, 2016) and assume full risk sharing within the household so that individual members' different employment status does not result in intra-household differences in consumption. As a result, we shall not address the distributional consequences of shocks or reforms.

$$U'(C_t)=\beta E_t\left[U'(C_{t+1})(1+r_{t+1}-\delta)\right], \tag{7}$$

and the following relationships govern the household's labour market participation decisions

$$\frac{A^{u\prime}(X_t^u)}{U'(C_t)}-b_t=q_t^l E_t\Lambda_{t+1}\left[w_{t+1}^{ul}-\frac{A^{u\prime}(X_{t+1}^u)}{U'(C_{t+1})}+\frac{(1-\eta^l)}{q_{t+1}^l}\left(\frac{A^{u\prime}(X_{t+1}^u)}{U'(C_{t+1})}-b_{t+1}\right)\right], \tag{8}$$

$$\begin{aligned}\frac{A^{sl\prime}(X_t^{sl})}{U'(C_t)}-b_t=q_t^l E_t\Lambda_{t+1}\Bigg[& w_{t+1}^{sl}-\frac{A^{sl\prime}(X_{t+1}^{sl})}{U'(C_{t+1})}\\ &+\frac{(1-eq_{t+1}^h)(1-\eta^l)}{q_{t+1}^l}\left(\frac{A^{sl\prime}(X_{t+1}^{sl})}{U'(C_{t+1})}-b_{t+1}\right)+e(1-\eta^l)\left(\frac{A^{sh\prime}(X_{t+1}^{sh})}{U'(C_{t+1})}-b_{t+1}\right)\Bigg],\end{aligned} \tag{9}$$

$$\frac{A^{sh\prime}(X_t^{sh})}{U'(C_t)}-b_t=q_t^h E_t\Lambda_{t+1}\left[w_{t+1}^{sh}-\frac{A^{sh\prime}(X_{t+1}^{sh})}{U'(C_{t+1})}+\frac{(1-\eta^h)}{q_{t+1}^h}\left(\frac{A^{sh\prime}(X_{t+1}^{sh})}{U'(C_{t+1})}-b_{t+1}\right)\right], \tag{10}$$

where we have used (7) to define $\Lambda_{t+1}=\beta U'(C_{t+1})/U'(C_t)$ as the stochastic discount factor. Each equation equates the net marginal cost of the relevant members' participation with their expected net marginal benefit of securing a lasting job match and thus regulates the transition of individuals from outside the labour force into the pool of those searching for jobs.

2.2. Vacancies and matching

We assume that two types of 'specialised' hiring agencies, labelled low- and high-tech, act as intermediaries between workers and firms operating in the intermediate good sector to meet their respective labour demand. The high-tech agency only considers high-skill workers. The low-tech agency, instead, posts vacancies that can be filled by either type of worker. In both segments of the labour market, random matching governs the pairing of workers to vacancies. The absence of differentiation in job postings between low-skill and mismatched workers in low-tech segment of the labour market and the fact that a low-tech vacancy can be filled by either a high- or a low-skilled worker then give rise to direct competition for jobs between low- and high-skill workers, reflecting an additional externality that arises from mismatch (see, e.g., Shimer and Smith, 2001; Arseneau and Epstein, 2018). Allowing for OTJS, however, implies that high-skill mismatched workers (searching for a high-tech job while employed in a low-tech job) exert an externality on the job prospects of other high-skill workers – see Arseneau and Epstein (2014).

Vacancies are denoted by $V^j, j=h,l.$ They are created and posted at a unit cost of c^j – which is measured in terms of output and treated as a constant exogenous parameter[9] – and are

[9] The vacancy creation cost is meant to reflect the expenses involved in opening up a job vacancy and recruiting a worker.

filled following the process governing the search and matching frictions. As previously noted, the existing low-tech and high-tech job matches are subject to exogenously determined separation (or job destruction) rates, η^j, and a fixed firing cost of *f* per worker is incurred by the agencies. Below we describe the job-matching process between each type of agency and worker that determines the respective wages.

2.2.1. *Low-tech job agency*

At any time *t*, the aggregate number of matches in the low-tech segment of the labour market is determined by the matching function $\mathcal{M}_t^l = m^l\left(S_t^{ul} + S_t^{sl}, V_t^l\right)$, which is assumed to satisfy the standard properties described by Pissarides (2000). We define market tightness by $\theta_t^l \equiv V_t^l / \left(S_t^{ul} + S_t^{sl}\right)$ and the probability of filling a low-tech vacancy (hiring rate) by $\rho_t^l \equiv \mathcal{M}_t^l / V_t^l$. Let $\xi_t^{sl} \equiv S_t^{sl} / \left(S_t^{ul} + S_t^{sl}\right)$ be the fraction of high-skill workers searching for low-tech job. The effective probabilities that a low-tech hiring agency matches a vacancy with a high-skill and a low-skill searcher therefore are $\rho_t^{sl} \equiv \xi_t^{sl}\rho_t^l$ and $\rho_t^{ul} \equiv \left(1-\xi_t^{sl}\right)\rho_t^l$, respectively. Thus, from the agency's perspective, employment of low- and high-skill workers evolves according to

$$N_{t+1}^{ul} = \left(1-\eta^l\right)N_t^{ul} + \rho_t^{ul}V_t^l, \tag{11}$$

$$N_{t+1}^{sl} = \left(1-eq_t^h\right)\left(1-\eta^l\right)N_t^{sl} + \rho_t^{sl}V_t^l, \tag{12}$$

which reflect the competition, noted above, between high- and low-skill workers for low-tech jobs.

The intermediate sector firms buy the services of the workers hired by the agency in man-hour units. Letting H^l be the effective man-hours obtained from the pool of workers employed to perform low-tech tasks, N_t^{ul} and N_t^{sl}, the agency is assumed to use a technology $H^l = h^l\left(N^{ul}, N^{sl}\right)$ which is increasing and concave in its arguments. The agency's revenue from these workers is then $w_t^l H_t^l$, where w^l is the wage rate it receives per man-hour from the firms. Thus, the agency's temporal profit is

$$\pi^l\left(N_t^{ul}, N_t^{sl}, V_t^l\right) = w_t^l H_t^l - \left[w_t^{ul}N_t^{ul} + w_t^{sl}N_t^{sl} + c_t^l V_t^l + \eta^l f\left(N_t^{ul} + N_t^{sl}\right)\right], \tag{13}$$

where the term in square brackets on the right-hand-side consists of the costs from employment, vacancy creation, and firing. Letting $\mathcal{F}\left(N_t^{ul}, N_t^{sl}\right)$ define the job value for the agency at each point in time, it follows that the solution to the maximisation of its present value satisfies the Bellman equation

$$\mathcal{F}\left(N_t^{ul}, N_t^{sl}\right) = \max_{V_t^l}\left[\pi^l\left(N_t^{ul}, N_t^{sl}, V_t^l\right) + E_t\Lambda_{t+1}\mathcal{F}\left(N_{t+1}^{ul}, N_{t+1}^{sl}\right)\right]. \tag{14}$$

Let $\mathcal{J}_t^{ul} \equiv \partial\mathcal{F}\left(N_t^{ul}, N_t^{sl}\right) \big/ \partial N_t^{ul}$ and $\mathcal{J}_t^{sl} \equiv \partial\mathcal{F}\left(N_t^{ul}, N_t^{sl}\right) \big/ \partial N_t^{sl}$. The marginal condition that removes any incentives for other competing agencies to be set up is

$$c_t^l = E_t\Lambda_{t+1}\left[\rho_t^{ul}\mathcal{J}_{t+1}^{ul} + \rho_t^{sl}\mathcal{J}_{t+1}^{sl}\right], \tag{15}$$

which eliminates profits from vacancy creation by equating its unit cost with the expected present value of its marginal benefit, given by the weighted average of marginal gains from employing low- and high-skill workers. The latter evolve according to the partial derivatives of equation (14) with respect to N^{ul} and N^{sl},

$$\mathcal{J}_t^{ul} = w_t^l \frac{\partial H_t^l}{\partial N_t^{ul}} - w_t^{ul} - \eta^l f + \left(1-\eta^l\right) E_t\Lambda_{t+1}\mathcal{J}_{t+1}^{ul}, \tag{16}$$

$$\mathcal{J}_t^{sl} = w_t^l \frac{\partial H_t^l}{\partial N_t^{sl}} - w_t^{sl} - \eta^l f + \left(1-eq_t^h\right)\left(1-\eta^l\right) E_t\Lambda_{t+1}\mathcal{J}_{t+1}^{sl}, \tag{17}$$

which state that the marginal gain (or the surplus) of a job match to the agency is given by the marginal revenue of a worker net of the wage rate it receives from the agency plus the expected discounted continuation value of the job.

2.2.2. *High-tech job agency*

From the agency's perspective, its employment of high-skill workers evolves according to

$$N_{t+1}^{sh} = \left(1-\eta^h\right) N_t^{sh} + \rho_t^h V_t^h, \tag{18}$$

where $\rho_t^h \equiv \mathcal{M}_t^h \big/ V_t^h$ is the vacancy filling probability. The number of matches is determined by the matching function $\mathcal{M}_t^h = m^h\left(S_t^{sh} + e\left(1-\eta^l\right)N_t^{sl},\, V_t^h\right)$, where $S_t^{sh} + e\left(1-\eta^l\right)N_t^{sl}$ is the number of high-tech job seekers consisting of those who search directly and those who engage in OTJS while employed in a low-tech job. Thus, market tightness in this case is therefore given by $\theta_t^h \equiv V_t^h \big/ \left(S_t^{sh} + e\left(1-\eta^l\right)N_t^{sl}\right)$.

Similar to the low-tech agency case, the temporal profit of the agency is

$$\pi^h\left(N_t^{sh}, V_t^h\right) = w_t^h H_t^h - \left[w_t^{sh} N_t^{sh} + c_t^h V_t^h + \eta^h f N_t^{sh}\right], \tag{19}$$

where $H^h = h^h\left(N^{sh}\right)$ is the effective man-hour supplied by N_t^{sh} workers and w^h is the wage rate the agency receives for a worker from firms that employ their services. The maximized job value $\mathcal{F}\left(N_t^{sh}\right)$ should then solve the Bellman equation

$$\mathcal{F}\left(N_t^{sh}\right) = \max_{v_t^h}\left[\pi^h\left(N_t^{sh}, V_t^h\right) + E_t\Lambda_{t+1}\mathcal{F}\left(N_{t+1}^{sh}\right)\right], \tag{20}$$

and the marginal condition that eliminates profits from vacancy creation is

$$c_t^h = \rho_t^h E_t\Lambda_{t+1}\mathcal{J}_{t+1}^{sh}, \tag{21}$$

where $\mathcal{J}_t^{sh} \equiv \partial \mathcal{F}\left(N_t^{sh}\right) / \partial N_t^{sh}$, whose evolution is given by the derivative of equation (20) with respect to N^{sh}. Hence,

$$\mathcal{J}_t^{sh} = w_t^h \frac{\partial H_t^h}{\partial N_t^{sh}} - w_t^{sh} - \eta^h f + \left(1-\eta^h\right) E_t \Lambda_{t+1} \mathcal{J}_{t+1}^{sh}. \tag{22}$$

2.3. Wage determination

We use the conventional instantaneous Nash bargaining approach to model wage negotiations where the objective function to be maximised is the weighted product of the two parties' match surpluses. Given that profits from vacancy creation are eliminated, the match surpluses for the agencies are $\mathcal{J}_t^j$, $j = ul, sl, sh,$ as derived above. The corresponding surpluses for each type of worker, denoted by $\mathcal{W}_t^j$, $j = ul, sl, sh,$ can be shown to satisfy the recursive equations below, where workers' threat point is the value of unemployment:[10]

$$\mathcal{W}_t^{ul} = w_t^{ul} - b_t + \left(1-\eta^l - q_t^l\right) E_t \Lambda_{t+1} \mathcal{W}_{t+1}^{ul}, \tag{23}$$

$$\mathcal{W}_t^{sl} = w_t^{sl} - b_t + \left(1-\eta^l - q_t^l\right) E_t \Lambda_{t+1} \mathcal{W}_{t+1}^{sl} + \left(1-\eta^l\right) e q_t^h E_t \Lambda_{t+1} \left(\mathcal{W}_{t+1}^{sh} - \mathcal{W}_{t+1}^{sl}\right), \tag{24}$$

$$\mathcal{W}_t^{sh} = w_t^{sh} - b_t + \left(1-\eta^h - q_t^h\right) E_t \Lambda_{t+1} \mathcal{W}_{t+1}^{sh}. \tag{25}$$

Assuming that the bargaining power of workers is job-type specific, and denoting it by α_j, $j = h, l,$ the corresponding Nash bargaining functions are $\left(\mathcal{W}_t^{ul}\right)^{\alpha_l} \left(\mathcal{J}_t^{ul}\right)^{1-\alpha_l}$, $\left(\mathcal{W}_t^{sl}\right)^{\alpha_l} \left(\mathcal{J}_t^{sl}\right)^{1-\alpha_l}$, and $\left(\mathcal{W}_t^{sh}\right)^{\alpha_h} \left(\mathcal{J}_t^{sh}\right)^{1-\alpha_h}$, which imply the following surplus sharing rules:

$$\alpha_l \mathcal{J}_t^{ul} \left(\partial \mathcal{W}_t^{ul} / \partial w_t^{ul}\right) + \left(1-\alpha_l\right) \mathcal{W}_t^{ul} \left(\partial \mathcal{J}_t^{ul} / \partial w_t^{ul}\right) = 0,$$

$$\alpha_l \mathcal{J}_t^{sl} \left(\partial \mathcal{W}_t^{sl} / \partial w_t^{sl}\right) + \left(1-\alpha_l\right) \mathcal{W}_t^{sl} \left(\partial \mathcal{J}_t^{sl} / \partial w_t^{sl}\right) = 0,$$

$$\alpha_h \mathcal{J}_t^{sh} \left(\partial \mathcal{W}_t^{sh} / \partial w_t^{sh}\right) + \left(1-\alpha_h\right) \mathcal{W}_t^{sh} \left(\partial \mathcal{J}_t^{sh} / \partial w_t^{sh}\right) = 0.$$

Together with equations (16), (17) and (22) to (25), these yield the following solutions for w_t^{ul}, w_t^{sl} and w_t^{sh} which have the standard interpretation:

$$w_t^{ul} = \alpha_l \left(w_t^l \frac{\partial H_t^l}{\partial N_t^{ul}} - \eta^l f + q_t^l E_t \Lambda_{t+1} \mathcal{J}_{t+1}^{ul} \right) + \left(1-\alpha_l\right) b_t, \tag{26}$$

$$w_t^{sl} = \alpha_l \left(w_t^l \frac{\partial H_t^l}{\partial N_t^{sl}} - \eta^l f + q_t^l E_t \Lambda_{t+1} \mathcal{J}_{t+1}^{sl} - \left(1-\eta^l\right) e q_t^h E_t \Lambda_{t+1} \mathcal{J}_{t+1}^{sh} \right) + \left(1-\alpha_l\right) b_t, \tag{27}$$

$$w_t^{sh} = \alpha_h \left(w_t^h \frac{\partial H_t^h}{\partial N_t^{sh}} - \eta^h f + q_t^h E_t \Lambda_{t+1} \mathcal{J}_{t+1}^{sh} \right) + \left(1-\alpha_h\right) b_t. \tag{28}$$

[10] As pointed out by Aresenau and Epstein (2016), this allows to "*circumvent the issues raised in Shimer (2006) regarding the use of Nash bargaining in models with OTJ search*", p. 15.

2.4. The final good sector

The final good sector produces a homogenous good competitively combining domestically produced and imported varieties of the intermediate good according to a CES technology

$$Y_t = \left(M^{-\frac{1}{\sigma}} \int_{i\in M} \left(y_{it}^d \right)^{1-1/\sigma} di + M^{*-\frac{1}{\sigma}} \int_{i\in M^*} \left(y_{it}^* \right)^{1-1/\sigma} di \right)^{\frac{1}{1-1/\sigma}}, \tag{29}$$

where Y is the quantity of the final good, y_{it}^d and y_{it}^* and M and M^* are, respectively, the quantities and the masses of domestically produced and imported intermediate input varieties. Denoting the output and input prices respectively by P_t, p_{it}^d and p_{it}^*, the sector's profit is $\Pi_{Yt} = P_t Y_t - \int_{i\in M} p_{it}^d y_{it}^d di - \int_{i\in M^*} \tau_t p_{it}^* y_{it}^* di$ where $\tau \geq 1$ is an iceberg trade cost incurred when importing varieties from abroad. Maximisation of profit yields the demand functions

$$y_{it}^d = \frac{Y_t}{M}\left(\frac{p_{it}^d}{P_t} \right)^{-\sigma}, \quad i \in M, \tag{30}$$

$$y_{it}^* = \frac{Y_t}{M^*}\left(\frac{\tau_t p_{it}^*}{P_t} \right)^{-\sigma}, \quad i \in M^*. \tag{31}$$

The price index dual to (29),

$$P_t = \left(\frac{1}{M} \int_{i\in M} \left(p_{it}^d \right)^{1-\sigma} di + \frac{1}{M^*} \int_{i\in M^*} \left(\tau_t p_{it}^* \right)^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}, \tag{32}$$

then ensures that $\Pi_{Yt} = 0$.

2.5. The intermediate good sector

The mass M of intermediate varieties is assumed to be time-invariant and each variety is produced by a firm whose total factor productivity is denoted by φ. We assume that firms differ in their productivity and that φ is distributed over the $[1,\infty)$ support with a time-invariant density function. We therefore use the productivity parameter to distinguish between firms and firm-level variables and simplify notation by dropping the variety index, $i \in M$. Denoting export-related variables by the superscript x, a typical firm's input requirement for its domestic and export production satisfies

$$y_t^d(\varphi) = \varphi a_t^d(\varphi), \qquad y_t^x(\varphi) = \varphi \tau a_t^x(\varphi), \tag{33}$$

where $a_t(\varphi)\left(\equiv a_t^d(\varphi) + a_t^x(\varphi)\right)$ is a composite input consisting of capital, k, and labour man-hours employed in high-tech and low-tech jobs, l^h and l^l (respectively supplied by high-skill workers only and by both low-skill and mismatched high-skill workers). We assume that these primary factors are combined according to the Cobb-Douglas technology,

$$a_t(\varphi)=\left(\frac{k_t(\varphi)}{\vartheta_k}\right)^{\vartheta_k}\left(\frac{l_t^h(\varphi)}{\vartheta_h}\right)^{\vartheta_h}\left(\frac{l_t^l(\varphi)}{\vartheta_l}\right)^{\vartheta_l},\ \vartheta_k+\vartheta_h+\vartheta_l=1. \tag{34}$$

A firm's cost of production therefore is

$$p_t^a a_t(\varphi)=r_t k_t(\varphi)+w_t^h l_t^h(\varphi)+w_t^l l_t^l(\varphi), \tag{35}$$

where p^a is the unit price of *a*. Efficiency requires

$$r_t k_t(\varphi)=\vartheta_k p_t^a a_t(\varphi), \tag{36}$$

$$w_t^h l_t^h(\varphi)=\vartheta_h p_t^a a_t(\varphi), \tag{37}$$

$$w_t^l l_t^l(\varphi)=\vartheta_l p_t^a a_t(\varphi), \tag{38}$$

$$p_t^a=(r_t)^{\vartheta_k}\left(w_t^h\right)^{\vartheta_h}\left(w_t^l\right)^{\vartheta_l}. \tag{39}$$

For domestic sales, the firm's real profit is $\pi_t^d(\varphi)=p_t^d(\varphi)y_t^d(\varphi)/P_t-p_t^a a_t^d(\varphi)$ which is maximised subject to $y_t^d(\varphi)=(Y_t/M)\left(p_t^d(\varphi)/P_t\right)^{-\sigma}$, yielding

$$\frac{p_t^d(\varphi)}{P_t}=\frac{\sigma p_t^a}{(\sigma-1)\varphi}. \tag{40}$$

The real profit from exporting is $\pi_t^x(\varphi)=p_t^x(\varphi)y_t^x(\varphi)/P_t-p_t^a a_t^x(\varphi)$. We assume, for simplicity, that the foreign demand for a typical domestic variety is $y_t^x(\varphi)=\left(F_t^*/M\right)\left(p_t^x(\varphi)/P_t^*\right)^{-\sigma}$ where P^* and F^* are the relevant foreign price level and the scale factor representing the real foreign income share spent on the good. It can be verified that $p_t^x(\varphi)=\tau p_t^d(\varphi)$ maximises $\pi_t^x(\varphi)$.

2.6. General equilibrium

Based on the above results, the following relationships hold for any two productivity values, e.g. φ and $\bar{\varphi}$:

$$\frac{p_t^j(\varphi)}{p_t^j(\bar{\varphi})}=\frac{\bar{\varphi}}{\varphi};\ \frac{y_t^j(\varphi)}{y_t^j(\bar{\varphi})}=\left(\frac{\bar{\varphi}}{\varphi}\right)^{-\sigma};\ \frac{a_t^j(\varphi)}{a_t^j(\bar{\varphi})}=\left(\frac{\bar{\varphi}}{\varphi}\right)^{1-\sigma};\ \frac{\pi_t^j(\varphi)}{\pi_t^j(\bar{\varphi})}=\left(\frac{\bar{\varphi}}{\varphi}\right)^{1-\sigma};\ j=d,x. \tag{41}$$

Defining the average industry productivity as in Melitz (2003) and hence setting

$$\bar{\varphi}=\left(\int_{\varphi} g(\varphi)\varphi^{\sigma-1}d\varphi\right)^{\frac{1}{\sigma-1}}, \tag{42}$$

we can express all aggregate measures in terms of $\bar{\varphi}$ – e.g., the aggregate demand for capital by all firms is $K_t^D=\int_{i\in M}\left[k_{it}^d+k_{it}^x\right]di=\int_{\varphi}Mg(\varphi)\left[k_t^d(\varphi)+k_t^x(\varphi)\right]d\varphi=M\left[k_t^d(\bar{\varphi})+k_t^x(\bar{\varphi})\right]$.

We use the following standard decreasing returns to scales technologies to obtain effective man-hours from workers for the low-tech and high-tech inputs,

$$H_t^l = \frac{\overline{h}_{ul}}{\psi_{ul}}\left(N_t^{ul}\right)^{\psi_{ul}} + \frac{\overline{h}_{sl}}{\psi_{sl}}\left(N_t^{sl}\right)^{\psi_{sl}}, \tag{43}$$

$$H_t^h = \frac{\overline{h}_{sh}}{\psi_{sh}}\left(N_t^{sh}\right)^{\psi_{sh}}, \tag{44}$$

where $\overline{h}_j$ and ψ_j, $j = ul, sl, sh$, are constant positive coefficients and the latter captures the required decreasing returns to scale. The respective man-hour wage rates paid by the firm, w_t^l and w_t^h, are then determined by the labour market clearing condition that equates demand and supply for man-hours,

$$Ml_t^l\left(\overline{\varphi}\right) = H_t^l, \tag{45}$$

$$Ml_t^h\left(\overline{\varphi}\right) = H_t^h. \tag{46}$$

The government operates a balanced budget and finances its expenditures – unemployment benefit and public investment I^g – with revenues generated through lump-sum tax from households and firing fees from employment agencies as well as the profit of the latter which we assume to be owned publicly. Thus,

$$b_t S_t + I_t^g = T_t + \left(N_t^{ul} + N_t^{sl}\right)\eta^l f + N_t^{sh}\eta^h f + \pi^l\left(N_t^{ul}, N_t^{sl}, V_t^l\right) + \pi^h\left(N_t^{sh}, V_t^h\right). \tag{47}$$

Note that the government budget constraint takes account of vacancy creation costs which are included in employment agencies' profits – see (13) and (19). In our baseline analysis we avoid the use of proportional taxation in order to circumvent their distortionary effects but will later examine whether the results change if labour and non-labour income were taxed proportionally.

Given the above, the demand for the final good, i.e. domestic absorption denoted by *Y* is given by

$$Y_t = C_t + I_t + I_t^g + c_t^l V_t^l + c_t^h V_t^h,$$

which encompasses spending on consumption, private and public investments, and vacancy creation costs. *GDP* is then the sum of domestic absorption and its foreign equivalent (net exports):

$$GDP = Y_t + \frac{M\tau_t p_t^d\left(\overline{\varphi}\right) y_t^x\left(\overline{\varphi}\right) - M^*\tau_t \overline{p}_t^* \overline{y}_t^*}{P_t}, \tag{48}$$

where we have assumed $p_{jt}^* = \overline{p}_t^*$ and $y_{it}^* = \overline{y}_t^*$.

We assume that capital mobility is governed by the (exogenously determined) rule

$$r_t - r_t^* = \kappa\left(K_t^D - K_t\right)\big/K_t, \tag{49}$$

where the excess demand for capital raises *r* above r^* by an amount determined by the given value of $\kappa \geq 0$ which is an inverse measure of capital mobility: $\kappa = 0$ corresponds to perfect mobility and the country can, in principle, sustain any excess demand for capital at the rate $r = r^*$; $\kappa \to \infty$ instead frees any ties between *r* and r^* and requires it to be determined by the capital market clearing condition $K^D = K$ which ought to hold in this case.

The balance of payments, which requires the value of net exports to match the interest payments on net capital flow,

$$r_t^* \left(K_t^D - K_t \right) = \frac{M \tau_t p_t^d \left(\overline{\varphi} \right) y_t^x \left(\overline{\varphi} \right) - M^* \tau_t \overline{p}_t^* \overline{y}_t^*}{P_t}, \tag{50}$$

can be shown to hold as long as all markets are cleared.

In order to obtain closed form solutions, we assume that firms' productivity parameter has a time-invariant Pareto distribution,

$$g(\varphi) = \gamma \varphi^{-(1+\gamma)}, \quad \varphi \in [1, \infty), \quad \gamma > \sigma - 1. \tag{51}$$

Thus, equation (42) implies

$$\overline{\varphi} = \left(\frac{\gamma}{\gamma - (\sigma - 1)} \right)^{\frac{1}{\sigma - 1}}. \tag{52}$$

We also assume that the household utility function has the following functional form

$$U_t = \frac{C_t^{1-\upsilon_c}}{1-\upsilon_c} - \frac{\overline{A}^u \left(X_t^u \right)^{1+\upsilon_u}}{1+\upsilon_u} - \frac{\overline{A}^{sl} \left(X_t^{sl} \right)^{1+\upsilon_{sl}}}{1+\upsilon_{sl}} - \frac{\overline{A}^{sh} \left(X_t^{sh} \right)^{1+\upsilon_{sh}}}{1+\upsilon_{sh}}, \tag{53}$$

where $1/\upsilon_c$ is the intertemporal elasticity of substitution and $\overline{A}^j$ and υ_j, $j = u, sl, sh$, are constant positive parameters – respectively capturing the weight and elasticity attached to the disutility of participation in the labour force.

The matching functions are assumed to have the standard Cobb-Douglas constant returns to scale form

$$\mathcal{M}_t^l = \exp\left(m_t^l \right) \left(S_t^{ul} + S_t^{sl} \right)^{\lambda_l} \left(V_t^l \right)^{1-\lambda_l}, \tag{54}$$

$$\mathcal{M}_t^h = \exp\left(m_t^h \right) \left(S_t^{sh} + e\left(1 - \eta^l \right) N_t^{sl} \right)^{\lambda_h} \left(V_t^h \right)^{1-\lambda_h}, \tag{55}$$

where, for $j = h, l$, $\lambda_j \in (0,1)$ determines match elasticities and m_t^j is a job-specific measure of the effectiveness of matching process. We assume that the latter is influenced by ALMPs such as investment in employment services. This form of public investment is seen as a cost-effective way of reducing the frictions that characterise the labour market (ILO, 2015b) and has featured in labour market policies in many countries in recent years. In particular, job search assistance (which might include the adoption of information technology that influences the way jobs are advertised by firms and/or sought and applied for by workers, which reduces search times and information asymmetry, or a form of investment in upgrading public job centres) has been found to be the most cost effective ALMP – with its short-run effectiveness exceeding that of training – Card *et al*. (2010) and Hotz *et al*. (2006). Consistently, findings from a number of OECD countries associate positive outcomes with investment towards public employment services which evidence shows to strengthen the effects of other ALMPs (ILO, 2015a,b).[11] Despite its importance in policy discourse, the effect of investment in public employment services has scarcely been studied as an instrument of labour market reform enabling policy interventions to target the efficiency of job search and matching. We capture its role here by letting $m_t^j = \bar{m}^j + \bar{\varepsilon}^j K_t^g$, where $\bar{m}^j > 0$, $K_t^g = \left(1-\delta^g\right) K_{t-1}^g + I_t^g$ is the stock of public capital used in employment services that enhance the effectiveness of matching and whose effect is captured by $\bar{\varepsilon}^j > 0$. In essence, $\bar{m}^j$ can be thought of as the *underlying* quality of matching of the corresponding segment of the labour market. For given values of $\bar{m}^j$ and $\bar{\varepsilon}^j$, the *effective* quality of matching is driven by the level of investment in employment services, I_t^g.

Finally, in order to examine how mismatch is affected by exogenous shocks, we construct the following index which is a modified version of the aggregate skill dispersion indicator recommended by Kiss and Vandeplas (2015), and which accounts for the actual size of employment in the low-tech task jobs,

$$ASDI = \left| \frac{N^{sh}}{N^{sh} + N^{sl} + N^{ul}} - Z \right| + \left| \frac{N^{ul} + N^{sl}}{N^{sh} + N^{sl} + N^{ul}} - \left(1-Z\right) \right|. \tag{56}$$

3. Calibration

We calibrate the model's steady state to reflect the stylised characteristics of the UK economy, with emphasis on the labour market features. We assume a quarterly time-frequency and base the calibration of all parameters on empirical evidence and data averages. When these are lacking, we choose the values commonly used in the relevant literature. In particular, following the common practice in the literature, we use the standard values for the subjective discount factor and capital depreciation rate, $\beta = 0.99$ and $\delta = 0.025$, and normalise the elasticity parameters in the utility function by setting $\upsilon_j = 1,\ j = c, ul, sl, sh.$ We also normalise GDP to unity and assume that trade is balanced in the initial steady state equilibrium.

OECD (2016, 2018) data show that the 56% of the work force in the UK consists of unskilled workers, identified as those with at most an upper secondary education. Based on the

[11] In Germany, the restructuring of the federal employment agency, as part of the Hartz reform between 2003 and 2005, was aimed at improving job matching efficiency (Krebs and Scheffel, 2013) and was found to explain about 23% of the decrease in unemployment in the following years (Launov and Wälde, 2016). In the UK, the complete overhaul of the Jobcentre Plus resulted in the introduction of Jobseeker Direct (a telephone job matching service) (Riley *et al.*, 2011) and the Universal Job Match Service (offering a comprehensive 'one-stop-shop' for the unemployed allowing them to upload CVs and apply online within the same platform (European Commission, 2017). Mosseri-Marlio (2016) argues that digital tools, relying on data driven intervention, can drastically improve job centres' effectiveness. As pointed out by a referee, introducing this element to the matching function makes it akin to production functions used in the growth literature where total factor productivity is assumed to evolve, e.g. the Hicks-neutral process, or the more recent endogenous growth models with investment in human capital.

empirical evidence provided by Gomes (2012), we target inactivity rates of the high- and low-skill as $L^s/Z = 0.12$ and $L^u/(1-Z) = 0.28$. The average share of employed and unemployed in the UK labour force between 2008 and 2014 are respectively 73% and 6%, based on ONS statistics. These imply an aggregate inactivity level of 21% given the normalisation of the household population to unity. Using these values and allowing for the scale parameters for the disutility of labour market participation $\overline{A}^j$, $j = u, sl, sh,$ to be freely determined by the model, we target the aggregate unemployment rate $u = (S^{ul} + S^s)/(X^u + X^s)$ within the 5%-8.4% range, so as to match the figures reported by the OECD statistics for the UK over the 2008-2015 period. The measure of OTJS efficiency is set as e = 0.1 to yield the mismatched employment ratio $N^{sl}/(N^{ul} + N^{sl} + N^{sh})$ within the 0.13-0.15 interval as observed in the UK (ONS, 2016).

Job destruction rates, η^h and η^l, are respectively set to 0.009 and 0.02 based on the empirical estimates reported in Gomes (2012). The initial steady state unemployment benefit payment, b, is set based on evidence provided by van Vliet and Caminada (2012) so that the corresponding benefit replacement rate, $b(N^{ul} + N^{sl} + N^{sh})/(N^{ul}w^{ul} + w^{sl}N^{sl} + w^{sh}N^{sh})$, is 0.23. We assume symmetric bargaining across the job spectrum and set $\alpha_j = 0.5,\ j = l, h$, and follow common practice in using the Hosios parameterisation by setting $\lambda_j = \alpha_j$. As is well known, in the absence of distortions other than those arising from search externalities, the latter ensures that the market equilibrium solution delivers the socially optimal level of unemployment relative to vacancies (Hosios, 1990). However, this condition is not sufficient to yield constrained efficiency in a model, such as ours, which is characterised by several other distortions arising from workers heterogeneity and skill mismatch, on-the-job-search, endogenous labour supply and international openness.[12]

Assuming that trade and capital mobility are both frictionless and free to start with, we set $\tau = 1$ and $\kappa = 0$ in the benchmark calibration. The latter implies $r^* = r$. Using the foreign final good as the numeraire, we normalise its price to unity setting $P^* = 1$. Utilising the relevant trade-related series over the 2008-2014 period from the World Bank Development Indicators dataset (WDI, 2016), we calculate the scale factor in foreign demand and the relative price of exported to foreign varieties respectively as $F^* = 0.415$ and $\overline{p}^x/\overline{p}^* = 0.785$ and, to ensure that our calibration reflects the actual UK to world GDP ratio, we set $M/M^* = 0.0465$.

[12] Shimer and Smith (2001) provide a comprehensive account of the externalities that arise in the presence of workers heterogeneity. Arseneau and Chugh (2012) identify the efficiency conditions in general equilibrium models. In a number of papers, Arseneau and Epstein identify and outline the distortions and derive the corresponding efficiency conditions in analytically tractable general equilibrium models with heterogenous jobs and workers: Arseneau and Epstein (2018) show that the Hosios condition does not generate an efficient surplus split in the presence of mismatch, and Arseneau and Epstein (2014) demonstrate that OTJS amplifies the mismatch distortion.

Given that we start with a balanced trade, $K^D = K$ holds initially and is sustained by private investment, which is set consistently with the UK investment/GDP ratio of 16.61% over the period 2008-2014. Using the data from EU-KLEMS (2016), we set the labour input elasticities as $\vartheta_h = 0.44$ and $\vartheta_l = 0.26$, respectively, corresponding to the average values over the 2008-2015 period, and let $\vartheta_k = 1 - \vartheta_h - \vartheta_l$ for consistency with the constant returns to scale assumption.[13] The values of the elasticity of substitution and the shape parameter of the Pareto distribution of firms' productivity, σ and γ, are set to yield a profit/output ratio of roughly 20%, corresponding to the average UK business profit share over the 2008-2014 period.[14] The chosen values, $\sigma = 4.5$ and $\gamma = 3.8$, are within the range used in similar studies and satisfy $\gamma > \sigma - 1$.

The existing evidence suggests that, on average, overeducated mismatched workers receive a wage premium over non-overeducated workers in the same job (despite suffering a wage penalty relative to their counterparts in correctly matched jobs) – see, e.g., ONS (2019) for the UK, Büchel (2000) for Germany, and CEDEFOP (2010) for EU countries. There is also evidence that over-education has positive direct effects on firm-level productivity – see, e.g. Kampelmann and Rycx (2012) and Benoît *et al*. (2015) for Belgium. We therefore assume that the high-skill workers are more productive when properly matched, and that they are mildly more productive than their low-skill peers in performing low-tech tasks, and set the labour input conversion technology parameters as $\overline{h}_{ul} = 0.06$, $\overline{h}_{sl} = 0.065$ and $\overline{h}_{sh} = 0.111$. These values are such that the steady state wage ratio is $w^l / w^h = 0.62$ which is consistent with the average wage ratio of non-graduates to graduates reported over the 2008-2016 period (Department for Education, 2017).[15] In order to allow for sufficient concavity in converting labour to man-hours in equations (43) and (44), we follow Christoffel and Kuester (2009) and set $\psi_{ul} = \psi_{sl} = \psi_{sh} = 0.995$.

To explore the quantitative effects of allowing government investment in matching efficiency, we set $I^g / GDP = 0.003$ which reflects the UK's GDP share of public expenditure on Employment Services (ILO, 2015b) and let $\delta_g = 0.009$, which corresponds to the ratio of private to public capital depreciation rate of 0.36 as reported in Angelopoulos *et al*. (2012). We also use $\overline{\varepsilon}^l = \overline{\varepsilon}^h = 0.15$ and choose the values of $\overline{m}^l$ and $\overline{m}^l$ consistently with the value of

[13] Source: http://www.euklems.net.

[14] Sources: http://ec.europa.eu/eurostat/web/sector-accounts/data/ annual-data.

[15] Our assumptions have clear implications for the nature of the low-skill/mismatched wage differential. However, since the low- and high-tech hiring agencies make separate, independent, decisions about vacancy posting, there are no implications for the willingness to post high-tech relative to low-tech jobs for given factor input demands expressed by firms. An alternative, as in Arseneau and Epstein (2014), would have been to target the high-tech to low-tech ratio of take home (negotiated) wages. We chose to base our calibration on the firm-level hourly wages, w^l and w^h, since they are more readily observable. We have, however, verified that small deviations in the productivity differential from the initial calibration values for $\overline{h}_j$ do not alter the qualitative nature of the results.

mismatch of roughly 0.13. Finally, in choosing the values for the unit costs of vacancy creation $c^l = 0.308$ and $c^h = 3.628$, we targeted the ratio of aggregate vacancies to aggregate unemployment.

Our benchmark solution for the immediately relevant variables, corresponding to the calibration described above, is given in column 2 of Table 1 in the Appendix and was found to be robust to sensitivity analysis in which we perturbed the values of parameters of interest and relevant exogenous variables.

4. De-globalisation

Trade flows have slowed down worldwide after the 2007-2008 financial crisis. At the same time, revival of protectionist stances and backlashes against globalisation have resulted in political developments that are likely to raise trade barriers and reduce international trade further – e.g., Brexit in the UK, the rise of anti-EU sentiments in other EU nations, and the recent trade policies of the Trump administration in the US.

To examine the impact of raising trade frictions, we consider an increase in trade costs – specifically, in the form of a perfect foresight permanent increase in τ by 20%. We then examine the transitional dynamics which shows the paths that endogenous variables take to reach their new equilibrium values. Figure 1 displays the results for selected variables where solid-lines illustrate the adjustment paths in the absence of labour market reforms.

The immediate effect of a higher τ is to increase the effective prices of both exported and imported intermediate varieties, leading to a reduction in the volume of trade as, ceteris paribus, both foreign demand for domestically produced varieties and domestic demand for foreign varieties drop and remain permanently below their initial steady-state levels. The higher import price also raises the production cost in the final good sector as the intermediate price level rises. The higher price index, together with the higher export prices, reduces demand in both downstream and upstream sectors. Despite a substitution of demand away from foreign towards domestic varieties, and inducing some shifting of resources from exports to domestic production, firms reduce their demand for primary factors which results in both lower wages and lower incentives for vacancy creation especially in the short-run and, consequently, in a reduction in job finding probabilities – reflected in lower employment across all worker types. The worsening of job prospects lowers the opportunity cost of leisure, initially reducing participation, and results in lower short-run unemployment rate and mismatch (reflecting a lower crowding out of low-skill workers by high-skill workers in low-tech occupations). The fall in wages and employment levels implies, however, that household income drops, triggering an income effect on household decisions whereby participation increases as the economy transitions to a new equilibrium characterised by higher unemployment rate and mismatch. Thus, despite the fact that with mark-up pricing in the intermediate sector the lower wages ultimately translate into a reduction in the price of domestic varieties, the rise in trade cost implies that domestic and foreign absorption both fall and so do GDP, labour force and employment, whilst skill mismatch increases.

Broadly, these results match observed empirical regularities. For instance: Barattieri *et al.* (2018) find that protectionist shocks are recessionary; Cooray *et al.* (2017) document empirically the adverse effect of trade frictions on the size of labour force; Felbermayr *et al*. (2011b) discuss the greater unemployment consequences of trade restrictions; and Davidson *et al.* (2014) and Krishna *et al.* (2014) also offer evidence of improved firm-worker sorting as a result of trade integration.

5. The effects of labour market reform

In this section we ask how labour market reforms would affect the impact of raising trade barriers. To do so, we start from our benchmark calibration, which portrays a liberal welfare state system, and examine how implementing a flexicurity reform package (FRP) affects the economy's response to increasing trade frictions. As previously noted, since changes in individual policy instruments may have opposite effects on the equilibrium, the extent to which they are altered relative to each other is an important determinant of the net impact of a given reform package. To this end, we use Denmark, one of the flexicurity pioneers, as our example of the flexicurity system and change the relevant UK policy parameters *in the direction of and by a proportion consistent with taking them to their corresponding Danish counterparts*. This implies: (i) increasing the unemployment benefit rate b by 60% (based on the estimates provided by Nickell *et al*., 2005; Vliet and Caminada, 2012); (ii) raising the firing cost f by 43% (OECD, 2013); (iii) increasing public expenditure on labour market services I^g by 40% (ILO, 2015b); and (iv) reducing the unit vacancy creation costs c^j, $j = l, h$. Quantifying the reduction in c^j to mimic the Danish situation is not straightforward since there is no clearly defined measure of these parameters in the available data. One way to circumvent this problem is to utilise World Bank's *ease of doing business indicator* which shows that it is relatively easier to establish a business (and presumably hire workers) in Denmark than in the UK and the analysis therein suggests a reduction around 50%. We therefore opted for a 45% reduction in costs c^l and c^h in the first instance but shall reconsider this later in the paper.

Figure 1 juxtaposes the transitional dynamics of the impact of an increase in trade cost in the baseline case (solid lines) and in the case in which the rise in trade cost goes hand in hand with the implementation of the FRP (broken lines). As the graphs show, reforming the benchmark liberal labour market in the direction of flexicurity can moderate both the short- and long-run effects of a rise in trade cost. Specifically, in our numerical example, the reform attenuates the negative impact the latter on *GDP* and on both domestic and foreign absorptions. It also more than offsets the impact of the trade shock on key labour market variables resulting in a new steady-state that is characterised by higher labour force participation, market tightness and job-to-job transition and in a lower skill mismatch than in the original benchmark.

Interestingly, our model predicts that in the short-run the economy may experience greater aggregate as well as skill-specific unemployment rates; this is due to an increase in participation and the presence of matching frictions. In the long-run, however, successful matching results in the new equilibrium being characterised by lower unemployment rates.

Given the multifaceted nature of the reform, to appreciate the driving mechanisms behind these results it is worth examining the effects of changes in the individual policy instruments. These are reported in Table 1; as one would expect, the various instruments have different quantitative and, in some cases, qualitative effects. Consider the effect of an increase in firing cost f, which can be interpreted as lowering the degree of labour market flexibility. By exerting a downward pressure on the value of employment and profits from job matches, a higher f reduces vacancy creation and this works towards an increase in unemployment. At the same time, however, by worsening job prospects, individuals' incentive to participate in the labour market reduces, resulting in an opposite effect on employment. We find the first impact to dominate since the net effect of raising f is an increase in both unemployment levels and rates.[16] Overall, our model shows that an increase in f has a contractionary impact on both domestic and foreign absorption and hence on GDP. This is however quantitatively mild, which is consistent with the ambiguous effects of employment protection found in the empirical literature.

Changes to all other policy instruments have expansionary effects on the level of economic activity, albeit to different extents. This is very intuitive for an ALMP measure such as investment in employment services, I^g: by simultaneously increasing job finding and vacancy filling probabilities, a rise in I^g facilitates job matching and results in a lower level of unemployment across worker types and in a reduction in the duration spell of both unemployment and vacancies. Consistent with the evidence provided by Riley *et al.* (2011), who evaluate the impact of job-brokering on labour market outcomes in the UK, our results show that a higher investment in employment services leads to a lower aggregate level of inactivity. Also, even though participation of mismatched high-skill workers rises, which exerts a negative externality on the job prospects of low-skill workers, the ensuing increase in job-to-job transition leads to a long-run reduction in mismatch and greater employment for all worker types.[17]

Unsurprisingly, and consistent with the implications of the standard search and matching model, lowering vacancy creation costs is also expansionary. By incentivising vacancy creation, a reduction in c^l and c^h increases market tightness and bargained wages for all

[16] Somewhat counterintuitively, skill mismatch tends to fall when f is raised. The main reason for this lies in the adjustment of the participation margin: as market tightness falls, so do searchers' job finding rates, resulting in higher unemployment duration and in an outflow from the labour force which mitigates the higher competition for jobs.

[17] As noted, and as shown by Arseneau and Epstein (2014), this effect reflects an externality that mismatched high-skill workers exert via OTJS on other high-skill individuals.

searchers, stimulating participation and reducing the incidence of mismatch due to greater job-finding probabilities and higher OTJS transition rates. These effects result in lower unemployment rates, a higher aggregate demand and a higher level of economic activity, reflected in an increase in GDP and in both domestic and foreign absorption.

Interestingly, and somewhat counter to conventional wisdom, an increase in unemployment benefit b – a typical passive labour market policy – is also found to be expansionary. The key mechanism underpinning this results hinges on the indirect effect of this policy instrument on the matching function – which is increasing in both vacancies and searchers. By raising the value of a worker's outside option in wage negotiations, a higher b results in a higher bargained wage. This works towards reducing vacancy creation. At the same time, it also raises the opportunity cost of leisure – and, through this channel, stimulates search activity. Clearly, in models characterised by exogenous participation (e.g., as in Cacciatore *et al.*, 2016), this second effect would not arise and the number of job matches would unambiguously reduce. With endogenous participation, however, the net impact of a higher b on aggregate job matches depends on which of these two effects dominates. In our policy experiments, the effect on participation is sufficiently large to slightly dominate the negative effect on vacancy creation and lead to a small increase in the number of job matches.[18] The intuition for this is that the increase in household income resulting from the higher take home wage and unemployment benefit raises aggregate demand which triggers an increase in demand for both labour and capital by firms, stimulating capital inflow. The latter, in turn, requires raising net exports to satisfy the balance of payments, which further enhances the overall demand for labour, N, necessitating an increase in the number of successful matches, since $\mathcal{M} = \eta N$ should hold in equilibrium. Therefore, the final adjustments in unemployment (job searchers) and vacancies ought to deliver the necessary rise in the number of matches – i.e. the effect of the increase in the former needs to dominate that of the reduction in the latter. This, combined with higher wages, explains the increase in GDP, with domestic and foreign absorption both rising. In this case, however, skill mismatch increases since the greater participation across the skill spectrum combines with lower vacancy creation to increase competition for jobs – with a larger number of high-skill workers willing to accept low-tech jobs. Thus, an important implication of our analysis is that the endogeneity of workers' participation in the labour market is a key channel in the transmission mechanism of the policy and implies that a passive labour market policy instrument such as the unemployment benefit rate can be used as an activation measure.

Two caveats are in order in interpreting the above results. First, they are clearly sensitive to the size of the changes in individual instruments. As can be seen from the column of Table 1 labelled FRP, the reduction in vacancy creation costs plays the dominant role amongst the four policy instruments included in the FRP we have analysed. This is hardly surprising given

[18] The aggregate labour market response to an increase in b resonates the evidence in Bruckner and Pappa (2012) who find that a fiscal shock that raises aggregate demand can result in both higher employment and unemployment by inducing greater participation which reinforces the number of job searchers.

the relatively large reduction we have implemented and the fact that it has a direct first order effect on vacancies – which in turn raise matches directly. As mentioned above, our decision to reduce c^j by 45% was guided by empirical stylised facts. Our sensitivity analysis – based on varying the size of reduction in c^j within the reform package, including the case reported in the last column of Table 1 in which the reform does not encompass any reduction in c^j, – confirms that the smaller is the reduction in this parameter the more limited is the impact of the reform. In addition, whilst the qualitative effects of reform on GDP, domestic and foreign absorption and aggregate participation remain unchanged even when c^j is kept intact within the reform package, the effects on labour market variables can change qualitatively when the reductions in c^j is sufficiently small. For instance, market tightness falls and the aggregate unemployment rate increases following the implementation of a reform which involves a small reduction in c^j.

Second, and more generally, these results should not be interpreted as normative prescriptions but merely as suggesting that it is possible to formulate reforms of a liberal welfare state system in the direction of flexicurity which can improve labour market outcomes and moderate the adverse impact of increases in trade barriers. An implication of our analysis is that the effects of the reform depend on how the different instruments are combined. ALMPs that affect the degree of frictions in the labour market (such as investment in employment services or vacancy creation costs) are key important drivers in expanding employment and the level of economic activity. Perhaps more surprisingly, however, even a passive labour market policy such as unemployment benefit can be expansionary – and crucial to this result is the fact that this instrument can be used to stimulate labour market participation.

The relevance of our analysis is supported by the fact that, qualitatively, our results are broadly consistent with observed empirical regularities. For instance, a major review of the effects of flexicurity on the performance of different economies in the aftermath of the Great Recession of 2007, carried out by the European Commission (Smith *et al*., 2013), finds that the Nordic countries were better able to withstand the impact of the recession compared to the Anglo-Saxon countries. Consistent with our analysis, in terms of specific policy instruments, the review also found that countries with low expenditures on ALMPs experience greater skill mismatch. In an earlier study, Lehman and Kluve (2010) had already come to a similar conclusion, arguing that job creation subsidies can result in a higher job matching efficiency, implying a lower mismatch rate. It is important to note, however, that our theoretical analysis is not an 'inter-country' comparison between different welfare state regimes – which would entail contrasting models with different initial calibrations so as to reflect the structural characteristics of the two economies. Rather, we seek to understand how an economy – given its initial structural characteristics – would perform were it to introduce reforms in a certain direction.

6. Extensions

In this section we carry out two experiments to examine the robustness of the results. These concern the effects of a change in (i) the degree of capital mobility, which is the other aspect of international openness, and (ii) the nature of taxation, by allowing for proportional income taxation of different types of income.

(i) *Capital mobility frictions*

Whilst the rise of financial globalisation had been a defining feature of the world economy since the 1980s, it slowed down considerably in the aftermath of the financial crisis against a shifting consensus towards the desirability of regulating international financial flows. Here we consider the effect of introducing some friction in the cross border mobility of capital by letting $\kappa > 0$ in equation (49).

In a theoretical model such the one used in this paper, the extent of capital mobility, characterised by the response of capital flows to interest rate differential, enables the economy to accommodate an excess demand or supply of capital that is consistent with the trade balance. Specifically, with some capital mobility friction, the interest parity can no longer be attained and an interest rate differential persists that is consistent with the excess demand for capital – i.e. the discrepancy between domestic firms' demand for and households' accumulated capital stock. Consequently, the balance of payment will only hold if the resulting interest payments on capital inflow (outflow) is matched by a trade deficit (surplus). Put differently, the economy can sustain a trade deficit or surplus as long as it is offset by the return on capital flows; the higher is the barriers to capital flows, the smaller is the sustainable magnitude of the trade deficit/surplus. Thus, the impact of raising capital mobility frictions on the economy is likely to be contingent on whether an economy is initially in a position of trade surplus or deficit. Starting from a trade surplus position where the economy is a net exporter, the overall effect of an increase in such frictions will be contractionary. The opposite would hold if the economy were initially a net importer.

To illustrate this, we set $\kappa = 0.25$. In Figure 2 the solid and dashed lines depict respectively the effects of changes in the trade cost without and with restrictions to capital mobility. We find that, by restricting capital flow and thus the size of the trade balance, a higher κ leads to temporal moderation of the adverse effects of rising trade cost. As can be seen from the graphs, the short-run negative effects of raising trade cost on *GDP*, aggregate employment and participation are dampened. The underlying intuition is straightforward and relies on the substitutability between capital and labour in production. When capital mobility is frictionless, firms enjoy almost an infinitely elastic supply of capital at a constant rate $r = r^*$. Imposing capital mobility frictions changes this, such that any excess demand for capital raises r above r^* and induces factor substitution away from capital. In the long run, however, due to the fall in firms' profits, aggregate outcomes remain adversely affected by the increase in trade barriers.

(ii) *Distortionary Taxation*

Our analysis so far has been carried out by assuming away distortionary taxation and using a lump-sum tax to balance the government budget. This enabled us to isolate the effects of labour market polices. However, the fact that governments tax labour and non-labour income proportionally is relevant to our inquiry. We therefore examine here how our results would hold if we allowed for proportional taxation within the model. Using ζ_t^w and ζ_t^π to respectively denote the average proportional labour and non-labour income tax rates, we rewrite the household and government budget constraints respectively as follows

$$\begin{aligned} C_t + I_t + T_t = b_t S_t + \left(1-\zeta_t^w\right)\left[w_t^{ul} N_t^{ul} + w_t^{sl} N_t^{sl} + w_t^{sh} N_t^{sh}\right] \\ + \left(1-\zeta_t^\pi\right)\left[\Pi_t + r_t K_t^D + r_t^* \left(K_t - K_t^D\right)\right], \end{aligned} \tag{57}$$

$$\begin{aligned} b_t S_t + I_t^g = T_t + \left(N_t^{ul} + N_t^{sl}\right)\eta^l f + N_t^{sh}\eta^h f + \pi^l\left(N_t^{ul}, N_t^{sl}, V_t^l\right) + \pi^h\left(N_t^{sh}, V_t^h\right) \\ + \zeta_t^w\left(w_t^{ul} N_t^{ul} + w_t^{sl} N_t^{sl} + w_t^{sh} N_t^{sh}\right) + \zeta_t^\pi\left[\Pi_t + r_t K_t^D + r_t^*\left(K_t - K_t^D\right)\right]. \end{aligned} \tag{58}$$

We also modify all other equations involving labour and non-labour income as necessary so as to reflect the difference between gross and net income from each source. According to OECD data, the labour and corporate income tax rates in the UK are, on average, 23.4% and 19% respectively. We therefore re-calibrate the benchmark model setting $\zeta^w = 0.234$ and $\zeta^\pi = 0.19$ while ensuring that all key measures – such as labour force participation rate, mismatch, *GDP,* employment and unemployment levels, etc. – remain consistent with the original values.

For selected variables, Figure 3 gives the transitional dynamics following the trade shock with (dotted line) and without (solid line) the labour market reform. Clearly, the nature of taxation matters for the effectiveness of reforms. With proportional income taxation too, the reform mitigates the impact of the trade shock on GDP, domestic and foreign absorption, aggregate participation and market tightness. The unemployment rate, however, increases in the presence of the reform. Intuitively, the presence of distortionary taxation drives a wedge between the gross wages paid and net wages received by workers and affects their outside options and willingness to participate, the value they associate with a job, and thus alters the surplus split and negotiated wages. As a result, a shock that reduces the return to a job match, such as a trade shock, would lead to a higher reduction in vacancy creation – with a negative impact on unemployment – than what would be obtained with lump-sum taxation only.

7. Summary and conclusions

This paper has examined the labour market consequences of reducing the level of trade integration of an open economy characterised by vertical linkages in production and labour markets exhibiting search frictions and two-sided heterogeneity. Raising trade barriers are found to lead to under-utilisation and misallocation of resources, resulting in higher unemployment rates across skill levels and lower levels of economic activity. Maintaining frictionless cross-border capital flows does not necessarily moderate the negative effects of raising trade barriers in the long-run.

The model predicts that implementing a reform package which moves an economy with a liberal welfare state system in the direction of flexicurity, despite involving greater unemployment benefit and firing restrictions, can enable it to better withstand the adverse effects of increasing trade costs.

A broad implication of the paper is that labour markets do not need to be thin on worker security to ensure high levels of employment. Importantly, our results suggest that unemployment insurance can in fact act as an activation policy by fostering labour market participation; an effect that is reinforced if coordinated with other 'activation policies' – such as a reduction in vacancy creation costs and investment in employment services – that support job creation and reduce frictions in search activities.

Our results are broadly consistent with empirical stylised facts concerning the role of welfare state institutions and reforms in affecting countries' ability to withstand the effects of exogenous shocks. In providing theoretical underpinning for some of these documented facts, our analysis offers valuable insights into the role of labour market policy. More specifically, it is relevant to current debates in the UK, particularly considering the potential increase in trade costs with the country's main, and geographically closer, trading partners that might result from Brexit. The UK has also served as an interesting baseline case for our policy analysis: its labour market policies and institutions are among the most deregulated in mature industrial economies which ought to offer, according to received wisdom, the best supporting framework to the economy's ability to adjust to and withstand the effects of adverse shocks. Our analysis clearly casts doubt on this view.

Finally, our focus in this paper has been to examine the implications of policies that resonate with current debates on labour market reforms. To this end, in carrying out our policy experiments we have not addressed efficiency considerations – as is done, for instance, by Arseneau and Chugh (2012) who identify conditions of efficiency for general equilibrium welfare models and by Arseneau and Epstein (2014, 2018) who provide an analytical characterisation of the distortions resulting from mismatch and show that there is an optimal level of mismatch. This remains an interesting area for future research.

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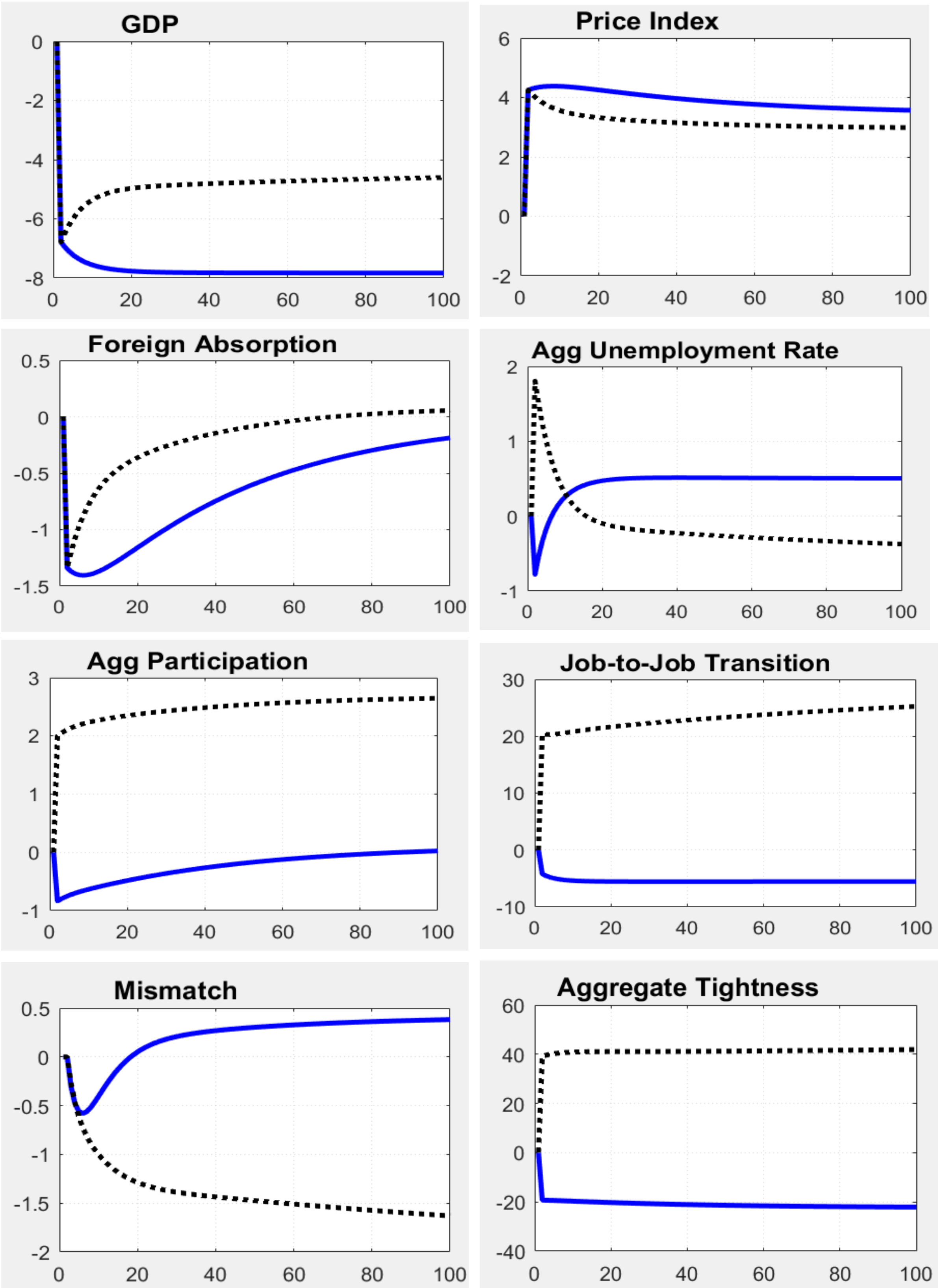
Appendix

Table 1: Long-run effects of implementing individual labour market policies and together as a reform package

Variables	Benchmark equilibrium solution	% change relative to the benchmark solution*					
		b raised by 60%	*f* raised by 43%	I^g raised by 40%	c^j reduced by 45%	FRP	FRP (c^j *intact*)
GDP	1.000	0.247	-0.021	0.312	3.208	3.597	0.531
Price Index	0.993	-0.040	0.003	-0.051	-0.513	-0.574	-0.086
Foreign Absorption	0.000	0.058	-0.005	0.073	0.748	0.839	0.124
Aggregate Participation	0.790	1.928	-0.029	0.147	0.951	2.391	2.004
Aggregate Unemployment Rate*	0.076	1.460	0.003	-0.169	-2.199	-1.268	1.266
Mismatch	0.148	0.372	-0.112	-0.166	-2.192	-2.168	0.086
Aggregate Market Tightness	0.893	-28.952	-0.081	0.561	96.271	41.981	-28.563
Job-to-Job Success Rate	0.001	-6.327	-0.056	2.636	44.537	39.006	-3.903

* The unemployment rate figures are reported in percentage points, e.g. the initial rate is 7.6% and the 60% increase in *b* increases this by 1.46 percentage point to 9.06%.

Figure 1: The effect of raising trade cost with and without labour market reform*

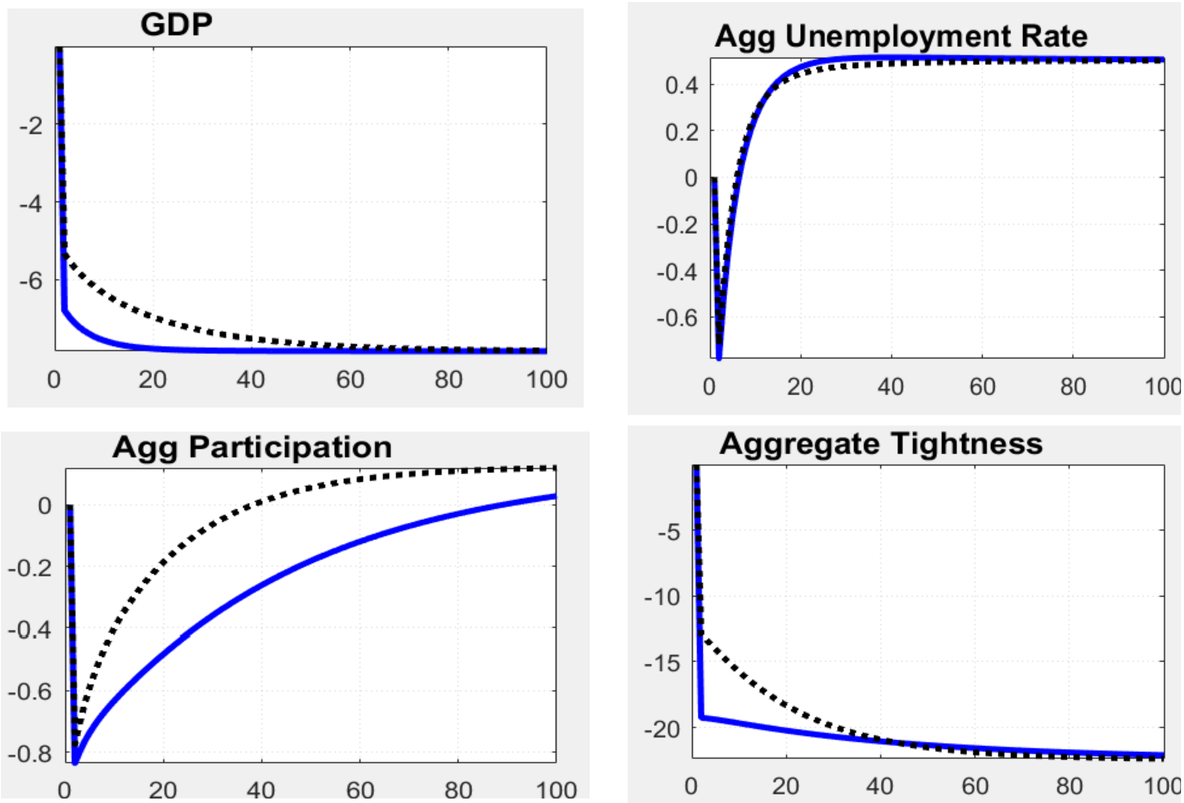


* Graphs show deviations in percentage points from the respective initial solutions.

—— Trade shock pre reform.

…… Trade shock post reform.

Figure 2: The effect of raising trade cost with and without capital mobility frictions*

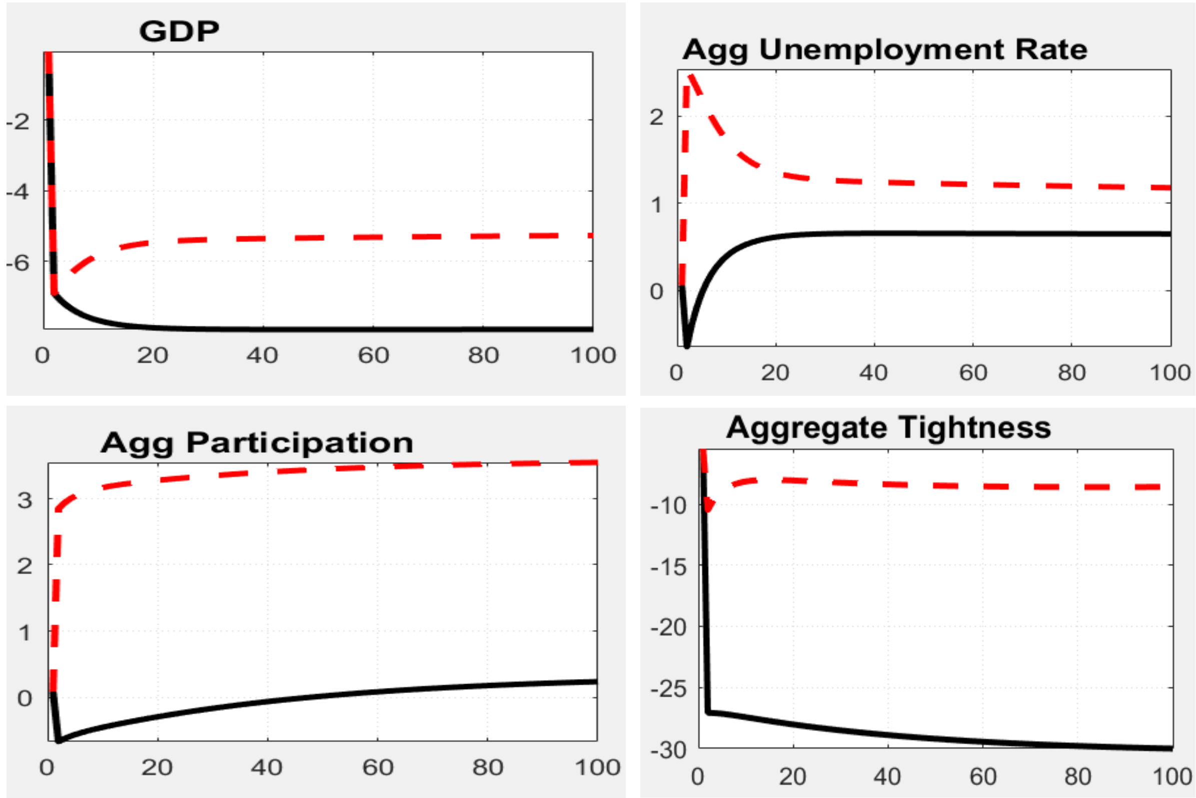


* Graphs show deviations in percentage points from the respective initial solutions.

—— Trade shock without capital mobility frictions.

······ Trade shock with capital mobility frictions.

Figure 3: The effect of raising trade cost with and without labour market reform* (model with distortionary taxation)



* Graphs show deviations in percentage points from the respective initial solutions.

——— Trade shock pre reform.

- - - Trade shock post reform.