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Abstract

In this paper, we show that the welfare implications of immigration which takes place in upturns, and may be partly reversed in downturns, are very different from the implications of immigration usually found in static models. Abstracting from any gains to capital owners and native workers due to complementarities, we find that (especially temporary) immigration may still benefit native workers in a European type of labour market where minimum wages may bind in downturns. However, in the presence of hiring costs, these effects may be reversed. Thus, promoting temporary immigration schemes may lead to adverse consequences if they also increase the costs of hiring foreign labour.

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1 Introduction

This paper considers the welfare implications for host countries of immigration that takes place in economic upturns, and which may be partly reversed in downturns.

Host countries are often reluctant to liberalise immigration flows; see, *e.g.*, Boeri and Brücker (2005) and Hatton (2007). One reason for this is that it is widely believed that workers in host countries lose on an inflow of foreign workers. A number of theoretical results support this belief. Winters *et al.* (2003) show that there are very big world wide gains from liberalising international mobility of labour, but these gains mainly go to the immigrants themselves. Capital owners in host countries also gain, but the workers in the host countries lose from liberalising migration. Similar results are found in Borjas (1999) and Boeri and Brücker (2005). Empirically, Borjas (2003) and Aydemir and Borjas (2007) also find that domestic workers on average lose from increased immigration.[1]

The analyses in Borjas (1999), Winters *et al.* (2003), Boeri and Brücker (2005) and other similar analyses are conducted in static models – or models without economic fluctuations. Our purpose is to analyse to which extent, the welfare implications of immigration are different when economies are cyclical and immigration varies over the business cycle. To our knowledge, this has not been done before, and there are at least two reasons why such an analysis is interesting. First, immigration has always been – and still very much is – a phenomenon closely related to business cycles. Already Jerome (1926) documented a close relationship between US business cycles and inflows of migrants into the US in the 19th century. But also evidence from the 20th century supports a strong relationship between job opportunities in receiving countries and the extent of immigration. A prominent example is the immigration into Western Europe in the period 1955-1973 (Zimmermann, 1995), but also the recent inflows of workers from Eastern Europe into Ireland, UK and Scandinavia have at least partly been a consequence of booming host economies.

Second, explicit temporary immigration programmes may be an alternative policy option to permanent immigration permits in host countries. Prominent examples of such programmes are the *Bracero* programme which

[1] There are a number of additional empirical studies on how immigrants affect wages and/or employment of native workers; see, *e.g.*, Card (2001), Dustmann *et al.* (2005), Pischke and Velling (1997), and Angrist and Kugler (2003). There is a lot of variation in the results but the general conclusion seems to be that immigration has small negative employment and/or wage implications for native workers; see also Longhi *et al.* (2005, 2006).

in the period 1942-64 brought temporary migrants from Mexico to the US and the *Gastarbeiter* system of 1955-73 that brought temporary migrants to Germany; see, *e.g.*, Dustmann (1996) and Hatton (2007).

In this paper, we set up a model of a small open economy with a European type of labour market (a minimum wage). Within this model, we show that the welfare implications of immigration which takes place in upturns, and may be partly reversed in downturns, are very different from the implications of immigration usually found in static models.

We assume away differences across native workers, and immigrants and native workers are assumed to be perfect substitutes. Thus, there are no gains from immigration due to complementarities between native workers and immigrants. We also leave aside any gains to capital owners by assuming perfect competition among domestic firms. Furthermore, we assume free international trade in symmetric but differentiated goods which by construction induces a negative terms-of-trade effect from immigration.

Thus, we abstract from most of the "traditional" gains from immigration that have been suggested in the literature, *i.e.* gains to capital owners and native workers due to complementarities. Still, we find that immigration may benefit native workers. The reason is two-fold: First, while immigration pushes down wages of native workers in upturns, it also raises the incentives for firms to invest in capital which in turn has positive consequences for native employment in downturns. Second, foreign workers are taxed in good states but receive unemployment benefits in bad states. While this asymmetry would typically disfavour native workers as immigrants increase unemployment relatively more than they increase employment, this effect may be reversed in the presence of return migration in downturns.

Thus, our results show that business cycles are important for understanding not only the nature of immigration (as argued already by Jerome in 1926) but also the consequences of immigration for host countries. Without business cycles, immigration would unambiguously decrease host country welfare in our model. However, large business cycles do not in themselves improve the gains from immigration. We need minimum wages, and (preferably) high return rates of immigrants in downturns to ensure a positive business cycle induced effect of immigration in our model.

One interpretation of this is that a binding minimum wage prevents the labour market from clearing in downturns. Immigration may help alleviating this inefficiency. Although a substantial part of the gain goes to the immigrants themselves, the improvement in efficiency may be sufficiently high that native workers become better off. Seen in this perspective, our paper is related to Borjas (2001) who illustrates that immigration may "grease the wheels of the labour market" if there are rigidities in the responsiveness of the native labour supply to differences in wages across local areas. The idea in Borjas (2001) is that workers face mobility costs if they are to move from one local area to another. This implies that native workers are not sufficiently mobile to even out regional differences in wages. New immigrants, on the other hand, constitute a self-selected group of individuals who have decided to "pay" the mobility cost associated with immigration but are then free to settle in any area of the host country. Their choice of locality is, therefore, very sensitive to local wage differences. As Borjas (2001) shows, this may improve efficiency in the allocation of workers across local areas compared to the situation without immigration. Our model shows that immigration may also improve efficiency if the allocation of native workers across time periods (the business cycle) is inefficient.

Hiring foreign labour is likely to be associated with additional expenses such as extra search costs or costs of applying for a permission to use foreign labour. Obviously, such hiring costs may completely eliminate immigration if they are sufficiently high. We show that moderate hiring costs typically dampen the welfare consequences of immigration for native workers. More surprisingly, we also show that in some cases, hiring costs may completely reverse any positive consequences associated with immigration causing the situation with hiring costs to be worse than both the "no immigration" and the "free immigration" scenarios. The reason for this somewhat counterintuitive result is that hiring costs of immigrants invoke an option value in the employment of immigrant workers. With hiring costs and business cycles, it may become optimal to keep the (less productive) immigrants in downturns, thereby increasing the likelihood of native workers being laid off.

An interesting policy implication of this is that while temporary immigration schemes may work to increase the benefits to native workers of immigration by fostering more return migration in downturns, they may have the exact opposite consequences if they also increase the costs associated with hiring immigrants. This could, for example, happen if they are constructed in a way which burdens employers with the extra tasks of getting the required permissions.

The rest of the paper is structured as follows. In Section 2, we set up the model. The model is solved and results are presented in Section 3. Section 4 concludes. An Appendix with analytical details of the solution and proofs of propositions is attached at the end.

2 The Model

We consider a model of a small open economy (the home country), which interacts with the rest of the world in both goods and labour markets. Specifically, we assume that there is free international trade in n final goods which are imperfect substitutes in consumption. The home country (country i) produces only one of the n goods (good i), and this good is produced exclusively in the home country. Furthermore, the home country can allow immigrants to enter the domestic labour market. The model is of a partial equilibrium nature, as we model the equilibrium in the home country taking as given the world demand for goods, which varies over the business cycle, and the world supply of labour (potential immigrants).

We assume that there is perfect competition among the firms in the home country. Firms can either recruit from the domestic labour market or – if allowed to – from a low-wage foreign labour market (immigrants). At the domestic labour market, there is an exogenous (competitive) supply of native labour, but there is also a minimum wage. At the foreign labour market, the domestic firms face an infinite supply of labour, which is, however, less productive than domestic labour due to assimilation costs, language barriers, etc.; see, *e.g.*, Dustmann (1999).[2] Although foreigners (immigrants) are willing to supply labour at a very low wage, firms cannot pay less than the going minimum wage in the home country. Furthermore, the employment of foreigners may be associated with a hiring cost.

The public sector taxes wage income to finance benefits to unemployed natives and immigrants in the home country.

2.1 Consumers

Utility of the representative consumer in country i (the home country) is given by:[3]

$$EU = E\left(\sum_{t=0}^{\infty} (1+\delta)^{-t} u_t\right) \tag{1}$$

[2]Since our focus is on immigration resulting from firms hiring foreign labour in upturns where domestic labour is expensive, it seems natural to assume that these immigrants are less productive than natives – otherwise firms would also hire them in downturns. In practice some firms would hire some immigrants in downturns due to, *e.g.*, complementarities, but this is not the type of immigration we want to focus on in this paper.

[3]Note that we often suppress the subscript i to simplify notation in what follows.

where δ is the discount rate and u_t is the instantaneous utility function which is assumed to be of the CES form:

$$u_t = n^{\frac{1}{1-\xi}} \left(\sum_{j=1}^{n} c_{jt}^{\frac{\xi-1}{\xi}} \right)^{\frac{\xi}{\xi-1}} \tag{2}$$

where c_{jt} is consumption of good j in period t in the home country.

Maximising utility subject to an intertemporal budget constraint results in the following consumption of good j in period t in the home country:

$$c_{jt} = \left(\frac{p_{jt}}{P_t} \right)^{-\xi} \frac{1}{n} \left(\frac{C_t}{P_t} \right) \tag{3}$$

where C_t is the (nominal) amount spent on consumption in period t, and P_t is the cost of living index given by:

$$P_t = \left(\frac{1}{n} \sum_{j=1}^{n} p_{jt}^{1-\xi} \right)^{\frac{1}{1-\xi}} \tag{4}$$

Normalising this index to one, $P_t = 1$, consumption of good j by the representative consumer in the home country is given by:

$$c_{jt} = p_{jt}^{-\xi} \frac{1}{n} C_t \tag{5}$$

where C_t is now the nominal and real amount spent on consumption in period t.

As a consequence, instantaneous utility in (2) reduces to $u_t = C_t$ and overall utility of the representative consumer is simply given as the expected sum of discounted consumption expenditures:

$$EU = E \left(\sum_{t=0}^{\infty} (1+\delta)^{-t} C_t \right) \tag{6}$$

To simplify the dynamics, we assume that the discount rate, δ, is equal to the real rate of interest, r, in which case the indirect utility function is simply given by the sum of discounted expected real net income:

$$EU = \sum_{t=0}^{\infty} (1+r)^{-t} E \left(NI_t \right) \tag{7}$$

where NI_t is the real net (after tax) income of the representative consumer in period t in the home country.

2.2 Firms

World demand varies over the business cycle. Specifically, in period t, the demand for good i (the good produced by the home country) is given by:

$$d_{it} = p_{it}^{-\xi} Z_t^{\xi} \qquad or \qquad p_{it} = Z_t d_{it}^{-\theta} \tag{8}$$

where $\theta = 1/\xi$ and Z_t is a state variable which follows a two-state Markov process. There is a good state, where $Z_t = Z_G$, that persists with probability P_G, and a bad state, where $Z_t = Z_B < Z_G$, that persists with probability P_B.[4]

The representative firm in the home country produces according to a Cobb-Douglas production function:

$$y_t = l_t^{1-\alpha} k_t^{\alpha} \tag{9}$$

where y_t is output, l_t is labour input, and k_t is capital used in period t. With CRTS and perfect competition we can focus on one representative firm.

Effective labour input is given as:

$$l_t = l_t^n + a l_t^f, \qquad 0 < a < 1, \tag{10}$$

where l_t^n is the employment of natives, and l_t^f is the employment of foreigners (immigrants). Thus, we assume natives and immigrants to be perfect substitutes, but a reflects that the productivity (effective labour) of foreigners is lower than that of natives.

Given the level of capital, variable profits (excluding hiring costs) are given by:

$$\pi_t = p_{it} y_t - w_t^n l_t^n - w_t^f l_t^f \tag{11}$$

where w_t^n (w_t^f) is the wage of natives (foreigners) in period t.

Taking all prices as given, the representative firm maximises the expected discounted cash flow:

$$v_0 = E\left(\sum_{t=0}^{\infty} (1+r)^{-t} (\pi_t - \phi_t - h_t) \right) \tag{12}$$

with respect to labour and capital, where ϕ_t is the investment cost in period t and h_t is hiring costs of foreign labour in period t.

To simplify the model, we assume away any exogenous separations between firms and workers and no depreciation of capital. If we further assume

[4] Note that this demand function is consistent with CES preferences over the n goods when $Z_t = \left(\frac{D_t}{n}\right)^{1/\xi}$, where D_t is total world wide expenditures on consumption in period t.

that the initial period is a period of high demand, Z_G, there will only be investments in the initial period.[5] This implies that the capital costs are given as:

$$\phi_0 = \phi \cdot k_0, \qquad \phi_t = 0 \quad for \quad t > 0 \tag{13}$$

and $k_t = k_0$ for all $t > 0$. Thus, (12) can be written as:

$$v_0 = E\left(\sum_{t=0}^{\infty} (1+r)^{-t} (\pi_t - h_t)\right) - \phi k_0 \tag{14}$$

Since all future (non-investment) good states become identical, and all future bad states become identical, the values of the representative firm in future good and bad states are:

$$\begin{aligned} v_G &= \pi_G + \tfrac{1}{1+r}\left(P_G v_G + (1-P_G) v_B\right) \\ v_B &= \pi_B + \tfrac{1}{1+r}\left(P_B v_B + (1-P_B)\left(v_G - h \cdot (l_G^f - l_B^f)\right)\right) \end{aligned} \tag{15}$$

where h is the unit cost of hiring foreign workers, and we have used that $l_G^f \geq l_B^f$, *i.e.* (additional) foreign labour is only hired when entering an upturn.

Solving for v_G and v_B from (15), we get:

$$v_B = \frac{1}{N}\Big[(1+r)(1+r-P_G)\pi_B + (1+r)(1-P_B)\pi_G - (1-P_B)\, h(l_G^f - l_B^f)\Big] \tag{16}$$

$$v_G = \frac{1}{N}\Big[(1+r)(1+r-P_B)\pi_G + (1+r)(1-P_G)\pi_B - (1-P_G)(1-P_B)\, h(l_G^f - l_B^f)\Big] \tag{17}$$

where

$$N = (1+r-P_G)(1+r-P_B) - (1-P_G)(1-P_B) \tag{18}$$

Since the firm enters the market and invests in a good state (the initial period), the value of the firm in the investment period is given as:

$$v_0 = v_G - h \cdot l_G^f - \phi k_0 = 0 \tag{19}$$

where the last equality follows from the free entry of firms in equilibrium. This last condition implicitly determines the aggregate capital stock, k_0, which can be interpreted as the number (or size) of firms in the economy.

[5]Note that it would not make any important difference if we assumed that the first period was a period of low demand. In that case, the solution would be slightly different in the first periods, but from the first time a period of high demand was encountered, the solution would be as the one we find above.

2.3 The Labour Market

The supply of labour by domestic workers in each period is given as $\bar{L}^n$, which is assumed to be constant. The number of unemployed natives in period t is thus given as $u_t^n = \bar{L}^n - l_t^n$.

In upturns, the number of foreign workers present in the home country equals the number of foreign workers employed, l_n^f.[6] In downturns, the share ρ of the workers who are fired are assumed to return to their home countries. This parameter is exogenous, but in practice, it may depend on the exact formulation of a guest worker programme. It is, however, beyond the scope of the present paper to model the forces determining return migration – see Dustmann (1996) for examples of this.

The wages of natives and foreigners can differ in equilibrium, but both wages have to respect a minimum wage, $\bar{w}$. For simplicity, we assume that the minimum wage is fixed, *i.e.* it is the same in downturns and upturns, and it is independent of the labour mobility regimes considered below. This need not be the case in practice, but in order to compare the implications of different policy regimes, it seems natural to compare the implications of different policies in one dimension (labour mobility) – given the policy in other dimensions (the minimum wage). We are also going to assume that the wage rate at the foreign labour market is (much) lower than the minimum wage. Therefore, foreigners always prefer to work at the minimum wage in the home country compared to the wage in their own country, *i.e.* there is an infinite supply of foreign workers at the minimum wage. As a consequence, foreigners always receive the minimum wage when employed by domestic firms: $w_t^f = \bar{w}$, $t = G, B$.

2.4 The Public Budget

We assume that the public sector collects revenue by levying an income tax, t, on all employed workers, and for simplicity we assume that public expenditures solely consist of unemployment benefits, b, paid out to unemployed natives and foreigners. The model can easily be extended to include "other government expenditures" as well. As far as these "expenditures" are proportional to the population size, there will only be minor changes in our results. On the other hand, if the expenditures are independent of the size

[6] One way to ensure this is if all foreign workers who are not employed in subsequent upturns must return to their home countries. Alternatively, we can assume that the cost of hiring foreign workers who are already in the country is marginally lower than the costs of bringing new foreigners to the country. This will imply that all foreign workers present in the country will be employed first whenever the economy enters an upturn.

of the population ($i.e.$ "fixed costs"), there will be an increase in the gains from immigration as this implies that the expenditures per person decrease.

With respect to the public budget, we assume that it should balance initially. In other words, the expected present value of future budgets should be zero initially. Furthermore, we do not allow t to vary across periods.[7] As there will only be unemployed foreigners in downturns, this implies:

$$\Omega_G t\left(l_G^n w_G^n + l_G^f w_G^f\right) + \Omega_B t\left(l_B^n w_B^n + l_B^f w_B^f\right) = \Omega_G b u_G^n + \Omega_B b(u_B^n + u_B^f) \quad (20)$$

where:

$$\Omega_G = \frac{1+r-P_B}{1-P_G+1+r-P_B} \quad (21)$$

and:

$$\Omega_B = \frac{1-P_G}{1-P_G+1+r-P_B} \quad (22)$$

Ω_G and Ω_B are the time discounted long-run proportions of good and bad states, respectively. As b is exogenous, t is endogenously determined as:

$$t = \frac{\Omega_G b u_G^n + \Omega_B b(u_B^n + u_B^f)}{\Omega_G\left(l_G^n w_G^n + l_G^f w_G^f\right) + \Omega_B\left(l_B^n w_B^n + l_B^f w_B^f\right)} \quad (23)$$

2.5 Welfare

Since we are going to evaluate the implications of foreign labour flowing into the home labour market, we will only consider the welfare of natives. As in the case of firms, since there are only two possible states, the indirect utility (the value function) of the representative individual can be written as:

$$EU = \frac{1}{N}\left[(1+r)(1+r-P_B)E(NI_G) + (1+r)(1-P_G)E(NI_B)\right] \quad (24)$$

As profits are driven to zero by free entry, the expected net income of the representative individual is a weighted sum of wage income and unemployment benefits:

$$E(NI_t) = \left((1-t)w_t^n \frac{l_t^n}{\bar{L}^n} + b\frac{u_t^n}{\bar{L}^n}\right) \quad (25)$$

where $l_t^n/\bar{L}^n$ and $u_t^n/\bar{L}^n$ are the proportions of employed and unemployed natives, respectively.

[7] An alternative would be to assume that the expected present value of future public budgets should always balance. The disadvantage of assuming this is that tax rates are then going to vary over the business cycle with relatively low tax rates in upturns and relatively high tax rates in downturns. While technically more cumbersome, this alternative would not lead to qualitatively different results.

3 Results

In this section, we present the results of the model. We are going to consider three versions of the model. First, the "no immigration" regime where immigration is prohibited. Alternatively, we can think of this as a case where hiring costs are very (infinitely) high, $h = \infty$. Second, we consider a "free immigration" regime where hiring costs are absent, $h = 0$. Finally, we consider the case where hiring costs are positive but finite, $0 < h < \infty$. We shall refer to this as the "hiring cost" regime.

Below, we first give the general flavour of how the model is solved while we relegate most of the analytical details to the Appendix. Then we consider the implications of opening up the economy to immigration when there are no costs associated with hiring foreign workers. That is, we compare the cases of "no immigration" and "free immigration". Finally, in the last subsection, we consider how the results change in the presence of hiring costs.

3.1 Solving the Model

In solving the model, we first need to determine the firms' demand for effective labour. Firms are competitive and labour is supplied inelastically by domestic workers who are more productive than immigrants and who can be fired and hired without costs. Hence, the wage of native workers, w_t^n, will always equal the prevailing market price of effective labour. This implies that the demand for effective labour in each period can be found by maximising the profit function in (11) with respect to effective labour, l_t, given the cost of effective labour, w_t^n, the price of output, p_{it}, and the capital stock, k_t. This results in:

$$l_t = \left[\frac{w_t^n}{(1-\alpha)\, p_{it}}\right]^{-\frac{1}{\alpha}} k_t, \quad t = G, B \tag{26}$$

Firm supply can then also be written as a function of the prevailing wage of native labour, the price of output and the capital stock:

$$y_t = k_t \left(\frac{w_t^n}{(1-\alpha)\, p_{it}}\right)^{-\frac{1-\alpha}{\alpha}}, \quad t = G, B \tag{27}$$

Setting the supply in (27) equal to the demand from (8), we can express the production, y_t, and the output price, p_{it}, as functions of the wage of native labour and the capital stock:

$$p_{it} = \left[Z_t^{\alpha} k_0^{-\alpha\theta} \left(w_t^n\right)^{\theta(1-\alpha)} (1-\alpha)^{-\theta(1-\alpha)}\right]^{\frac{1}{1-\beta}}, \quad t = G, B \tag{28}$$

and:

$$y_t = \left[Z_t^{1-\alpha} k_0^{\alpha} \left(w_t^n\right)^{-(1-\alpha)} (1-\alpha)^{(1-\alpha)} \right]^{\frac{1}{1-\beta}}, \quad t = G, B \tag{29}$$

where $\beta = (1-\alpha)(1-\theta)$ and we have used that $k_t = k_0$. The resulting demand for effective labour in each period as a function of the wage of native labour and the capital stock is then given by inserting (28) into (26):

$$l_t = \left(\frac{w_t^n}{(1-\alpha) Z_t k_0^{\alpha(1-\theta)}} \right)^{\frac{1}{\beta-1}}, \quad t = G, B \tag{30}$$

The second step is then to find the equilibrium in the labour market in each period. Here we use that labour is supplied inelastically, but that the equilibrium should respect the minimum wage. The equilibrium will, of course, depend on the regime considered ("no immigration", "free immigration" or "hiring costs"). Furthermore, in each regime we must distinguish between a number of outcomes depending on when and where the minimum wage binds.[8]

Finally, in the third step, we insert the resulting equilibrium values of wages and labour in the zero-profit condition from (19) to solve for the capital stock, k_0. Details of the solutions can be found in the Appendix. In the following, we focus on the central results.

3.2 Free Immigration versus No Immigration

In this section, we consider the consequences of opening up the economy to immigration when hiring costs are absent, $h = 0$. Subscripts "no" and "free" are used to indicate equilibrium values under "no immigration" and "free immigration", respectively.

Intuitively, immigrants will only be hired by domestic firms under "free immigration" if the effective cost of foreign labour, $\bar{w}/a$, is lower than the prevailing wage of native workers in good states under "no immigration", $w_{G,no}^n$. As shown in the appendix, this condition is equivalent to:

$$\frac{\bar{w}}{a} < (1-\alpha) Z_G \left(\bar{L}^n\right)^{\beta-1} k_{0,no}^{\alpha(1-\theta)} \tag{31}$$

[8]For example, in the "no immigration" scenario, we must distinguish between three possible outcomes: (1) where the minimum wage does not bind in any of the states; (2) where the minimum wage binds only in bad states; and (3) where the minimum wage binds in both states. In the "free immigration" scenario, we get even more possible outcomes as the total demand for effective labour must now be divided across foreign and native workers. See Appendix for details.

where $k_{0,no}$ is the capital level under "no immigration". In the remainder of this section, we shall assume that the condition in (31) is satisfied. If not, the outcome under "free immigration" will simply be identical to the outcome under "no immigration".

In general, the effect of immigration on welfare is ambiguous in our model. Proposition 1 gives the precise condition for getting a welfare gain from immigration:

Proposition 1 *With $h = 0$, the welfare gain from opening up the economy to immigration is positive if and only if:*

$$\frac{(1+r-P_B)}{1-P_G}\left(\frac{\bar{w}}{a}-w^n_{G,no}\right)\bar{L}^n+\left(l^n_{B,free}w^n_{B,free}-l^n_{B,no}w^n_{B,no}\right)+$$
$$t_{free}\bar{w}\left[l^f_{B,free}+\frac{(1+r-P_B)}{1-P_G}l^f_{G,free}\right]-b\left(1-\rho\right)\left(l^f_{G,free}-l^f_{B,free}\right)>0 \quad (32)$$

provided that immigration will take place, i.e. (31) is satisfied.

Proof. See Appendix A.1. ■

To understand why immigration may increase native welfare, it is instructive to consider each of the terms on the left hand side in (32) in turn. The first term expresses the loss in native wages in good states from an immigrant inflow.[9] Immigrants will push down native wages in good states to the effective cost of foreign labour, $\bar{w}/a$. Thus, this term is always negative given that an inflow will occur.

However, firms also invest more as a consequence of the increased labour supply. These investments in turn implies that the capacity of the economy, and therefore the marginal productivity of labour, is higher in downturns. This may have positive consequences for native workers. If a binding minimum wage is causing unemployment in bad states in the "no immigration" regime, allowing for immigration will push up native employment in bad states. Since native workers are more productive than foreign workers, firms will prefer natives in a bad state where the minimum wage is binding. This effect – which is captured by the second term in (32) – has not been considered previously in the literature as it only arises in a model where business cycles are explicitly taken into account.

However, if minimum wages are not binding in bad states in the "no immigration" regime, immigration may also push down wages in bad states

[9]The factor $(1-r-P_B)/(1-P_G)$ expresses the weight of good states relative to bad states.

causing a negative wage effect in both states. Hence, the second term in (32) can be either negative or positive, depending on the level of the minimum wage.[10]

The third and fourth terms in (32) represent the fiscal effects. The third term captures the taxes paid by foreign workers in good and bad states. This term is always positive, although the contribution from foreigners in bad states is only positive if they are employed in bad states, *i.e.* if $l^f_{B,free} > 0$. Finally, the fourth term is the fiscal loss from paying benefits to unemployed foreigners in bad states. This term is always negative but depends on the return rate of immigrants, ρ.[11]

With a low return rate, the total fiscal effect of immigration is negative as it increases unemployment in bad states relatively more than it increases employment in good states. In this case, the sum of the third and fourth terms in (32) will always be negative. However, with a sufficiently high return rate, this asymmetric effect is reversed causing employment (and hence tax income) in good states to increase relatively more than unemployment (and hence public expenditures) in bad states. However, depending on parameter values, we can still have a positive overall welfare effect even with a return rate of zero.

In sum, assuming that the minimum wage binds for native workers in bad states, Proposition 1 states that native welfare increases if the value of the higher native employment in bad states plus the tax income from foreigners in good states exceed the value of the lower native wage in good states plus the value of benefits paid to foreigners in bad states. Thus, contrary to the classical labour market model of immigration, the net effect on welfare in our model can be positive – even without taking the fiscal consequences – the third and fourth terms in (32) – into account.

To illustrate these points, columns 1 and 2 of Table 1 contain a numerical example of the effects of opening up for immigration when the minimum wage is binding in downturns.[12] In the example shown, the minimum wage equals 1.22 which is also the wage paid to native workers in downturns both before and after immigration. In the lower part of the Table, we have illustrated the

[10] In fact, there is also a third (and more subtle) possibility, namely that wages of natives go up in bad states. This happens if the minimum wage is not binding but still high enough to prevent employment of foreigners in bad states. See Appendix A.3 for details.

[11] Note that only tax payments from foreigners affect the welfare condition in Proposition 1. Redistribution among native tax payers and native unemployed does not affect welfare. Furthermore, labour supply is assumed to be insensitive to the tax system.

[12] The parameter values used are: $\theta = 0.1$, $r = 0.03$, $Z_G = 1.1$, $Z_B = 0.9$, $P_G = P_B = 0.7$, $\alpha = 0.3$, $a = 0.9$, $\phi = 2$, $\bar{L}_n = 1$, $\rho = \{0, 0.8, 0.95\}$, $b = \{0, 0.7\}$, and $\bar{w} = 1.22$ (columns 1 and 2) and $\bar{w} = 1.04$ (columns 3 and 4).

welfare gains for different values of the benefit level, b, and the return rate, ρ. With $b = 0$, there are no fiscal effects, and the welfare gain is in this case positive (1.32%) and independent of the return rate, ρ. At a benefit level of $b = 0.7$, on the other hand, welfare decreases at low levels of the return rate while it increases at higher levels. Note also that the increase in welfare when $\rho = 0.95$ is higher than the increase in welfare without a fiscal effect ($b = 0$), which illustrates that the fiscal gain can be positive in itself at high return rates.

Table 1: Numerical Examples of Opening Up for Immigration

	$\bar{w} = 1.22$		$\bar{w} = 1.04$	
	(1)	(2)	(3)	(4)
	"no imm"	"free imm"	"no imm"	"free imm"
w_G^n	1.388	1.356	1.414	1.156
w_B^n	1.220	1.220	1.157	1.156
u_B^n	17.6%	11.9%	0%	0%
ΔEU $(b = 0)$	1.32%		-10.55%	
ΔEU $(b = 0.7, \rho = 0)$	-2.42%		-25.54%	
ΔEU $(b = 0.7, \rho = 0.8)$	0.77%		-13.55%	
ΔEU $(b = 0.7, \rho = 0.95)$	1.36%		-11.30%	

Note: Remaining parameter values are given in footnote 12.

It follows from the discussion of Proposition 1 that business cycles affect the potential welfare gains to be realised from immigration. The reason is that the benefits to the natives from immigration in good states mainly materialise in bad states. First, there is lower unemployment of natives in bad states. Second, the taxation of immigrants in good states may contribute to finance the unemployment benefits to natives in bad states.

In a static version of this model economy (*i.e.* one where $Z_G = Z_B$), the wage of native workers would simply be pushed down to the effective cost of foreign labour, $\bar{w}/a$, whenever immigration occurs. This effect is reminiscent of the classical labour market effect of immigration which the empirical literature has focussed on; see, *e.g.*, Borjas (2003) and Aydemir and Borjas (2007). Furthermore, this negative effect would not be counteracted by a gain to capital owners due to perfect competition among firms, and there would be no fiscal gain as we cannot both have unemployed natives and immigration in the static economy.

Similarly, if the economy is sufficiently flexible (*i.e.* no or low minimum wages), the effects of opening up the economy to immigration are also negative. This is illustrated in columns 3 and 4 of Table 4 above where the minimum wage is so low that immigration pushes down native wages in both good and bad states. This results in a (large) negative effect of immigration, which can be made smaller, but not positive by low benefit levels and/or high return rates.[13]

Thus, in order to achieve a welfare gain from immigration a combination of business cycles and minimum wages is required. Otherwise, immigration solely reduces the marginal product of labour in at least one state without having counteracting (positive) effects in the other state.

Another way to think of this is that the minimum wage creates an inefficient allocation of native labour over the business cycle with unemployment in downturns but full employment and relatively high wages in upturns. Immigration may help address this inefficiency by providing a better match between demand and supply of labour. In this sense, there is some similarity between the effects from immigration illustrated here and the "immigration greasing the wheels of the labour market" argument in Borjas (2001). In Borjas (2001), there is an inefficient allocation of native workers across local areas due to high mobility costs. Immigration may diminish this efficiency loss, since immigrants prefer to settle in areas where wages are relatively high.

3.3 Hiring Costs

Above, we assumed that firms were able to hire foreign labour at no extra cost compared to native workers. In the following, we consider how the results change when the hiring of immigrants is associated with some cost, $h > 0$. Besides being a more realistic scenario as the hiring of foreign labour is likely to be associated with additional expenses, h may also reflect politically induced costs such as the cost of applying for a permission to use foreign labour.

Thus, the case with hiring costs may be interpreted as a situation with public intervention to prevent free immigration. For example, a potential policy implication of the previous section was to promote temporary immigration schemes. One possible way of doing this is to condition residence permits on employment. This may result in increased hiring costs by, *e.g.*, burdening employers (explicitly or implicitly) with the extra task of getting the required permissions.

A substantial hiring cost may, of course, block immigration completely, yielding the same outcome as in the "no immigration" scenario above. Under

[13]Note that the fiscal effect can never be positive in this case, as this requires unemployment of native workers.

some circumstances, however, the introduction of even a small hiring cost may also effectively block immigration as stated in the following Proposition.

Proposition 2 *With hiring costs, $h > 0$, and if foreigners can move freely (or just at a lower cost than h) to another firm after immigration, there will be no immigration.*

The result in Proposition 2 follows from the fact that a firm which initially employs a foreign worker has to pay the hiring cost, h. A firm will only do so if it is able to pay the foreign worker a wage sufficiently below his or her productivity. If other firms are able to employ ("poach") the foreign worker without paying the full hiring cost, this will not be possible. Hence, there will be no hiring of foreign workers in the first place.

As a consequence, in the following, we consider the case where hiring costs are not high enough to block immigration completely and where poaching of workers by rival firms is not possible. In other words, if a firm in the host country employs a foreign worker, it has to pay the same hiring cost irrespectively of whether the foreign worker is already in the country or not.[14]

Intuitively, the introduction of a hiring cost then increases the effective cost of foreign labour, which under free immigration was $\bar{w}/a$. This in turn limits immigration in good states and hence the negative wage consequences for native workers who no longer see their wages pushed all the way down to $\bar{w}/a$. It also reduces investments in capital compared to the "free immigration" scenario and hence also limit the potentially positive consequences for natives in bad states. Similarly, due to the smaller inflow of foreigners, the fiscal effects also become smaller. Altogether, the introduction of a hiring cost will thus diminish the welfare effects of opening up for immigration.

However, as shown in the Appendix, there is also another possibility. The presence of hiring costs may completely reverse the welfare consequences of opening up for immigration as stated in Proposition 3 below, where the subscript "hc" indicates the hiring cost regime ($h > 0$).

Proposition 3 *Welfare effects of immigration with hiring costs:*

1. *There exist a h_1 and values of the other parameters such that $EU_{no} > EU_{hc}(h_1) > EU_{free}$*

2. *There exist a h_2 and values of the other parameters such that $EU_{free} > EU_{hc}(h_2) > EU_{no}$*

[14] Alternatively, one can assume that firms can attempt poaching at some cost, but that the outcome of the poaching is uncertain.

3. *There exist a h_3 and values of the other parameters such that $EU_{free} > EU_{no} > EU_{hc}(h_3)$*

4. *There exist a h_4 and values of the other parameters such that $EU_{no} > EU_{free} > EU_{hc}(h_4)$*

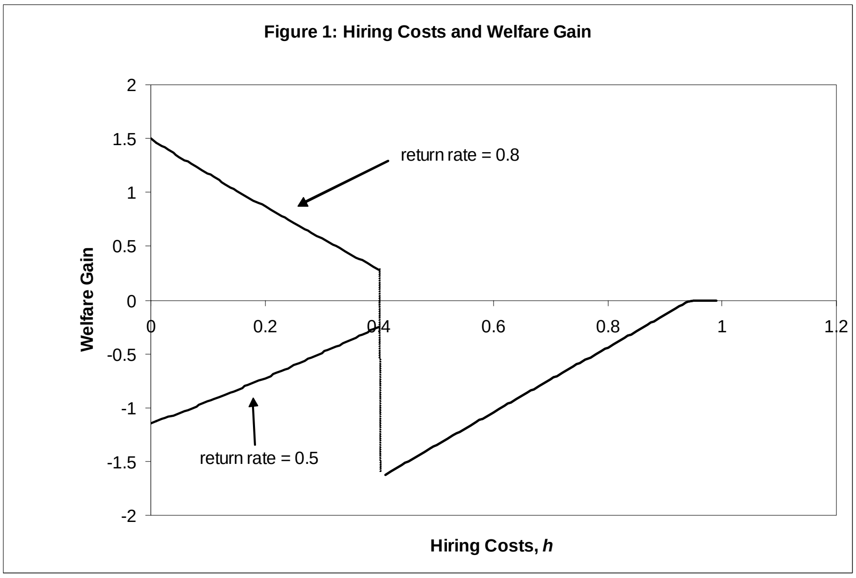
Proof. See Appendix A.4 and examples below. ■

Cases 1 and 2 are the expected intermediate outcomes. By making foreign labour more expensive, hiring costs give us a welfare outcome in between that of "free immigration" and "no immigration". Thus, if welfare under "no immigration" is higher than under "free immigration", hiring costs can reduce some of the loss by restricting immigration (Case 1). Similarly, if welfare is higher under "free immigration", hiring costs reduce some of this gain (Case 2).

Cases 3 and 4 are more surprising – namely that the presence of hiring costs can be worse than both the case of "free immigration" and "no immigration". To see why such situations may arise, we must acknowledge that hiring costs introduce an option value into the model. The presence of hiring costs create an interdependency between the two periods. As firing costs are incurred every time a foreign worker is hired, it may be optimal to keep these workers during downturns in order to save the hiring cost when returning to a good state. This may be optimal, even though the foreign workers are less productive than native workers and have to be paid the same (minimum) wage.

Figure 1 shows two numerical examples of the welfare gain of opening up for immigration as a function of the hiring cost, h.[15] In one of the examples, the welfare gain is initially positive but decreasing in h. In the other case, it is initially negative but increasing in h. This illustrates Cases 1 and 2 of Proposition 3. However, as h reaches a certain level (0.4 in this case), it becomes optimal to keep the foreign workers instead of native workers in downturns. This causes the welfare gain to drop dramatically in both cases, illustrating Cases 3 and 4 from Proposition 3.

[15] The parameter values used are: $\theta = 0.1$, $r = 0.03$, $Z_G = 1.2$, $Z_B = 0.8$, $P_G = P_B = 0.7$, $\alpha = 0.3$, $a = 0.9$, $\phi = 2$, $\bar{L}_n = 1$, $b = 0.7$, $\bar{w} = 1.18$, $\rho = 0.8$ (the upper line) and $\rho = 0.5$ (the lower line).



The change in behaviour by firms happens when the hiring costs become sufficiently high to make it worthwhile for firms to keep the foreign labour instead of the native labour in downturns. The exact condition for this is stated in the following Proposition.

Proposition 4 *If parameter values are such that foreigners are hired in good states and the minimum wage binds for native workers in bad states, the condition for foreign workers crowding out native workers in bad states is:*

$$\bar{w}\,(1-a) > \frac{(1-P_B)\,h}{1+r} \tag{33}$$

Proof. See Appendix A.4. ■

Intuitively, if the extra cost of using a unit of foreign labour in a bad state, which is $\bar{w}\,(1-a)$, is less than the expected discounted hiring cost next period, $(1-P_B)\,h/\,(1+r)$, firms will keep all their foreign labour when they enter a bad state.

In sum, while hiring costs in general dampen the effects of immigration by making foreign labour more expensive, we have shown that in some cases, they may induce an "adverse" effect by creating an option value of keeping the immigrants employed. In that case, the hiring costs may create a regime inferior to both the "no immigration" and the "free immigration" regimes.

In the previous section, we showed that one way to increase the gains from immigration was to promote a temporary immigration scheme. The present section has shown that if the implementation of such a scheme gives rise to increased hiring costs for domestic firms, *e.g.*, by resulting in more paper work for the firms when hiring immigrants, the consequences may become opposite to those intended. Hence, the overall policy implication is that temporary migration schemes can increase host country welfare *provide*d that they do not raise the hiring costs faced by the host country firms.

4 Conclusion

Although it is an empirical fact that immigration often takes place in upturns, no papers have previously considered how that affects the consequences of immigration. In this paper, we have shown that such immigration may in fact benefit native workers – even if it puts downward pressure on wages to native workers in upturns. There are two reasons for this. First, with immigration, firms invest more as they have access to more and cheaper labour in upturns. This increases the capacity of the economy – also in downturns – and, therefore, the unemployment of natives in downturns will be lower. Second, the incomes earned by immigrants in upturns are taxed, and these taxes are used to finance public expenses such as unemployment benefits to natives in downturns. For these effects to dominate the negative effects of immigration, we need a combination of business cycles and minimum wages, preferably coupled with high return rates of immigrants in downturns. Hence, a potential policy implication of this could be that host countries should seek to promote temporary immigration schemes.

No immigration and free immigration are two "extreme" cases. We also considered the intermediate case where firms can only hire foreign workers at a cost. We showed that this typically dampens the consequences of immigration. However, it also introduces an option value into the model which may cause firms to hang on to their foreign workers – instead of their native workers – in downturns if hiring costs are substantial. In that case, hiring costs may produce an outcome inferior to both the "free immigration" and the "no immigration" regimes. This is particularly interesting as the case with hiring costs may be interpreted as a politically induced situation, *e.g.*, by requiring residence permits for foreign workers. It also qualifies the first policy implication that host countries should seek to promote temporary immigration schemes. To be sure that this will benefit native workers such schemes must not give rise to extra costs for the host country firms.

A Appendix

In Section A.1 below, we provide a proof of Proposition 1 from Section 3.2 in the paper. Sections A.2 and A.3 provide detailed analytical solutions for the "no immigration" regime and the "free immigration" regime, respectively. These analytical solutions are used for constructing the numerical examples used in Section 3.2. Finally, Section A.4. contains the analytical details of the "hiring cost" regime considered in Section 3.3, including a proof of the propositions in that section.

A.1 Proof of Proposition 1

First, it follows from the labour demand function in (30) that the equilibrium wage to native workers in good states under "no immigration" is given by:

$$w_{t,no}^{n} = \max\left(\bar{w},\ \left(\bar{L}^{n}\right)^{\beta-1}(1-\alpha)\, Z_t k_{0,no}^{\alpha(1-\theta)}\right) \tag{34}$$

where $k_{0,no}$ is the equilibrium capital level under "no immigration". Now, the effective cost of foreign workers is always $\bar{w}/a$. It then follows that foreign workers will be employed (and immigration therefore occur) if and only if:

$$\frac{\bar{w}}{a} < (1-\alpha)\, Z_G \left(\bar{L}^{n}\right)^{\beta-1} k_{0,no}^{\alpha(1-\theta)} \tag{35}$$

as $Z_G \geq Z_B$. This proves the condition in (31).

Second, assuming that (35) holds, natives will never be unemployed in good states, $u_{G,no}^{n} = u_{G,free}^{n} = 0$ and $l_{G,no}^{n} = l_{G,free}^{n} = \bar{L}^{n}$. Furthermore, the wages of natives in good states under "free immigration" will be pushed down to the effective cost of foreign labour, $\bar{w}_{G,free}^{n} = \bar{w}/a$, while foreign labour will always be paid the minimum wage, $w_{G,free}^{f} = w_{B,free}^{f} = \bar{w}$. We can then use (24) and (25) to write the welfare gain from "free immigration" as:

$$\begin{aligned} EU_{free} - EU_{no} = \frac{(1+r)}{N\bar{L}^{n}} \cdot \\ \Big[(1+r-P_B)\left((1-t_{free})\frac{\bar{w}}{a} - (1-t_{no})\, w_{G,no}^{n}\right)\bar{L}^{n} + (1-P_G)\cdot \\ \left((1-t_{free})\, w_{B,free}^{n} l_{B,free}^{n} - (1-t_{no})\, w_{B,no}^{n} l_{B,no}^{n} + b\left(l_{B,no}^{n} - l_{B,free}^{n}\right)\right)\Big] \end{aligned} \tag{36}$$

where taxes, t_{free} and t_{no}, are given by:

$$t_{free} = \frac{b\left[\bar{L}^{n} - l_{B,free}^{n} + (1-\rho)\left(l_{G,free}^{f} - l_{B,free}^{f}\right)\right]}{\frac{(1+r-P_B)}{(1-P_G)}\left(\bar{L}^{n}\frac{\bar{w}}{a} + l_{G,free}^{f}\bar{w}\right) + \left(l_{B,free}^{n} w_{B,free}^{n} + l_{B,free}^{f}\bar{w}\right)} \tag{37}$$

$$t_{no} = \frac{b\left(\bar{L}^n - l^n_{B,no}\right)}{\frac{(1+r-P_B)}{(1-P_G)}\bar{L}^n w^n_{G,no} + l^n_{B,no} w^n_{B,no}} \tag{38}$$

Using these expressions for t_{free} and t_{no}, we can (after some manipulations) rewrite the welfare gain as:

$$\begin{aligned} EU_{free} - EU_{no} = \frac{(1+r)}{N\bar{L}^n} \cdot \Big[& (1+r-P_B)\,\bar{L}^n \left(\frac{\bar{w}}{a} - w^n_{G,no}\right) \\ & - (1-P_G)\, b\,(1-\rho)\left(l^f_{G,free} - l^f_{B,free}\right) \\ & + t_{free}\bar{w}\left[(1-P_G)\, l^f_{B,free} + (1+r-P_B)\, l^f_{G,free}\right] \\ & - (1-P_G)\, l^n_{B,no} w^n_{B,no} + (1-P_G)\, l^n_{B,free} w^n_{B,free}\Big] \end{aligned} \tag{39}$$

This gain is positive if and only if:

$$\begin{aligned} & \left(l^n_{B,free} w^n_{B,free} - l^n_{B,no} w^n_{B,no}\right) + t_{free}\bar{w}\left[l^f_{B,free} + \frac{(1+r-P_B)}{1-P_G} l^f_{G,free}\right] + \\ & \frac{(1+r-P_B)}{1-P_G}\left(\frac{\bar{w}}{a} - w^n_{G,no}\right)\bar{L}^n - b\,(1-\rho)\left(l^f_{G,free} - l^f_{B,free}\right) > 0 \end{aligned} \tag{40}$$

which completes the proof of Proposition 1.

A.2 The "No Immigration" Regime (not intended for publication)

This section provides a detailed analytical solution to the "no immigration" regime. In this case, the demand for effective labour in each period, (30), translates into a demand for domestic labour. The labour supply function, on the other hand, has an inverse L-shape as domestic labour is supplied inelastically but has to respect a minimum wage. From (30) and given the level of capital, $k_{0,no}$, the labour market equilibrium in period t is therefore given by:

$$w^n_{t,no} = \max\left(\bar{w},\ \left(\bar{L}^n\right)^{\beta-1}(1-\alpha)\, Z_t k_{0,no}^{\alpha(1-\theta)}\right) \tag{41}$$

$$l^n_{t,no} = \begin{cases} \bar{L}^n & if \quad \bar{w} \le \left(\bar{L}^n\right)^{\beta-1}(1-\alpha)\, Z_t k_{0,no}^{\alpha(1-\theta)} \\ \left(\frac{\bar{w}}{(1-\alpha)Z_t k_{0,no}^{\alpha(1-\theta)}}\right)^{\frac{1}{\beta-1}} & if \quad \bar{w} > \left(\bar{L}^n\right)^{\beta-1}(1-\alpha)\, Z_t k_{0,no}^{\alpha(1-\theta)} \end{cases} \tag{42}$$

If the minimum wage exceeds the wage that would prevail in the absence of a minimum wage, $\left(\bar{L}^n\right)^{\beta-1}(1-\alpha)\, Z_t k_{0,no}^{\alpha(1-\theta)}$, the minimum wage will bind and there will be unemployment of natives in period t.

As we have two labour demand functions – one for each state – this gives us three types of equilibria: Case 1 where the minimum wage does not bind in any of the states. We can think of this as the situation where both demand curves cut the labour supply function on its vertical part. Case 2 where the minimum wage only binds in the bad state. This corresponds to the case where the labour demand function for the bad state intersects the supply function on its horizontal part but where the demand function for the good state still cuts the supply function on its vertical part. Finally, case 3 where the minimum wage binds in both states. This is the when the demand functions both intersect the labour supply function on its horizontal part.

In each case, the level of $k_{0,no}$ is derived from the zero-profit condition in (19) by inserting the relevant expressions for $w^n_{t,no}$ and $l^n_{t,no}$ from above into the expressions for variable profits from (11) together with the expressions for p_{it} and y_{it} from (28) and (29):

Case 1: If the minimum wage does not bind in bad states (and therefore not in good states either), *i.e.* if

$$\bar{w} \leq \left(\bar{L}^n\right)^{\beta-1}(1-\alpha)\, Z_B k_{0,no}^{\alpha(1-\theta)} \tag{43}$$

then:

$$w^n_{i,no} = \left(\bar{L}^n\right)^{\beta-1}(1-\alpha)\, Z_i k_{0,no}^{\alpha(1-\theta)} \qquad \textit{and} \qquad l^n_{i,no} = \bar{L}^n, \qquad i = G, B \tag{44}$$

and inserting the profit expressions in the zero profit condition results in:

$$k_{0,no} = \left[\frac{(1+r)\,\alpha \bar{L}_n^\beta}{\phi N}\left[(1+r-P_B)\, Z_G + (1-P_G)\, Z_B\right]\right]^{\frac{1}{1-\alpha(1-\theta)}} \tag{45}$$

Case 2: If the minimum wage binds in the bad state but not in the good, *i.e.*:

$$\left(\bar{L}^n\right)^{\beta-1}(1-\alpha)\, Z_B k_{0,no}^{\alpha(1-\theta)} < \bar{w} \leq \left(\bar{L}^n\right)^{\beta-1}(1-\alpha)\, Z_G k_{0,no}^{\alpha(1-\theta)} \tag{46}$$

then:

$$\begin{aligned} w^n_{G,no} &= \left(\bar{L}^n\right)^{\beta-1}(1-\alpha)\, Z_G k_{0,no}^{\alpha(1-\theta)}, & l^n_{G,no} &= \bar{L}^n \\ w^n_{B,no} &= \bar{w}, & l^n_{B,no} &= \left(\frac{\bar{w}}{(1-\alpha) Z_B k_{0,no}^{\alpha(1-\theta)}}\right)^{\frac{1}{\beta-1}} \end{aligned} \tag{47}$$

and inserting the profit expressions in the zero profit condition gives us:

$$\begin{aligned} k_{0,no} = \Bigg\{ &\left[\frac{(1+r)(1+r-P_B)}{N\cdot\phi}\right]\left(\alpha Z_G \left(\bar{L}^n\right)^\beta k_{0,no}^{-\frac{\beta\alpha(1-\theta)}{1-\beta}}\right) \\ &+ \frac{(1+r)(1-P_G)}{N\cdot\varphi}\left((1-\alpha)^{\frac{\beta}{1-\beta}} - (1-\alpha)^{\frac{1}{1-\beta}}\right) Z_B^{\frac{1}{1-\beta}}\, \bar{w}^{\frac{-\beta}{1-\beta}} \Bigg\}^{\frac{1-\beta}{\theta}} \end{aligned} \tag{48}$$

which uniquely defines $k_{0,no}$.

Case 3: Finally, if the minimum wage binds in both good and bad states:

$$\bar{w} > \left(\bar{L}^n\right)^{\beta-1}(1-\alpha) Z_G k_{0,no}^{\alpha(1-\theta)} \tag{49}$$

then:

$$w_{i,no}^n = \bar{w} \qquad and \qquad l_{i,no}^n = \left(\frac{\bar{w}}{(1-\alpha) Z_i k_{0,no}^{\alpha(1-\theta)}}\right)^{\frac{1}{\beta-1}}, \qquad i = G, B \tag{50}$$

and we get:

$$k_{0,no} = \left[\frac{(1+r)}{\phi N}(\bar{w})^{\frac{-\beta}{1-\beta}}\left((1-\alpha)^{\frac{\beta}{1-\beta}} - (1-\alpha)^{\frac{1}{1-\beta}}\right)\right.$$
$$\left.\left((1+r-P_B) Z_G^{\frac{1}{1-\beta}} + (1-P_G) Z_B^{\frac{1}{1-\beta}}\right)\right]^{\frac{1-\beta}{\theta}} \tag{51}$$

Furthermore, the above expressions can be used to derive the critical values of the minimum wage, $\bar{w}$, that separate the three cases. The critical value of $\bar{w}$ that separates case 1 from case 2 can be found by inserting (45) in (43) yielding:

$$\bar{w}_{crit12,no} = \left(\bar{L}^n\right)^{\beta-1}(1-\alpha) Z_B \cdot$$
$$\left[\frac{(1+r)\,\alpha \bar{L}_n^{\beta}}{\phi N}\left[(1+r-P_B) Z_G + (1-P_G) Z_B\right]\right]^{\frac{\alpha(1-\theta)}{1-\alpha(1-\theta)}} \tag{52}$$

Similarly, by inserting (51) in (49), we get the critical value of $\bar{w}$ that separates case 2 from case 3:

$$\bar{w}_{crit23,no} = \left(\left(\bar{L}^n\right)^{\beta-1}(1-\alpha) Z_G\right)^{\frac{\theta}{\theta+\beta\alpha(1-\theta)}} \cdot$$
$$\left[\frac{(1+r)}{\phi N}\cdot\left((1-\alpha)^{\frac{\beta}{1-\beta}} - (1-\alpha)^{\frac{1}{1-\beta}}\right)\right.$$
$$\left.\left((1+r-P_B) Z_G^{\frac{1}{1-\beta}} + (1-P_G) Z_B^{\frac{1}{1-\beta}}\right)\right]^{\frac{(1-\beta)\alpha(1-\theta)}{\theta+\beta\alpha(1-\theta)}} \tag{53}$$

where $\bar{w}_{crit23,no} > \bar{w}_{crit12,no}$.

Finally, the tax-level, t_{no}, can be found by inserting into (23) and the expected utility of a home worker by inserting into (24).

A.3 The "Free Immigration" Regime (not intended for publication)

This section provides a detailed analytical solution for the "free immigration" regime. Here, we can distinguish four different cases. First, if the wage to native workers in good states with no mobility is less than or equal to the effective wage of foreigners, $\bar{w}/a$, there will be no effect of opening up the economy to immigration. Foreigners will never be hired, and the equilibrium will be as in the case above. This is our case 4 and happens if:

$$\frac{\bar{w}}{a} \geq \left(\bar{L}^n\right)^{\beta-1} \left(\left(1-\alpha\right) Z_G k_{0,no}^{\alpha(1-\theta)}\right) \tag{54}$$

where $k_{0,no}$ is the corresponding equilibrium capital level in the "no immigration" regime, given by (45), (48) or (51) above.

If, on the other hand, the effective wage of foreigners, $\bar{w}/a$, is strictly smaller than the wage natives received in good states with no immigration:

$$\frac{\bar{w}}{a} < \left(\bar{L}^n\right)^{\beta-1} \left(\left(1-\alpha\right) Z_G k_{0,no}^{\alpha(1-\theta)}\right) \tag{55}$$

foreigners will be hired when the economy is open for immigration. The wage of natives in good states will now be pushed down to the effective wage of foreign labour, $\bar{w}/a$. Furthermore, foreign labour will satisfy the excess demand for labour at this wage. Thus, from (30), we get the following outcomes in good states whenever (55) is satisfied:

$$\begin{array}{ll} w_{G,free}^n = \frac{\bar{w}}{a}, & l_{G,free}^n = \bar{L}^n \\ w_{G,free}^f = \bar{w}, & l_{G,free}^f = \frac{1}{a}\left(\left(\frac{\bar{w}}{a(1-\alpha)Z_G k_{0,free}^{\alpha(1-\theta)}}\right)^{\frac{1}{\beta-1}} - \bar{L}^n\right) \end{array} \tag{56}$$

As foreign labour is less productive than domestic labour ($a < 1$), firms will first lay off foreign workers in downturns. This means that we need to distinguish between three possible downturn outcomes in the case where (55) holds: Case 1 where foreigners are also hired in bad states and therefore the minimum wage does not bind for natives in bad states either. Case 2 where foreigners are hired only in good states, but the minimum wage still does not bind for natives in bad states but the effective cost of foreigners is just too high. Case 3 where foreigners are only hired in good states and where the minimum wage binds for natives in bad states. As the outcome will influence the initial capital investment, we shall consider each of these cases in turn.

Case 1: This case requires:

$$\frac{\bar{w}}{a} < \left(\bar{L}^n\right)^{\beta-1} \left(1-\alpha\right) Z_B k_{0,free}^{\alpha(1-\theta)} \tag{57}$$

From the labour demand function in (30), we then get:

$$\begin{array}{ll} w^n_{B,free} = \frac{\bar{w}}{a}, & l^n_{B,free} = \bar{L}^n \\ w^f_{B,free} = \bar{w}, & l^f_{B,free} = \frac{1}{a}\left(\left(\frac{\bar{w}}{a(1-\alpha)Z_B k_{0,free}^{\alpha(1-\theta)}}\right)^{\frac{1}{\beta-1}} - \bar{L}^n\right) \end{array} \tag{58}$$

and the capital stock is then derived by use of the zero profit condition in (19), using that in this case:

$$\pi_G = p_{iG} y_{G,free} - \frac{\bar{w}}{a}\bar{L}^n - \bar{w} l^f_{G,free} \tag{59}$$

$$\pi_B = p_{iB} y_{B,free} - \frac{\bar{w}}{a}\bar{L}^n - \bar{w} l^f_{B,free} \tag{60}$$

After some manipulations, this results in the following expression for the initial capital investment:

$$k_{0,free} = \left[\frac{(1+r)\frac{\bar{w}}{a}^{\frac{-\beta}{1-\beta}}}{N\phi}\left((1+r-P_B)\, Z_G^{\frac{1}{1-\beta}} + (1-P_G)\, Z_B^{\frac{1}{1-\beta}}\right)\right.$$
$$\left.\left((1-\alpha)^{\frac{\beta}{1-\beta}} - (1-\alpha)^{\frac{1}{1-\beta}}\right)\right]^{\frac{1-\beta}{\theta}} \tag{61}$$

Case 2 requires:

$$\bar{w} \leq \left(\bar{L}^n\right)^{\beta-1}(1-\alpha)\, Z_B k_{0,free}^{\alpha(1-\theta)} < \frac{\bar{w}}{a} \tag{62}$$

From the labour demand function, we then get:

$$\begin{array}{ll} w^n_{B,free} = \left(\bar{L}^n\right)^{\beta-1}(1-\alpha)\, Z_B k_{0,free}^{\alpha(1-\theta)}, & l^n_{B,free} = \bar{L}^n \\ w^f_{B,free} = \bar{w}, & l^f_{B,free} = 0 \end{array} \tag{63}$$

and the capital stock is then derived by use of the zero profit condition, using that in this case:

$$\pi_G = p_{iG} y_{G,free} - \frac{\bar{w}}{a}\bar{L}^n - \bar{w} l^f_{G,free} \tag{64}$$

$$\pi_B = p_{iB} y_{B,free} - w^n_{B,free}\bar{L}^n \tag{65}$$

which after some manipulations results in the following expression for $k_{0,free}$:

$$k_{0,free} = \frac{(1+r)(1+r-P_B)}{\phi N}\left((1-\alpha)^{\frac{\beta}{1-\beta}} - (1-\alpha)^{\frac{1}{1-\beta}}\right)\cdot$$
$$\left(\frac{\bar{w}}{a}\right)^{\frac{\beta}{\beta-1}} Z_G^{\frac{1}{1-\beta}} k_{0,free}^{\frac{\alpha(1-\theta)}{1-\beta}} + \frac{(1+r)(1-P_G)}{\phi N}\alpha Z_B \left(\bar{L}^n\right)^{\beta} k_{0,free}^{\alpha(1-\theta)} \tag{66}$$

Note that the above expression determines $k_{0,free}$ indirectly.

Case 3 requires:

$$\left(\bar{L}^n\right)^{\beta-1}(1-\alpha) Z_B k_{0,free}^{\alpha(1-\theta)} < \bar{w} \tag{67}$$

From the labour demand function, we then get:

$$\begin{aligned} w^n_{B,free} &= \bar{w}, \qquad & l^n_{B,free} &= \left(\frac{\bar{w}}{(1-\alpha) Z_B k_{0,free}^{\alpha(1-\theta)}}\right)^{\frac{1}{\beta-1}} \\ w^f_{B,free} &= \bar{w}, \qquad & l^f_{B,free} &= 0 \end{aligned} \tag{68}$$

The capital stock is then derived by use of the zero profit condition, using that in this case:

$$\pi_G = p_{iG} y_{G,free} - \frac{\bar{w}}{a}\bar{L}^n - \bar{w} l^f_{G,free} \tag{69}$$

$$\pi_B = p_{iB} y_{B,free} - \bar{w} l^n_{B,free} \tag{70}$$

which results in:

$$\begin{aligned} k_{0,free} = {} & \left[\frac{(1+r)}{N\phi}\left((1-\alpha)^{\frac{\beta}{1-\beta}} - (1-\alpha)^{\frac{1}{1-\beta}}\right)\right]^{\frac{1-\beta}{\theta}} \cdot \\ & \left[(1+r-P_B) Z_G^{\frac{1}{1-\beta}} \frac{\bar{w}}{a}^{\frac{-\beta}{1-\beta}} + (1-P_G) Z_B^{\frac{1}{1-\beta}} \bar{w}^{\frac{-\beta}{1-\beta}}\right]^{\frac{1-\beta}{\theta}} \end{aligned} \tag{71}$$

Furthermore, the above expressions can be used to derive the critical values of the minimum wage, $\bar{w}$, that separate the three cases. First, the critical value that separates case 1 from case 2 can be found by inserting (61) in (57). This yields:

$$\begin{aligned} \bar{w}_{crit12,free} = {} & a\left[\left(\bar{L}^n\right)^{\beta-1}(1-\alpha) Z_B\right]^{\frac{\theta}{\theta+\beta\alpha(1-\theta)}} \cdot \\ & \left[\frac{(1+r)}{N\phi}\left((1+r-P_B) Z_G^{\frac{1}{1-\beta}} + (1-P_G) Z_B^{\frac{1}{1-\beta}}\right) \cdot \right. \\ & \left.\left((1-\alpha)^{\frac{\beta}{1-\beta}} - (1-\alpha)^{\frac{1}{1-\beta}}\right)\right]^{\frac{(1-\beta)\alpha(1-\theta)}{\theta+\beta\alpha(1-\theta)}} \end{aligned} \tag{72}$$

Second, the critical value separating cases 2 and 3 can be found by using (71) in (67):

$$\bar{w}_{crit23,free} = \left[\left(\bar{L}^n \right)^{\beta-1} (1-\alpha) Z_B \right]^{\frac{\theta}{\theta+\beta\alpha(1-\theta)}} \cdot \left[\frac{(1+r)}{N\phi} \left((1+r-P_B) Z_G^{\frac{1}{1-\beta}} a^{\frac{\beta}{1-\beta}} + (1-P_G) Z_B^{\frac{1}{1-\beta}} \right) \cdot \left((1-\alpha)^{\frac{\beta}{1-\beta}} - (1-\alpha)^{\frac{1}{1-\beta}} \right) \right]^{\frac{(1-\beta)\alpha(1-\theta)}{\theta+\beta\alpha(1-\theta)}} \quad (73)$$

Finally, the tax-level, t_{free}, can be found by inserting into (23) and the expected utility of a home worker by inserting into (24).

A.4 The "Hiring Cost" Regime

This section provides the analytical details of the solution in the "hiring cost" regime, where domestic firms can only hire foreign workers at a cost. While the demand for effective labour in the two states still follows from (30), where the native wage rate is the prevailing price of effective labour, the presence of hiring costs create an interdependency between the two states.

In the following, we shall assume that parameter values are such that: (i) foreigners are always hired in good states, $l_{G,hc}^f > 0$; and (ii) the minimum wage binds in bad states. Formally, these conditions require:

$$w_{G,hc}^n < \left(\bar{L}^n \right)^{\beta-1} \left((1-\alpha) Z_G k_{0,hc}^{\alpha(1-\theta)} \right) \quad (74)$$

and

$$\left(\bar{L}^n \right)^{\beta-1} \left((1-\alpha) Z_B k_{0,hc}^{\alpha(1-\theta)} \right) < \bar{w} \quad (75)$$

To show the interdependency between the two states, we can use that the amount of native labour demanded can be expressed as the total demand for effective labour less the effective amount of foreign labour demanded:

$$l_{t,hc}^n = l_{t,hc} - a l_{t,hc}^f, \quad t = G, B \quad (76)$$

Then we can write variable profits (excluding hiring costs) in good and bad states as:

$$\begin{aligned} \pi_{G,hc} &= p_{iG,hc} y_{G,hc} - w_{G,hc}^n l_{G,hc} + \left(a w_{G,hc}^n - \bar{w} \right) l_{G,hc}^f \\ \pi_{B,hc} &= p_{iB,hc} y_{B,hc} - \bar{w} l_{B,hc} - (\bar{w} - a\bar{w}) l_{B,hc}^f \end{aligned} \quad (77)$$

The last term in the expression for $\pi_{G,hc}$ is the amount saved by using foreign labour instead of native labour in good states, whereas the last term in the second line is the extra cost of using foreign labour instead of native labour in bad states.

Without hiring costs, the last term in $\pi_{G,hc}$ would be zero as the wage to native workers would be pushed down to $\bar{w}/a$ whenever immigration takes place. Hence, there would be no gain from using immigrants instead of natives in good states – only losses in bad states as $\bar{w} > a\bar{w}$. With hiring costs, however, the wage of native workers in good states is not pushed down to $\bar{w}/a$, as the effective cost of foreign labour now includes the hiring cost.

The expected discounted cash flow, v_0, can be expressed as:

$$\begin{aligned} & v_{0,hc} = \\ & \frac{1}{N}\Big[(1+r)(1+r-P_B)\Big\{p_{iG,hc}y_{G,hc} - w^n_{G,hc}l_{G,hc} + \left(aw^n_{G,hc} - \bar{w}\right)l^f_{G,hc}\Big\} \\ & \qquad + (1+r)(1-P_G)\Big\{p_{iB,hc}y_{B,hc} - \bar{w}l_{B,hc} - \bar{w}(1-a)l^f_{B,hc}\Big\} \\ & \qquad\qquad - (1-P_G)(1-P_B)\,h(l^f_{G,hc} - l^f_{B,hc})\Big] - h\cdot l^f_{G,hc} - ck_{0,hc} \end{aligned} \tag{78}$$

Given wages, $w^n_{G,hc}$ and $\bar{w}$, and the total demand for effective labour by firms, $l_{G,hc}$ and $l_{B,hc}$, we can use the above expression to find the part of that demand which is a demand for foreign labour, $l^f_{G,hc}$ and $l^f_{B,hc}$.

First, in good states, the amount of foreign labour used is determined by the difference between the total demand for effective labour, $l_{G,hc}$, and the available native labour, $\bar{L}^n$. Second, given the amount of foreign labour used in good states, $l^f_{G,hc}$, we can differentiate $v_{0,hc}$ with respect to the amount of foreign labour used in bad states, $l^f_{B,hc}$:

$$\left.\frac{\partial v_{0,hc}}{\partial l^f_{B,hc}}\right|_{l^f_{B,hc}<l^f_{G,hc}} = \frac{1-P_G}{N}\left[-(1+r)\,\bar{w}(1-a) + (1-P_B)\,h\right] \tag{79}$$

Note that in the case without hiring costs ($h = 0$), the right hand side is always non-positive, implying that $l^f_{B,hc} = 0$ is the optimal choice (as we have assumed that the minimum wage binds in bad states). With hiring costs, however, things are different. As long as $l^f_{B,hc} < l^f_{G,hc}$, there are two effects of raising $l^f_{B,hc}$. First, it increases the wage costs in bad states, as foreigners must be paid the same wage as natives but are less productive. This is the first term in the square brackets above. Second, it reduces hiring costs when the economy returns to a good state. This is the second term. It follows from this expression that the optimal amount of foreign labour in bad states is given as:

$$l^f_{B,hc} = \begin{cases} 0 & if \quad \bar{w}(1-a) > \frac{(1-P_B)h}{1+r} \\ l^f_{G,hc} & if \quad \bar{w}(1-a) < \frac{(1-P_B)h}{1+r} \end{cases} \tag{80}$$

which proves Proposition 4. Intuitively, if the extra cost of using foreign labour in a bad state, $\bar{w}(1-a)$, is less than the expected discounted hiring cost next period, $(1-P_B)\,h/(1+r)$, firms will keep all their foreign labour when they enter a bad state, $l^f_{B,hc} = l^f_{G,hc}$. This defines two separate subcases: Case 1, where foreigners are fired in downturns, and case 2, where they are kept in downturns.

Now, the wage of native workers in good states, $w^n_{G,hc}$, must adjust to ensure that all native workers are employed in good states. The condition for this is that $\partial v_{0,hc}/\partial l^f_{G,hc} = 0$. That is, there must be no extra benefit of hiring an extra foreign worker at the expense of a native worker in a good state. This condition gives us the equilibrium wage for native workers for each of the two subcases:

$$w^n_{G,hc} = \begin{cases} \frac{\bar{w}}{a} + \frac{Nh+(1-P_B)(1-P_G)h}{(1+r)(1+r-P_B)a} & if \quad \bar{w}(1-a) > \frac{(1-P_B)h}{1+r} \\ \frac{\bar{w}}{a} + \frac{Nh+(1+r)(1-P_G)\bar{w}(1-a)}{(1+r)(1+r-P_B)a} & if \quad \bar{w}(1-a) < \frac{(1-P_B)h}{1+r} \end{cases} \tag{81}$$

Thus, with hiring costs, $w^n_{G,hc}$ exceeds $\bar{w}/a$. In case 1, where foreigners are fired in downturns, the wage of natives is raised by the repeated costs of hiring alternative foreign workers. In case 2, where foreigners are fired, the wage of natives in good states is raised by the value of the initial hiring cost plus the cost of keeping the foreign workers in bad states. Note also that the case of free immigration is a special case of case 1, where $h = 0$.

Labour inputs can then be derived from (30) and (76). In good states, the inputs of natives and foreigners are:

$$\begin{aligned} l^n_{G,hc} &= \bar{L}^n \\ l^f_{G,hc} &= \frac{1}{a}\left(\left[\frac{w^n_{G,hc}}{(1-\alpha)Z_G k_{0,hc}^{\alpha(1-\theta)}}\right]^{\frac{1}{\beta-1}} - \bar{L}^n\right) \end{aligned} \tag{82}$$

In bad states, we need to distinguish between the two cases. In Case 1:

$$\begin{aligned} l^n_{B,hc} &= \left(\frac{\bar{w}}{(1-\alpha)Z_B k_{0,hc}^{\alpha(1-\theta)}}\right)^{\frac{1}{\beta-1}} \\ l^f_{B,hc} &= 0 \end{aligned} \tag{83}$$

whereas in Case 2:

$$\begin{aligned} l^n_{B,hc} &= \left(\frac{\bar{w}}{(1-\alpha)Z_B k_{0,hc}^{\alpha(1-\theta)}}\right)^{\frac{1}{\beta-1}} - a l^f_{G,hc} \\ l^f_{B,hc} &= l^f_{G,hc} \end{aligned} \tag{84}$$

assuming that not all natives are crowded out in downturns.

The equilibrium capital level is determined as in the previous sections using the zero-profit condition:

$$k_{0,hc} = \left[\frac{(1+r)}{Nc}\left((1-\alpha)^{\frac{\beta}{1-\beta}} - (1-\alpha)^{\frac{1}{1-\beta}}\right)\right]^{\frac{1-\beta}{\theta}} \cdot \\ \left[(1-P_G)\, Z_B^{\frac{1}{1-\beta}}\, \bar{w}^{\frac{-\beta}{1-\beta}} + (1+r-P_B)\, Z_G^{\frac{1}{1-\beta}}\left(w_{G,hc}^{n}\right)^{\frac{-\beta}{1-\beta}}\right]^{\frac{1-\beta}{\theta}} \quad (85)$$

where $w_{G,hc}^{n}$ is given by (81).

Finally, the tax-level, t_{hc}, can be found by inserting into (23) and the expected utility of a home worker by inserting into (24). Using these to construct the example in Figure 1 completes the proof of Proposition 3.

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