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Trainspotting: 'Good Jobs', Training and Skilled Immigration*

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Abstract

While skilled immigration *ceteris paribus* provides an immediate boost to GDP per capita by adding to the human capital stock of the receiving economy, might it also reduce the number of 'good jobs', i.e. those with training, available to indigenous workers? This paper analyzes this issue theoretically and empirically. The theoretical model shows how skilled immigration may affect the sectoral allocation of labor and how it may have a positive or negative effect on the training and social mobility of native born workers. The empirical analysis uses UK data from 2001 to 2018 to show that training rates of UK born workers have declined in a period where immigration has been rising strongly, and have declined significantly more in high wage non-traded sectors. At the sectoral level however this link is much less strong but there is evidence of different effects of skilled immigration across traded and non-traded sectors and evidence that the hiring of UK born workers in high wage non-traded sectors has been negatively affected by skilled immigration, although this effect is not large. Taken together the theoretical and empirical analyses suggest that skilled immigration may have some role in allocating native born workers away from 'good jobs' sectors but it is unlikely to be a major driver of social mobility.

Keywords: Immigration, Training, Income Distribution

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1 Introduction

Recent studies on the effects of immigration have argued that skilled immigrants add to the human capital stock of an economy and thereby improve its productivity.[1] Moreover the empirical evidence for the UK suggests that rising immigration has had few detrimental effects on the average employment prospects of UK-born workers, whether less skilled or otherwise.[2] Yet these findings do not exclude the possibility that migrants with human capital may crowd out the human capital formation of indigenous workers if firms hire ready trained workers rather than undergo the expense of hiring and training a local workforce.

UK data suggests that training rates of native born workers have been declining significantly over a period when skilled immigration has been rising strongly. This paper describes a theoretical model where skilled immigration may have a positive or negative effect on training and hiring depending on the characteristics of the sector and of the migrant. The paper then investigates the effects of skilled immigration empirically using sector level data from the UK from 2001-2018.

There is long established literature on the economics of training following Becker's (1964) insight that firms will only provide general training if they are able to capture part of the resultant increase in worker's productivity.[3] The literature however has largely neglected the role of on-the-job training on social mobility, i.e. the opportunity for individuals from low wealth backgrounds to enter high wage employment. In this paper we focus on this issue and in turn analyse the effects of skilled immigration on training and hiring, and the implications for social mobility. We imbed a model of employment based training into a model of income distribution dynamics where informational asymmetries imply that low wealth individuals cannot borrow to finance their own training. However if firms have an informational advantage over financial markets in monitoring their employees and are also able to capture a part of the increase in their workers' productivity due to training, then the provision of on-the-job training may allow low wealth individuals to accumulate skills. In this way on-the-job training may have a beneficial effect on social mobility.

[1] See e.g. Mountford and Rapoport (2011) and Wadsworth (2010).

[2] See e.g. Manacorda, Manning and Wadsworth (2012).

[3] See Acemoglu and Pischke (1999a, 1999b). This can occur due to asymmetric information between employers and employees, imperfect competition in the labour market, or contractual obligations of training programs. See Dustmann and Schoenberg (2012).

We then examine the effects that immigration may have on this process. The literature on skilled migration has emphasized the potential of skilled immigration to add to the economy's human capital stock.[4] However skilled immigration also has the potential to limit and erode the provision of on-the-job training. We demonstrate this possibility in a model where training opportunities differ across sectors. We derive the model for the case where the two sectors are traded and non traded, and where training opportunities are available only in the non-traded goods sector. We abstract from training in the traded sector as traded production is tied with location decisions. Without immigration a traded good producer may choose to relocate away from the home economy.[5] In contrast the non-traded sector must produce in the home economy and its scale is limited by the size of the domestic economy. Consequently, skilled immigration may potentially cause indigenous labor to be allocated away from this sector and any associated training opportunities.

There are also potentially positive effects of skilled immigration on training. Increased profitability caused by skilled immigration may induce firm entry into sectors which train workers. Skilled migrants may also directly train domestic workers. Wealthy migrants will increase the demand for non-traded goods and so will increase the need for trained workers in this sector. All these effects are present in the model. Furthermore it should also be stressed that positive and negative effects may be operating on the economy both at the same time and differently across and within sectors. Thus ultimately the effect of skilled immigration on the training of native workers is an empirical matter and this motivates the second part of the paper.

Using UK data across industries and occupations from the Labour Force Survey (LFS), we find a large variation in both the level of and trends in the training and hiring of UK born workers across sectors, alongside differential use of skilled immigrant labour. Immigration appears to have a differential effect on training rates across the traded and non-traded sectors, being positive in the former and negative in the latter. There is also evidence of a negative association between hiring rates and skilled immigration in the high wage non-traded sector. These effects are not large but suggest that immigration may have some role in allocating native workers to sectors with lower levels of training. If so then social mobility in the receiving economy, as well as the welfare of this group,

[4] See e.g. Mountford and Rapoport (2011) and Wadsworth (2010), Manacorda, Manning and Wadsworth (2012).

[5] The logic of the paper only requires that training opportunities differ within sectors and would apply if these also existed in the traded sector.

Table 1: Broad Sector Trends in Training, Hiring and Immigration 2001-2018

Sector	On-The-Job Training Share of UK Born Employees in Sector (%) Point Change	Skilled Adult Immigrant Share in Sector (%) Point Change	Sector Share of all UK-Born Hires (%) Point Change
Total	-6.1	+5.1	0
Traded	-5.4	+5.5	-0.15
Non-Traded Low Wage	-4.3	+5.2	-0.06
Non-Traded High Wage	-8.7	+4.9	0.17

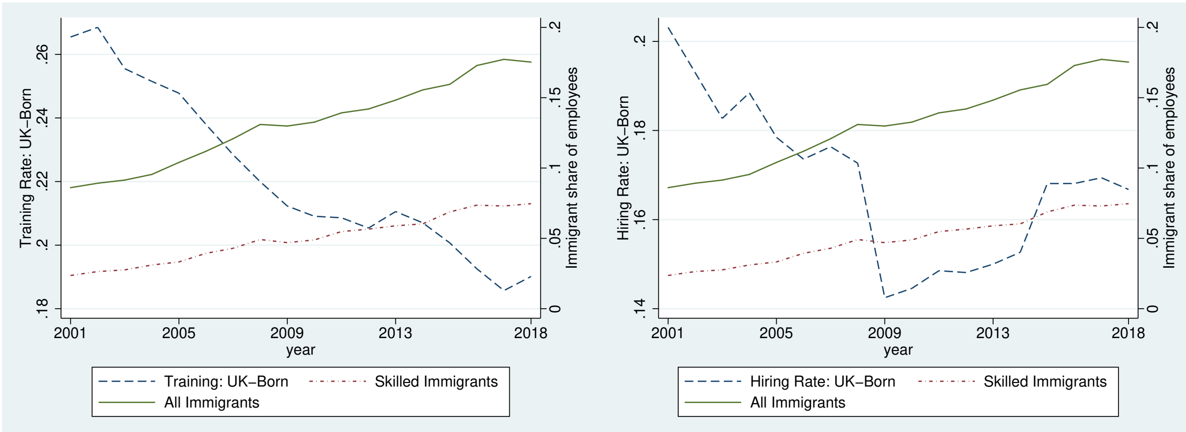
Notes: Source LFS and authors' calculations.

could be being reduced by skilled immigration.

The paper is organised as follows. In Section 2, we motivate the analysis and outline some of the broad stylised facts about recent immigration, hiring and training trends in the UK economy. Section 3 describes the dynamic general equilibrium model of training. Section 4 analyzes theoretically the effect of immigration on training and social mobility in this model. Section 5 describes the empirical analysis. Section 6 concludes.

2 Recent Trends in Training and Immigration

At an aggregate level one may be tempted to conclude that there is an obvious negative association between immigration and the training of UK-born workers. Figure 1a) shows a large downward trend in the share of UK-born employees who say they have received some training (at work or at college) while employed over the previous 3 months. Aggregate on the job training rates of UK-born workers fell from 26.5% in 2001 to 20.4 % in 2018, see Table 1. This has coincided with a clear rise in both the total immigrant and skilled immigrant shares of the workforce. The hiring rate of UK-born workers, in contrast, is much more cyclical. Figure 1b) shows a negative association between immigration and hiring prior to the downturn and a positive one in a recovery of employment. However, it is important to investigate whether these associations hold



(a) Training Rates and Immigration

(b) Hiring Rates and Immigration

Figure 1: Aggregate Training, Hiring of UK Born Workers and Immigration

at a sectoral level.

Table 1 outlines the change in the rate of on-the-job training and hiring in the UK over time by three broad sectors; high-wage non-traded sector, low wage non-traded sector and the traded sector.[6] There is a clear downward trend in all three sectors in the share of UK-born employees who say they have received some training in the previous 3 months. While native training levels remain highest in the high wage non-traded sector, the trend decline is notably steepest in this sector. Training in this sector fell from about 33% to 24% between 2001 and 2017, compared to the traded sector which fell from about 22% to 16%. Table 1 shows that the average sectoral share of hiring, is much more stable, although there is a clear upward trend in the share of the high wage non-traded sector in hiring, mostly at the expense of the traded sector.

A more disaggregated analysis shows great variation across sectors. Table 2 displays for three digit level sectors the sample mean training and immigration rates for the highest and lowest training and hiring rate sectors at the beginning and end of the sample. In 2001, the sectors with the highest on-the-job training rates were associate professionals in Health and Social Care, predominantly nurses, and the occupations with the lowest on-the-job training share were Carers and Elementary Domestic Workers, such as cleaners. There is no clear association with immigrant share as two of the best and worst sectors had greater than average shares of skilled migrants. In 2017, the best and worse

[6]We define a high wage as a sector paying above the mean sectoral hourly wage. The traded sector is defined as SIC classifications 1-4 which corresponds to agriculture, energy and manufacturing.

Table 2: Training, Hiring and Immigration by Sector and Year

Year	Sector	On-the-Job Training Share UK-born Employees in Sector (%)	Skilled Adult Immigrant Share (%)	Sector	Average Sector Share of all UK born Hires (%)	Skilled Adult Immigrant Share (%)
2001						
Total		26.5	2.3		0.64	2.3
Top 3	Ass.Prof(Health)(322)	52.1	2.3	Sales(Retail)(708)	10.0	0.9
	Prof. Social Care(324)	49.0	4.4	Element.(Food)(910)	6.2	2.7
	Ass.Prof(Pub.Adm)(320)	48.5	1.8	Skill(Constrn.)(507)	3.20	0.5
Bottom 3	Caring(Dom.)(629)	3.8	6.6	Managers(Arts)(125)	0.01	3.3
	Managers(Dom.)(129)	4.3	7.3	Managers(Sci)(117)	0.02	5.1
	Element(Dom.)(929)	5.7	1.3	Prof.(Food)(203)	0.03	2.4
2017						
Total		20.0	7.2		0.64	7.2
Top 3	Ass.Prof(Health)(322)	40.3	10.8	Element.(Food)(910)	8.1	9.7
	Prof. (Health) (222)	38.4	16.8	Sales(Retail)(708)	7.8	5.1
	Ass.Prof(Pub.Adm)(320)	36.9	2.7	Prof.(Educ.)(221)	4.4	7.5
Bottom 3	Element(Support)(918)	5.8	11.7	Managers(Dom)(129)	0.01	0.1
	Process.(Manuf)(804)	4.8	5.6	Managers(Arts)(125)	0.02	4.4
	Element(Dom.)(929)	2.4	15.6	Prof. (Food)(203)	0.03	14.3

Source LFS

sectors for training are similar (Designers replace Cleaners in the lowest three training rate sectors). As before, two of the top three high training occupations had higher than average immigration shares and two of the bottom three had higher than average immigration shares. Similar patterns emerge in the second part of Table 2 concerning hiring. While there is considerable variation in the share of native hiring attributable to each sector it is hard to see a clear correlation with skilled immigrant share.

3 A Model of Training and Social Mobility

This section describes a theoretical model which illustrates the effects of training opportunities on human capital accumulation, social mobility and the income distribution. We then analyze the potential effects of skilled immigration on these processes. The model builds on the framework of Galor and Zeira (1993) and Maoz and Moav (2004) assuming an informational asymmetry between borrowers looking to invest in training and lenders. Lenders cannot observe the effort that the borrower puts into making their training a success. In addition, we assume that lenders are not able to force borrowers below a minimum level of consumption. These two imperfections in the loan market can prevent low wealth individuals from being able to borrow to fund their training in equilibrium. Employers in some sectors, however, have an advantage over the financial market in that they have a close interaction with their employees and so are able, for a small cost, to monitor their investment in training.[7] We assume that benefits of training are shared between the worker and the firm via a bargaining process.[8] In this way on-the-job training allows individuals, who otherwise wouldn't have been able to, to accumulate skills and is thus a source of upward social mobility. As we shall see, the possibility to hire already trained workers from overseas alters the equilibrium and so may potentially impede social mobility.

3.1 Production

We assume that there is a traded good and a non-traded good. We focus our analysis on the non-traded sector and abstract from training in the traded sector. The traded sector is assumed to have a perfectly competitive market structure as in, for example

[7] This assumption follows the financial literature on monitoring of e.g. Diamond (1984, 1991).

[8] See Dustmann and Schoenberg (2009) for empirical evidence for the positive effects of intertemporal agreements or understanding between unions and employers on training.

Galor and Zeira (1992), and output of the traded good at time period s, Y_s^t, is given by the following production function,

$$Y_s^t = F^U(L_{t,s}^U) + F^H(L_{t,s}^H, K_{t,s})$$

where $L_{t,s}^U$ is the number of unskilled workers, $L_{t,s}^H$ is the number of educated or skilled workers and $K_{t,s}$ is the amount of capital employed in the traded goods sector at time period s. We assume that both elements of the production function operate under constant returns to scale. Thus for unskilled workers $F^U(L_{t,s}^u) = w_s^U L_{t,s}^U$ and $F^H(L_{t,s}^H, K_{t,s})$ is a constant returns to scale function with decreasing positive marginal products and boundary conditions such that $L_{t,s}^H$ and $K_{t,s}$ are always positive in equilibrium. We assume that wages in this sector are determined competitively and equal their marginal products and that the rate of interest is set exogenously by the world capital market, at a level R. Capital flows in and out of the economy in an unrestricted way so that the interest rate in the economy always equals R, and this fixes the skilled wage, w_s^H. There is free movement of unskilled workers between sectors.

The non traded good is also produced under perfect competition using a continuum of specialized inputs, $Y_{j,s}$, following the production structure in Christiano, Eichenbaum and Trabandt (2016). At time s, the output of the non-traded good, Y_s^{nt}, is given by the following CES production function

$$Y_s^{nt} = \left[\int_0^1 Y_{j,s}^{\rho} dj\right]^{\frac{1}{\rho}}$$

where $0 < \rho < 1$ and where $Y_{j,s}$ is the output of specialist input j at time s. Each specialized input is produced by a monopolist according to a constant returns to scale production function so that

$$Y_{j,s} = A_j x_s^j$$

where x_s^j is the amount of the homogeneous intermediate good, x, which is used to produce the specialist input good Y_j at time period s.

The intermediate good, x is produced competitively and sold at the price of p_s^x in period s. The intermediate good can be produced using either unskilled labor, or by trained workers. We describe the implications of these options below. The price of the intermediate good determines the marginal cost of producing the specialized input $\frac{p_s^x}{A_j}$. As is well known in this set up the monopolist sets the price of the specialized input as a markup over its marginal cost so that,

$$p_s^j = \frac{p_s^x}{A_j \rho} \quad \forall j$$

where $\varepsilon = \frac{1}{1-\rho}$ is the price elasticity of demand for the specialist inputs.

3.2 Individuals

The population consists of overlapping generations. A generation of size 1 is born in each period and lives for two periods. Each individual has one parent and one child. In their first period of life agents receive a bequest from their parent and have a choice of whether to invest in human capital. In their second period of life agents supply labor inelastically but choose optimally between consuming and bequeathing to their child. We assume that agents are subject to a subsistence constraint in the tradeable good i.e. consumption cannot fall below level $\tilde{c}$.

Preferences of each individual agent i born in period s are defined over their second period choices for consumption of the traded good c^t_{s+1}, consumption of the non-traded good c^{nt}_{s+1} and their bequest b_{s+1} and are represented by the following utility function

$$u_s = (c^t_{s+1} - \tilde{c})^{\alpha}(c^{nt}_{s+1})^{\beta} b_{s+1}^{1-\alpha-\beta}$$

where $0 < \alpha, \beta < \alpha + \beta < 1$ and where $\tilde{c}$ is the subsistence level of consumption of the traded good. Each agent has a budget constraint

$$c^t_{s+1} + p^{nt}_{s+1} c^{nt}_{s+1} + b_{s+1} = I^i_{t+1}$$

where I^i_{s+1} is the income of agent i at time period $s+1$. Utility maximization implies the following optimal shares of expenditure:

$$\begin{aligned} c^t_{s+1} &= \tilde{c} + \alpha(I^i_{s+1} - \tilde{c}) \\ p^{nt}_{s+1} c^{nt}_{s+1} &= \beta(I^i_{s+1} - \tilde{c}) \\ b^i_{s+1} &= (1-\alpha-\beta)(I^i_{s+1} - \tilde{c}) \end{aligned}$$

3.3 Human Capital Investment and Capital Market Imperfections

We assume, following Galor and Zeira (1993), that being skilled in period $s+1$ requires an indivisible investment of size e in period s. However the success of this investment is not guaranteed. The probability of success depends on the actions of individuals, as in Holmstrom and Tirole (1997). Individuals have a choice between being diligent which implies a success probability of π^h and being less diligent which implies a success probability of π^l but which also confers a private benefit, B. The action of the individual and so the probability of success cannot be observed by the financial markets, only the outcome. Furthermore, we assume that financial markets cannot force people below the subsistence level of consumption and so banks cannot recover all the costs of training in the event that it is not successful.

We first derive conditions under which there is no lending by financial markets for low wealth individuals for human capital accumulation in equilibrium. Then in section 3.5 we assume that employers in the intermediate goods sector have the ability to ensure their employee's diligence at a cost of C, via monitoring.[9] This allows the employer to offer on the job training which can enable low wealth agents working in the intermediate sector to become trained and so earn more than the unskilled wage. We show in section 4 how this on the job training can have a persistent effect on social mobility.

3.3.1 Individual Human Capital Investment Decision

In the absence of informational asymmetries, we assume that being diligent in training is the best strategy for all agents and so agents with a sufficient level of wealth (bequests) will choose to be diligent.[10] We restrict the parameters in the model so that

$$\begin{aligned} \pi^h(w^H - w^U) &> eR \\ \pi^l(w^H - w^U) + B &< eR \end{aligned}$$

However financial markets are not able to recover all the costs of training in the event that it is not successful. Specifically we assume that banks cannot force people below the subsistence level of consumption, $\tilde{c}$. This distorts the investment decision of individuals with low wealth. Individuals will only have an incentive to be diligent if the rate at which they borrow, R^* satisfies the following inequality

$$R^* < \frac{1}{(e-b^i)}\left[(w^H - \tilde{c}) - \frac{B}{\pi^h - \pi^l}\right]$$

In equilibrium financial intermediaries need to make the expected international rate of return, R. This can only occur if R^* satisfies the following inequality

$$R^* > \frac{1}{(e-b^i)}\frac{R(e-b^i) - (1-\pi^h)(w^U - \tilde{c})}{\pi^h}$$

[9] This follow the financial economics literature on monitoring and financial markets see especially Diamond's (1984,1991) Holmstrom and Tirole (1997) and Freixas and Rochet (2008).

[10] The model would not be of interest if this was not the case.

Those with a higher level of wealth (bequests) have a greater incentive to be diligent and so can be charged a lower interest rate in equilibrium. These inequalities imply that there will be no lending in equilibrium to individuals with wealth level, b^i, if

$$\frac{1}{(e-b^i)}\frac{R^*(e-b^i)-(1-\pi^h)(w^u-\tilde{c})}{\pi^h} > \frac{1}{(e-b^i)}\left[(w^H-\tilde{c})-\frac{B}{\pi^h-\pi^l}\right]$$

which implies that only agents with wealth higher than $\widehat{b}$ will be able to borrow to invest where

$$\widehat{b} = e - \frac{(w^u-\tilde{c})+\pi^h(w^H-w^u)-\frac{\pi^h B}{\pi^h-\pi^l}}{R}$$

The model therefore describes what we regard as a realistic scenario where agents with low wealth are unable to borrow to invest in human capital accumulation. Agents with higher wealth, in contrast, will use their wealth to accumulate skills. Thus in the absence of government intervention there would be no upward income mobility for low wealth agents.[11]

3.4 Equilibrium Without On-The-Job Training

When there is no training all the homogeneous intermediate good, x, is produced competitively under constant returns to scale using unskilled labor. The production function for x at time period s, is the following

$$x_s = a_x^u L_{x,s}^U$$

where $L_{x,s}^U$ is the amount of unskilled labor employed in the intermediate goods sector at time s. Thus the price of one unit of the intermediate good is $p_s^x = \frac{w_s^u}{a_x^u}$.
The monopolist sets the price of each of the specialized inputs, p_s^j as a markup over its marginal cost and so

$$p_s^j = \frac{p_s^x}{A_j\rho} = \frac{w_s^u}{a_x^u A_j \rho} \quad \forall j$$

Symmetry in equilibrium implies that the price of the non-traded good is equal to the price of the specialized inputs and so equilibrium is achieved by the allocation of unskilled workers between the traded and non-traded sectors. Given the agent's first order conditions, the market clearing condition is given by

[11] See the Section 4 below on income distribution dynamics

$$\frac{\beta}{p_s^{nt}}\left[\int_{i\varepsilon L^u}(b_s^i + w^u - \tilde{c}) + \int_{i\varepsilon L^e}(b_s^i + w^e - \tilde{c}) + \int_j \Pi_j\right] = a_x^u A_j L_{x,s}^u$$

where Π_j are the profits from the specialist input firms which are distributed firm owners.[12]

3.5 On-The-Job Training

In this section we assume that on-the-job training is also a possible route to accumulating human capital in the intermediate goods sector. We assume that the nature of work is such that some employers can ensure the diligence of an employee by monitoring at an additional cost of C. For ease of comparison we assume that the cost of training and success probability of trained workers and their productivity is the same as for skilled workers, although this is not necessary for the analysis.[13] If C is sufficiently small then there will be enough surplus for both the firm and the worker to gain from the on the job training of any agent without the wealth to pay for their own skill accumulation. We assume that the surplus is shared between the firm and the worker according to a bargaining mechanism.

We apply the alternative offers bargaining mechanism, following Christiano, Eichenbaum and Trabant (2016), and assume that in each period a number of matches between a worker and a firm are made. In each match a firm and worker bargain with each other over the wage in M subperiods. M can be any even number but for ease of exposition we will assume M to be 4.[14] In the odd periods the firm proposes a wage to the worker and if rejected the worker makes a counter offer in the subsequent even period. In the final sub-period, in our case period 4, the worker makes the firm a final take it or leave it offer. This final sub-period closes the model which can then be solved by backward induction. After each sub-period, there is an exogenously given chance that the match is broken and that both the firm and the worker have to fall back to their outside option.

[12] We assume these are a very small number of firm owners and ignore their impact on income distribution dynamics.

[13] The level of skills and cost of training could be different in the intermediate goods sector. What is needed for the analysis is that return to labor from this type of training is below that of borrowing to become skilled in period 1. i.e. we want to rule out wealthy agents taking this route to becoming skilled which is counter factual.

[14] M can be generalized to any positive even integer (Christiano, Eichenbaum and Trabandt (2016)).

We assume that there are measure J^M firms with the capability of offering on the job training in the intermediate goods sector. Each firm, k, must pay a fixed cost $\tilde{\Phi}_k$ in the previous period to enter the sector. Paying the fixed cost allows a firm to meet with one worker with probability one. The firm and worker then bargain with each other over the wage. A firm and worker combination i together can produce x^i $(= a_x^t = w_t^h > a_x^u)$ units of the intermediate good. The value to the firm of agreeing a wage with a worker in period s and training her/him on the job is denoted by J_s, and is given by the following expression

$$J_s = p_s^x a_x^t - w^T - eR - C$$

where w^T is the wage of the trained worker, eR is the cost of training and C is the cost of monitoring.

Firms borrow this fixed cost under limited liability from the financial market at rate $\tilde{R} = \frac{R}{\pi^H}$ as the loan is only repaid in the event that training is successful. The firm's liabilities in the following period are $\Phi_k \equiv \tilde{\Phi}_k \tilde{R}$. We assume that this fixed cost liability, Φ_k, is distributed in the range $[\underline{\Phi}, \overline{\Phi}]$. Otherwise the firms are identical and operate under free entry and behave competitively.

In equilibrium, there are two possibilities, either the intermediate goods firms employing unskilled workers are operative or they are not. If they do operate then the price of intermediate goods, p_s^x, is given by the price that unskilled workers can supply it $p_s^x = \frac{w_s^u}{a_x^u}$ and for the marginal firm, k, that offers training $J_s = \Phi_k$. Alternatively, if the entire demand for intermediate goods is satisfied by the training firms then p_s^x will be the highest price that satisfies the total demand for intermediate goods as well as the constraints that $p_s^x \leq \frac{w_s^u}{a_x^u}$ and that $J_s \geq \underline{\Phi}$.

The value of a match and successful training and employment to a worker is w^T while the value to the worker of not agreeing with the firm, being unsuccessful at training or not finding a match is being an unskilled worker, earning wage w^U. As shown in the Appendix this leads to a division of the surplus from the match described by the following equation

$$w^T = \kappa w^U + \xi(p_{i,s} a_x^t - eR - C)$$

where

$$\kappa = \tau[1 + (1-\tau)^2]; \quad \xi = (1-\tau)[\tau + (1-\tau)^2]$$

Note that when $\tau = 0$ then $w^T = p_s^x a_x^t - eR - C$ and if $\tau = 1$ then $w^T = w^u$ For intermediate values of τ the surplus of the match is split between the firm and the worker.[15] Thus by varying τ - a measure of the bargaining power of labor - all possible divisions of the surplus between the firm and the worker are possible.

3.6 Skilled Immigration and On-The-Job Training

The effect of skilled immigration on the economy will differ depend on the wealth of the immigrant and the sector they work in. We first analyze the direct effect of a skilled immigrant working in the on-the-job training sector, before proceeding to discuss the cases where skilled immigrants work in the traded sector, or act as entrepreneurs.

To analyze the case in the non-traded sector where firms may be matched with less expensive or easier to train migrants we modify the set up above by assuming that each firm, k, paying the fixed cost $\tilde{\Phi}_k$ to enter the sector has a probability π^m of being matched with a migrant. We assume that the migrant's outside option in the event of a breakdown in bargaining, w^m, is lower than that of domestic workers, i.e. $w^m < w^U$ and also that the firm has the possibility of meeting another migrant worker in between subperiods 2 and 3 of the bargaining process.[16] As is intuitive, this has the effect of reducing the equilibrium share of the match's surplus given to trained workers.

If a firm is matched initially with an indigenous worker then the only change to the bargaining process from above is between subperiods 2 and 3. The counter offer, w_2^T by the worker to the firm must take into account that the firm has the possibility of meeting another migrant worker if it rejects the counter offer, w_2^T. It is shown in the Appendix that this leads to a division of the surplus from the match described by the following equation

$$w^T = \kappa^u w^u + \kappa^m w^m + \xi(p_{i,s} a_x^t - eR - C)$$

where

$$\kappa^u = \tau(1 + (1-\tau)^2); \quad \kappa^m = (1-\tau)\tau^2\pi^m; \quad \xi = (1-\tau)[\tau + (1-\tau)^2 - \tau^2\pi^m)]$$

Thus as before when $\tau = 0$ then $w_1^T = p_s^x a_x^t - [eR - C]$ and so w^T extracts the entire surplus of the match. If $\tau = 1$ then $w^T = w^u$ i.e. the firm extracts all the surplus from the match. For intermediate values of τ the surplus of the match is split between the firm and the worker, with π^m having a negative effect on the training wage. The possibility of employing migrants therefore increases a firm's profits and reduces the wage of an indigenous worker even if an immigrant is not hired in equilibrium.

[15] See Appendix for the derivation of the sharing rule.

[16] We regard w^m as the wage in the source economy.

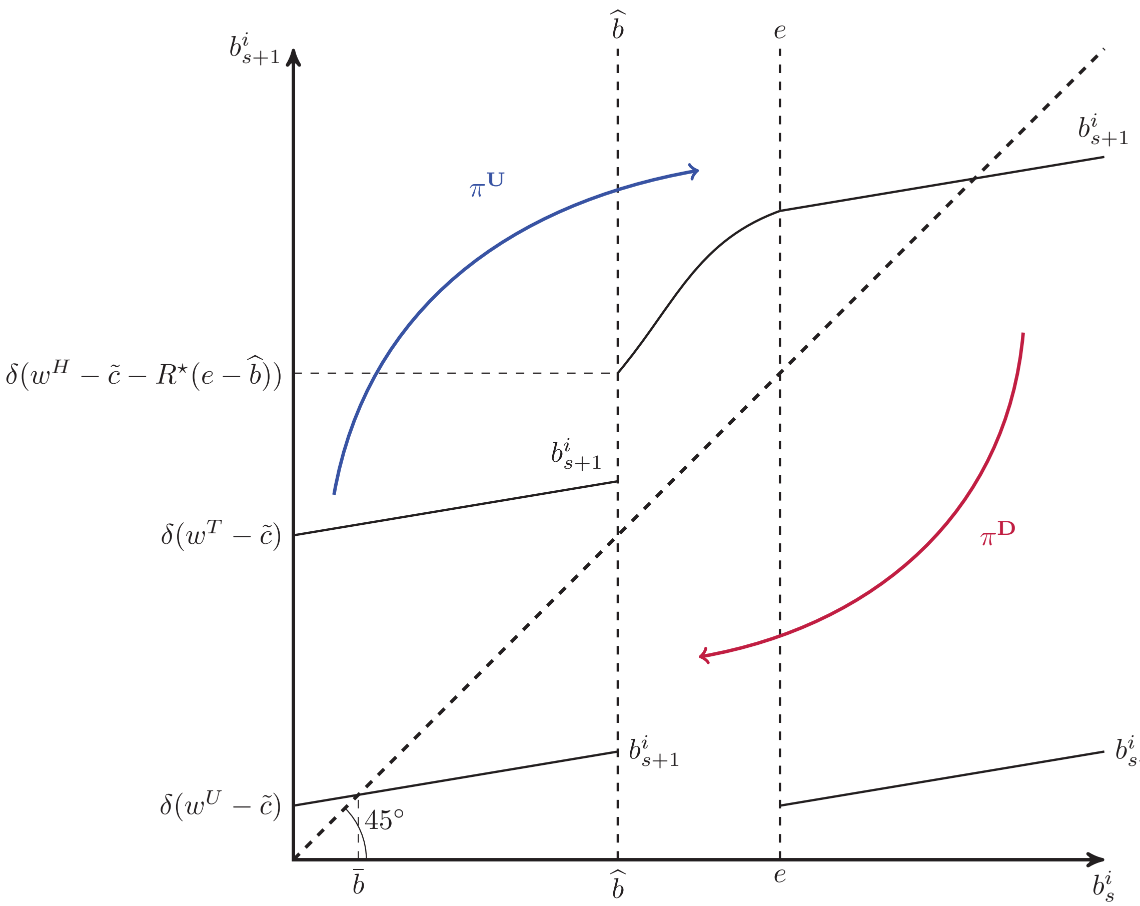


Figure 2: Income distribution dynamics with on-the-job training.

Other cases will follow a similar logic. If a migrant worker is already trained (or has smaller training costs) then the structure of the wage bargain doesn't change but the expected surplus from the match will increase. In this case therefore while the profit of the firm will certainly rise from the possibility of hiring migrants, the equilibrium wage may rise or fall depending on the level of τ. Thus the effect on wages is an empirical matter. For evidence on this see Manacorda, Manning and Wadsworth (2012) and Dustman and Frattini and Preston (2013).

In terms of the effects on the provision of training for indigenous workers, as skilled immigration raises the profitability of firms engaged in on-the-job training, then more firms should enter this sector of the economy. Whether the net effect of skilled immigrants on training places for indigenous workers is positive or negative depends on the strength of this entry effect relative to the direct immigration effect. In equilibrium, because of free entry, it must be the case that the marginal firm, k, makes zero expected profits. The number of entering firms is determined by the slope of the fixed cost distribution function at the equilibrium point. The flatter the distribution, the more firms enter and so for a given migration probability the number of training opportunities for native workers rises. Therefore immigration may cause the number of training places for native to rise or fall. This is ultimately therefore an empirical matter which we address in Section 5 below.

The effects of skilled migrants working in the traded sector are straightforward. These immigrants will increase the demand for the non-traded good and so will have a non-negative effect on the number of training places available to native workers. Similarly skilled migrants who work as entrepreneurs setting up new firms that train native workers will also have a non-negative effect on the number of training places available for native workers. If skilled workers do not utilize their skills and work as unskilled workers, this should also increase the demand for the non-traded good and so will have a non-negative effect on the number of training places available to native workers.[17]

4 Social Mobility

In this section we describe the implications of on-the-job training and of skilled immigration for social mobility. In section 4.1 we first describe the dynamics and social mobility of the economy without immigration before analyzing the case with immigration in section 4.2. To ensure a non-degenerate income distribution we assume that skilled wages are high enough to ensure that someone who receives income from a skilled wage and a bequest of $\widehat{b}$ will themselves leave a bequest of $\widehat{b}$ or more as well as a corresponding assumption about unskilled wages. This implies the following conditions for w_s^u and w_s^H,

$$\begin{aligned} w^U &< \tilde{c} + \frac{\widehat{b}}{\delta} - R\widehat{b} \\ w^H &> \tilde{c} + \frac{\widehat{b}}{\delta} \end{aligned}$$

where $\delta = (1 - \alpha - \beta)$

[17]It follows that unskilled immigration will have the same effect.

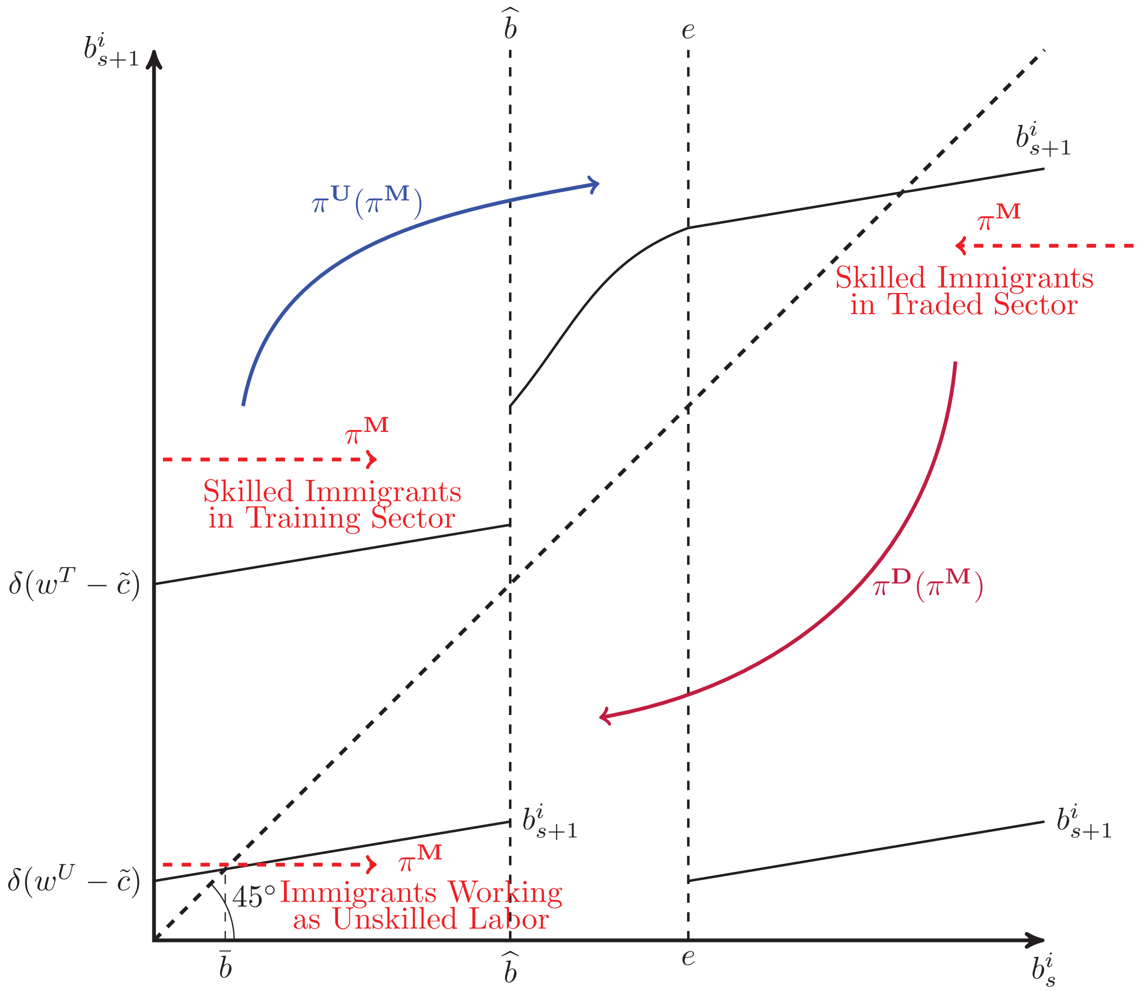


Figure 3: Channels through which migration may affect social mobility.

4.1 Income Distribution Dynamics Without Immigration

The agents' optimal human capital decisions together with their demand functions implies that equation (1), below, describing the intergenerational dynamics, has three sections. Those with wealth (bequests) above e will find it optimal to invest in skills and will become skilled workers with probability π^h. For those with wealth (bequests) below $\widehat{b}$, those who can obtain on the job training will receive the training wage while the rest become unskilled workers. Those with wealth (bequests) greater then $\widehat{b}$ but less than e will use their bequest and borrow the remainder to become skilled with probability π^h.

$$b^i_{s+1} = \begin{cases} \text{for} \quad b^i_s > e & \begin{cases} \delta[w^H_{s+1} - \tilde{c} + R((b^i_s) - e)] & \text{if training successful} \\ \delta[w^u_{s+1} - \tilde{c} + R((b^i_s) - e)] & \text{if training unsuccessful} \end{cases} \\ \text{for} \quad \widehat{b} < b^i_s < e & \begin{cases} \delta[w^H_{s+1} - \tilde{c} - R^\star(e - b^i_s)] & \text{if training successful} \\ 0 & \text{if training unsuccessful} \end{cases} \\ \text{for} \quad b^i_s < \widehat{b} & \begin{cases} \delta[w^t_{s+1} - \tilde{c} + Rb^i_s)] & \text{if training successful} \\ \delta[w^u_{s+1} - \tilde{c} + Rb^i_s] & \text{if training unsuccessful} \end{cases} \end{cases} \tag{1}$$

The dynamics described by equation (1) are depicted in Figure 2. The income distributional dynamics have both a force for upward mobility as well as downward mobility. Downward mobility, depicted by the arrow labelled π^D in Figure 2, is when a wealthy agent does not succeed in becoming skilled and so only earns an unskilled wage and suffers a reduction in wealth of e. Upward mobility, depicted by the arrow labelled π^U in Figure 2, is when low wealth agents succeed in accumulating enough wealth for their offspring to purchase education in the following period. Clearly this potential depends on workers trained via on the job training obtaining significantly higher wages than unskilled workers.

A large range for w^T is possible in this model, as described in section 3.6. Figure 2 depicts the case where w^T is high enough so that trained workers' bequests will be above $\widehat{b}$ and thus their offspring will have as great a chance as anyone of becoming skilled the following period. This is the most optimistic case for upward social mobility. Clearly a w^T lower than this will reduce the prospects for upward social mobility.

4.2 The Effects of Skilled Immigration

We analyse the case of skilled immigration on social mobility with reference to Figure 3, which depicts three of the possible paths through which skilled immigration may affect social mobility in this economy; (i) the effect of skilled immigrants working in the traded sector (ii) the effect of skilled immigrants working in the job training sector and (iii) the effects of skilled immigrants working as unskilled workers. We discuss these cases in turn.

4.2.1 Skilled Migrants in the Traded Sector

Skilled immigrants in the traded sector will increase GDP per capita in the economy. This case is depicted by the arrow in the top right section of Figure 3. Such immigrants will increase the demand for non-traded goods and thus the number of agents working in the non-traded sector must rise. This will have no effect on the number of trained workers if all potential on-the-job training firms are active and unskilled workers are employed in the intermediate goods sector. However if there are potential on-the-job training firms that are not previously producing then this increase in demand may lead some to enter the market, raising the overall amount of training places. This would therefore raise the probability for upward social mobility, π^U. The probability for downward mobility, $(1-\pi^h)$, will not be affected but the proportion of trained workers in the economy in the long run will increase if the probability of obtaining on-the-job training increases.

4.2.2 Skilled Migrants in the Non-Traded Sector

As discussed in Section 3 skilled immigration into the on-the-job training sector will increase the profitability of this sector by saving on training costs and so should cause new firms to enter this sector. Whether this increases or decreases the probability of an indigenous worker obtaining training depends on whether then increase in training places created by new firms entering the market outweighs the loss of training places taken by the migrants. This case is depicted by the arrow in the top left section of Figure 3. In addition to this there is also the effect that skilled migration in the on-the-job training sector has on the equilibrium trained wage, w^T. As described in Section 3, this also may fall or rise depending on the reservation wage of the migrants, w^m, and the increase in the surplus of a match due to reduced training costs. The lower is w^T the lower the possibility for upward social mobility for the next generation due to lower bequests. A sufficiently low level of w^T would eliminate upward social mobility entirely.

4.2.3 Skilled Migrants Working in Unskilled Jobs

Many skilled immigrants in the UK work in unskilled jobs, see Wadsworth (2018). This case is depicted by the arrow in the lower left section of Figure 3. Within the period this will increase the demand for non-traded goods and this will have a non-negative effect on the training opportunities for native workers as described in section 4.2.1. However the offspring of these migrants may have a chance of taking a training place the following period and so may reduce the dynastic prospects for upward social mobility for native workers. If this type of migration is permanent then this may increase the proportion of unskilled agents in the economy and reduce measured aggregate productivity.

4.2.4 High Wealth Immigrants and Skilled Migrants as Entrepreneurs

Any migrants that work as entrepreneurs and who increase the number of firms offering on the job training will clearly increase social mobility. Similarly any immigrant with high wealth will increase the demand for non-traded goods and so will have a non-negative effect on the training opportunities for native workers as described in section 4.2.1. The contrast between these two effects is that the effect of the high wealth immigrant will be temporary as the wealth of the dynasty will tend to that of the average high skill worker over time. Whereas if the entrepreneur permanently increases the probability of obtaining on the job training then the proportion of high skilled workers in the economy, and so aggregate productivity in the long run will increase.

5 Empirical Evidence

In order to test the implications of the model above we need data on both the incidence of training and hiring, the age, education and country of origin of those trained and the share of skilled immigrants working in each sector. All these pieces of information are contained in the UK Labour Force Survey (LFS). The LFS is a quarterly random sample of around 50,000 households and the individuals therein. Since 1995 there has been a question on whether an employed individual has received any work or college based training in the past 3 months.[18] We define a new hire as anyone in a job for less

[18] The training variable used is the response to the LFS question "In the 3 months since [date] have you taken part in any education or any training connected with your job or a job that you might be able to do in the future? "The question is only asked to those in employment under the age of 70 and not

than twelve months. The LFS also contains details of the country of birth. This allows us to split the sample into UK-born and Immigrants. The LFS also contains information on year of arrival and age leaving full time education. From this we can define a skilled adult immigrant as someone who left full-time education after the age of 18 (i.e. with some level of tertiary education) and who arrived in the UK after the age of 22, (i.e. with some degree of work experience abroad).

The training and hiring data of individuals are then averaged to a sectoral level. A sector in our analysis is a combination of one digit occupation and two digit industry.[19] The occupational sector definitions change significantly in 2001, which makes matching before this period difficult. We therefore begin our sample period from this point.[20] We pool across all quarters in each year. This ensures that there is a minimum of 100 observations in each sector in each year with a median cell size of 2226. This generates a balanced panel of 158 sectors over 18 years. The model above makes a distinction between good and bad jobs, and between traded and non-traded jobs. We define the traded sector as all occupations in industries Agricultural Production 01 to Miscellaneous Manufacturing 39.[21] A good job sector is defined as a sector with a mean wage higher than the aggregate mean wage over the sample period.

The estimated model has the following form

$$OJT_{it} = \beta_0 + \beta_1 Immigrant_{it-1} + \gamma Z_{it} + s_i + s_{it} + \epsilon_{it} \quad (2)$$

where OJT_{it} is the share of all UK born workers in sector i at time t, in receipt of on the job training, $\frac{OJT_{it}^N}{N_{it}}$. Since the model can also be interpreted as a willingness to take on local-born workers we also estimate the incidence of hiring, replacing the dependent variable in equation (2) with the sector share of all UK-born hires at time t, defined as $\frac{H_{it}^N}{H_t^N}$. $Immigrant_{it-1}$ is the share of skilled adult immigrants working in sector i at time $t-1$, and β_1 is the parameter of interest. Z are a set of controls associated with training and

to working students. See
$http://doc.ukdataservice.ac.uk/doc/7985/mrdoc/pdf/lfs_user_guide_vol2_questionnaire2016.pdf$
This variable was used by Dearden, Reed and Van Reenen (2006) and shown by them to be positively associated with higher productivity.

[19] For example sector 322 is an associate professional(1-digit SOC code = 3) working in the health industry(2-digit SIC code = 22).

[20] The industry classifications also change in 2009 but we correct for this using the mapping of Smith https://warwick.ac.uk/fac/soc/economics/staff/jcsmith/sicmapping/

[21] We have investigated the sensitivity of our results to different definitions of the traded sector and the results, available on request, are generally little changed.

hiring. The controls include the sector mean proportions of women, graduates, part-time working, self-employment, temporary working, large firm size, public sector, along with sector mean age, job tenure and hourly wages. There is also a control for the percentage change in sector size to try to account for the differential effect of growth sectors. The s_{it} are sector fixed effects and sector trends. The immigrant variable is lagged to reduce contemporaneous endogeneity concerns. This does not however exclude the possibility of a violation of strict exogeneity that would compromise the estimation. Since the bias in fixed effects estimation of equation (2) if strict exogeneity is violated is $O(\frac{1}{T})$, we proceed with the estimation under this caveat, although we do explore alternative estimation procedures in the robustness checks which follow. The variance of the error term may contain a group (sector) specific component but could also be influenced by possible unobserved spillovers across groups both spatially and over time. We therefore estimate the model using HAC error robustness, that is, robust to heteroskedasticity of unknown form and which also allows for unknown autocorrelation, (see Cameron and Millar (2013)).[22]

5.1 Results

Table 3 outlines the estimates from a set of sectoral-level regressions of the share of UK-born adults receiving training on the lagged employment share of immigrants who arrived as adults with education after high school. The first column is an OLS regression giving the raw correlation between the variables. Column 2 gives the estimate of the training effect of immigration net of sectoral controls alongside sector fixed effects. Column 3 additionally includes sector trends. This is arguably a more stringent test of the effect of immigration and is our preferred specification. Since some sectors are larger than others we also weight the observations by sector sample population. These estimates are given in Column (4). Panel A estimates the average skilled immigration effect across all sectors. This is insignificant in all specifications. Panel B allows the immigration effect to vary across the three broad sectors suggested by the model: traded, non-traded (High Wage) and non-traded (Low Wage) sectors. The individual point estimates for the non-traded sectors are negative but insignificantly different from zero in our preferred specification (Column 3). They are however significantly different from the traded sector indicating that there may be a differential effect of immigration on training

[22] We also test the sensitivity of the estimated standard errors to different clustering assumptions.

across the traded and non-traded sector as predicted by our theoretical model. However the data do not indicate a significant difference between the effect of skilled immigration on training between the high and low wage non-traded sectors. The weighted least squares estimates for the effect of skilled immigration on training in all three sectors are statistically insignificant but are again suggestive of a larger negative effect of skilled immigration in the non-traded good job sectors.

Since there may be concerns that the skilled immigration effect may be picking up other aspects of immigration, Panel C additionally includes interactions of the sectors with other immigrant groups. The estimates of the skilled immigration effect are broadly the same as those for Panel B. While insignificant, the negative point estimates again suggest that the skilled immigrant effect on training may be larger in the non-traded sector than that of other immigrants. The weighted least squares estimates also point to an additional effect of unskilled immigration on training in the non-traded low wage sector. [23]

Table 4 outlines the estimates from a set of regressions where the sector share of all native born hires is now the dependent variable. Table 4 has the same format as Table 3. The skilled immigrant effect on hiring of UK-born workers is more significant than for training. While there is no overall skilled immigration effect on hiring (Panel A) this obscures a significant negative effect in the high wage non-traded Sector (Panel B Columns 3 and 4). The weighted estimates of this effect in column 4 are somewhat larger but tell the same story. The skilled immigration effect on hiring holds when the other immigrant share variable is included as a control (Panel C). The magnitude of the effect is however not large. A 5 percentage point increase in the skilled immigrant sector share, the average increase in the sample over the period, see Table 1, reduces the sector share of native hiring by 0.02 percentage points. [24]

[23] This result does not map straightforwardly to the model but would be consistent with an extended model that allows for differential training effects between high wage and low wage non-traded sectors.

[24] The mean hiring share in this period is 0.006 thus the effect is a reduction of $0.004 \times 0.05/0.006$ i.e. about 3% or about $0.013 \times 0.05/0.006 = 10.8\%$ if using the weighted least squares point estimate. 5% is also approximately one standard deviation of the skilled immigrant workforce share in the high wage non-traded sector As the dependent variable is the share of hiring this implies that on average share of native hiring on other sectors must go up, i.e. native labor is being reallocated away from the high wage non-traded sector.

Table 3: Training

	1	2	3	4
Panel A				
Skilled Immigrants	-0.065	0.039	-0.034	-0.030
	(0.075)	(0.037)	(0.041)	(0.033)
Panel B				
Non-Traded(Low Wage)×Skilled Immigrant	-0.147	0.114*	-0.068	-0.004
	(0.091)	(0.050)	(0.058)	(0.049)
Traded×Skilled Immigrant	-0.058	0.172*	0.089	0.006
	(0.086)	(0.057)	(0.080)	(0.064)
Non-Traded(High Wage)×Skilled Immigrant	0.009	-0.199	-0.113	-0.066
	(0.102)	(0.053)	(0.063)	(0.047)
Panel C				
Non-Traded(Low Wage)×Skilled Immigrant	-0.153	0.019	-0.078	-0.011
	(0.103)	(0.055)	(0.060)	(0.049)
Traded×Skilled Immigrant	0.173	0.072	0.090	0.004
	(0.111)	(0.070)	(0.078)	(0.065)
Non-Traded(High Wage)×Skilled Immigrant	-0.231	-0.293	-0.113	-0.067
	(0.121)	(0.056)	(0.063)	(0.047)
Non-Traded(Low Wage)×Other Immigrant	-0.177	0.012	-0.070	−0.109*
	(0.051)	(0.040)	(0.048)	(0.040)
Traded×Other Immigrant	-0.388	0.046	0.039	0.007
	(0.059)	(0.061)	(0.064)	(0.051)
Non-Traded(High Wage)×Other Immigrant	0.267	-0.049	-0.029	-0.024
	(0.106)	(0.077)	(0.063)	(0.0051)
Controls				
Year	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes
Sector	No	Yes	Yes	Yes
Sector Trends	No	No	Yes	Yes

Notes: Sample Size 2686, * significant at 5% level. HAC robust panel standard errors in brackets.

Table 4: Hiring

	1	2	3	4
Panel A				
Skilled Immigrants	0.003	0.001	-0.001	-0.001
	(0.010)	(0.002)	(0.001)	(0.004)
Panel B				
Non-Traded(Low Wage)×Skiiled Immigrant	0.002	-0.002	0.002	0.016*
	(0.018)	(0.004)	(0.002)	(0.008)
Traded×Skilled Immigrant	-0.015	−0.008*	0.001	-0.002
	(0.010)	(0.003)	(0.001)	(0.006)
Non-Traded(High Wage)×Skilled Immigrant	0.013	0.014*	−0.004*	−0.012*
	(0.010)	(0.003)	(0.001)	(0.005)
Panel C				
Non-Traded(Low Wage)×Skilled Immigrant	-0.042	0.001	0.002	0.015*
	(0.019)	(0.003)	(0.002)	(0.008)
Traded×Skilled Immigrant	-0,007	−0.007*	-0.001	-0.002
	(0.011)	(0.002)	(0.001)	(0.006)
Non-Traded(High Wage)×Skilled Immigrant	0.015	0.012*	−0.004*	−0.013*
	(0.009)	(0.003)	(0.001)	(0.005)
Non-Traded(Low Wage)×Other Immigrant	0.035	-0.009	-0.001	-0.004
	(0.017)	(0.002)	(0.001)	(0.005)
Traded×Other Immigrant	-0.002	-0.006	−0.002*	−0.009*
	(0.008)	(0.001)	(0.001)	(0.004)
Non-Traded(High Wage)×Other Immigrant	0.003	0.003	-0.002	0.002
	(0.013)	(0.002)	(0.002)	(0.005)
Controls				
Year	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes
Sector	No	Yes	Yes	Yes
Sector Trends	No	No	Yes	Yes

Notes: Sample Size 2686, * significant at 5% level. HAC robust panel standard errors in brackets.

In the Appendix we assess the robustness of the estimates to different measures of immigrant concentration, standard errors and estimation techniques. Since there is little consensus in the literature regarding the appropriate measure of immigrant concentration, Tables A1 and A2 display the results from estimates of the model using different measures of immigrant concentration. In column 2 we use the immigrant ratio $\frac{M}{N}$, used as a measure of immigrant concentration in many studies, see e.g. Dustmann, Frattini and Preston (2013). In column 3 we use the fixed ratio $\frac{M}{N_0}$ where N_0 is the sector count of native workers in the initial period, the year 2000. The latter means that the changes are identified off the absolute change in immigration numbers rather than the relative change. These estimates are generally insignificantly different from each other and continue to suggest a similar small negative association between skilled immigration and native hiring shares.

Table A3 tests the sensitivity of the standard error estimates to different assumptions about heteroskedasticity and/or autocorrelation. Again the standard error estimates are very similar and do not change the overall conclusions regarding significance or otherwise. Table A4 presents estimates of the skilled immigrant effect using different estimation techniques. Column 1 estimates the model in first differences rather than within groups. The estimates are generally less precise than for the fixed effects model but of similar sign and magnitude. Column 2 adds a lagged dependent variable to the model estimated with fixed effects. Fixed effect estimation of lagged dependent variable models are of course inconsistent, with the bias again being of order $O(\frac{1}{T})$. One potential solution is to instrument the lag and all other strictly endogenous variables with values lagged $t-2$ and beyond and estimate the model in first differences. The data however precludes this approach since we have autocorrelation in the differenced residuals going back at least 10 periods. For completeness we nevertheless present first difference estimates using 5 period lags as instrumental variables in column 3. Column 4 estimates the fixed effects model using instruments from outside the system, namely the standard Bartik shift-share instrument. These instruments perform poorly in the presence of sector trends.

6 Conclusion

Despite a strong decline in aggregate training rates in the UK over the last twenty years and a strong increase in skilled immigration, this paper has found only small skilled immigration effects on the training of natives across traded and non-traded sectors and no significant evidence of different training effects between the high wage and low wage non-traded sector. The negative effect of skilled immigration on the hiring of natives in 'good job' sectors that we do find is also small and therefore is not likely to be a major driver of social mobility. This paper has demonstrated theoretically that skilled immigration may have both negative and positive effects on native training and hiring. These may have broadly offset each other in the empirical estimation.

References

[1] Acemoglu, Daron and Jorn-Steffen Pischke, (1998). "Why Do Firms Train? Theory and Evidence," *The Quarterly Journal of Economics*, Vol. 113(1), 79-119.

[2] Acemoglu, Daron and Jorn-Steffen Pischke, (1999). “Beyond Becker: Training in Imperfect Labour Markets,” *The Economic Journal* Vol. 109, F112-42.

[3] Acemoglu, Daron and Jorn-Steffen Pischke, (1999). "Minimum Wages and On-the-job Training," NBER Working Papers 7184, National Bureau of Economic Research, Inc.

[4] Becker, G., (1964). *Human Capital*, University of Chicago Press

[5] Bernard A, Jensen J. Bradford, Redding S.J. and and Peter K. Schott (2012). "The Empirics of Firm Heterogeneity and International Trade," *Annual Review of Economics* Vol. 4 (March): 283-313.

[6] Cameron, C. and D. Miller., (2015), "A Practitioner's Guide to Cluster-Robust Inference", *Journal of Human Resources*, Vol. 50(2), 317-372.

[7] Christiano L. , M. Eichenbaum,and M Trabandt, "Unemployment and Business Cycles", *Econometrica*, July 2016, 84(4), pp. 1523-1569,

[8] Dearden L., Reed H. and Van Reenen , J., (2006), “The Impact of Training on Productivity and Wages: Evidence from British Panel Data”, *Oxford Bulletin of Economics and Statistics*, Vol. 68, No. 4, pp. 397-421.

[9] Diamond, D.W., (1984). "Financial Intermediation and Delegated Monitoring," *Review of Economics Studies*, Vol. 51(3), 393-414.

[10] Diamond, D.W., (1991). "Monitoring and Reputation: The choice between bank loans and directly placed debt," *Journal of Political Economy*, Vol. 99, 689-721.

[11] Donald, S. G., and K. Lang., (2007)."Inference with Di§erence-in-Di§erences and Other Panel Data", *Review of Economics and Statistics* Vol. 89, 221-233.

[12] Dustmann, Christian, Tommaso Frattini and Ian Preston , (2013), “The Effect of Immigration along the Distribution of Wages”, Review of Economics Studies, Vol. 80, pp 145-173.

[13] Dustmann, Christian and Uta Schönberg, (2009). "Training and Union Wages," *The Review of Economics and Statistics*, Vol. 91(2), 363-376.

[14] Dustmann, Christian and Uta Schönberg, (2012). "What Makes Firm-Based Vocational Training Schemes Successful? The Role of Commitment," *American Economic Journal: Applied Economics*, Vol. 4(2), 36-61.

[15] Frexias, X and J-C. Rochet (2008). "Microeconomics of Banking", Second Edition *MIT Press*

[16] Galor, O. and J.Zeira, (1993). "Income Distribution and Macroeconomics," *Review of Economic Studies,* Vol. 60(1), 35-52.

[17] Holmstrom, B. and J. Tirole (1997). "Financial Intermediation, Loanable Funds, and The Real Sector" *The Quarterly Journal of Economics,* vol. 112(3), 663-691

[18] Moav, O., (2002). "Income distribution and macroeconomics: the persistence of inequality in a convex technology framework," *Economics Letters,* Vol. 75(2), 187-192.

[19] Maoz, Y. D. and O. Moav, (2004)."Social Stratification, Capital Skill Complementarity, And The Nonmonotonic Evolution Of The Education Premium," *Macroeconomic Dynamics,* Vol. 8(3), 295-309.

[20] Hatton, J. T. (2015) "American Immigration Policy: The 1965 Act and its Consequences," *The Scandinavian Journal of Economics*, Vol. 117(2), 347-368.

[21] Kiguchi, T., and A. Mountford (2013). "The macroeconomics of immigration," MPRA Paper No. 45517.

[22] Manacorda, M., A. Manning, and J. Wadsworth (2012). "The Impact of Immigration on the Structure of Wages: Theory and Evidence from Britain," *Journal of the European Economic Association*, Vol. 10(1), 120-151.

[23] Mountford, A. (1997), "Can a brain drain be good for growth in the source economy?," *Journal of Development Economics,* Vol 53(2), 287-303.

[24] Mountford, A. and H. Rapoport (2011), "The Brain Drain and the World Distribution of Income," *Journal of Development Economics,* vol 95(1), 4-17.

[25] Piketty, T., and E. Saez (2003). "Income Inequality in the United States, 1913-1998," *Quarterly Journal of Economics*, Vol. 118(1), 1-39.

[26] Piketty, T., and E. Saez (2006). "The evolution of top incomes: A historical and international perspective," *The American Economic Review, Papers and Proceedings*, Vol.96(2), 200-205.

[27] Wadsworth, J. (2010). "The UK Labour Market and Immigration," *National Institute Economic Review*, Vol. 213(1), 35-42.

[28] Wadsworth, J. (2018). "Off EU Go? Brexit, the UK Labour Market and Immigration," *Fiscal Studies*, Vol. 39(4).

Appendix

Table A1: Training - Alternative Immigration Definitions

	Share(M/(N+M))	Ratio (M/N)	Fixed Ratio (M/N_0)
Panel A			
Skilled Immigrants	-0.034	- 0.028	-0.003
	(0.041)	(0.028)	(0.021)
Panel B			
Non-Traded(Low Wage)×Skilled Immigrant	-0.068	-0.052	-0.006
	(0.058)	(0.040)	(0.042)
Traded×Skilled Immigrant	0.089	0.055	0.078
	(0.080)	(0.052)	(0.063)
Non-Traded(High Wage)×Skilled Immigrant	-0.113	-0.079	-0.016
	(0.063)	(0.047)	(0.021)
Panel C			
Non-Traded(Low Wage)×Skilled Immigrant	-0.078	-0.040	-0.010
	(0.059)	(0.039)	(0.044)
Traded×Skilled Immigrant	0.090	0.052	0.068
	(0.078)	(0.055)	(0.074)
Non-Traded(High Wage)×Skilled Immigrant	-0.113	-0.074	-0.024
	(0.063)	(0.045)	(0.022)
Non-Traded(Low Wage)×Other Immigrant	-0.070	-0.049	-0.027
	(0.048)	(0.033)	(0.023)
Traded×Other Immigrant	0.039	0.019	0.026
	(0.063)	(0.046)	(0.066)
Non-Traded(High Wage)×Other Immigrant	-0.029	-0.049	0.015
	(0.063)	(0.033)	(0.024)
Controls			
Year	Yes	Yes	Yes
Covariates	Yes	Yes	Yes
Sector	Yes	Yes	Yes
Sector Trends	Yes	Yes	Yes

Notes: Sample Size 2686, * significant at 5% level. HAC robust panel standard errors in brackets.

Table A2: Hiring - Alternative Immigration Definitions

	Share(M/(N+M))	Ratio (M/N)	Fixed Ratio (M/N_0)
Panel A			
Skilled Immigrants	-0.001	- 0.001	0.001
	(0.001)	(0.001)	(0.001)
Panel B			
Non-Traded(Low Wage)×Skilled Immigrant	0.002	0.012*	0.003*
	(0.002)	(0.001)	(0.002)
Traded×Skilled Immigrant	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Non-Traded(High Wage)×Skilled Immigrant	−0.004*	−0.004*	0.001
	(0.001)	(0.001)	(0.001)
Panel C			
Non-Traded(Low Wage)×Skilled Immigrant	0.002	0.002*	0.003*
	(0.001)	(0.001)	(0.001)
Traded×Skilled Immigrant	-0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Non-Traded(High Wage)×Skilled Immigrant	−0.004*	−0.004*	-0.001
	(0.001)	(0.001)	(0.001)
Non-Traded(Low Wage)×Other Immigrant	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Traded×Other Immigrant	−0.002*	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Non-Traded(High Wage)×Other Immigrant	−0.002*	-0.001	-0.001
	(0.001)	(0.001)	(0.001)
Controls			
Year	Yes	Yes	Yes
Covariates	Yes	Yes	Yes
Sector	Yes	Yes	Yes
Sector Trends	Yes	Yes	Yes

Notes: Sample Size 2686, * significant at 5% level. HAC robust panel standard errors in brackets.

Table A3: Standard Error Robustness Check

	HAC (Table 3)	Parsen Kernel	HAC (Bandwidth 2)	Cluster: Sector	Cluster: Sector Year
Training					
Non-Traded(Low Wage)×Skilled Immigrant	-0.078	-0.078	-0.078	-0.078	-0.078
	(0.060)	(0.061)	(0.063)	(0.057)	(0.083)
Traded×Skilled Immigrant	0.090	0.090	0.090	0.090	0.090
	(0.078)	(0.077)	(0.075)	0.080	0.077
Non-Traded(High Wage)×Skilled Immigrant	-0.113	-0.113	-0.113	-0.113	-0.113
	(0.063)	(0.062)	(0.059)	(0.067)	(0.074)
Hiring					
Non-Traded(Low Wage)×Skilled Immigrant	0.0017	0.0017	0.0017	0.0017	0.0017
	(0.0016)	(0.0016)	(0.0016)	(0.0015)	(0.0015)
Traded×Skilled Immigrant	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
	(0.0011)	(0.0011)	(0.0011)	(0.0011)	(0.0010)
Non-Traded(High Wage)×Skilled Immigrant	−0.0042*	−0.0042*	−0.0042*	−0.0042*	−0.0042*
	(0.0014)	(0.0015)	(0.0016)	(0.0018)	(0.0017)

Notes: Sample Size 2686, * significant at 5% level. Controls as in Column 3 Table 3. The default kernel in column 1 is Bartlett. Bandwidth 2 with a Bartlett Kernel implies autocorrelation of order 1 is allowed for.

Table A4: Estimation Robustness Checks

	First Diff	LDV	First Diff IV	Within Group IV
Training				
Non-Traded(Low Wage)×Skilled Immigrant	0.014	-0.065	-0.152	-0.338
	(0.067)	(0.061)	(0.174)	(0.493)
Traded×Skilled Immigrant	0.180	0.063	0.050	-0.665
	(0.085)	(0.026)	(0.208)	(1.014)
Non-Traded(High Wage)×Skilled Immigrant	-0.023	-0.097	-0.121	0.763
	(0.069)	(0.065)	(0.176)	(1.129)
Hiring				
Non-Traded(Low Wage)×Skilled Immigrant	0.0026	0.0038	0.0029	0.0239
	(0.0012)	(0.0015)	(0.0037)	(0.0221)
Traded×Skilled Immigrant	0.0014	0.0010	0.0037	-0.0128
	(0.0007)	(0.0010)	(0.0021)	(0.0292)
Non-Traded(High Wage)×Skilled Immigrant	-0.0012	-0.0027	0.0059	0.0286
	(0.0013)	(0.0014)	(0.0034)	(0.0289)

Notes: Sample Size 2686, * significant at 5% level. Controls as in Column 3 Table 3

Derivation of Wages Under Bargaining

The Case Without Migration

The offered wage to the worker in the first sub-period of bargaining, w_1^T, satisfies .

$$w_1^T = \tau w^u + (1-\tau) w_2^T$$

where w_2^T is the wage that the worker would offer in their counter offer to the firm. w_2^T must satisfy

$$p_s^x a_x^t - w_2^T - eR - C \geq \tau 0 + (1-\tau)[p_s^x a_x^t - w_3^T - eR - C]$$

where w_3^T is the further counter offer by the firm and where τ is the exogenous chance that the match breaks down. Similarly w_3^T must satisfy

$$w_3^T = \tau w^u + (1-\tau) w_4^T$$

Since subperiod 4 is the final sub period then w_4^T will simply be set to the maximum level that the firm will accept so that

$$w_4^T = p_s^x a_x^t - eR - C$$

These equations can be solved by iterated substitution (backward induction) into the expression for w_1^T to give

$$w_1^T = \tau[1 + (1-\tau)^2] w^u + (1-\tau)[\tau + (1-\tau)^2](p_s^x a_x^t - eR - C)$$

This gives us the expression for w^T in the text

$$w^T = \kappa w^u + \xi(p_{i,s} a_x^t - eR - C)$$

The Case With Skilled Immigration

If a firm is matched initially with an indigenous worker then the offered wage in the first sub-period of bargaining, w_1^t, satisfies the same expression as before

$$w_1^T = \tau w^u + (1-\tau) w_2^T$$

But now w_2^T must take into account that the firm has the possibility of meeting a migrant worker if it rejects the counter offer. Thus w_2^T must satisfy

$$p_s^x a_x^t - w_2^T - eR - C \geq \tau(1-\pi^m)0 + \tau\pi^m[p_s^x a_x^t - w_3^{T,m} - eR - C] + (1-\tau)[p_s^x a_x^t - w_3^T - eR - C]$$

where $\tau\pi^m$is the exogenous chance that the match breaks down and the firm is matched with a migrant worker.

The firm will choose the offer, w_3^T or $w_3^{T,m}$ so that the relevant worker is indifferent between accepting and making a final take it or leave it counter offer w_4^t (which will be the same for both types of workers) so that

$$w_3^T = \tau w^u + (1-\tau)w_4^t; \quad w_3^{T,m} = \tau w^m + (1-\tau)w_4^t;$$

It follows that $w_3^T > w_3^{T,m}$ since $w^u > w^m$
Given this the equations can be solved by iterated substitution as before so that

$$w_1^T{=}\tau(1+(1-\tau)^2)w^u{+}(1-\tau)\tau^2\pi^m w^m{+}(1-\tau)[\tau+(1-\tau)^2-\tau^2\pi^m)](p_s^x a_x^t - eR - C)$$

Thus we can write the equation for w^t in the text

$$w^T = \kappa^u w^u + \kappa^m w^m + \xi(p_{i,s}a_x^t - eR - C)$$