‘Good Jobs’, Training and Skilled Immigration*

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This Version September 2017

Abstract

While skilled immigration ceteris paribus provides a short term 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 develops a theoretical model of income distribution dynamics with training in equilibrium. It shows that while the immigration of high wealth agents and skilled workers into traded sectors may be beneficial for both income per capita and social mobility in the receiving economy, skilled immigration also has the potential to reduce training levels in non-traded sectors, thereby enforcing income inequality and reducing the expected welfare of low wealth indigenous workers, even though it increases profitability and GDP per capita. Furthermore, the paper presents evidence from the UK labour market that this may not be a purely theoretical concern. Training and hiring rates of UK-born younger workers have fallen more in sectors with larger increases in the share of ready trained immigrant workers.

Keywords: Immigration, Training

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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 have a beneficial impact on an economy’s aggregate productivity. (See e.g. Mountford and Rapoport (2011) and Wadsworth (2010)). Moreover the empirical evidence for countries like the UK, (Manacroda, Manning and Wadsworth (2012)), suggests that rising immigration appears to have had little detrimental effects on the average employment prospects of UK-born workers, whether less skilled or otherwise. 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 instead source a ready supply of trained workers rather than undergo the expense of training a local workforce. Consequently social mobility in the receiving economy, as well as the welfare of this group, could be reduced by skilled immigration. In this paper we develop a simple theoretical model to show how these effects may occur in equilibrium and offer some empirical evidence to suggest that training and hiring rates of indigenous workers are falling in industries and occupations with rising immigration rates of trained adults.

The existing theoretical literature on the economics of training has long followed Becker (1964) to show that firms will not provide general training unless they are able to capture part of the worker’s increased marginal productivity. In this paper we examine the role of training on social mobility and in turn analyse the effects of skilled immigration on this. We imbied a model of employment based training into a model of income distribution dynamics and show how informational asymmetries imply that low wealth individuals cannot borrow to finance their own training. However if a) firms have an informational advantage over financial markets in monitoring their employees and b) are also able, via wage bargaining, to capture a part of the increase in their workers’ productivity due to training, then 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.

Skilled immigration has the potential to limit and erode the beneficial effect of on-the-job training in the non-traded sector. In contrast to the traded sector, the number of firms offering on-the-job training is limited by the demand from the domestic economy.

\[1\text{See Acemoglu and Pischke (1999a, 1999b). This can occur due to asymmetric information between employers and employees, imperfect competition in the labour market, or contractual obligations of training programs see Dustmann and Schoenberg (2012)}\]
While an immigrant worker in the traded sector will increase the demand for non-traded goods and so potentially increase the number of ‘good jobs’ in the non-traded sector, an immigrant in the non-traded sector will not increase demand by enough to cover their own output and so the possibilities for training among indigenous workers is reduced. Furthermore if firms are able to hire already trained workers from abroad, this will improve the firms’ bargaining position and reduce the returns to training for indigenous workers. In short, there may be negative effects of skilled immigration on the numbers of indigenous workers trained and on social mobility. We demonstrate these possibilities below in a dynamic general equilibrium model.

The role played by human capital accumulation in both economic growth and social mobility is well established and widely accepted, (Barro and Sala-i Martin (1992), Galor and Zeria (1993) ). We show in section 6 using data on training across sectors in the UK taken from the Labour Force Survey (LFS) that there is a negative association between rates of training and immigration levels. We do not argue that this is conclusive evidence that skilled immigration reduces indigenous training - there is insufficient data to fully trace the effects of skilled immigration on social mobility - but given the widely accepted empirical link between human capital accumulation and social mobility, and the theoretical mechanism outlined in the model then these findings in our view give cause for concern and merit deeper investigation and further study.

2 Recent Trends in Training and Immigration

In this section we provide broad motivation for our analysis by setting out some recent trends in immigration and training levels in the UK economy. Figure 1 outlines the changing incidence of on-the-job training and hiring in the UK over time. There is a clear downward trend in the share of employees who say they have received some training (at work or at college) while employed over the past 3 months. The trend decline is notably steeper for the UK-born under 25s. The hiring rate, in contrast is much more cyclical, either in aggregate or among younger workers, where the annual hiring rate is typically close to one half of all employees.
Figure 1: Training and Hiring Rates by Age

Figure 2 shows the aggregate shares of immigrants (who arrived as adults) working in different sectors and occupations. While the aggregate trend over the sample period is undoubtedly upward, it is clear that certain sectors and occupations make differential use of migrant workers around this rising trend.

Figure 2: Immigrant Adult Share by Industry and Occupation
3 A Simple Model of Training and Social Mobility

To establish how immigration could influence the allocation of native-born workers to different sectors, this section describes a simple model to illustrate the potential effects of immigration on human capital accumulation, social mobility and income distribution. The theoretical model builds on the framework of social mobility and income distribution dynamics of Galor and Zeira (1993) and Maoz and Moav (2004). We assume 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. We show that 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 daily interaction with their employees. They are able, for a small cost, to monitor them and oversee their investment in training.\footnote{This assumption follows the financial literature on monitoring of e.g. Diamond (1984, 1991).} We assume that the wages of trained workers are determined by bargaining so that the benefits of training are shared between the worker and the firm.\footnote{Dustmann and Schoenberg (2009) argue that intertemporal agreements or understanding between unions and employers allows training to take place.} 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 in section 5 the possibility to hire already trained workers from overseas alters the equilibrium and so may impede social mobility.

3.1 Production

We assume there is a traded good and a non-traded good. The output of the traded good at time period $s$, $Y^t_s$, is given by the following production function,

$$Y^t_s = F^U(L^u_{t,s}) + F^H(L^H_{t,s}, K_{t,s})$$

where $L^u_{t,s}$ is the number of unskilled workers, $L^H_{t,s}$ 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 $F^U(L^u_{t,s}) = u^u_s L^u_{t,s}$ and $F^H(L^H_{t,s}, K_{t,s})$
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. The production function thus follows Galor and Zeira (1992) and assumes that capital is more complimentary in production with skilled labor than with unskilled labor. We will assume that wages in this sector are determined competitively and are equal to their respective marginal products.

The non-traded good is the sector of interest in this paper. In order to incorporate bargaining in models with competitive firms and markets we follow the macroeconomics literature and assume that the non-traded good is produced perfectly competitively using a variety of specialized inputs, where each variety producer has monopoly power. Specifically we follow Christiano, Eichenbaum and Trabandt (2016), where at time $s$ the non traded good, $Y_{s}^{nt}$ is produced under perfect competition using a continuum of specialized inputs, $Y_{j,s}$, according to the following production function

$$Y_{s}^{nt} = \left[ \int_{0}^{1} Y_{j,s}^{p} dj \right]^{\frac{1}{\rho}}$$

where $0 < \rho < 1$.

Each specialized input is produced by a monopolist according to a constant returns to scale production function

$$Y_{j,s} = A_{j} x_{s}^{j}$$

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 $p_{x,s}$ 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 $\frac{p_{x}}{A_{j}}$. 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,

$$p_{s}^{j} = \frac{p_{x}}{A_{j} \rho} \quad \forall j$$

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4We are interested in sectors which employ skilled workers and which derive their demand from the domestic market such as teachers, health workers, lawyers although of course it is possible to sell these services abroad. However for simplicity in the baseline model we abstract from this possibility.

5The results of this paper are not dependent on these particular assumptions as will become clear below but these assumptions do allow for a straightforward closed form analytical solution.
where \( \varepsilon = \frac{1}{1 - \rho} \) is the price elasticity of demand for the specialist inputs.

The rate of interest is set exogenously by the world capital market, at a level \( R \) and capital is allowed to flow in and out of the economy in an unrestricted way so that the interest rate in the economy always equals \( R \). This implies that amount of capital in the economy is always such that

\[
k_s = \frac{K_{t,s}}{L_{t,s}} = \tilde{k}
\]

where \( f'(\tilde{k}) + (1 - \delta) = 1 + r = R \). Thus the skilled wage, \( W^H_t \), is fixed at the marginal product of human capital is \( f(\tilde{k}) - f'(\tilde{k})\tilde{k} \) where \( \tilde{k} \) is fixed. The unskilled wage is also fixed and equal to \( w^u \). There is free movement of unskilled workers between sectors.

### 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.

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

\[
c^t_{s+1} + p^{nt}_{s+1} c^{nt}_{s+1} + b_{s+1} = I^i_{s+1}
\]

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:

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

(1)
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 with the probability of success depending on the actions of individuals. Following Holmstrom and Tirole (1997) we assume that individuals have a choice between being diligent which implies a success probability of $\pi^h$ and being less diligent which implies a success probability of $\pi^l$ 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, i.e. obtaining skills, in equilibrium. The below, in section 3.5, we follow the financial economics literature on monitoring and financial markets and assume that employers in the intermediate goods sector have the ability to ensure their employee’s diligence at a cost of $C$, via monitoring.\(^6\) 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 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.\(^7\) This implies that the parameters in the model are such that

\[
\pi^h(w^H - w^u) > eR \\
\pi^l(w^H - w^u) + B < eR
\]

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

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\(^7\)The model would not be of interest if this was not the case.
subsistence level of consumption, \( \bar{c} \). This distorts the investment decision of individuals with low wealth. Individuals will have an incentive to borrow at rate \( R^* \) to invest in human capital accumulation if either of the following two conditions hold

\[
\pi^h(w^H - \bar{c} - R^*(e - b^i)) + (1 - \pi^h)(0) > w^u - \bar{c} + b^i R
\]
\[
\pi^l(w^H - \bar{c} - R^*(e - b^i)) + (1 - \pi^l)(0) + B > w^u - \bar{c} + b^i R
\]

This implies that for individuals to choose to be diligent, \( R^* \) must satisfy the following inequality

\[
R^* < \frac{1}{(e - b^i)}[(w^H - \bar{c}) - \frac{B}{\pi^h - \pi^l}] \tag{2}
\]

Banks need to make the expected international rate of return, \( R \). This can only occur if individuals choose to be diligent and also if \( R^* \) satisfies the following inequality

\[
R^* > \frac{1}{(e - b^i)} \frac{R(e - b^i) - (1 - \pi^h)(w^u - \bar{c})}{\pi^h} \tag{3}
\]

Those with a higher level of wealth (bequests) have a greater incentive to be diligent and so can be charged a higher interest rate in equilibrium. Inequalities (2) and (3) imply that there will be no lending in equilibrium to individuals with wealth level, \( b^i \), if

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

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

\[
\hat{b} = e - \frac{(w^u - \bar{c}) + \pi^h(w^H - w^u) - \pi^h B}{\pi^h R} \tag{4}
\]

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 can use their wealth to purchase education. Thus in the absence of government intervention there would be no upward income mobility for low wealth agents.\(^8\)

### 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

\(^{8}\text{See the Section 4 below on income distribution dynamics}\)
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

\[ p_s^j = \frac{p_s^x}{A_j \rho} = \frac{w_s^u}{a_s^u A_j \rho} \quad \forall j \]

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

\[
\frac{\beta}{p_{sL}} \left[ \int_{i \in L^u} (b^i_s + w^u - \tilde{c}) + \int_{i \in L^x} (b^i_s + w^x - \tilde{c}) + \int_j \Pi_j \right] = a_x^u A_j L_{x,s}^u
\]

where \( \Pi_j \) are the profits from the specialist input firms which are distributed firm owners.\(^9\)

In the event that there are not enough unskilled workers then all unskilled workers would work in the non-traded sector and their wage and so the price of the non-traded good would be bid up until equilibrium was obtained. Wages can only rise as high as to make wealthy agents indifferent to becoming skilled or unskilled.

### 3.5 On-The-Job Training

In this section we assume that on-the-job training is a possible route to accumulating human capital in the intermediate goods sector. We assume that the nature of work is such that employers can ensure the diligence of an employee by monitoring at an additional cost of \( C \), in the spirit of Holmstrom and Tirole (1997). For ease of comparison we assume that the cost of training and success probability of these workers and their productivity is the same as for skilled workers, although this is not at all necessary for the analysis.\(^{10}\) If \( C \) is sufficiently small then there is enough surplus for both the

\(^9\)We assume these are a very small number of firm owners and ignore their impact on income distribution dynamics.
\(^{10}\)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
firm and the worker to gain from the firm offering on the job training to 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 the alternative offers bargaining mechanism of Christiano, Eichenbaum and Trabant (2016) as this provides a clean closed form solution to the sharing problem whilst maintaining consistency with the competitive structure of the rest of the model.

We assume that there are measure $M$ firms with the capability of offering on the job training in the intermediate goods sector. Each firm, $k$, must pay a fixed cost $\Phi_k$ 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 $x^i$ 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 $J_s$, is given by the following expression

$$J_s = p^s_s x^i - w^t - eR - C$$

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 $\Phi_k = \Phi_k \tilde{R}$. We assume that this fixed cost liability, $\Phi_k$, is uniformly distributed in the range $[\Phi, \bar{\Phi}]$. Otherwise the firms are identical and operate under free entry and behave competitively.

In equilibrium, because of free entry, it must be the case that the marginal firm, $k$, makes zero profits. Thus it must either be the case that $J_s = \Phi_k$ with the residual demand for intermediate goods being satisfied by the constant returns to scale firm using untrained unskilled labor, or the entire demand is satisfied by the training firms in which case $J_t \geq \bar{\Phi}$. In the former case the price of intermediate goods, $p^s_s$, is given by the price that unskilled workers can supply it $p^s_s = w^u_s / a^u_x A_j \rho$ and in the latter case it will be the highest price that satisfies the total demand for intermediate goods as well as the constraints that $p^s_s \leq w^u_s / a^u_x A_j \rho$ and that $J_s \geq \bar{\Phi}$.

The value of a match and successful training and employment to a worker is simply $w^t$ while the value to the worker of not agreeing with the firm, being unsuccessful at

\footnote{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.}
training or not finding a match is being an unskilled worker, earning wage \( w^u \). The bargaining process is costly in two dimensions. It is costly in terms of resources in that every round of bargaining (both offer and counteroffer) after the first implies a loss of a fraction \( \zeta \) of output. There is also the exogenous probability \( \tau \) that negotiations irrevocably break down in between bargaining rounds. Given this the firm will not propose a wage that the worker will reject in the first round and so a firm will offer their worker a wage, \( w^t \) that make him/her indifferent between accepting and making a counter offer. This is given by the following expression.

\[
w^t = \tau w^u + (1 - \tau)w^c
\]

where \( w^c \) is the wage that the worker would offer in their counter offer to the firm. What is this wage \( w^c \)? Again it makes sense for the worker to offer a wage that the firm will accept. The firm will be indifferent between accepting and rejecting the offer if the benefit of accepting the offer \( p^s x^i (1 - \zeta) - w^c - hR - C \) is equal to or better than the expected benefit of making a counter offer which is \( \tau 0 + (1 - \tau)(1 - \zeta)J_t \) or such that

\[
p^s x^i - w^c - hR - C = (1 - \tau)(1 - \zeta)J_t
\]

These equations can be solved to provide a formula for the sharing of the surplus of the on the job training arrangement between the firm and the worker. This is given by

\[
w^t = \kappa w^u + \xi (p_{i,s} x^i - hR - C)
\]

where

\[
\kappa = \frac{\tau}{(1 - (1 - \zeta)(1 - \tau))^2} \quad \xi = \frac{\tau - (1 - \tau)(1 - \zeta)}{(1 - (1 - \zeta)(1 - \tau))^2} (1 - \tau)
\]

Note that if \( \tau \) is zero then \( \kappa \) is zero and \( \xi \) is one and so \( w^t \) extracts the entire surplus of the match. Conversely if \( \tau \) is one then \( \kappa \) is one and \( \xi \) is zero and then the firm extracts all the surplus from the match. For intermediate values of \( \tau \) the surplus of the match is split between the firm and the worker. Thus by varying \( \tau \) - a measure of the bargaining power of labor - all possible divisions of the surplus between the firm and the worker are possible.

3.5.1 Equilibrium with On-the-Job Training

As in section 3.4 equilibrium with the job training is achieved by the allocation of unskilled workers between the traded and non-traded sectors. The equilibrium conditions
must now account for the additional income of the trained workers in the non-traded sectors. Given the agent’s first order conditions and assuming a symmetric equilibrium where \( p^i_t = p \ \forall i \) the market clearing condition is given by

\[
\frac{\beta}{p_{nt,s}} \left[ \int_{i \in L^u} (b^i_s + w^u - \hat{c}) di + \int_{i \in L^e} (b^i_e + w^e - \hat{c}) di + \int_j \Pi_j dj + \int_j \Pi_d dj \right] = \int_{i \in L^t} x^i + a_x A_j L_{x,s}^u
\]

where \( \Pi_j \) are the profits from the specialist input firms and the on the job training firms which are distributed to a very number of firm owners and we ignore their impact on income distribution dynamics.

### 4 Social Mobility and Human Capital Accumulation

The previous section has shown how agents may not be able to borrow to finance human capital accumulation and how on the job training may allow low wealth individuals to earn more than the unskilled higher. In this section we first describe the implications of on the job training for social mobility. In section 4.1 we first describe the dynamics and social mobility of the economy without on the job training before analyzing the case with on the job training 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 \( \hat{b} \) will themselves leave a bequest of \( \hat{b} \) or more as well as a corresponding assumption about unskilled wages. We therefore assume that the following conditions for \( w^u_s \) and \( w^H_s \),

\[
w^u_{s+1} < \hat{c} + \frac{\hat{b}}{(1 - \alpha - \beta)} - R\hat{b}
w^H_{s+1} > \hat{c} + \frac{\hat{b}}{(1 - \alpha - \beta)}
\]

Note that this implies that \((1 - \alpha - \beta)R < 1\) since bequests must be positive.

#### 4.1 Income Distribution Dynamics Without On-the-Job Training

When there is no on-the-job training then agents with bequest lower than \( \hat{b} \) will remain unskilled. Agents with bequest greater than \( \hat{b} \) will be able to borrow to invest in their
skills. The above implies that the interest rate charged to borrowers will be greater than the world rate of interest received by lenders. Given this the equation describing the intergenerational dynamics, equation 6 will have three sections, those with wealth (bequests) below \( \tilde{b} \), those with wealth (bequests) greater then \( \tilde{b} \) but less than \( e \) and those with wealth (bequests) above \( e \). Equation 6 follows from our parameter restrictions above and the agents’ demand function from equation 1 and it is depicted in Figure 3.

\[
\begin{align*}
  b_{s+1}^i &= \begin{cases} 
    (1 - \alpha - \beta)[w_s^{H+1} - \tilde{c} + R((b_s^i) - e)] & \text{if training successful} \\
    (1 - \alpha - \beta)[w_s^{u+1} - \tilde{c} + R((b_s^i) - e)] & \text{if training unsuccessful} \\
    (1 - \alpha - \beta)[w_s^{H+1} - \tilde{c} - R^*(e - b_s^i)] & \text{if training successful} \\
    0 & \text{if training unsuccessful}
  \end{cases} \\
  \text{for } \tilde{b} < b_s^i < e
\end{align*}
\]

The dynamics described by equation 6 are depicted in Figure 3. It appears to show two steady state levels of bequests where \( b_{s+1}^i = b_s^i \) but this is misleading as a fraction \( 1 - \pi^H \) wealthy agents do not succeed at becoming skilled and so there is a force in the direction of downward mobility in this group. However there is no corresponding force for upward mobility for low wealth agents and so the lower steady state level of \( b^i \) is indeed a steady state i.e. where

\[
b^i = \frac{(1 - \alpha - \beta)[w^u - \tilde{c}]}{1 - (1 - \alpha - \beta)R}
\]

Thus in this economy without government intervention there is no sustained upward social mobility. Being unskilled is an absorbing state and all unskilled workers face a positive probability that their wealth will decline and there dynasty will move closer to the trap of having wealth lower than \( \tilde{b} \).\textsuperscript{11}

### 4.2 Income Distribution Dynamics With On the Job Training

The presence of on the job training allows for the possibility of upward social mobility as some agents with low initial wealth may become trained in the intermediate goods sector and so earn a higher wage and leave a larger bequest to their offspring than an unskilled worker. As some low wealth agents will be trained this adds another line to
The dynamics described by equation 7 are depicted in Figure 4. Now the income
distributional dynamics have both a force for upward mobility as well as downward mobility. There is downward mobility for those wealthy agents who do not succeed in becoming skilled but now there is the potential for upward mobility for low wealth agents via on the job training. Clearly this potential depends on workers trained via on the job training obtaining significantly higher wages than unskilled workers but as equation 5 shows a large range for $w^t$ is possible in this model.

Figure 4 depicts the case where $w^t$ are high enough so that trained workers’ bequests will be above $\hat{b}$ 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 but clearly if $w^t$ is lower then the prospects for upward social mobility are reduced. We discuss the implications for long run social mobility in the following section.
5 The Effects of Skilled Immigration

We now analyse the case of skilled immigration into the economy. We have two main results which we will address in turn. In subsection 5.1 we show that high wealth and high skilled immigration into the traded sector has a positive effect on GDP per capita and a non-negative and potentially positive effect on the upward social mobility of low wealth indigenous workers. In contrast in subsection 5.2 we show how immigration into the on the job training sector even though it also can increase firm profitability and GDP per capita, will have a negative impact on the social mobility of low wealth indigenous workers. This is because the number of ‘good jobs’ - those with training - in the non-traded sector is limited by the size of the economy. An immigrant that works in the traded sector will increase the demand for non-traded goods and so potentially increase the number of ‘good jobs’ in the non-traded sector. However an immigrant that works in the non-traded sector will not increase demand by enough to cover their own output and so the possibilities for training among indigenous workers is reduced. Furthermore as we detail below immigrants in the non-traded sector may have additional negative effects on social mobility by reducing the bargaining power of workers in this sector.

5.1 High Wealth Migrants and Skilled Migrants in the Traded Sector

High wealth migrants or skilled individuals who can command their marginal product in the traded sector will increase the GDP per capita in the economy. This is seen from the market clearing condition, equation 6. An immigrant with sufficiently high wealth or one who works in the traded sector will increase the demand for non-traded goods and so clearly 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 not previously producing then this increase in demand will lead some to enter the market, raising the overall amount of training and hence raise the probability for upward social mobility.
5.2 Skilled Migrants in the Non-Traded Sector

There are various possible ways of modelling the immigration of skilled workers into the non-traded sector but the simplest is to assume that a given number of firms that pay their fixed cost $\Phi_k$ are able to meet and hire one already trained worker from abroad. The ability to hire trained workers from abroad rather than domestic unskilled workers will be preferred by firms as the surplus from the match will be increased by the size of the training cost, $e$, and so profitability in the intermediate goods sector will increase. The increase in the supply of the non-traded good produced by the migrant will be more than the increased demand from the wages and profits from this employment. Therefore the number of indigenous trained workers in this sector will fall and social mobility for this group will decrease.

The intuition of this example carries over to other possible set ups. For example if all potential on the job training firms are active and unskilled workers are employed in the intermediate goods sector then the negative effect on low wealth indigenous agents will be exacerbated. Similarly one could model scenarios where the equilibrium wages of trained workers fall in response to the possibility of a firm turning to trained migrant workers in the event of a failed bargain with an indigenous worker. Thus the intuition behind this result is very strong. We show in the following section that there is empirical evidence that such an effect may indeed be occurring,

6 Empirical Evidence on the Effects of Skilled Immigration

6.1 Data

In order to test the implications of the model above we need data on both the incidence of training, the age, education and country of origin of those trained and the share of trained immigrants working in each sector. All these pieces of information are contained in the UK Labour Force Survey (LFS). The LFS is a random sample of around 50,000 households and the individuals therein conducted every quarter. 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. This is the measure of on-the-job training that we use. The LFS also contains details of the country of birth, age and year of arrival of any
immigrants. From this we can estimate the incidence of training for young (defined here as age 16-24) UK-born workers alongside an identifier for whether the immigrant arrived as an adult, with or without some after high school education - proxied here by age of arrival after the age of 22 of anyone who left full-time education after the age of 18 (ie after high school). These data can then be aggregated to 2-digit sectoral level or 3-digit SOC occupations. To boost the sample size in each sector we pool across all 4 LFS quarters in each year.\textsuperscript{12} We utilise the longest consistent period of SIC classifications in the LFS, based on the 1992 SIC - which run consistently in the LFS from 1995 to 2010. As a robustness check we also undertake the analysis using 45 (3 digit 2000 SOC) occupations estimated over a shorter 10 year window also afforded by the data.\textsuperscript{13} This generates a balanced panel of around 50 sectors over 16 years of data. The estimation is thus of the type

\[ OJT_{it} = \beta^0 + \beta^1 X_{it} + \gamma Z_{it} + u_{it} + \epsilon_{it} \]  

(8)

where $\beta^1$ is the parameter of interest and $Z$ are a set of controls that can include sector fixed effects or a lagged dependent variable. The variance of the error term will contain a group (sector) specific component but also could be influenced by the different sized populations in each sector as well as possible unobserved spillovers across groups. The number of clusters is quite small and close to the threshold at which Donald and Lang (2007) suggest caution needs to be exercised with regard to clustering techniques. We therefore estimate the model that uses HAC error robustness, that is is robust to heteroskedasticity of unknown form and also allow for unknown autocorrelation of order two or less, (see Cameron and Millar (2013) .

Since the model can also be interpreted as a willingness to take on local-born workers we also examine the incidence of hiring, measured here as the proportion of the sector workforce who are UK-born and in a job for less than 12 months.

6.2 Results

Table 1 gives the sample mean training and hiring rates across sectors and occupations over the sample period. In 1995 around 4.2% of the workforce were aged 16-24 born in the UK and in receipt of on-the-job training. Some 6% of the workforce had been hired in

\textsuperscript{12}This ensures that there is a minimum of 100 observations in each sector in each year
\textsuperscript{13}It is very difficult to obtain consistent estimates of either the dependent or independent variables across breaks in the SIC or SOC
the last year aged 16-24 and born in the UK. The workforce share of young native-born workers in receipt of training was highest in the Hotel and Restaurants sector (SIC 55) and lowest in the transport sector (SIC 60). These sectors also had, respectively, a high (low) hiring rate of the same type of workers and a relatively high (low) share of the workforce who had arrived in the UK as adults. By 2010 the average training share of young workers had fallen to 2.8% of the workforce. The hiring rate for young native-born youth was down to 3.5% and the average immigrant adult share at the workplace had grown to 7.6%. On-the-job training in the Hotels sector was little changed but the immigrant share at the workplace had tripled. In contrast, training and hiring in the transport sector were both down and the adult immigrant share had also risen threefold.

Table 1: Immigration and On-the-Job Training by Sector 1997-2010

<table>
<thead>
<tr>
<th></th>
<th>Training</th>
<th>Hiring</th>
<th>Immigrant Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995 Total</td>
<td>0.042</td>
<td>0.060</td>
<td>0.024</td>
</tr>
<tr>
<td>SIC 55 (Hotels)</td>
<td>0.086</td>
<td>0.176</td>
<td>0.055</td>
</tr>
<tr>
<td>SIC 60 (Transport)</td>
<td>0.019</td>
<td>0.027</td>
<td>0.027</td>
</tr>
<tr>
<td>2010 Total</td>
<td>0.028</td>
<td>0.035</td>
<td>0.076</td>
</tr>
<tr>
<td>SIC 55 (Hotels)</td>
<td>0.084</td>
<td>0.152</td>
<td>0.153</td>
</tr>
<tr>
<td>SIC 60 (Transport)</td>
<td>0.011</td>
<td>0.013</td>
<td>0.087</td>
</tr>
</tbody>
</table>

Source LFS

To see which of the effects observed in Table 1 win out in the full sample, Table 2 outlines the estimates from a set of regressions of the UK-born adult training workforce share on the sectoral (2 digit SIC) employment share of immigrants who arrived as adults, with or without some education after high school. The immigrant variables are lagged to try to reduce endogeneity concerns over simultaneity, as are any control variables. Column 1 gives the raw correlation, column 2 the pooled OLS estimate of the training level effect of immigration net of any controls. Column 3 controls for industry fixed effects and hence identifies any immigration effects through differential changes in training rates across sectors. Column 4 instruments the lagged immigrant variable with a further lag and column 5 attempts to bound the immigrant effect by estimating a model with
a lagged dependent variable and no fixed effect.\textsuperscript{14} The results suggest there may be a significant, but economically small, negative association between the share of (trained) immigrants in the sector and the incidence of on-the-job training among young UK-born adults employed in the sector. The levels effect (column 2) are negative and highly significant, though the magnitude of the estimated immigration effect for young workers in particular is not large. A one percentage point increase in the share of immigrants in the sector, reduces the training share of young adults by around 0.2 percentage points.

The fixed effects estimators are also negative, more significant for young UK-born adults rather than all UK-born workers. The point estimates are generally larger when the explanatory variable is the share of trained immigrants, though the effect is not statistically different from the point estimates using all adult immigrants. Column 3, row 4 suggests that a five percentage point rise in the share of immigrants in the sector (approximately the mean change over the period) is associated with a 0.5 percentage point fall in the incidence of on-the-job training of young native-born workers. The bounding effect implied by estimation of a lagged dependent variable and fixed effects models suggest the effect does not stray too far from this. The IV estimates are generally larger than the fixed effects estimates, suggesting the fixed effects estimates may be attenuated by measurement error or biased up by other endogeneity concerns.\textsuperscript{15}

\textsuperscript{14}See Angrist and Pischke for a discussion of how the fixed effects and LDV estimators can bound the effect.

\textsuperscript{15}Tables A1 and A2 in the appendix repeat the estimation using 67 (3 digit) occupation as the cross-section unit over a shorter time period determined by data availability. The results for hiring are broadly similar to those using industry, though not as significant. While the levels effect of immigration on training remains, the estimated training (growth) effect is not significant and the point estimates are sometimes positive when using occupation.
Table 2: Immigration and On-the-Job Training of UK-Born Adults by Sector 1997-2010

<table>
<thead>
<tr>
<th>Variables</th>
<th>OLS 1</th>
<th>OLS 2</th>
<th>Fixed Effects 3</th>
<th>IV 4</th>
<th>LDV 5</th>
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<tbody>
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<td>All UK-born</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immigrant t-1</td>
<td>-0.156</td>
<td>-0.793**</td>
<td>-0.105</td>
<td>-0.420**</td>
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<td></td>
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<td>(0.074)</td>
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<tr>
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<td>-0.927</td>
<td>-0.955**</td>
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<td>-1.108**</td>
<td>-0.070</td>
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<td></td>
<td>(0.182)</td>
<td>(0.041)</td>
<td>(0.103)</td>
<td>(0.295)</td>
<td>(0.064)</td>
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<td>UK-born 16-24</td>
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<td>Immigrant Share t-1</td>
<td>-0.003</td>
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<td>-0.060**</td>
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<td>-0.056**</td>
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<tr>
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<td>(0.037)</td>
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<td>(0.029)</td>
<td>(0.059)</td>
<td>(0.021)</td>
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<td>Immigrant Trained t-1</td>
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<tr>
<td>Industry</td>
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<td>No</td>
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<td>No</td>
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</tbody>
</table>

Notes: ** significant at 5% level. HAC robust panel standard errors in brackets. Sample size in each column is 714. 51 industries. Immigration is instrumented with 2nd lag. Controls include lagged average (mean) age, log hourly wage, share of female, self-employed, part-time, temporary job, graduate workers in the sector.

Table 3 repeats the exercise using the sectoral hiring rate of young UK-born adults as the dependent variable. The raw correlations between hiring and immigration are positive, (column 1), but the point estimates turn negative with the addition of time and sector varying controls (column 2). The fixed effects immigration estimates are also negative and significant, with the exception of trained immigrants on youth hiring. Hiring of UK-born workers was generally lower in occupations with a large immigrant share, though again the magnitude of this effect is not large. Unlike with the estimates for training, the hiring effects are generally larger and more negative for all UK-born workers.
Table 3: Immigration and Hiring of Young UK-Born Adults by Sector 1997-2010

<table>
<thead>
<tr>
<th>Variables</th>
<th>OLS 1</th>
<th>OLS 2</th>
<th>Fixed Effects 3</th>
<th>IV 4</th>
<th>LDV 5</th>
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</thead>
<tbody>
<tr>
<td>All UK-born</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immigrant t-1</td>
<td>0.319**</td>
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<td>-0.260**</td>
<td>-0.621**</td>
<td>0.011</td>
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<td>(0.065)</td>
<td>(0.132)</td>
<td>(0.037)</td>
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<tr>
<td>Immigrant Trained t-1</td>
<td>0.155**</td>
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<td>-0.332**</td>
<td>-0.909**</td>
<td>-0.038</td>
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<td></td>
<td>(0.078)</td>
<td>(0.067)</td>
<td>(0.091)</td>
<td>(0.257)</td>
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<tr>
<td>UK-born 16-24</td>
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<td>Immigrant t-1</td>
<td>0.200**</td>
<td>-0.097**</td>
<td>-0.079**</td>
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<td>Immigrant Trained t-1</td>
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<td>-0.152**</td>
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<tr>
<td>Industry</td>
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<td>No</td>
<td>Yes</td>
<td>Yes</td>
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</tbody>
</table>

Notes: See Table 2.

Since the model suggests the economy-wide negative effects of immigrant supply may be greater if trained immigrants are brought into the non-traded sector, we next split the sample according to whether the industry is likely to trade abroad or not (SICs 1 to 39 against SICs 40 to 95). The mean share of the workforce who are UK-born and in receipt of training is higher in the non-traded sector in each year of the sample, while the native-born hiring rate and workforce share of immigrants is broadly the same. The results for traded and non-traded sector, using the the fixed effects estimates, are given in Table 4.\(^{16}\) The negative point estimates for the traded sector, when either training or hiring is the dependent variable are not significantly different, from those of the non-traded sector.\(^{17}\)

\(^{16}\)Results for other specifications available on request.
\(^{17}\)The samples are not large when split. Just 23 traded sectors and 28 non-traded sectors over 14 years.
<table>
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<tr>
<th></th>
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<th>Non-Traded</th>
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<th>Non-Traded</th>
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<tr>
<td>Immigrant t-1</td>
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<td>Immigrant Trained t-1</td>
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<td>(0.121)</td>
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<td>UK-born 16-24</td>
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Notes: See Table 2.

7 Conclusion

This paper has developed a theoretical model of income distribution dynamics with training in equilibrium. It shows that while the immigration of high wealth agents and skilled workers into traded sectors may be beneficial for both income per capita and social mobility in the receiving economy, skilled immigration also has the potential to reduce training levels in non-traded sectors, thereby enforcing income inequality and reducing the expected welfare of low wealth indigenous workers, even though it increases profitability and GDP per capita. Furthermore, the paper presents evidence from the UK labour market that this may not be a purely theoretical concern. While most existing empirical work finds very small effects of immigration on job prospects or wages of native-born workers the evidence here suggests there may be a (small) effect on which sectors native-born workers enter. UK training rates and hiring rates of UK-born young workers
appear to have fallen more in sectors with higher rates of immigration.
8 Appendix

Table A 1: Immigration and Training of Young UK-Born Adults by Occupation 2001-2010

<table>
<thead>
<tr>
<th>Variables</th>
<th>OLS</th>
<th>OLS</th>
<th>Fixed Effects</th>
<th>IV</th>
<th>LDV</th>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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<td>Immigrant Share t-1</td>
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Controls

Year: Yes
Covariates: Yes
Occupation: No

Notes: See Table 2. Sample size 536

Table A 2: Immigration and Hiring of Young UK-Born Adults by Occupation 2002-2010

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<th>Variables</th>
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<td>(0.021)</td>
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Controls

Year: Yes
Covariates: Yes
Occupation: No

Notes: See Table 2. Sample size 536
References


