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Working Paper

The impact of immigration on the structure of male wages: theory and evidence from Britain

IZA Discussion Papers, No. 2352

Provided in Cooperation with:
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Suggested Citation: Manacorda, Marco; Manning, Alan; Wadsworth, Jonathan (2006) : The impact of immigration on the structure of male wages: theory and evidence from Britain, IZA Discussion Papers, No. 2352, Institute for the Study of Labor (IZA), Bonn, https://nbn-resolving.de/urn:nbn:de:101:1-20090622390

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DISCUSSION PAPER SERIES

IZA DP No. 2352

The Impact of Immigration on the Structure of Male Wages: Theory and Evidence from Britain

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October 2006

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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IZA Discussion Paper No. 2352
October 2006

ABSTRACT

The Impact of Immigration on the Structure of Male Wages: Theory and Evidence from Britain*

Immigration to the UK has risen over time. Existing studies of the impact of immigration on the wages of native-born workers in the UK have failed to find any significant effect. This is something of a puzzle since Card and Lemieux, (2001) have shown that changes in the relative supply of educated natives do seem to have measurable effects on the wage structure. This paper offers a resolution of this puzzle – natives and immigrants are imperfect substitutes, so that an increase in immigration reduces the wages of immigrants relative to natives. We show this using a pooled time series of British cross-sectional micro data of observations on male wages and employment from the mid-1970s to the mid-2000s. This lack of substitution also means that there is little discernable effect of increased immigration on the wages of native-born workers, but that the only sizeable effect of increased immigration is on the wages of those immigrants who are already here.

JEL Classification: J6

Keywords: wages, wage inequality, immigration

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* We are grateful to Steve Machin, John Van Reenen and seminar participants at the LSE and the UCL-Cream Conference on "Immigration: Impacts, Integration and Intergenerational Issues" London, March 2006, for comments and suggestions.

1. Introduction

There is renewed interest in the economic impact of immigration in Britain, prompted by a rise in the share of foreign-born individuals in the working age population over the last ten years. In 2005, 11.5% of the working age population had been born overseas, up from the 8.5% share observed at the end of the last recession in 1993 and the 7% share observed in the mid-seventies, (see Figure 1 for the evolution of the immigrant share over the period 1975-2005). The addition to the UK population over this period caused by the rise in the number of working age immigrants, from 2.3 to 4.1 million, is about the same as that stemming from the increase in the native-born working age population caused by the baby boom generation reaching adulthood (up from 29.5 to 31.3 million).

The impact of immigration on labour market outcomes is a controversial issue among both economists and the general public. The largest body of evidence comes from the United States where different researchers have come to different conclusions about its effects. Card (1990, 2001, 2005) finds little discernible impact of immigration on native wages, while Borjas et al. (1996), Borjas (1999, 2003) argue that there is a pronounced negative effect on the wages of native-born workers caused by changes in the relative supply of immigrants.

However British evidence on the impact of immigration is rather scarce and one should not automatically assume that the impact of immigration in Britain will be similar to that in the U.S.[1] One notable recent UK study by Dustmann, Fabbri and Preston (2005) uses variation in the composition of immigrants relative to natives by skill and region and concludes that immigration has no discernible effect on the level of native wages. However there is a puzzle here. The conclusion that shocks to the supplies of different sorts of labour have no effect on wages is not easy to reconcile with the findings of Card and Lemieux (2001) who find that the return to education in Britain is sensitive to the supply of educated relative to less educated workers. If

[1] For example, as shown below, immigrants to Britain are, on average, better educated than native-born, something that is not true in the U.S. (see for example Schmitt and Wadsworth 2006).

changes in immigration affect relative supplies this would seem to imply that immigration must have an effect on labour market outcomes of native-born workers.

In this paper we offer a resolution of this apparent paradox. Starting from the multi-level CES production function approach used by Card and Lemieux (2001) to assess the contribution of changes in the supply and demand for skills on the wage structure, we extend the approach by allowing for the possibility that native and immigrant workers are perfect substitutes in production, an approach also taken by Ottaviano and Peri (2006) for the U.S.[2]

Like Ottaviano and Peri (2006) we find evidence that natives and immigrants are imperfect substitutes within age-education groups so that the native-immigrant wage differential is sensitive to the share of immigrants in the working age population. A 10% rise in the population share of immigrants is estimated to increase the native-migrant wage differential by around 2%. However, since immigrants and natives are not perfect substitutes this also acts to attenuate any effect of increased labour supply, caused by rising immigration, on the native wage distribution. Our estimates suggest that the only sizeable effect of increased immigration is on the wages of those immigrants who are already here. It is thus not surprising that Dustmann, Fabbri and Preston (2005) fail to find any effects of immigration on the wages of natives.

The structure of the paper is as follows. Section 2 describes the model of wage determination underlying our empirical approach. Section 3 highlights the empirical strategy based on this theoretical model and discusses identification and specification issues. Section 4 discusses the data used to produce the estimates and Section 5 reports the results of the regression analysis. Section 6 presents some simple simulations of the effects of immigration on the wage distribution based on our results and Section 7 concludes.

[2] Others (Grossman (1982), Chiswick et al. (1985), Borjas (1987)) have explicitly attempted to identify the elasticity of substitution between immigrant and native workers but differently from us these papers treat workers with different skills as perfect substitutes. Lalonde and Topel (1991), is an exception that looks at the extent of substitutability within the stock of immigrants.

2. Theoretical Framework

Consider a stylised model of labour demand, disaggregated by skill, age, similar to Card and Lemieux's (2001) model of changes in the returns to education and the 'structural' model in the second part of Borjas (2003). Unlike Card and Lemieux and Borjas, but similar to Ottaviano and Peri (2006) we treat immigrant and native workers as two different production inputs that may not be perfect substitutes and then estimate the elasticity of substitution between these two inputs from the data. We assume that the production function is of a nested CES form. Firms produce output using a combination of skilled and unskilled labour according to the production function:[3]

$$Y_t = A_t \left[\theta_t L_{1t}^{\rho} + L_{2t}^{\rho} \right]^{\frac{1}{\rho}} \tag{1}$$

where 1 is skilled labour, 2 is unskilled labour and $L_{et}, e = 1,2$ denotes the aggregate labour input for workers skill e at time t. A_t is a skill-neutral technology parameter, θ_t is the efficiency of skilled relative to unskilled labour so that any rise in θ_t represents skill-biased technical change, (SBTC). The elasticity of substitution between skilled and unskilled labour is σ_E=1/(1-ρ).

We model each of the skill-specific labour inputs as a CES combination of a set of (potentially) imperfectly substitutable age-specific labour inputs according to:

$$L_{et} = \left(\sum_a \alpha_{ea} L_{eat}^{\eta} \right)^{(1/\eta)}, \qquad e = 1,2 \tag{2}$$

where the index *a* denotes a specific age group (*a* = 1,2,.. A) and the elasticity of substitution between different age groups, σ_A=1/(1-η), is a parameter to be estimated but assumed to be skill invariant. The α_{ea} 's are measures of the relative efficiency of different age inputs for each education group. We follow Card and Lemieux in assuming that there is no age-biased technical change so that the α do not vary over time. Any time effects are therefore subsumed in (A_t, θ_t) at

[3] This can be thought of either as a long-run production function in which capital is endogenous or as a short-run production function in which Y is a composite labour input. As we only ever estimate models for relative wages, the discussion is not affected by the interpretation preferred.

the top level of aggregation. Furthermore, we impose the normalisation that α_{e1}=1. The normalization is innocuous as it can be thought of as defining the units of measurement of L_{et}.

So far, this model is identical to Card and Lemieux (2001). As an addition to their model and similar to Ottaviano and Peri (2006) we also assume that each age-education specific labour input is a CES combination of native born and immigrant workers:

$$L_{eat} = \left(N_{eat}^{\delta} + \beta_{eat} M_{eat}^{\delta} \right)^{(1/\delta)} \tag{3}$$

where N is native-born, M is immigrant and β is the native-immigrant relative efficiency parameter. The coefficient on N in (3) is again restricted to be equal to one without loss of generality. Equation (3) therefore allows the relative efficiency parameters on the native and immigrant workers – the β_{eat} - to vary by skill, age and time. This implies that wages of native-born relative to immigrants can vary over time even at fixed levels of demand and supply. This can happen because of changes in discrimination, changes in the "quality" of the immigration stock caused by either between or within-country of origin changes across cohorts, selective immigration or out-migration over the life cycle as well as changing costs of assimilation.

From(3), the elasticity of substitution between immigrant and native workers is given by σ_I=1/(*1-*δ). If $\delta \neq 1$ immigrants and natives are not perfect substitutes and then immigration, or any change in the relative supply of these two groups, will change the native-migrant wage differential. By equating immigrant and native-born wages to the appropriate marginal products of labour, using (1) to (3) we can derive an expression for the wages of natives and immigrants in each education-age-time cell:

$$\ln W_{eat}^{s} = \ln A_t + \frac{1}{\sigma_E} \ln Y_t + \ln \theta_{et} + \ln \alpha_{ea} + \ln \beta_{eat}^{s} + \left(\frac{1}{\sigma_A} - \frac{1}{\sigma_E} \right) \ln L_{et} + \left(\frac{1}{\sigma_I} - \frac{1}{\sigma_A} \right) \ln L_{eat} - \frac{1}{\sigma_I} \ln S_{eat} \tag{4}$$

where S is immigrant status (Natives or immigrants; S=N, M) and $\beta_{eat}^{N} = 1$, $\beta_{eat}^{M} = \beta_{eat}$. From (4) we can derive the native-migrant wage differential in each age-education-time cell as:

$$\ln\left(\frac{W_{eat}^{N}}{W_{eat}^{M}}\right) = -\ln\beta_{eat} - \frac{1}{\sigma_I}\ln\left(\frac{N_{eat}}{M_{eat}}\right) \tag{5}$$

This shows that - net of changes in productivity proxied by the β_{eat} terms – wages of native born relative to immigrant workers in each age-education cell depend inversely on their relative supply.

We can also use (4) to obtain the relative returns to education by age, time and immigrant status. The skilled to unskilled relative wage for age group *a* at time *t* in nativity group *S* is given by:

$$\ln\frac{W_{1at}^{S}}{W_{2at}^{S}} = \ln\theta_t + \ln\left(\frac{\alpha_{1a}}{\alpha_{2a}}\right) + \ln\left(\frac{\beta_{1at}^{S}}{\beta_{2at}^{S}}\right) - \frac{1}{\sigma_E}\ln\frac{L_{1t}}{L_{2t}} - \frac{1}{\sigma_A}\left(\ln\frac{L_{1at}}{L_{2at}} - \ln\frac{L_{1t}}{L_{2t}}\right) - \frac{1}{\sigma_I}\left(\ln\frac{S_{1at}}{S_{2at}} - \ln\frac{L_{1at}}{L_{2at}}\right) \tag{6}$$

This simply shows that returns to education by age for each nativity group *S* depend on some measure of changes in demand for skills [$\ln\theta_t$+ $\ln(\alpha_{1a}/\alpha_{2a})$+ $\ln(\beta^{S}_{1at}/\beta^{S}_{2at})$], the aggregate relative supply by education $\ln(L_{1t}/L_{2t})$, the deviation in the supply of each age group relative to the overall supply [$\ln(L_{1at}/L_{2at})$- $\ln(L_{1t}/L_{2t})$] and the relative contribution of that nativity group to the age-skill supply [$\ln(S_{1at}/S_{2at})$-$\ln(L_{1at}/L_{2at})$].[4] Equations (4) and (6) are the basis for our empirical work.

3. Estimation and Identification

The difficulty with estimating (6) directly is that in order to obtain an estimate of σ_A one needs to have estimated L_{eat} first. To do so equation (3) tells us that we need an estimate of all the β_{eat} 's and σ_I. Similarly in order to obtain an estimate of σ_E we need an estimate of L_{et} and to do so equation (2) tells us that we need estimates of the α_{e}a's and σ_A. We therefore proceed iteratively. Consider the first stage of this process.

[4] Note that for $\sigma_I \to \infty$, equation (6) is the one estimated by Card and Lemieux (2001).

Step 1. Estimating σ_I and β_{eat}

Using (5) we constrain ln(β_{eat}) to vary additively by skill, time and age for each nativity group *S* so that:

$$-\ln \beta_{eat} = f_e + f_a + f_t \tag{7}$$

Given this we can obtain an estimate of σ_I from (4) based on estimation of the following model:

$$\ln\left(\frac{W_{eat}^N}{W_{eat}^M}\right) = f_e + f_a + f_t - \frac{1}{\sigma_I}\ln\left(\frac{N_{eat}}{M_{eat}}\right) \tag{8}$$

Hence, we regress the log relative wage of native to immigrant workers for each age-education-time cell on the relative supply for each cell alongside skill, age and time dummies. The coefficient on the cell-specific relative supply of graduates gives us an estimate of the elasticity of substitution between immigrants and natives. The coefficients on the additive education, age and time dummies provide an estimate of β_{eat}. We can then use these estimates to compute L_{eat} from (3).

Step 2: Estimating σ_A and α_{ea}

Given these estimates we use (6) to estimate the relative returns to education for native born and immigrants. Given our assumptions, this differential equals:

$$\ln\frac{W_{1at}^S}{W_{2at}^S} = d_a + d_t + d_S - \frac{1}{\sigma_A}\left(\ln\frac{L_{1at}}{L_{2at}}\right) - \frac{1}{\sigma_I}\left(\ln\frac{S_{1at}}{S_{2at}} - \ln\frac{L_{1at}}{L_{2at}}\right) \tag{9}$$

where the time dummies, d_t, capture all the time-invariant part of (6), the age dummies, d_a, capture the relative age-effects on productivity, i.e. ln(α_{1a}/α_{2a}) and the immigrant dummy variable, d_S, captures the effect of ln($\beta^S_{1at}/\beta^S_{2at}$). The coefficient on the cell-specific relative supply of graduates to high school workers gives an estimate of the elasticity of substitution across age groups, σ_A. Note, that estimation of (9) also provides a new estimate of σ_I and hence an implicit test of the specification of the model. One can then recover estimates of the ln(α_{ea}) based on (4) since:

$$\ln W^{s}_{eat} = d_{et} + d_{ea} - \frac{1}{\sigma_A}\ln L_{eat} - \frac{1}{\sigma_I}\left[\ln S_{eat} - \ln L_{eat} + \sigma_I \ln \beta_{eat}\right] \quad (10)$$

The coefficients on the estimated d_{ea} dummies enable us to recover the α parameters and hence one can compute L_{et} using (2).

Step 3: Estimating σ_E and θ_t

We then re-run equation (6) using the computed labour supply terms, assuming (as in Card and Lemieux, 2001) that the skill biased technical change term, ln(θ_t), varies linearly with time i.e. we estimate:

$$\ln\left(\frac{W^{s}_{1at}}{W^{s}_{2at}}\right) = \kappa_0 + \kappa_1 t + d_a + d_s - \frac{1}{\sigma_E}\ln\left(\frac{L_{1t}}{L_{2t}}\right) - \frac{1}{\sigma_A}\left[\ln\left(\frac{L_{1at}}{L_{2at}}\right) - \ln\left(\frac{L_{1t}}{L_{2t}}\right)\right] - \frac{1}{\sigma_I}\left[\ln\left(\frac{S_{1at}}{L_{1at}}\right) - \ln\left(\frac{S_{2at}}{L_{2at}}\right)\right] \quad (11)$$

Equation (11) provides an estimate of the elasticity of substitution between the two skills groups (σ_E), skilled biased technological change (κ_1) as well as new estimates of the σ_I and σ_A.

4. Data

In this section we give an overview of the data used for estimating the model described in the previous two sections. We use information contained in the Labour Force Survey (LFS) and General Household Survey (GHS) for the period from the mid 1970s to the mid 2000s. Both surveys contain some information on individual wages and employment status along with data on whether the individual was born abroad. The GHS also contains information on country of birth and, if born abroad, year of arrival into Britain.[5]

The LFS is the larger sample - from around 100,000 observations in the early years to around 320,000 observations from 1992 onwards. However, data on wages are only available from 1993. In contrast, the annual GHS has sample sizes that are generally one-tenth of the size, but does have the advantage of containing information on country of birth and wages since 1973. Since the aim of this paper is to assess the effect of exogenous changes in the supply of

[5] This information is also available in the LFS but only from 1983 onwards.

immigrants on the wage structure, we are interested in obtaining a measure of immigrant labour supply that is as free as possible of measurement error that would otherwise tend to attenuate the estimated impact of migration on the wage structure. For this reason and in order to have as long a sample period as possible, we use GHS data to estimate wages by cells based on age, education, immigrant status and time, and the LFS to estimate the corresponding population and employment structure for the same cells.[6]

The sample used for estimation is men aged 26-60. In our main estimates, we define as an immigrant someone who was born outside the United Kingdom, irrespective of the time of or age on arrival though we do also report results in which those who came to the UK as young children are grouped with the native-born. To measure labour supply we use population rather than employment or hours (as is more usual in the literature), since non-employment in non trivial among some groups and this could itself be an effect of immigration.[7] We test the robustness of our results to alternative measures of labour supply (employment and hours) in the regressions that follow. [8]

The definition of education groups also deserves discussion. In analysis of UK data it is standard practice to define education by the highest level of qualifications obtained. However, this is not possible when considering migrants as, in both the GHS and LFS, foreign qualifications are classified in the 'other' category. For a native-born worker a response that their highest qualification is in the 'other' category almost certainly means a very low level of education, as all the major UK educational qualifications are covered by the alternative possible responses. But, as discussed in the Data Appendix, there is good reason to believe that many of the immigrants in the 'other' category actually have quite high levels of qualifications.

[6] A similar procedure is used for example by Arellano and Meghir (1992).

[7] Dustmann and Fabbri (2005) document pronounced differences in employment between (non-white) immigrants and native born individuals. One explanation is that this might be due to language difficulties (on this see also Dustmann and Fabbri (2003)).

[8] Using employment as opposed to population means that the estimated coefficients will be a mix of the elasticities of substitution at different levels and the elasticity of labour supply (see for example Card (2001)). If one is willing to assume (as implicit in Card and Lemieux (2001)) that labour supply is completely inelastic, then the estimated coefficients should be unchanged if one uses employment or population as a measure of labour supply.

Consequently, we use 'age left full-time education' as the basis for our classification of education. As in Card and Lemieux (2001) but unlike Borjas (2003) and Ottaviano and Peri (2006) we use two education groups defining anyone who left full time education between the age of 17 and 20 as a "High School graduate" and anyone who left education at age 21 or later as a "University" graduate.[9] As in Card and Lemieux (2001) we give high school dropouts (those who left education before the age of 17) a lower weight in computing supplies of High School graduates to reflect the fact that they have lower wages than High School graduates.

In order to keep the analysis as consistent as possible with Card and Lemieux (2001), we group individuals into five year and five year-age cells. The mid-points of the time intervals are: 1975, 1980, 1985, 1990, 1995, 2000 and 2005. So the 1980 time cell, for example, contains sample observations from 1978 to 1982. Similarly the mid-points of the age intervals are 28, 33, 38, 43, 48, 53, and 58. So the age 28 group in 1980, for example, contains those aged between 26 and 30 in the mid-point year, that is, all those born from 1950 to 1954. As the data are pooled across five contiguous years, the age group 28 in 1980 also contains all those born between 1950 and 1954 in the surrounding survey years - 24-28 year olds in 1978, 25-29 year olds in 1979, 27-31 year olds in 1981 and 28-32 year olds in 1982. In total, we have 196 cells (7 years by 7 age groups by 2 education groups by 2 immigrant status groups).

The data appendix gives more detailed information on the sample selection rules used, the definition of variables, and the procedure used to compute returns to education, native-migrant wage gaps and labour supply in terms of education equivalents. The appendix also describes in detail how we construct cells that aggregate individuals from contiguous years into larger age and time cells.

[9] There is a substantive issue here regarding the number of groups used. Borjas (2003) and Ottaviano and Peri (2006) use four education groups for the U.S. and constrain the elasticity of substitution between any two education groups to be the same. However Card and Lemieux (2001) and Card (2005) show that High School graduates and High School dropouts are close substitutes, something that is not true of College graduates relative to high School graduates – their use of two groups with a composite measure of labour supply for the High School graduates reflects this.

Table 1 provides a summary of the data over our sample period, while Tables 2-4 present more detailed statistics. The first panel of Table 1 shows the increase in the share of immigrants in the male sample population over time, up from 8.1% in 1975 to 11.9% in 2005. Most of this increase has occurred since 1995 as can also be seen from Figure 1. Table 1 and Figure 1 also show that both the level of and the increase in, immigration shares are higher among university graduates.[10] The share of immigrants among college graduates increases from 12.8% to 20.1% with a steady growth through the period. Among those with less than university education the immigrant share rises from 7.8% to 9.3% over the same period with almost all of the increase concentrated in recent years.

The second panel shows a secular increase in the education of native born workers. From 1975 to 2005 the percentage of the native working age population that are university graduates rose from 6% to 21.6%. The subsequent row also shows a rising share of university graduates among immigrants – from 9.9% to 40.4%.

The third panel shows the evolution of the native-migrant wage differential, based on the coefficient on a native-born dummy from a regression of log weekly wage conditioning on a quadratic in age and a dummy variable for London. This differential does not show a marked trend for graduates. For high school workers, the native wage premium appears to have fallen over time. The final panel of Table 1 shows a measure of the return to university education for immigrants and natives again conditional on a quadratic in age and a London dummy. These regressions only include those with a university degree or a high school education (as defined above) There is a strong rise in the relative returns to university education for both natives and immigrants over the last twenty years of the sample period. The overall rise in returns to education in Britain since the 1970s is well known, (see for example Machin, 2003). Perhaps less

[10] This is different from the U.S. and can be largely explained by the changes in UK immigration policy over the period – for more discussions of this see Bell (1997), Dustmann and Fabbri (2005) and Schmitt and Wadsworth (2006).

well documented is the fact that both the level of returns to education as well as the change in returns is higher for immigrants.

Table 2 contains information on the ratio of immigrant to native-born in each age-year cell for the two education groups. For skilled individuals, this ratio varies between approximately 10% and 30%, with an average value of about 20%. At any given age the share of immigrant to native-born graduates rises with time especially among the older cohorts. For less skilled individuals, the ratio between immigrants and natives is closer to 10% and rises less over time, though some modest rises can be observed among the youngest cohorts in the latest time period. The bottom part of the table reports the ratio of the immigrant-native share for university graduates to that for high school workers. A value of one implies that immigrants are equally represented among skilled and less skilled individuals. Almost all of these ratios are above one, implying that immigrants are on average more educated than natives. These ratios tend to increase across subsequent cohorts. For example among those aged 41-45 in 1975, those born in 1930-1934, this ratio is around 1.4. Thirty years later, this ratio is 2.8. The skill ratio tends to fall among the youngest cohorts from 2000 onward.

Information on the estimated returns to education by immigrant status and the native-migrant wage premia for each age-time cell are reported in Tables 3 and 4 respectively along with their standard errors. Observations with higher standard errors will receive less weight in the regressions that follow. Consistent with Card and Lemieux (2001), reading down any column in Table 3, the relative returns to a university degree grew from the late 1970s onward. Younger graduate cohorts benefited relatively more until the mid 1990s. Since then the differential gain across age cohorts is less obvious. Reading across the rows, it is also apparent that the age profile of the university wage premium has become much flatter over time, while shifting up, i.e. ensuring a higher premium to all graduates over the same period. The results for immigrants are similar but much less precisely estimated because of the smaller sample sizes. Similarly, it is difficult to detect any clear trends in the native wage premia by education in Table 4, especially

among the most educated. The age-wage profiles for high school workers, suggest that in the 1970s there were large pay advantages for home born workers relative to similar qualified immigrants among older cohorts, though these premia appear to have fallen over time.

5. Results

We next estimate model (4) formally. The first step is to estimate equation (8) from which we can recover an estimate of the elasticity of substitution between immigrants and natives. Since little is known about the magnitude of this parameter in the UK, we present a number of different specifications to examine whether our results are sensitive to alternative specifications. Table 5 gives these estimates. Since the dependent variable, the relative native-born wage premia, is based on regressions using individual data for each cell, we use the reciprocal of the square of the standard error on these estimated returns as weights and run minimum distance weighted least squares regressions.

Column (1) reports the basic specification. The model controls for additive age, time and education dummies. The reported coefficient gives the estimate of the coefficient on the supply of natives relative to immigrants in the relative wage equation, the negative of the reciprocal of the elasticity of substitution between immigrants and natives (σ_I). Under the assumption of perfect substitutability, the wage gap in each cell should be constant, but the estimates suggest that the overall native-born wage premium is lower – or below trend – when immigration is lower. The estimated coefficient is -0.156 and significant at conventional levels, implying an elasticity of substitution between immigrants and natives of around 6.3. Column (2) interacts the supply term with the dummy for high school education, allowing for the possibility that elasticity of substitution could vary by education. Although the point estimates differ across education groups, the hypothesis that the two coefficients are the same cannot be rejected at usual significance levels (the difference being 0.053, with a standard error of 0.100).

To show that these results are not driven by outliers, in Figure 2 we plot the log native-immigrant wage (on the vertical axis) against the log native-immigrant supply (on the horizontal axis) by age, time and education cells. The values are obtained as residuals from regressions of the relevant variables on additive time, age and education dummies. Each circle represents an observation in the data, with larger circles implying greater weight. The line in the figure is the estimated regression line. One can clearly see that regression results are not driven by outliers and that a similar relationship between wages and supply appears to hold for both those with high school and those with university education.

One might wonder whether there any particular age-education-year observations which tend to be on the right or left of Figure 2. As a test, we re-estimate the model with less restrictive assumptions on the education-age-year dummies. Accordingly column (3) reports an estimate of model (4) where we include controls for all pair-wise interactions between the age, education and time dummies. This is a very saturated model and identification of the elasticity of substitution is only based on the interaction of age, time and education. Even in this highly saturated model, the negative effect of relative supply remains. The point estimate is -0.237 and significant at the 10% level.

We next undertake further robustness checks, restricting the definition of immigrants in the wage cells to be, respectively, recent immigrants (those who arrived in the last five years) and adult immigrants (those who arrived after finishing their education, age 18 for high school graduates and age 21 for university graduates).[11] Using recent immigrants, column(4) shows that the estimated coefficient on the supply term is -0.361, implying a low degree of substitution between natives and recent immigrants, of less than 3. This is intuitive, since it suggests that recent immigrants largely bear the cost of changes in the stock of immigrants. In column (5) we report results for older immigrants only. It appears that the wages of these workers are marginally

[11] Note we still use all immigrants (whether recent or old, or whether they came to the country as children or adults) to compute supply. This is because information on time since migration is not available in the LFS throughout the period of observation. Care should therefore be used when interpreting these coefficients.

more sensitive to changes in the stock of immigrants, though the coefficient is not significantly different from that in column (1). Finally the estimate in column (6) of the table is based on cells categorised by the interaction of time, education and potential experience rather than age. The results are essentially unchanged, with a coefficient of -0.145 and an implied elasticity of substitution between immigrant and native workers in the order of 6.9

Having ascertained that the estimate of the elasticity of substitution between immigrant and natives is broadly robust we now estimate the other parameters of the model, namely the elasticity of substitution between different age and education groups. We replicate the results from column (1) of Table 5 in the first column of Table 6. The second column reports a new estimate of this coefficient together with an estimate of the coefficient on the effect of changes in the relative supply of skills by age and time on the returns to university education (equation(9)). The estimate of $-1/\sigma_I$ remains similar to the one in column (1). The estimated elasticity between immigrants and native-born falls to around 5 while the estimated coefficient on age-specific relative labour supply, $-1/\sigma_A$, is -0.108 and statistically significant. This implies an elasticity of substitution across workers of different ages (σ_A) of around 10, rather larger than the estimates in the order of 4.5 found for Britain by Card and Lemieux (2001). Our different sample periods, sample size, differences in the data used to estimate labour supply, different weights given to immigrant and native workers and different definitions of education are all likely to explain these differences. Lastly in column (3) we report new estimates of the effects of the share of natives to immigrants, the relative supply of university workers by age alongside the estimate of the overall relative supply of university workers based on equation(11). The estimated coefficient on the linear time trend used to approximate SBTC is 0.013, so that the graduate to high school wage gap has grown by around 1.3% a year over the sample period. The data imply an estimated coefficient on the relative supply of university to high school workers of about -0.172, implying an elasticity of substitution between university and high school workers, σ_E, of around 5.8. Again

this is larger than the estimate of 2.5 found by Card and Lemieux. The estimate of the elasticity of substitution between native born and immigrants again remains virtually unchanged.

The estimates so far use population as a measure of labour supply because we believe that this is a 'more exogenous' source of variation in supply than the employment or hours measures often used. One can think of our estimates as a 'reduced-form'. But, there is a danger that our estimates reflect not just labour demand elasticities but also labour supply elasticities. In order to present results comparable to the ones generally produced and in order to check for the potential effect of changes in labour supply on employment, we repeat the exercise using hours of work or employment as alternative measures of supply and instrument this with the population in each cell. Table 7 reports two stage least squares results of the regression using hours worked.[12] For the first stage, we find an elasticity of hours relative to the labour supply (at all levels of aggregation) in the order of one, suggesting an inelastic labour supply curve. Not surprisingly then, the results based on 2SLS are similar to the estimates in Table 6.

6. Simulating the Effects of Immigration on Relative Wages

In this section we use our results to simulate the effect of changes in the stock and skill mix of immigrants on various aspects of the wage distribution. To keep things simple we look at only two summary measures of the wage distribution - the return to education among natives and the overall native-migrant wage differential. We derive the explicit expressions for the effect of migration on the wage structure in the Technical Appendix.

In our simulations we consider four cases. First, a 10% rise in the immigrant share in each cell i.e. a skill-neutral change. Because immigrants are about 10% of employment this is roughly equivalent to a 1 percentage point rise in the share of immigrants in the economy as a whole. Secondly, skill-biased changes to the immigrant mix, with a 20% rise in the number of skilled immigrants and no change in the number of unskilled immigrants. Thirdly, a 20% rise in the

[12] The estimates using employment are similar and are available from the authors on request.

number of less skilled immigrants and no change in the number of skilled immigrants. Finally we take the actual change over the period 1975-2005 in the immigrant share relative to the native share. For our simulations we use the estimates in the final column of Table 6.

The results are shown in Table 8. The first row shows that a 10% rise in the immigrant share in all cells is predicted to lead to a 2.0% rise in the native-migrant wage differential. This is what one would expect from a direct reading of the estimates in the final column of Table 6. But the predicted impact on the return to education among natives is zero – this is what one might expect from the skill-neutral nature of the change. However the second and third rows also show that this happens when there is skill bias in the immigrant flows. If all immigrants are skilled the native-migrant wage differential rises (but only slightly), because of the composition effect – immigrants are becoming more skilled relative to natives. But there is very little effect on the return to education among natives. The explanation is that the imperfect substitutability between natives and immigrants ameliorates the impact on natives.

This can most easily be understood using a simpler model than the one we have used in which the age dimension is removed from the technology. One can show (see Technical Appendix) that in this case the change in the return to education among natives in response to a change in the supply of migrants will be given by:

$$d\ln\frac{W_{1t}^{N}}{W_{2t}^{N}} = -\left(\frac{1}{\sigma_E}-\frac{1}{\sigma_I}\right)\left[s_1^M\, d\ln\left(M_{1t}\right) - s_2^M\, d\ln\left(M_{2t}\right)\right] \qquad (12)$$

where s^M_e is the share of the wage bill accruing to immigrants in education cell e. The important point is that the change in returns is likely to be very small and will be smaller the lower the degree of substitution among natives and immigrants. It will be small for a number of reasons. First the term involving the elasticity of substitutions is likely to be small and even 'perverse' in sign given our estimates. Secondly the impact of migration will only have an effect to the extent that there is a change in the migrants' skill mix or differences in the wage bill share in the two education groups.

One implication of this is that it is not at all surprising that researchers have failed to detect any significant effect of immigrants on native outcomes. However this failure does not mean that there are no economic effects, rather that the effects on groups other than the immigrants themselves are very small. One can see this also from the fourth column of Table 8 that simulates the effect of the actual changes in immigration over the period 1975-2005 relative to the case where the immigrant share in each cell remained constant. The prediction is that the changes have raised the native-migrant wage differential by 0.055 and raised the return to education by 0.004. This is tiny relative to the 0.15 actual changes over this period.

7. Conclusions

Based on a stylised model of labour demand that allows native-born workers and immigrants to be imperfect substitutes in production we show how one can, under appropriate identification assumptions, estimate the elasticity of substitution between immigrants and natives. Given this framework, the rise in immigration experienced in Britain over the past decades does appear to have changed the wage structure. It seems that immigration depresses the earnings of immigrants relative to the native-born, suggesting imperfect substitution between natives and immigrants in production. When combined with Card and Lemieux's (2001) conclusions (that we confirm even after the addition of later data) that the return to university education is sensitive to the relative supply of university graduates, this implies that when immigration has a different skill mix from the native population this will affect returns to education among natives. Because immigrants are better-educated than natives, immigration will have reduced the return to education among both migrants and natives. But, because of the imperfect substitutability between natives and immigrants and the fact that the immigrant share is still quite low, then the size of this effect will be small, so it is not surprising that existing studies have failed to find a significant effect on the labour market outcomes of natives. Our conclusions suggest that the main impact of increased immigration in the UK is on the outcomes for immigrants who are already here.

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Data appendix

Definition of education.

We classify the sample into two education categories, university and high school equivalents, similarly to Katz and Murphy (1992) and Card and Lemieux (2001). We define university workers as those who left full time education at age 21 or later and high school workers as those who left full time education between age 17 and 20. Using age left full-time education to define levels of schooling is not standard practice in Britain so our use of it here needs some justification.[13] Both the LFS and GHS do not always record the qualifications of immigrants accurately. This is important not just for our purposes but also for more general debates about the skills of immigrants to the UK.

A large proportion of immigrants in both the LFS and the GHS report holding 'other qualifications'. Table A1 based on LFS data from 2000-2005 shows that while 6.3% of natives report holding 'other qualifications', 28.8% of immigrants do so. The following two columns of Table A1 show that the problem is much worse for immigrants who arrived in the UK after the age at which they left full-time education with 41.8% of this group reporting they hold 'other' qualifications compared to 6.0% of immigrants who arrived in the UK before completing full-time education. The reason for this problem is not entirely clear but there are two likely causes. First, the qualifications listed in the LFS are British qualifications that do not translate directly into foreign equivalents and, secondly, it appears that the Office for National Statistics have deliberately coded all foreign qualifications into the 'other' category.

Researchers generally use one of two approaches to deal with the problem caused by those reporting 'other qualifications' – they either code them as missing or as a low level of qualifications (on the grounds that every conceivable high qualification is covered elsewhere in the classification). For natives it is likely that results are not very sensitive to this decision rule. But, for immigrants, it is more of a problem. To code the 'other' group as missing is only valid if

[13] Bell (1997) in his analysis of immigration to the UK uses a similar definition of skills.

they are ‘missing at random’ and to assume they have low qualifications is also problematic. We can get another idea of the extent of this problem by looking at Table A2 which reports, for each level of education, the percentage reporting leaving full-time education at or before the age of 16, 17-20 inclusive and 21 or later. The three panels report this information for natives, immigrants who arrived in the UK before completing full-time education and for those who arrived after. For natives 93% of those in the ‘other’ category left education by the age of 16 and only 1% after the age of 21. For immigrants who completed full-time education in the UK the figures are 55% and 20% and for immigrants who completed full-time education outside the UK 20% of the ‘other’ category completed education by the age of 16 and 38% after the age of 21. This suggests that immigrants in the ‘other category’ are quite well-educated – indeed they seem from Table A2 to be most similar to those with a degree.

Further information on this point comes from exploiting the panel element of the LFS. Individuals are in the LFS for 5 quarters and are asked the education question in each quarter so it is possible that they are coded as ‘other’ in one quarter and something else in another. Table A3 shows the distribution of qualifications among this group. The sample here excludes all who report being in full-time education or working towards a qualification. One should note that this group may be dominated by measurement error and is quite small in size. However, 11% of immigrants in this group report having a degree compared to 0.5% of natives, again suggesting the immigrants in the ‘other’ group are much better-qualified than the natives.

Table A4 reports the distribution of highest qualification from the 2001 Census (when such a question was asked for the first time). This question is similar to the LFS question, being very ‘UK-centric’. But the census does not have a markedly bigger problem with immigrants in the ‘other’ category or with missing information. And the census suggests a much larger proportion of immigrants than natives have a university degree.

In short, it is difficult to assign immigrants to the high and low qualification group using reported levels of qualification. Moreover the highest educational categories are not the same in

the GHS and LFS which again hinders the matching process across the two data sets. In order to circumvent these problems we use instead the variable "age left full time education", which is defined consistently across the two data sets.[14]

Wages

In order to compute wages by cell we use information on weekly earnings of male full time employees and we drop individuals with weekly earnings below £50 and above £2000 . For the regressions we group individuals into five year and five year-age cells. We use all the available data from the GHS spanning between 1973 and 2005.[15]

To derive measures of the returns to education by immigrant status, age and time we run separate regressions of the log weekly wages of every individual in each cell (for example native born workers, born in 1945-1949 observed in 1973-1977) on a dummy for university education, a linear age term (from 26-32), year dummies (from 1973 to 1977), and a London dummy. We run this regression only for those with exactly university or high school education (as defined above). We use a similar procedure to estimate native wage premia for each age-time-education status cell. Table 3 provides information on returns to education for natives while Table 4 provides wages of native-born relative to immigrants by skill.

Supply

In order to compute labour supply for each cell, we use the estimated number of individuals in the population falling in each age/education/migrant status category. In practice we measure the supply of university graduates as the number of individuals in the sample period that left full time education at age 21 or later. To compute the supply of high school equivalents we combine the number of individuals who left full time education between the ages of 17 and 20 together with

[14] Despite this, the GHS shows a slowdown in educational attainment based on years of education after 1998 when the questions ascertaining years of education changed from "how old were you when you finished your course" to "how old were you when you finished your continuous full-time education".
[15] There was no GHS from April 1997 to March 1998 and from April 1999 to March 2000.

the number of individuals who left full time education at age 16 or under. We weight this second quantity by the average (over all time periods) of the relative wage of individuals with less than high school relative to those with exactly high school in each age-nativity group, similarly to Katz and Murphy (1992) and Card and Lemieux (2001). The wage measure used conditions on a dummy for London. We use all the available data from the LFS spanning between 1977 and (the first quarter of) 2006. [16] We present data on the relative supply of natives and immigrants by skill and on the ratio of the two in table 2.

Technical appendix

The effect of immigration on the wage structure.

Denote the hypothetical changes in the numbers of immigrant in each education-age cell we are considering by $d\ln(M_{ea})$. From (4) and ignoring the time subscript we have for natives:

$$d\ln\left(W_{ea}^{N}\right)=\frac{1}{\sigma_E}d\ln(Y)-\left(\frac{1}{\sigma_E}-\frac{1}{\sigma_A}\right)d\ln(L_e)-\left(\frac{1}{\sigma_A}-\frac{1}{\sigma_I}\right)d\ln(L_{ea})$$

And for immigrants that:

$$d\ln\left(W_{ea}^{M}\right)=\frac{1}{\sigma_E}d\ln(Y)-\left(\frac{1}{\sigma_E}-\frac{1}{\sigma_A}\right)d\ln(L_e)-\left(\frac{1}{\sigma_A}-\frac{1}{\sigma_I}\right)d\ln(L_{ea})-\frac{1}{\sigma_I}d\ln(M_{ea})$$

This is the same as for natives but with a final direct impact on the supplies. The components of these two equations can be computed in the following sequential way:

$$d\ln(L_{ea})=\frac{\beta_{ea}^{M}M_{ea}^{\delta}}{\beta_{ea}^{N}N_{ea}^{\delta}+\beta_{ea}^{M}M_{ea}^{\delta}}d\ln(M_{ea})=s_{ea}^{M}d\ln(M_{ea})$$

Where s_{ea}^{M} can be shown to be the wage bill share of immigrants in the *ea* education-age cell. We also have that:

[16] The LFS is available from 1977 to the last quarter of 2005 with the exception of years 1978, 1980 and 1982. We use all the available waves in each 5-year interval to compute supply. For example, to compute supply in 1975 we use data from 1977 only. For the year 1980 we use data from 1979 and 1981.

$$d\ln(L_e) = \frac{\sum_a \alpha_{ea} L_{ea}^{\eta} d\ln(L_{ea})}{\sum_a \alpha_{ea} L_{ea}^{\eta}} = \sum_a s_{ea} d\ln(L_{ea})$$

Where s_{ea} can be shown to be the wage bill share of age-group *a* in education cell *e*. And finally that:

$$d\ln(Y) = \frac{\sum_e \theta_e L_e^{\rho} d\ln(L_e)}{\sum_e \theta_e L_e^{\rho}} = \sum_e s_e d\ln(L_e)$$

Where s_e can be shown to be the wage bill share of education cell *e*. We use the observed wage bill shares and estimated elasticities of substitution to compute the changes in wages for each cell in response to different hypothetical changes in the number and composition of immigrants.

Because we are interested only in summary statistics we need to weight these cell-specific changes by the employment shares to get the overall changes. When we consider the native immigrant-wage differential there is an additional composition effect from the change in the skill mix of immigrants and not just from changes in the wage structure.

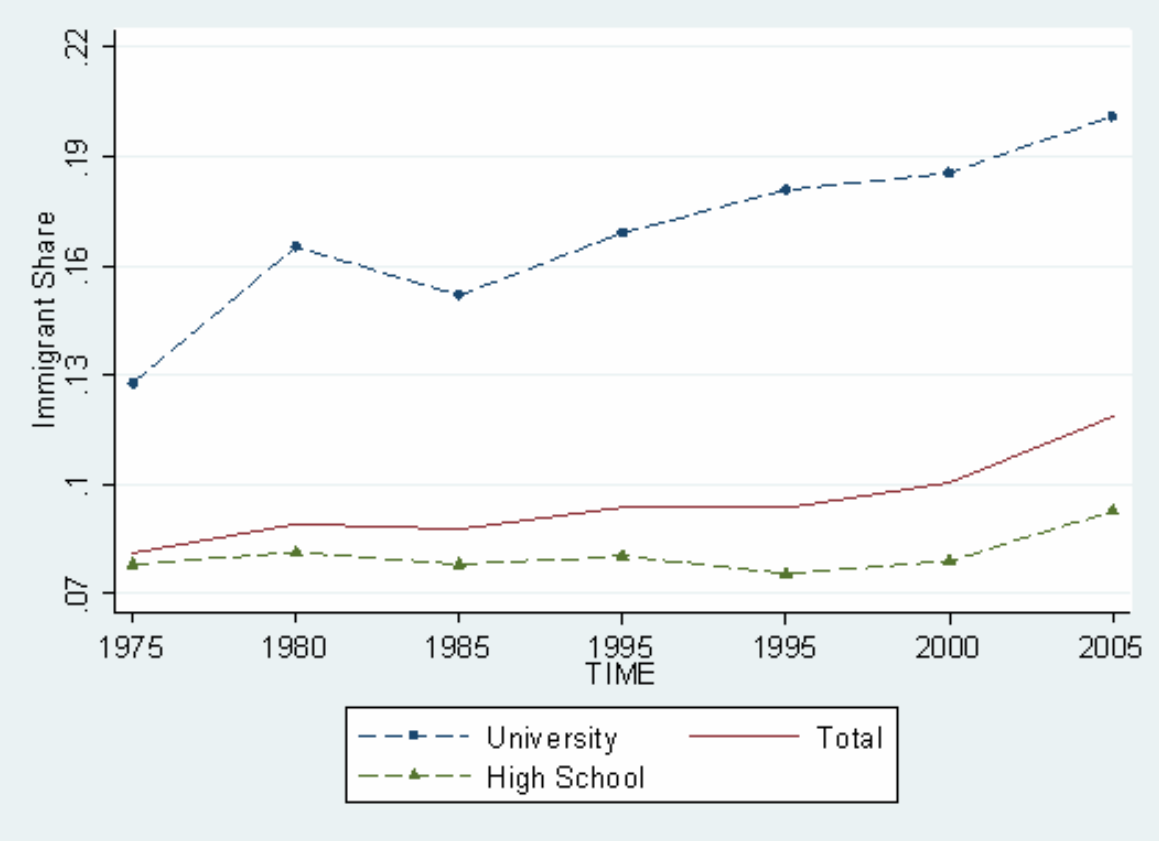
Equation (12)

Assuming there is no intermediate age-level in the production function, from the equations above

$$d\ln(W_e^N) = \frac{1}{\sigma_E}\left(d\ln(Y) - d\ln(L_e)\right) + \frac{1}{\sigma_I} d\ln(L_e)$$

where $d\ln(L_e) = s_e^M d\ln(M_e)$ and again s_e^M is the wage bill share of immigrants among the relevant education group. Taking differences across skills groups of this last equation, this leads to equation (12) in the text.

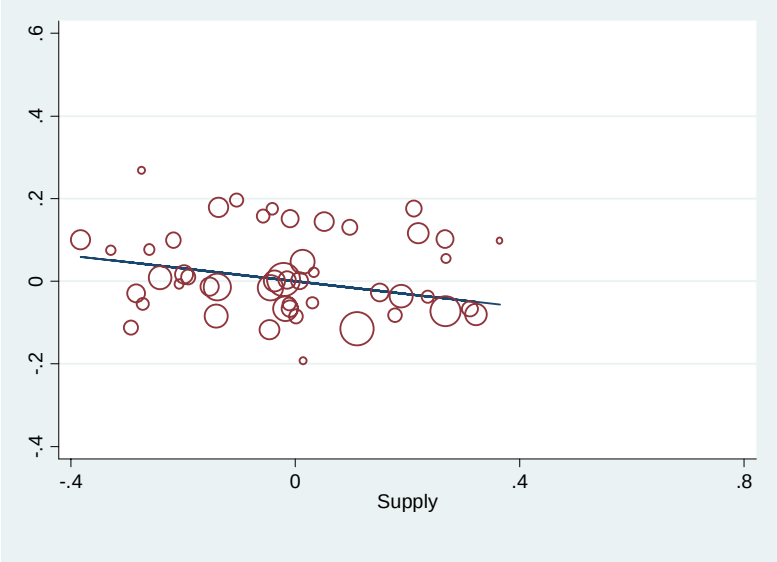
Figure 1. Immigrant Share in Male Population of Working Age



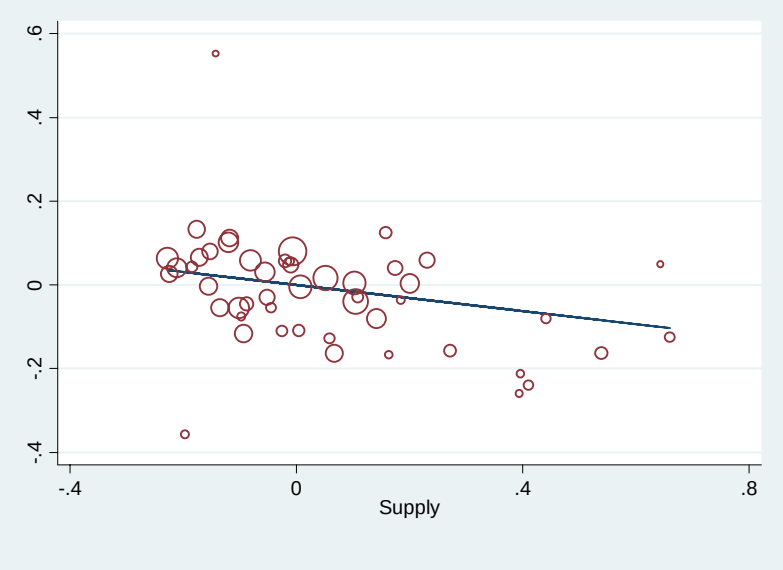
Source: Computations from LFS various years as described in the text.

Figure 2. Native-Migrant Wage Premia and Relative Supply by Age, Time and Education

High School



University



The graphs give the log native-migrant wage premia on the vertical axis on the log native-migrant labour supply on the horizontal axis. Both series are obtained as residuals from a regression on additive age, time and education dummies. The line in the figures refers to estimated GLS line. The top graph refers to high school workers while the bottom graph side panel refers to university workers.

Table 1. Male Immigrants and Native-Born Men in Britain

	1975	1985	1995	2005
Share of immigrants				
Total	0.081	0.088	0.094	0.119
University	0.128	0.151	0.181	0.201
High School or less	0.078	0.078	0.076	0.093
Share of university graduates				
Native-born	0.060	0.122	0.154	0.216
Immigrants	0.099	0.227	0.329	0.404
Returns to native-born workers				
University	0.089	0.100	0.029	0.088
High School	0.243	0.237	0.147	0.129
Returns to university education				
Native-born	0.123	0.122	0.164	0.244
Immigrants	0.257	0.243	0.296	0.299

Notes. Computations are based on LFS and GHS data as described in the Data Appendix. Returns to education are computed as the regression coefficient of log weekly wages on a dummy for university education, conditional on a quadratic in age and a dummy for London. The returns to native-born are computed as the regression coefficient of log weekly wages on a dummy for university education, conditional on a quadratic in age and a dummy for London. Regressions only include those with a university degree or a high school degree (as defined in the text).

Table 2: Immigrant-native-born population ratio by Age, Time and Education

	Age						
	26-30	31-35	36-40	41-45	46-50	51-55	56-60
University							
1973-1977	0.151	0.154	0.214	0.141	0.100	0.088	0.116
1978-1982	0.185	0.178	0.224	0.243	0.201	0.206	0.168
1983-1987	0.189	0.182	0.162	0.193	0.202	0.185	0.125
1988-1992	0.203	0.227	0.188	0.176	0.189	0.241	0.246
1993-1997	0.227	0.257	0.252	0.199	0.156	0.209	0.237
1998-2002	0.227	0.274	0.279	0.243	0.198	0.147	0.185
2003-2005	0.276	0.329	0.309	0.272	0.224	0.168	0.139
High school							
1973-1977	0.061	0.083	0.099	0.092	0.106	0.081	0.080
1978-1982	0.080	0.064	0.088	0.100	0.097	0.106	0.101
1983-1987	0.076	0.079	0.067	0.082	0.097	0.098	0.108
1988-1992	0.066	0.088	0.096	0.072	0.090	0.111	0.105
1993-1997	0.059	0.074	0.094	0.091	0.068	0.088	0.114
1998-2002	0.083	0.072	0.091	0.098	0.095	0.072	0.093
2003-2005	0.138	0.111	0.088	0.097	0.108	0.108	0.078
Ratio							
1973-1977	2.495	1.850	2.156	1.534	0.937	1.637	1.427
1978-1982	2.323	2.772	2.522	2.428	2.062	2.234	1.653
1983-1987	2.493	2.298	2.400	2.344	2.090	2.086	1.143
1988-1992	3.084	2.558	1.953	2.443	2.098	2.369	2.333
1993-1997	3.875	3.440	2.672	2.182	2.273	2.690	2.065
1998-2002	2.722	3.803	3.034	2.483	2.090	2.594	1.985
2003-2005	1.996	2.973	3.509	2.800	2.074	2.386	1.781

Notes. The table reports the ratio between immigrants and natives in the working age population by age, time and education. The top part of the table refers to those with a University degree, the middle part of the table to those with completed High school . Source LFS.

Table 3: Returns to University/High School by Age, Year and Immigrant Status

	Age						
	26-30	31-35	36-40	41-45	46-50	51-55	56-60
UK born							
1973-1977	0.091	0.120	0.118	0.124	0.116	0.138	0.171
	(0.019)	(0.028)	(0.037)	(0.042)	(0.048)	(0.053)	(0.070)
1978-1982	0.054	0.099	0.087	0.152	0.180	0.137	0.155
	(0.019)	(0.020)	(0.030)	(0.035)	(0.047)	(0.054)	(0.066)
1983-1987	0.074	0.087	0.156	0.141	0.169	0.051	0.177
	(0.022)	(0.023)	(0.028)	(0.039)	(0.051)	(0.061)	(0.090)
1988-1992	0.149	0.177	0.122	0.109	0.075	0.281	0.133
	(0.024)	(0.025)	(0.029)	(0.031)	(0.047)	(0.054)	(0.080)
1993-1997	0.169	0.161	0.173	0.135	0.089	0.209	0.151
	(0.027)	(0.029)	(0.032)	(0.034)	(0.040)	(0.054)	(0.079)
1998-2002	0.192	0.271	0.243	0.260	0.276	0.240	0.180
	(0.032)	(0.033)	(0.035)	(0.039)	(0.043)	(0.052)	(0.086)
2003-2005	0.221	0.285	0.276	0.251	0.275	0.203	0.303
	(0.039)	(0.041)	(0.044)	(0.057)	(0.054)	(0.059)	(0.077)
Foreign born							
1973-1977	0.036	0.175	0.123	0.162	0.455	0.508	0.657
	(0.057)	(0.063)	(0.083)	(0.092)	(0.104)	(0.121)	(0.148)
1978-1982	0.056	0.145	0.181	0.079	0.187	0.214	0.409
	(0.054)	(0.059)	(0.072)	(0.077)	(0.103)	(0.142)	(0.162)
1983-1987	0.190	0.102	0.345	0.173	0.421	0.149	0.588
	(0.072)	(0.068)	(0.082)	(0.097)	(0.152)	(0.165)	(0.185)
1988-1992	0.132	0.153	0.162	0.322	0.438	0.203	0.560
	(0.075)	(0.081)	(0.085)	(0.107)	(0.139)	(0.126)	(0.178)
1993-1997	0.034	0.148	0.239	0.528	0.280	0.572	-0.056
	(0.086)	(0.086)	(0.097)	(0.094)	(0.131)	(0.144)	(0.223)
1998-2002	0.530	0.417	0.454	0.282	0.328	0.612	0.101
	(0.086)	(0.088)	(0.101)	(0.113)	(0.135)	(0.177)	(0.213)
2003-2005	0.157	0.338	0.331	0.354	0.175	0.383	0.428
	(0.089)	(0.094)	(0.108)	(0.127)	(0.135)	(0.161)	(0.259)

Notes. Estimated returns to education for immigrants and natives by age and time. Standard errors of the estimated coefficients in brackets. See text for details. Source: GHS.

Table 4: Estimated Relative Returns to Native Born by Age, Year and Education

	Age						
	26-30	31-35	36-40	41-45	46-50	51-55	56-60
University							
1973-1977	0.107	0.108	0.234	0.203	-0.007	0.066	0.010
	(0.046)	(0.050)	(0.073)	(0.075)	(0.094)	(0.114)	(0.136)
1978-1982	0.183	0.075	0.195	0.222	0.226	0.148	0.069
	(0.041)	(0.045)	(0.059)	(0.065)	(0.090)	(0.114)	(0.149)
1983-1987	0.025	0.089	0.147	0.181	0.070	0.237	-0.047
	(0.054)	(0.049)	(0.060)	(0.073)	(0.136)	(0.140)	(0.156)
1988-1992	0.145	0.203	0.070	0.181	0.026	0.231	-0.137
	(0.054)	(0.058)	(0.060)	(0.078)	(0.108)	(0.103)	(0.143)
1993-1997	0.138	0.082	0.013	-0.105	-0.084	-0.004	0.690
	(0.066)	(0.053)	(0.065)	(0.066)	(0.094)	(0.106)	(0.180)
1998-2002	-0.080	0.090	0.096	0.060	0.073	-0.103	0.132
	(0.062)	(0.058)	(0.065)	(0.073)	(0.104)	(0.113)	(0.138)
2003-2005	0.144	0.072	0.050	-0.022	0.223	0.053	0.214
	(0.066)	(0.067)	(0.083)	(0.100)	(0.095)	(0.119)	(0.176)
High School							
1973-1977	0.052	0.166	0.239	0.237	0.334	0.447	0.496
	(0.040)	(0.049)	(0.059)	(0.073)	(0.071)	(0.070)	(0.099)
1978-1982	0.184	0.121	0.289	0.149	0.233	0.225	0.323
	(0.040)	(0.045)	(0.056)	(0.059)	(0.073)	(0.108)	(0.091)
1983-1987	0.141	0.104	0.336	0.214	0.323	0.335	0.364
	(0.052)	(0.054)	(0.064)	(0.079)	(0.087)	(0.123)	(0.141)
1988-1992	0.128	0.179	0.110	0.394	0.389	0.153	0.290
	(0.058)	(0.063)	(0.067)	(0.085)	(0.102)	(0.095)	(0.141)
1993-1997	0.002	0.069	0.078	0.288	0.107	0.359	0.483
	(0.063)	(0.074)	(0.080)	(0.077)	(0.105)	(0.117)	(0.177)
1998-2002	0.258	0.229	0.307	0.082	0.124	0.270	0.054
	(0.070)	(0.075)	(0.086)	(0.098)	(0.102)	(0.149)	(0.190)
2003-2005	0.080	0.124	0.105	0.081	0.123	0.232	0.340
	(0.073)	(0.179)	(0.086)	(0.099)	(0.124)	(0.133)	(0.217)

Notes. Estimated wage differential between natives and immigrants by age and time. Standard errors of the estimated coefficients in brackets. See text for details. Source: GHS.

Table 5. Estimated Elasticities of Substitution by immigrant status (step 1)

	(1) Basic specification	(2) Different σ_I by education	(3) Saturated model	(4) Recent immigrants only	(5) Adult immigrants only	(6) Controls for experience
log supply	-0.156**	-0.178**	-0.237*	-0.361**	-0.187**	-0.145**
	(0.053)	(0.068)	(0.122)	(0.121)	(0.070)	(0.052)
log supply * high school		0.053				
		(0.100)				
Education dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Age dummies	Yes	Yes	Yes	Yes	Yes	No
Education *Age			Yes			
Education * Time			Yes			
Time * Age			Yes			
Experience dummies						Yes

Notes: The table reports the reciprocal of the negative of the elasticity of substitution between immigrants and natives ($-1/\sigma_I$) (equation 8 in the text). The dependent variable is the native-migrant log wage differential by education, time and age. The independent variable is the log native-migrant relative supply of by education, time and age. Column (1) includes all immigrants and natives and conditions on additive education, age and time dummies. Column (2) allows for the coefficient on relative supply to vary by education. Column (3) uses the same specification as in column (1) but additionally controls for each pairwise interaction between education, age and time dummies. Column (4) uses the same specification as in column (1) but only restricts to recent immigrants, defined as those who arrived in the country in the last five years. Column (5) only restricts to adult immigrants, defined as those who arrived in the country after the age they could have theoretically completed their highest qualification achieved. Column (6) calculates the elasticity of substitution between immigrants and natives based on cells defined by the interaction of education, time and potential experience (instead of age). Sample size = 98. All regressions weighted by inverse of estimated variance of dependent variable. ** significant at 5% level, * significant at 10% level. Source GHS and LFS. See text for details.

Table 6. Estimated Elasticities of Substitution by Immigrant status, Age and Education

Variable		Dependent variable: log relative wages		
	Parameter	(1) Native/ Immigrant	(2) University/ High School (by age)	(3) University/ High School (aggregate)
Independent variable: log relative supply		(Step 1)	(Step 2)	(Step 3)
Native-immigrant by age and education	$(-1/\sigma_I)$	-0.156** (0.053)	-0.199** (0.065)	-0.198** (0.054)
University-High school by age	$(-1/\sigma_A)$		-0.108** (0.047)	-0.101** (0.048)
University-High school (aggregate)	$(-1/\sigma_E)$			-0.172** (0.054)
Time trend	S.B.T.C.	`		0.013** (0.003)
Education dummies		Yes		
Time dummies		Yes	Yes	
Age dummies		Yes	Yes	Yes
Immigrant dummy			Yes	Yes

Notes. The Table reports OLS estimates of equations (8), (9) and (10) in the text. The regression in column (1) is the same as reported in Table 5, column (1). See also notes to table 5.

Table 7. Elasticities of Substitution by Education, Age and Education (IV estimates)

	Dependent Variable					
		1st Stage Log employment			2nd Stage Log wages	
	(1) Native/ Immigrant	(2) University/ High School (by age)	(3) University/ High School (aggregate)	(4) Native/ Immigrant	(5) University/ High School (by age)	(6) University/ High School (aggregate)
Independent variable: log relative supply				(Step 1)	(Step 2)	(Step 3)
Native-immigrant by age and education	0.938** (0.081)			-0.172** (0.059)	-0.209** (0.043)	-0.204** (0.071)
University-High school by age		1.185** (0.058)			-0.099** (0.043)	-0.095** (0.44)
University-High school (aggregate)			1.186** (0.056)			-0.086** (0.028)
Time trend				`		0.010** (0.002)
Education dummies	Yes			Yes		
Time dummies	Yes	Yes		Yes	Yes	
Age dummies	Yes	Yes	Yes	Yes	Yes	Yes
Immigrant dummy		Yes	Yes		Yes	Yes
Method of estimation	OLS	OLS	OLS	2SLS	2SLS	2SLS

Notes. The Table reports 2SLS estimates of equations (8), (9) and (10) in the text where employment is instrumented by population. Columns (1) to (3) reports the first stage estimates. Column (4) to (6) report the 2SLS estimates. See also notes to table 6.

Table 8. Simulations of the Impact of Immigration on Relative Wages

	Log Native-Migrant Wage Differential	Log Skilled-Unskilled Wage Differential (Natives Only)
10% rise in all immigrants	0.023	0
20% rise in skilled immigrants, No change in unskilled immigrants	0.009	0.001
20% rise in unskilled immigrants, No change in skilled immigrants	0.037	-0.001
Actual change in immigrants relative to natives	0.055	0.004

Notes. These simulations are based on actual wage bill shares in 2005, and the estimates of the elasticities of substitution from the final column of Table 6.

Table A1. Highest Qualification of Natives and immigrants, (LFS Data, 2000-2005)

Highest qualification	Natives	Migrants All	Migrants Left FT Education before UK arrival	Migrants Left FT Education after UK arrival
Degree or equivalent	14.3	18.3	12.8	28.0
Higher education	9.0	7.7	6.4	10.1
GCE A-level or equivalent	23.4	13.4	10.0	19.3
GCSE/CSE or equivalent	28.7	12.7	6.4	23.9
Other qualification	6.3	28.8	41.8	6.0
No qualification	17.5	18.4	22.0	12.0
Missing	0.7	0.6	0.6	0.6

Notes. Source: LFS 2000-2005. Sample is individuals aged 16-64 not in full-time education.

Table A2. Highest Qualification and Age Left Full-Time Education of Natives and immigrants, (LFS Data, 2000-2005)

	Age lest education		
Highest qualification	16 or earlier	17/20 inclusive	21 or later
Migrants – Left FT Education before UK arrival			
Degree or equivalent	3.9	23.3	72.9
Higher education	18.3	54.2	27.5
GCE A-level or equivalent	33.3	50.7	16.0
GCSE/CSE or equivalent	36.0	49.7	14.3
Other qualification	20.0	41.7	38.2
No qualification	80.3	17.7	2.0
Missing	58.3	33.4	8.3
Migrants – Left FT Education after UK arrival			
Degree or equivalent	3.3	12.9	83.8
Higher education	19.1	44.6	36.2
GCE A-level or equivalent	35.9	54.3	9.8
GCSE/CSE or equivalent	54.0	43.6	2.4
Other qualification	55.4	22.7	21.9
No qualification	87.7	11.3	1.0
Missing	61.2	33.1	5.7
Natives			
Degree or equivalent	10.0	17.6	72.4
Higher education	36.5	42.7	20.9
GCE A-level or equivalent	59.6	37.8	2.6
GCSE/CSE or equivalent	71.6	28.1	0.4
Other qualification	93.5	5.8	0.7
No qualification	97.2	2.7	0.1
Missing	80.6	17.3	2.2

Notes. See notes to Table A1.

Table A3. Highest Qualification of Natives and immigrants who report 'Other' Qualifications, (LFS Data, 2000-2005)

Highest qualification	Natives	Migrants All	Migrants Left FT Education before UK arrival	Migrants Left FT Education after UK arrival
Degree or equivalent	0.9	11.0	11.5	8.2
Higher education	2.4	6.9	7.5	4.0
GCE A-level or equivalent	32.1	34.9	36.3	27.4
GCSE/CSE or equivalent	39.8	22.3	19.1	40.2
Other qualification	23.5	23.4	24.1	19.8
Missing	1.3	1.4	1.6	0.3

Notes. Sample includes those who report 'other qualification' in one quarter and something else in another and excludes those that report being in full-time education or working towards a qualification in any quarter. See also notes to Table A1.

Table A4. Highest Qualification of Natives and Immigrants: Census, 2001

Highest qualification	Natives	Migrants All
Degree or equivalent	19.5	34.9
Higher education	7.1	8.3
GCE A-level or equivalent	39.2	21.8
GCSE/CSE or equivalent	6.1	5.2
Other qualification	25.1	24.3
Missing	3.1	5.4

Source: 2001 Census Sample of Anonymized Records (SARS). Sample is those aged 16-60 inclusive who are not in full-time education and whose country of birth is not missing.