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# Estimating the Effect of Immigration on Wages

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**Abstract:** We discuss approaches to estimating the effect that immigration has on wages of native workers which assume a three-level CES model, where immigrants and natives are allowed to be imperfect substitutes within an age-education cell, and predict the wage impact based on estimates of the elasticities of substitution at each level. We argue that this approach is sensitive to immigrants downgrading at arrival, and we illustrate the possible bias in estimating the elasticity of substitution between immigrants and natives.

## 1. Introduction

The effect that immigration has on labour markets in the receiving countries, and in particular on wages, is one of the most debated questions on immigration. A key challenge in addressing this question empirically is to construct an appropriate counterfactual situation: although wages of native workers are observed after immigration has taken place, it is not observed how wages would have evolved in the absence of immigration. The central issue in the empirical literature is the construction of a plausible estimate for this counterfactual situation.

One approach is to “slice” the labour market into cells along some dimension, such as regions or skill groups, and to use the variation induced by the differences in immigration intensity across these cells to estimate the effect of immigration on wages.<sup>2</sup> Of course, understanding how immigrants select into these cells is critical, and the literature has addressed this by

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<sup>1</sup> We are grateful to Tommaso Frattini and Anna Rosso for help with the data, and to an anonymous referee for constructive comments.

<sup>2</sup> Examples of such divisions include spatial areas (see e.g. Altonji and Card 1991 for an early application), occupation groups (e.g. Card 2001), and age-education cells (Borjas 2003).

either focussing on situations in which the allocation to cells is plausibly random (see e.g. Card 1990, Glitz 2011), or by instrumenting immigrant inflows.

Another approach is to impose stronger structural assumptions. An example is work by Borjas, Freeman and Katz (1997), who formulate a CES model with different skill groups, where immigrants and natives are assumed perfect substitutes within a skill cell. Using estimates of the elasticity of substitution between skill groups, they then compare the actual supplies of workers in particular skill groups to those that would have prevailed in the absence of immigration, and compute the change in wages of native workers, based on estimates for the elasticity of substitution between skill groups. The two papers by Manacorda, Manning and Wadsworth (MMW) (2011) and by Ottaviano and Peri (OP) (2011) extend this work in two important directions. First, and building on work by Card and Lemieux (2001), they allow for workers with different labour market experience to be non-perfect substitutes, even if they are in the same education cell. Second, they allow immigrants and natives to be imperfect substitutes within experience and education cells. Using a two-level CES production technology as in Card and Lemieux (2001) as a starting point, they implement this idea by adding a third level, where immigrants and natives may be imperfect substitutes within experience-education cells.

This approach is clearly appealing, and the exploration of the idea that immigrants and natives are not perfectly substitutable is a welcome addition to this literature. On the other hand, the imposed structure is clearly restrictive: estimation of wage effects relies on the choice of a nested three-level CES production technology, which is characterised by three parameters, and imposes strong assumptions about separability between groups of inputs. It also relies on assumptions about the nesting structure, with different nesting assumptions leading to different estimates – the paper by OP illustrates this nicely.<sup>3</sup>

Moreover, it relies on the assumption that immigrants and natives can be assigned to education-experience cells, based on their observed characteristics even though immigrants typically “downgrade” upon arrival, as illustrated, for the case of the UK, in a paper by Dustmann, Frattini and Preston (2008). Thus, immigrants may compete with natives at parts of the skill distribution which is different to where they have been assigned due to their observed characteristics. As a consequence, estimates of the elasticity of substitution between

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<sup>3</sup> In principle it should be possible to compare the empirical fit of alternative structures. In practice, this is complicated by the non-nested nature of the different CES trees.

these two groups may be driven by immigrants competing with natives at parts of the skill distribution other than those to which they have been assigned based on their observed education, possibly leading to biased estimates in the estimation of the elasticity of substitution between immigrants and natives. As this elasticity is a key parameter in this approach, we will explore this further in the next section. Note that downgrading is not only a problem when using this structural approach, but also in the skill-cell correlation approach introduced by Borjas (2003), which also relies on similar pre-assignment of immigrants to age-education cells.

## 2. Downgrading and the Estimation of the Elasticity of Substitution between Immigrants and Natives

In Figures 1 and 2, we illustrate the issue of downgrading. Figures 1a and 1b, drawing on data from the British Labour Force Survey (LFS) and the Current Population Survey (CPS) for the US, and using the years between 1994 and 2004, show the actual and predicted position of recent immigrants, defined as those who arrived over the last two years, in the distribution of native earnings. The dotted lines denote their actual position, based on their observed earnings. The dashed lines denote the position which they would occupy in the native wage distribution based on their education and age structure if immigrants were to receive the same returns to observable characteristics as natives.<sup>4</sup> The figures show clearly that allocation of immigrants according to their observed skills would result in placing them at different parts of the wage distribution to where they are actually located. This is particularly evident for immigrants to the UK, but also for immigrants to the US.

Many potential explanations for these wage differences exist, including discrimination and differing productivities in the same jobs but we choose to explore here the implications of slow integration into the labour market resulting in initial downgrading into jobs unsuited to the immigrant's skills.

### [Figures 1a, 1b]

To the extent that this is what is happening then, after arrival, immigrants may move along the distribution of native wages through “upgrading”, as they accumulate human capital that is complementary to their existing skills, and transfer existing skills to the needs of the host country labour market. In Figures 2a and 2b, we illustrate that, again for the CPS and the

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<sup>4</sup>We explain in the Appendix how these figures are constructed.

LFS. We now plot the actual and predicted positions of immigrants in the native wage distribution, for immigrants who have been in the country for more than 10 years, as well as their “predicted” position, based on their observed age-education characteristics. The predicted and actual positions are much closer together than for recent immigrants, which suggests that “upgrading” takes place.

[Figures 2a, 2b]

What would be the consequences for the estimation of the elasticity of substitution between immigrants and natives of initial downgrading and subsequent upgrading? The equations estimated in the two papers regress the log ratio of wages of natives and immigrants within an age-education cell on relative labour supply:

$$(1) \ln\left(\frac{w_{jt}^I}{w_{jt}^N}\right) = f_j + \tau_t - \frac{1}{\sigma} \ln\left(\frac{N_{jt}^I}{N_{jt}^N}\right) + u_{jt},$$

where  $w_{jt}^N, w_{jt}^I$  and  $N_{jt}^N, N_{jt}^I$  are real wages and labour supply of immigrants and natives in skill cell  $j$  in time period  $t$ , respectively,  $f_j$  and  $\tau_t$  are skill group and time fixed effects, and the  $u_{jt}$  are error terms.

The empirical implementation of equation (1) involves assigning immigrants and natives to skill groups based on their observed educational characteristics and their potential labour market experience. The variation used for estimation is then the variation within skill cells over time. If downgrading and subsequent upgrading takes place, so that skilled immigrants initially take unskilled jobs, then the *actual* composition of the population in the cell  $N_{jt}^I$  will not correspond to where immigrants would be allocated based on their observed characteristics, and it will change over time. As a consequence, the estimates of  $1/\sigma$  may not reflect substitutability between immigrants and natives within an age – education cell, and could be sensitive according to whether e.g. yearly or decennial information is used.

To see how this could work, we present a simplified example. Suppose that there are two skill types  $j$ , skilled ( $j=S$ ) and unskilled ( $j=U$ ), and that natives and immigrants are not only perfect substitutes but equally productive within skill cells so that wages are equal,  $w_{jt}^I = w_{jt}^N$ , and  $\sigma$  is infinite. In an initial period  $t=0$ , immigrants already in the country are fully integrated and working in jobs appropriate to their qualifications. A one-off influx of  $\delta$  skilled immigrants occurs but there is initial downgrading and gradual integration at rate  $\alpha$  so that for  $t>0$

$$\begin{aligned} N_{St}^I &= N_{S0}^I + (1 - e^{-\alpha t})\delta \\ N_{Ut}^I &= N_{U0}^I + e^{-\alpha t}\delta \end{aligned}$$

Wages of skilled immigrants working in skilled jobs are equal to those of skilled natives,  $w_{St}^I = w_{St}^N$ , but the average wage of immigrants with skilled qualifications  $\tilde{w}_{St}^I$  only approaches that level slowly as the newly arrived immigrants regrade,

$$\tilde{w}_{St}^I = (N_{St}^I w_{St}^I + e^{-\alpha t} \delta w_{Ut}^I) / (N_{S0}^I + \delta) = w_{St}^I \left( 1 - \frac{\mu}{1 + \mu} \phi e^{-\alpha t} \right).$$

where  $\mu = \delta / N_{S0}^I$  is the intensity of the immigrant inflow and  $\phi = (w_{St}^I - w_{Ut}^I) / w_{St}^I$  is the relative wage gap between skill types.

Assume no change in native skill supplies. Taking (1) and differencing to eliminate time and skill cell effects gives

$$\begin{aligned} 0 &= E \left[ \ln \left( \frac{w_{St}^I}{w_{St}^N} \right) - \ln \left( \frac{w_{S0}^I}{w_{S0}^N} \right) - \ln \left( \frac{w_{Ut}^I}{w_{Ut}^N} \right) + \ln \left( \frac{w_{U0}^I}{w_{U0}^N} \right) \right] \\ &= -\frac{1}{\sigma} E \left[ \ln \left( \frac{N_{St}^I}{N_{St}^N} \right) - \ln \left( \frac{N_{S0}^I}{N_{S0}^N} \right) - \ln \left( \frac{N_{Ut}^I}{N_{Ut}^N} \right) + \ln \left( \frac{N_{U0}^I}{N_{U0}^N} \right) \right] \end{aligned}$$

suggesting a difference-in-difference estimator

$$\frac{1}{\hat{\sigma}} = - \left[ \ln \left( \frac{w_{St}^I}{w_{St}^N} \right) - \ln \left( \frac{w_{S0}^I}{w_{S0}^N} \right) - \ln \left( \frac{w_{Ut}^I}{w_{Ut}^N} \right) + \ln \left( \frac{w_{U0}^I}{w_{U0}^N} \right) \right] / \left[ \ln \left( \frac{N_{St}^I}{N_{St}^N} \right) - \ln \left( \frac{N_{S0}^I}{N_{S0}^N} \right) - \ln \left( \frac{N_{Ut}^I}{N_{Ut}^N} \right) + \ln \left( \frac{N_{U0}^I}{N_{U0}^N} \right) \right]$$

Suppose now that wages and numbers of skilled and unskilled immigrants are calculated using the population of immigrants with skilled and unskilled qualifications rather than the number actually working in skilled and unskilled jobs. Then the mismeasured numerator will

tend to  $-\ln\left(\frac{\tilde{w}_{St}^I}{w_{St}^N}\right) = -\ln\left(1 - \frac{\mu}{1+\mu}\phi e^{-\alpha t}\right)$  and the mismeasured denominator to  $\ln(1+\mu)$  so

that  $\frac{1}{\hat{\sigma}}$  will estimate  $1 - \ln(1 + \mu(1 - \phi e^{-\alpha t})) / \ln(1 + \mu)$ . As  $t$  gets large, immigrants and natives will appear accurately to be perfect substitutes; for small  $t$  however, the misclassification will tend to suggest that there are more immigrants occupying skilled jobs and that immigrant wages in skilled jobs are lower than is actually the case so that natives and immigrants will appear to be imperfect substitutes. The error will be greater the smaller is  $t$ . This is only a crude example designed to illustrate a particular point but it is suggestive. The results found in the two papers are compatible with this. While OP estimate an elasticity of substitution of about 20 for the US, MMW estimate an elasticity of substitution of about 7.5. These differences could be due to the larger degree of downgrading in the UK, and the use of decennial Census data for the US, but data at most 5 years apart in the case of the UK.

What this highlights is that an appearance of imperfect substitutability of immigrant and native labour can appear as a consequence of delayed integration into the labour market. This suggests that it may be misleading to conclude that immigrants and natives are intrinsically different types of input into production. The unfamiliarity of recently arrived immigrants with language (see e.g Dustmann and Fabbri 2003) and customs and their lack of integration into job networks may hinder them in their ability to find jobs appropriate to their skills.

### 3. Conclusions

The papers by MMW and OP are a welcome addition to the literature on the impact of immigration on native wages. They introduce an important and relevant new aspect to this area of research: the substitutability between immigrants and natives, suggesting that imperfect substitutability between immigrants and natives may induce wage effects on natives that go undiscovered in models that assume perfect substitutability. There is a problem however to any approach that relies on identifying where immigrants compete by pre-assignment on the basis of observed qualifications. In our comment, we point to an important caveat, showing how downgrading may bias estimates of imperfect substitutability within education- and age cells, with the bias being dependent on the degree of downgrading, the pace of subsequent upgrading, and the length of the interval between two data points.

There is an appeal to methods that do not rely on pre-assignment of immigrants to skill groups, and allow the data to dictate where in the native wage distribution effects are felt. In that spirit, the recent work of Dustmann, Frattini and Preston (2011) estimates the impact of overall immigration along the distribution of wages and reveals a persuasive association between the location of measured effects and the actual location of immigrants in the native wage distribution. There is a compelling case for continued research in the area that can develop a method integrating a data-driven approach to identifying where immigrants compete with natives with an allowance for imperfect substitutability of immigrant and native labour, as in MMW and OP.



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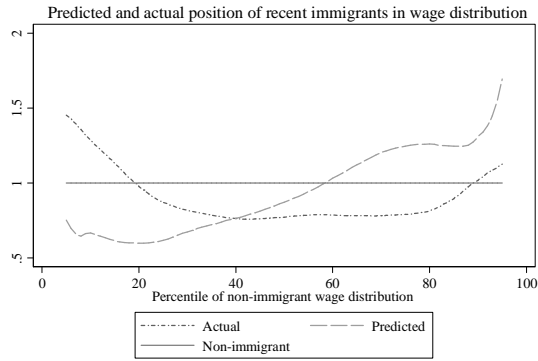


Figure 1a: Recent immigrants, arrived in the UK within the last two years.

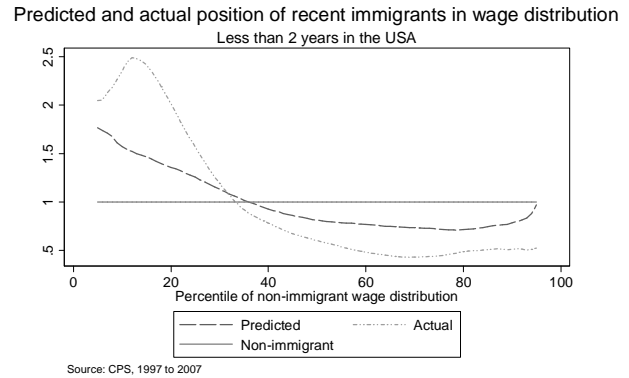


Figure 1b: Recent immigrants, arrived in the USA within the last two years.

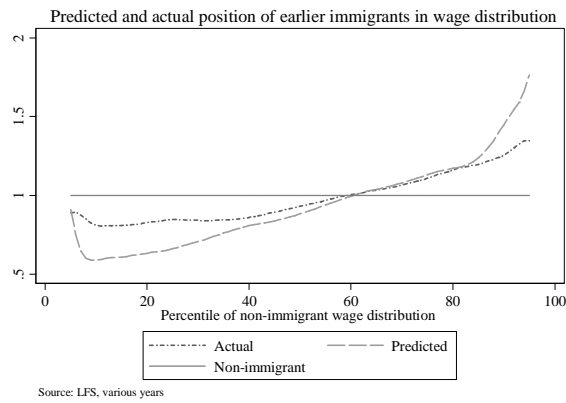


Figure 2a: Earlier immigrants, in the UK for more than 10 years

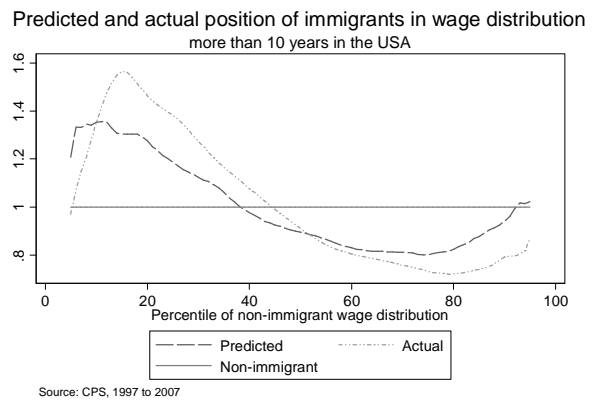


Figure 2b: Earlier immigrants, in the U.S. for more than 10 years

## **Appendix: Data description and wage prediction for immigrants**

The graphs are based on data from the British Labour Force Survey (LFS) and the IPUMS-CPS (Integrated Public Use Microdata Series of the March Current Population Survey). We use years from 1997 to 2007. For the LFS, we use the sample as in Dustmann, Frattini and Preston (2010). For the CPS, we construct a sample following Borjas, Grogger and Hanson (2008) and Ottaviano and Peri (2011), using workers aged between 17 to 65, who are not living in group quarters, who worked at least a week in the previous year and have a positive salary income. We use personal weights and construct pre-tax weekly wages in 2000 prices. To compute the counterfactual distribution of wages for immigrants, we estimate log wage regressions for natives conditioning on education, age, state of residence and whether the individual lives in a metropolitan area, separately by year and gender. We compute heteroscedastic error terms (by age, education and gender) from their asymptotic normal distribution. We then predict a distribution of wages for immigrants, using the estimated parameters and the heteroscedastic estimated error terms.

To assign immigrants to their position in the native wage distribution according to their actual or predicted wages, we rank immigrants in the wage distribution of natives for each year and compute the log odds ratio for each percentile, and sum over immigrants and years. We then compute kernel estimates of the relative density of the log odds ratios at each point of the distribution.