The Impact of Immigration:
Why Do Studies Reach Such Different Results?

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Abstract We classify the empirical literature on the wage impact of immigration into three groups, where studies in the first two estimate different *relative* effects, and the third the *total* effect of immigration on wages. We interpret the estimates obtained from the different approaches through the lens of the canonical model to demonstrate that they are not comparable. We then relax two key assumptions in this literature, allowing for inelastic and heterogeneous labor supply elasticities of natives and the downgrading of immigrants. We show that heterogeneous labor supply elasticities, if ignored, may complicate the interpretation of wage estimates, in particular of relative wage effects. Moreover, downgrading may lead to biased estimates in those approaches that estimate relative effects of immigration, but not in approaches that estimate *total* effects. We conclude that empirical models that estimate total effects not only answer important policy questions, but are also more robust to alternative assumptions than models that estimate relative effects.

The canonical model for studying the impact of immigration is a partial equilibrium model that combines one or various types of labor with capital in a constant-returns-to-scale production function (for an early example, see Altonji and Card 1991). The implications of this model for how immigration affects wages and employment are straightforward and intuitive. An expansion of a certain type of labor will lead to a decrease in the wage of native labor of the same type, in absolute terms and relative to other types of labor—as well as an increase in the marginal productivity of capital. This model has led to the common view of immigration being potentially harmful for individuals whose skills are most similar to those of immigrants, but possibly beneficial for those whose skills are different. However, when this canonical model is implemented through empirical models, some studies using this approach find a sizeable effect of immigration on wages of native workers, while others do not. For instance, while Card (2009) finds that immigration to the US has only a minor effect on native wages, Borjas (2003) provides evidence for wages of natives being harmed by immigration and Ottaviani and Peri (2012) report positive wage effects on natives. One reaction to these apparently contradictory findings has been to expand the theoretical framework in various ways. For example, one approach is to acknowledge the multiple output nature of an economy, thus adding possibilities of adjustment to immigration along the product mix and technology margins (e.g., Card and Lewis 2007; Lewis 2011; Dustmann and Glitz 2015). Another theoretical alternative is to allow the price of the output good to vary, rather than being fixed (e.g., Özden and Wagner 2015).

Such alternative theories are worth exploring for their own sake, but we do not believe that they are necessary for explaining the differing findings from empirical studies of how immigration affects wages. We argue here that the often contradictory results in the empirical literature have two important sources. First, despite being derived from the same canonical model, different

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empirical specifications measure different parameters. Second, two assumptions that are commonly and tacitly made when bringing this framework to the data may be invalid: (i) that the labor supply elasticity is homogenous across different groups of natives, and (ii) that we can place immigrants and natives into education-experience cells within which they compete in the labor market, based on their reported education and age.

In the next section, we classify existing empirical specifications into three groups. One specification, as in for example Borjas (2003), exploits variation in immigrant inflows across education-experience cells on a national level ("national skill-cell approach"). Another specification, as in for example Altonji and Card (1991), uses variation in the total immigrant flow across regions ("pure spatial approach"), while a third specification, as in for example Card (2001) uses variation in immigrant inflows both across education groups and across regions ("mixture approach"). As we illustrate in Table 1, the national skill-cell approach tends to produce more negative wage effects for natives in response to immigration than the mixture approach, while estimates obtained from the pure spatial approach vary widely depending on which skill group is studied. However, as we argue below, estimates obtained from the different models are not comparable, answer different questions, and have different interpretations. While the national skill-cell and the mixture approach identify a *relative* wage effect of immigration—of one experience group versus another within education groups and of one education group versus another—the pure spatial approach recovers the *total* wage effect of immigration on a particular native skill group that takes into account complementarities across skill-cells and across labor and capital. We illustrate that the different specifications are motivated by variants of the *same* canonical model, but estimate *different structural* parameters.

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We then turn to two extensions. First, research in this area typically assumes that the elasticity of labor supply is homogenous across different groups of natives (with many papers implicitly postulating a vertical labor supply curve). This assumption allows focusing the analysis on wages and ignoring employment responses. However, if the employment of natives responds to immigration, part of its overall impact on the labor market will be absorbed by employment as opposed to wage responses. Moreover, not only is labor supply likely to be elastic, but it is also likely to differ across groups of native workers (such as skilled and unskilled, or younger and older workers). We illustrate that with group-specific labor supply elasticities, the national skill-cell approach may produce estimates that are hard to interpret, while approaches that estimate *total* effects still produce estimates that have a clear interpretation. Furthermore, the degree to which the labor supply response of natives differs across groups, and its overall level, depend on the variation the chosen approach uses for identification. When using variation across skill-experience cells on the national level, employment adjusts only at the un- and non-employment margin. In contrast, when using variation across local labor markets, as in the pure spatial or mixture approach, the labor supply of natives may respond more elastically, due to the regional migration of workers.

Second, the national skill-cell and the mixture approach rely on the assumption that an immigrant and a native with the same *measured* education and experience compete against each other. However, there is strong empirical evidence that immigrants "downgrade" upon arrival, and we demonstrate the downgrading of immigrants for three countries, the US, the UK, and Germany. Consequently, assigning immigrants to skill groups according to their measured skills may lead to misclassification, and seriously impair the estimates of wage responses of natives to immigration. Although the bias cannot be unambiguously signed, we provide evidence suggesting that in the

US context, downgrading may overstate the negative impact of immigration in both the national skill-cell and the mixture approach, but particularly so in the national skill-cell approach. Downgrading may therefore be one reason why the national skill-cell approach tends to produce more negative native wage effects than the mixture approach. In contrast, approaches that estimate *total* effects of immigration are robust to downgrading as they do not require the allocation of immigrants into skill groups.

In a final step, we turn to approaches that explicitly estimate the underlying parameters of the canonical model above and then use that model to predict the wage effects of immigration, as in for example Ottaviano and Peri (2012) and Manacorda, Manning and Wadsworth (2012). We contend that downgrading may seriously impair the estimation of a key parameter in this approach, the elasticity of substitution between immigrants and natives, which may help to explain why studies using this approach find often positive wage effects of immigration for natives.

In summary, we argue that differences in coefficients estimated by the different specifications, and the assumptions being made about native labor supply responses and downgrading may explain many of the apparent contradictions among the empirical findings reported in the literature. We advocate investigating the effects of the *overall* (as opposed to the group-specific) immigration shock on wages and employment of various native groups. This procedure avoids the pre-classification of workers into groups and is therefore immune to the misclassification of immigrants that arises due to the "downgrading" phenomenon. Further, it estimates a parameter that is of direct policy relevance and easily interpretable, even if labor supply elasticities differ across groups of native workers.

We should emphasize that this paper is about the correct *specification* of empirical models and the interpretation of the estimated parameters, not about empirical *identification*. Any of the approaches we discuss slices the labor market in different sub-labor markets, and uses variation in the inflow of immigrants into these sub-labor markets as an identification device. We assume here that the allocation of immigrants to these sub-labor markets is (conditionally) independent of shocks to wages or employment of native workers (which could be achieved either through random allocation of immigrants, or by use of an appropriate instrument), and that some, but not other sub-labor markets are exposed to an inflow of immigrants.[1]

Throughout the paper, we explain our arguments informally and verbally. We have prepared a self-contained companion appendix to this paper which provides more formal derivations and technical discussions.

Estimation Approaches Used in the Literature

The existing empirical literature has derived three conceptually different effects of immigration on wages, estimated using different types of variation for identification: estimation at the national level exploiting variation in the skill-cell specific inflow of immigrants, as pioneered by Borjas (2003), estimation at the regional level exploiting variation in the total inflow of immigrants, as pioneered by Altonji and Card (1991), and estimation at the regional level

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[1] The identification of empirical models is a key problem in the literature. Studies that slice the labor market into spatial units typically rely on using past settlement of immigrants as an instrumental variable, as used in Altonji and Card (1991) and further developed in Card (2001). Studies that slice the labor market into skill groups instead typically assume that immigrant inflows are exogenous, an assumption that may be violated (Llull 2014). A number of studies exploit natural quasi-experiments that lead to a sharp rise or fall in immigration for identification purposes, such as Card (1990), Hunt (1992), Carrington and De Lima (1996), Friedberg (2001), Glitz (2012), Dustmann, Schönberg and Stuhler (2015), and Foged and Peri (2016). Moreover, "push factors" that generate out-migration can be combined with the past settlement instrument (e.g., Boustan et al. 2010; Ganguli 2014; Aydemir and Kirdar 2014; Monras 2015a).

exploiting variation in the inflow of immigrants both across areas and skill-cells, as for instance in Card (2001). These different empirical approaches identify conceptually different parameters that are not directly comparable—even if the estimation regressions are motivated by the same canonical model (or versions of it).

The National Skill-Cell Approach: Variation in the Immigration Shock across Skill-cells

Borjas (2003) estimates the wage effects of immigration at the national level by categorizing immigrants and natives into education-experience cells using data from various census waves. This method identifies the *relative* wage effect of immigration by experience. To see this, we rewrite his baseline estimation equation (see equation (3) in his paper) as a first difference equation to obtain:[2]

$$\Delta logw_{gat} = \theta^{skill}\Delta p_{gat} + \Delta\pi_t + \left(s_g \times \Delta\pi_t\right) + (x_a \times \Delta\pi_t) + \Delta\varphi_{gat}, \qquad (1)$$

where $\Delta logw_{gat}$ denotes the change in native wage (in logs) in education group g, experience group a at time t and Δp_{gat} denotes the education-experience specific immigration shock, defined as the difference in the ratio of immigrants to all labor in each education-experience group ga between two time periods. The variables $s_g, x_a,$ and π_t are vectors of education, experience and time fixed effects. In the case of two education and experience groups, the parameter θ^{skill} may be thought of as a triple difference estimator where differences are taken over time, experience groups, and education groups. The inclusion of time fixed effects in first differences absorbs the overall immigration shock—any effects of immigration common to all education and experience

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[2] We have swapped the sub-indices *i* and *j* used by Borjas to denote education and experience cells with the sub-indices *g* and *a* used by us in the next section.

groups are therefore differenced out. The education-time fixed effects capture, in addition to differential time trends by education unrelated to immigration, differences in immigration shocks across education groups—any effects of immigration common to all experience groups within education groups are therefore likewise differenced out. The inclusion of experience-time fixed effects, in turn, soaks up the experience-specific immigration shock, in addition to allowing for differential time trends by experience unrelated to immigration. The parameter θ^{skill} therefore identifies the relative effect of immigration by experience and answers the question: "How does immigration affect native wages of experienced relative to inexperienced workers in the same education group?" Since the effects of immigration that are common to the education group are differenced out, this parameter is not informative about the distributional effects between education groups, nor about its absolute effects. The upper panel of Table 1 provides an overview of some of the papers adopting the national skill-cell approach. Typical wage estimates for native men are around -0.5 (e.g., Borjas 2003; Aydemir and Borjas 2007; Borjas 2014). Estimates turn substantially more negative when instrumenting for the potential endogeneity of the immigration shock across education-experience cells (Llull 2014). In contrast, using an alternative measure for the education-experience specific immigration shock, Card and Peri (2016) report a smaller estimate of -0.1.

The Pure Spatial Approach: Variation in the Total Immigration Shock across Regions

In many studies that exploit spatial variation in immigrant inflows, the log wage changes of natives in education group *g* and experience group *a* in region *r* are related to the *total* region-specific immigration shock (defined as the ratio of all immigrants entering the region and all natives in that region), controlling for nation-wide education-experience specific time trends ($s_{ga} \times \Delta\pi_t$):

$$\Delta logw_{gart} = \theta_{ga}^{spatial}\Delta p_{rt} + s_{ga} \times \Delta\pi_t + \Delta\varphi_{gart}. \qquad (2)$$

In the case of two time periods and two regions A and B, the parameter $\theta_{ga}^{spatial}$ equals a difference-in-difference estimator where differences are taken over time and across regions. Provided that region B, otherwise identical to region A, did not experience an inflow of immigrants and is not indirectly affected by the immigration shock in region A through, e.g., outmigration of natives, this parameter identifies the total effect of immigration on wages of a particular skill group. It answers the question: "What is the overall effect of immigration on native wages of a particular education-experience group?" It is informative about the distributional effects of immigration both between education and experience groups, as well as about its absolute effects. The second panel of Table 1 provides an overview of some papers that adopt the pure spatial approach. For example, Altonji and Card (1991) report total wage estimates for white male high school dropouts of about -1.1, while Dustmann, Frattini and Preston (2013) find negative total wage effects of about -0.5 at the 10th percentile, and positive wage effects of 0.4 at the 90th of the earnings distribution. Card (2007) finds small positive total wage effects (0.06) for natives on average.

The Mixture Approach: Variation in the Immigration Shock across both Skill-Cells and Regions

A third set of papers exploits variation in the immigration shock across both skill-cells and regions, and are therefore a mixture of the pure skill-cell approach and the pure spatial approach. Most papers which fall into this category distinguish only between education (or occupation) cells. These papers then relate the wage change of natives in education group g and region r to the education-specific immigration shock in that region (Δp_{grt}), controlling for education- and region-specific time trends $(s_g \times \Delta\pi_t$ and $s_r \times \Delta\pi_t)$:

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$$\Delta logw_{grt} = \theta^{spatial,skill}\Delta p_{grt} + (s_r \times \Delta\pi_t) + (s_g \times \Delta\pi_t) + \Delta\varphi_{grt}. \qquad (3)$$

In the simple case of two regions A and B, two time periods and two education groups, the parameter $\theta^{spatial,skill}$ can be expressed as a triple difference estimator where differences are taken over time, across regions, and across education groups. By conditioning on region-specific time effects and thus absorbing the total region-specific immigration shock, $\theta^{spatial,skill}$ identifies the relative effect of immigration by education and answers the question: "How does immigration affect native wages of low skilled relative to high skilled workers?" Since the effects of immigration common to all education-experience groups are differenced out, the mixture approach is informative about the distributional effects of immigration between education groups, but not about its absolute effects. The bottom panel of Table 1 provides an overview of some of the papers that adopt the mixture approach. Estimates are generally less negative than those obtained from the national skill-cell approach. For example, Card (2001), who uses just one cross-section and distinguishes between occupations rather than education groups, reports a wage estimate of -0.1 for native men. Dustmann and Glitz (2015) find a more negative response in non-tradable industries, but little response in tradable or manufacturing industries.

In sum, depending on the definition of the immigration induced labor supply shock (skill group specific or overall) and the variation in immigration shocks used (across skill-cells, across regions, or both), the level of the analysis (e.g., education groups vs education-experience groups), and the control variables used in the estimation regressions, different approaches identify conceptually different parameters. Although these parameters are not directly comparable, it is possible to transform total effects into relative effects of immigration by experience and education. In contrast,

since total effects of immigration contain additional information to relative effects, the latter cannot be transformed into the former.

Interpretation of Relative and Total Effects of Immigration through the Lens of the Canonical Model

To aid the interpretation of the parameters estimated by the three main empirical approaches, we now present a simple version of the canonical model that motivates the empirical specifications outlined above.

Set-Up

Production Function: We assume a simple Cobb-Douglas production function that combines capital K and labor L into a single output good Y, $Y = AL^{1-\alpha}K^{\alpha}$. Labor is assumed to be a CES aggregate of different education types, and we distinguish here between low (L_L) and high skilled (L_H) labor only, so that $L = [\theta_L L_L^{\beta} + \theta_H L_H^{\beta}]^{1/\beta}$. The elasticity of substitution between low and high skilled workers is given by $1/(1-\beta)$, and measures the percentage change in the ratio of low skilled workers to high skilled workers in response to a given percentage change in the wages of low skilled to high skilled workers. The higher this elasticity, the more substitutable the two groups are. The two skill types are perfect substitutes (implying an infinite substitution elasticity) if $\beta = 1$.

Within each education group, we allow, similar to Card and Lemieux (2001), inexperienced (L_I) and experienced (L_E) workers to be imperfect substitutes, so that $L_g = [\theta_{gI} L_{gI}^{\gamma} + \theta_{gE} L_{gE}^{\gamma}]^{1/\gamma}$, and where $1/(1-\gamma)$ is the elasticity of substitution between inexperienced and experienced workers within an education group. If $\gamma = 1$, the two groups are perfect substitutes. We assume here that immigrants can be correctly classified to education and experience groups and that within

an education-experience group, immigrants and natives are perfect substitutes. We turn to the possibility of misclassification and imperfect substitutability between immigrants and natives below.

Firms choose capital and labor by maximizing profits, taking wage rates and the price of capital as given. Output prices are assumed to be determined in the world market and are normalized to 1.

Capital and Labor Supply: Capital is supplied to the labor market according to $r = K^{\lambda}$, where r denotes the price of capital and $1/\lambda$ is the elasticity of capital supply. We assume that the labor supply of immigrants who enter the country is inelastic. In contrast, native employment in an education-experience group depends on the wage in that education-experience group. Let η_{ga} denote the labor supply elasticity for a particular education-experience group. It measures the percentage change in the supply of native labor in the education-experience group in response to a given percentage change in the wage of that group. The degree to which native labor supply responds to an immigration induced labor supply shock (and the heterogeneity across groups) depends on the alternatives an individual has when wages in the current (or desired) job decline. If wages decline in the local economy, workers may respond by moving away (or no longer moving into the area). However, if wages decrease in all firms in the national economy, workers can respond only by moving from and into unemployment or by entering or exiting the labor force. Thus, when using spatial variation in immigrant inflows (as in the pure spatial and the mixture approach), estimated labor supply elasticities of natives are likely larger than when using variation across skill-cells in the national labor market (as in the national skill-cell approach).

Labor supply elasticities on the national level may differ between different groups of workers. For instance, Altonji and Blank (1999) find that married women have the largest labor supply elasticities on the national level, while Ljungqvist and Sargent (2007) and Rogerson and Wallenius (2009) emphasize that individuals near retirement or those with low wage rates exhibit particularly large extensive margin responses. Groups that have the weakest attachment to the labor force, such as single mothers, appear more elastic on the extensive margin (see, e.g., Meyer and Rosenbaum 2001, Gruber and Wise 1999, Heckman 1993, Keane and Rogerson 2015, and Chetty et al. 2012 for a summary).

The labor supply elasticity at the local level captures in addition the internal migration of workers between areas and may thus depend on additional factors such as the supply of housing (Moretti 2011) and the size of the labor market that is considered (see, e.g., Borjas 2006). This adjustment margin may have different importance for different types of workers. For example, geographic mobility may be a more important adjustment margin for skilled workers, as migration rates rise with education (Greenwood 1975; Molloy, Smith and Wozniak 2011). Indeed, Bound and Holzer (2000) find that skilled workers are more likely to move in response to a local shock, as do Wozniak (2010), Notowidigdo (2011), Amior and Manning (2015), and Dustmann, Schönberg and Stuhler (2015). Similarly, Cadena and Kovak (2016) note that location choices respond more strongly to demand shocks for Mexican-born immigrants than for natives. Such patterns affect the incidence of local shocks. For example, Hornbeck and Moretti (2015) find that because college graduates move in greater numbers in response to a local productivity shock, its incidence is reduced for skilled workers. Both the overall size of the elasticity and the relative importance of the underlying adjustment margins may vary across groups. For example,

Dustmann, Schönberg and Stuhler (2015) find that young workers respond more strongly at the geographic margin than older workers.

Interpretation of Relative and Total Wage Effects of Immigration if Labor Supply is Inelastic

A common assumption in the literature is that native employment does not respond to wage changes (e.g., Borjas 2003; Ottaviano and Peri 2012). With inelastic native labor supply, the only reason why total, education- and education-experience specific employment change is because of immigration. In this case, the equilibrium native wage response due to immigration equals:

$$\Delta log w_{ga} = -\frac{\alpha\lambda}{1-\alpha+\lambda}\Delta\tilde{I} + (\beta-1)(\Delta\tilde{I}_g - \Delta\tilde{I}) + (\gamma-1)(\Delta I_{ga} - \Delta\tilde{I}_g), \qquad (4)$$

where $\Delta\tilde{I}$ and $\Delta\tilde{I}_g$ are the overall and education-specific immigration shocks, measured as percentage change in efficiency units, and ΔI_{ga} is the education-experience specific immigration shock. Consider first the third term in equation (4), and suppose that within each education group immigration is relatively inexperienced. This term is then negative for inexperienced natives, and positive for experienced natives. Thus, ceteris paribus, immigration will lower wages of inexperienced natives and raise wages of experienced natives within each education group.

The second term in this equation looks at how changes in immigration disproportionately affect education levels. The second term will be negative for the education group that is exposed to the larger inflow of immigrants and positive for the other education group, implying wage declines for the former and wage increases for the latter group (holding the other terms constant). Thus, the second and third terms summarize the key insight of the simple competitive model: Immigration will decrease the marginal product and hence wages of native workers most similar to immigrant

workers, and may increase the marginal product and wages of native workers most dissimilar to immigrant workers.

Finally, the first term in equation (4) captures the wage effects of immigration common to all education and experience groups and can, at an intuitive level, be understood at the slope of the aggregate demand curve. If capital supply is fully elastic ($\lambda = 0$), this term disappears and on *average*, wages do not change in response to immigration. If in contrast capital supply is not fully elastic, the direct overall immigration shock pulls down wages of all skill groups in the same way, and an immigration-induced labor supply shock has a negative effect on average wages—as immigration will lead to increases in the rent of capital and re-distribute a share of output from labor to capital. The literature often denotes the case of inelastic capital supply as the *short-run* effect of immigration, and the case of perfectly elastic labor supply as the *long-run* effect.

Based on equation (4), it is now straightforward to provide a structural interpretation of the relative and total effects of immigration identified by the three empirical approaches described in the previous section.

National Skill-Cell Approach: As explained above, the national skill-cell approach pioneered by Borjas (2003) identifies the relative wage effect of immigration by experience, and any effects of immigration common to all education and experience groups as well as any effects of immigration common to all experience groups within education groups are differenced out. Put differently, in the empirical specification underlying the national skill-cell approach the total and the education-specific immigration shocks are held constant through the inclusion of general and education-specific time fixed effects. The parameter θ^{skill} estimated by the spatial skill-cell approach may therefore be thought of as the direct partial effect of immigration, holding the total and the

education-specific immigration shock constant. From equation (4), θ^{skill} identifies $(\gamma - 1)$, the inverse of the elasticity of substitution between experienced and inexperienced workers within education groups. It is unambiguously negative (as $\gamma < 1$), the more so the less substitutable experienced and inexperienced workers are within education groups.

Mixture Approach: Studies that exploit variation in the immigration shock across both skill-cells and regions (e.g., LaLonde and Topel 1991; Card 2009) identify the relative wage effect of immigration by education, as any effects of immigration common to all education groups are differenced out. The parameter $\theta^{spatial,skill}$ estimated by the mixture approach may thus be thought of as the direct partial effect of immigration holding the total immigration shock constant. From equation (4), $\theta^{spatial,skill}$ identifies $(\beta - 1)$, the inverse of the elasticity of substitution between unskilled and skilled workers. This parameter is unambiguously negative, the more so the less substitutable low and high skilled workers are.

Pure Spatial Approach: The pure spatial approach adopted by for example Altonji and Card (1991) identifies the total wage effect of immigration for workers in education and experience group *ga*. From equation (4), the parameter $\theta_{ga}^{spatial}$ corresponds to $\frac{\Delta log w_{ga}}{\Delta I}$, where ΔI denotes the total immigration shock in head counts, measured in the same way as in the empirical equation (2). In addition to the elasticities of substitution between inexperienced and experienced workers and low and high skilled workers, it depends on the elasticity of capital supply and the share of capital in production. This total effect measures not only the direct partial effects of an immigration induced labor supply shock on native workers in a particular education-experience or education group, but also the indirect effects through complementarities across skill-cells and across capital and labor and is, for this reason, in our view the most policy-relevant parameter. If capital supply is fully

elastic, the total wage effect of immigration will be zero on average, while negative for some skill groups—those experiencing the stronger inflow of immigrants—and positive for other skill groups. If capital supply is fully inelastic, the total wage effect may be negative for all skill groups.

Interpretation if Labor Supply is Elastic, but Constant Across Skill Groups

So far, we have discussed the interpretation of the relative and total wage effects of immigration under the assumption that native labor does not respond to wage changes. Next, we turn to the case in which native labor supply does adjust to wage changes, but the labor supply elasticity is constant across skill groups. In this case, the labor market effects of immigration are not only absorbed through wage changes, but also through employment changes. Therefore, to obtain a complete picture of both the relative and total effects of immigration, wage and employment responses need to be studied jointly. As the labor supply elasticity increases, both the relative and the total wage effects become more muted, whereas the respective employment effects increase. If labor supply is infinitely elastic, the relative and total wage effects of immigration approach zero, whereas the respective employment effects approach -1, implying that each immigrant displaces one native worker. As discussed, the labor supply elasticity is likely to be larger at the national level than at the local level—which, as emphasized by Borjas (2003), may help to explain why the national skill-cell approach tends to produce more negative wage effects than the mixture approach.

Our discussion so far has assumed that wages are fully downward flexible. In practice, wages may however be partially downward rigid at least in the short-run, for example because of institutional constraints or contractual agreements. The degree of downward wage rigidity plays a similar role in determining the wage and employment impacts of immigration as the labor supply elasticity;

the higher the degree of rigidity, the smaller the wage and the larger the employment response to immigration. Wage rigidity therefore provides an additional reason why native wage and employment responses need to be studied jointly to obtain an accurate picture of the labor market impacts of immigration.

Under the assumption that wages are fully downward flexible, estimates of the labor supply elasticities can be obtained by dividing the total or relative native wage response by the respective native employment response. It is important to emphasize that the ratio of wage and employment effects obtained from the pure spatial or the mixture approach identifies the *local* labor supply elasticity, while estimates obtained from the skill-cell approach identifies a *national* supply elasticity. Ebert and Stone (1992) estimates the local labor supply elasticity to be about 5 on the metropolitan statistical area level in the US, while Bartik (1991), Lettau (1994), Smith (2012) and Notowidigdo (2012) somewhat smaller estimates in the range of 1.5 to 4. Because of differences in specifications, such as the time frame and size of the local area considered, these estimates are not fully comparable. Estimates for the national labor supply elasticity at the extensive margin, typically estimated using tax changes, tend to be smaller: the meta-analysis in Chetty et al. (2012) points to an extensive margin elasticity of around 0.25. Longitudinal data, which trace workers over time across regions, make it possible to decompose the local employment response into inflows from and outflows to non-employment, and inflows from and outflows to employment in other regions. For instance, Dustmann, Schönberg and Stuhler (2015) show that in their context, movements across regions account for roughly one third of the overall local native employment response, which adjusts predominantly because inflows into employment in the affected region decline (see also Filer 1992 and Monras 2015b for similar evidence).

Interpretation if Labor Supply Elasticities Vary across Skill Groups

So far, we have assumed that the elasticity of labor supply is constant across education-experience groups. It is likely, however, that labor supply elasticities differ between different groups of workers, both on national and local level (see our discussion above). Alternatively, the degree of wage rigidity may differ across groups of workers. For example, Dustmann, Schönberg and Stuhler (2015), argue that older workers' wages may be more "protected" than those of younger workers and, unlike wages of younger workers, less likely to adjust downward. Next, we highlight the implications of heterogeneity in labor supply elasticities or in the degree of wage rigidities across groups of workers for the interpretation of the relative and total effects of immigration.

Mixture Approach: Consider first the relative effect of immigration by education identified by the mixture approach. A key implication of the canonical model is that natives who suffer the largest inflow of immigrations (e.g., low-skilled workers if immigration is relatively low-skilled) suffer the largest decline in wages as well as employment. With heterogeneous labor supply elasticities, however, this may no longer hold—a phenomenon we refer to as "perverse" effects (see also Dustmann, Schönberg, and Stuhler 2015). To grasp the intuition for the possibility of perverse effects, suppose that immigration is relatively low skilled and that, in line with the empirical evidence that low skilled workers respond more elastically to wage changes along the un- or non-employment margin, low skilled natives have a higher labor supply elasticity than high skilled natives. In equilibrium, low skilled natives' employment will then have responded strongly relative to high skilled natives' employment, while their wages adjust less, and may even increase relative to those of high skilled natives. In the presence of heterogeneous labor supply elasticities, the

relative wage and employment effect of immigration may therefore be of opposite sign. While the mixture approach continues to be informative about how immigration affects wages and employment of one education group relative to the other, focusing solely on native wage responses may yield a misleading picture of the overall relative effects of immigration. The possibility of perverse effects therefore reinforces our conclusion that wage and employment responses need to be studied jointly to obtain an accurate picture of the labor market impacts of immigration.

National Skill-Cell Approach: Consider next the wage and employment effects estimated by the national skill-cell approach (θ^{skill}), which compares wage changes between inexperienced and experienced low skilled workers with those of inexperienced and experienced high skilled workers. When labor supply elasticities (or the degrees of wage rigidity) vary across groups, estimates obtained from this approach are difficult to interpret and may no longer be informative about the effects of immigration on experienced natives relative to inexperienced natives within education groups. This is because the relative wage effect of one experience group versus the other among low skilled workers is likely to differ from that among high skilled workers. It can be shown that the triple difference estimator of θ^{skill} implied by equation (1) aggregates the two relative wage effects by experience in a non-meaningful way, as it assigns a negative weight to the relative effect in one education group and a weight greater than 1 to the relative effect in the other education group.

Pure Spatial Approach: In contrast, the total effect of immigration estimated by the pure spatial approach remains a meaningful and policy-relevant parameter even in the presence of heterogeneous labor supply elasticities, addressing the same question as in the case of homogenous (or inelastic) labor supply responses: "How does the overall immigration shock affect wages and

employment of a particular native education-experience group?" Estimates for the education-experience specific labor supply elasticities can then be obtained by dividing the estimates for the total native employment effect in a particular education-experience group by the respective estimate of the total wage effect.

Downgrading and Misclassification

Empirical Evidence of Downgrading

"Downgrading" occurs when the position of immigrants in the labor market, which is typically measured by wage or occupation, is systematically lower than the position of natives with the same observed education and experience levels. Downgrading means that immigrants receive lower returns to the same measured skills than natives when these skills are acquired in their country of origin.

The research literature provides ample evidence on the initial downgrading of immigrant arrivals and their subsequent economic assimilation. As one example, for the case of immigration from Russia to Israel in the 1990s, the returns immigrants receive for their schooling and experience are initially zero or even negative, but rise with time spent in the host country, while immigrants with high education climb up the occupational ladder to move into high-skill occupations (Eckstein and Weiss 2004). Estimates of earnings equations such as those by Chiswick (1978), Borjas (1985) or Dustmann (1993), among others, have long shown that immigrants' earnings profiles are comparatively flat with respect to labor market experience or schooling

acquired at home. Dustmann, Frattini and Preston (2013) present evidence on immigrant downgrading for the UK, and Dustmann and Preston (2012) for the UK and the US economies.[3]

In the presence of downgrading, placement of immigrants into education or education-experience cells within which they compete with natives—a pre-requisite of the skill-cell approach and the mixture approach—becomes difficult. For instance, a Polish surgeon who arrives in the UK may lack formal requirements or complementary skills such as the English language and might end up working as a nurse, at least initially. However, based on observed education, the researcher would allocate this surgeon to a skill-cell further up the skill distribution.

To illustrate the degree of downgrading of immigrants, we offer some evidence from the US, the UK, and Germany. We use data from the 2000 US Census, the German IAB Employment subsample, and from the UK labor force survey for the period between 1995 and 2005. In Figure 1, we show where recent immigrants (whom we define as immigrants who arrived over the past two years) are actually situated in the native wage distribution (the dashed lines in Panels A-C), and where we would assign them if they received the same return to their experience and education as natives (the solid lines in Panels A-C). The figures first illustrate that in all three countries, immigrants are, relative to natives with the same formal measurements of experience and education, overrepresented at the bottom of the wage distribution, and underrepresented in the middle or upper ends of the wage distribution. The dashed line (showing where immigrants are actually located) lies for all three countries above the solid line (showing where immigrants should be located based on their education and experience) at low percentiles of the wage distribution,

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[3] Indirect evidence on initial downgrading follows also from the occupational upgrading of immigrants upon legalization (Kossoudji and Cobb-Clark 2000) and the relation between changes in immigration status and native wages (Orrenius and Zavodny 2007). The issue of downgrading has also been acknowledged in various papers that use the skill-cell approach, such as Borjas, Freeman and Katz (1997, p. 42) and Borjas (2003).

but tends to be underneath the solid line further up the wage distribution.[4] Overall, for the three countries of Germany, the US and the UK, recent immigrants have on average wages that are 17.9 percent, 15.5 percent and, 12.9 percent below those native workers would receive after controlling for sex, age, education groups, and age-by-education interactions. The degree of downgrading may change over time and differ across groups. In the UK, our own calculations (not shown here) show that cohorts that arrived in the mid- or late 1990s downgrade less strongly than for those that entered in the mid-2000s. In Germany, immigrants arriving in 2000 from other EU countries do not downgrade on average, while the degree of downgrading is substantial for arrivals from other source countries.

Downgrading is most severe in the years after immigrants arrive, as immigrants upgrade their skills and acquire complementary skills in the host county. But the first years after arrival are exactly the years that matter when estimating the labor market impacts of immigration. For instance, when annual data is used, the change in the share of immigrants is driven by those who arrived over the past year. We illustrate "upgrading" in Figure 1d, where we plot the difference between the actual position of immigrants in the native wage distribution and their predicted position based on observable characteristics (the dashed lines), for immigrants with different durations in the US. If immigrants and natives with similar characteristics have similar wages, then

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[4] More specifically, the allocation of where immigrants should be located according to their observable human capital characteristics (and where the skill-cell approach as well as the structural approach we discuss below would allocate them) is based on a flexible log wage regression model estimated for natives. It includes five age categories (18/25, 26/35, 36/45, 46/55, 56/65), four educational categories (three for Germany), and interactions between the two. We fit separate models for men and women and for different years, compute fitted values for immigrants, and add a normally distributed error term (based on the category-specific residual variance for natives) to compute their predicted rank within the native wage distribution. As the income rank is bounded, conventional kernel estimation with fixed window width would give misleading estimates at the extremes. The kernel estimates are therefore calculated on the log of the odds of the position in the non-immigrant distribution, as in Dustmann, Frattini and Preston (2013).

the actual and predicted positons should coincide (solid line). The panel shows that these profiles become indeed more similar the longer immigrants are in the country.

In the companion appendix to this paper, we propose a simple procedure to impute the degree of immigrant downgrading upon arrival in each education-experience cell under the assumption that immigrants and natives of the same *effective* education-experience type are equally likely to work in a particular occupation-wage group. We apply this procedure to immigrant cohorts that entered the US, UK and Germany around the year 2000. Table 2 contrasts their observed education-experience distribution with their effective one. In all three countries, there is considerable downgrading by experience: in each of them, the share of immigrants who are observed to be experienced is at least twice as high as the share of immigrants who are effectively experienced. Downgrading by education is particularly striking in the UK: Whereas 69.7% of immigrant arrivals to the UK would be classified as high skilled based on their reported education, only 24.6% are effectively high skilled, suggesting that far from a supply shock for high skilled workers, immigrant arrivals to the UK were a supply shock in the market for low skilled workers.

Interpretation of Relative and Total Effects of Immigration when Immigrants Downgrade
Downgrading may seriously bias the assessment of the wage and employment effects of immigration in the national skill-cell and in the mixture approach that rely on the pre-assignment of immigrants to education and experience cells and then exploit variation in the relative density of immigrants across those skill groups. In contrast, the total effects of immigration obtained from the pure spatial approach is robust to the downgrading of immigrants and remains a policy relevant parameter, addressing the question of how the overall immigration shock affects wages and employment of a particular skill group. Dustmann, Frattini and Preston (2013) emphasize that with

this approach, the actual position of immigrants in the distribution of native skills is part of the estimated parameter.

Mixture Approach: Downgrading leads to an overestimate of the true immigration shock to high skilled natives, and an underestimate of the true immigration shock to low skilled natives. In the mixture approach, the direction of the bias due to downgrading is principally ambiguous, and depends on whether the observed immigration shock is relatively low-skilled or relatively high-skilled. If, as it is the case in the US context, observed immigration is relatively low-skilled, then downgrading will lead to an overstatement of the negative relative wage effect by education. In the US context, this type of bias is likely to be relatively small, since downgrading by education is, in contrast to downgrading by experience, small.

National skill-cell approach: Downgrading also leads to a bias in the estimates obtained from the national skill-cell approach. The direction of the bias is principally ambiguous, and depends on the relative importance of the observed education-experience immigration shocks. In Figure 2, we plot the bias factor from downgrading against the degree of downgrading by education, where 0 refers to no downgrading and 0.5 refers to the case where 50% of high skilled immigrants actually work in low skilled jobs. In the figure, we assume for simplicity that the degree of downgrading by experience is the same for high and low skilled immigrants, and depict the bias factor for varying degrees of downgrading by experience (no downgrading, 30% and 60% of downgrading). The observed education-experience immigration shocks are computed from the 2000 US Census, based on immigrants who entered the US in the past two years.[5] The figure illustrates that over this time

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[5] In this time period, the observed education-experience specific immigration shock ΔI_{ga} was at 0.0225 largest for low skilled inexperienced natives (workers with 20 or less years of potential experience who did not attend college),

period in the US, the bias factor exceeds one—implying an overstatement of the negative relative wage effect—and, depending on the degrees of downgrading, can be very large. In the companion appendix to the paper, we show that based on the 2000 US Census data, reasonable estimates for the degree of downgrading by education and by experience are 0.09 and 0.54, respectively. Such degrees of downgrading suggest a bias factor of more than 2—implying that the "true" relative effect by experience, were we able to correctly assign immigrants to skill-cells, is less than half of the estimated effect. Since in the US context downgrading by experience exceeds downgrading by education, the bias from downgrading will be larger in the skill-cell than in the mixture approach. Downgrading therefore provides an alternative explanation as to why the national skill-cell approach typically produces more negative wages effects of immigration than the mixture approach. Furthermore, as the degree of downgrading declines with time in the host country, any bias from downgrading will be larger when annual rather than decadal Census data are used for estimation.

Structural Models and Substitutability between Immigrants and Natives

A more structural approach is to estimate the underlying parameters of the canonical model above and to use that model to predict the wage effects of immigration. Using this approach, resulting estimates obviously rely on strong structural assumptions which are far more stringent than those imposed by the empirical literature discussed so far. Borjas, Freeman and Katz (1997) offer an early application of this approach. More recently, Ottaviano and Peri (2012) and Manacorda, Manning and Wadsworth (2012) extend this approach to more flexible production

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and at 0.0026 smallest for high skilled experienced natives. High skilled inexperienced natives experienced a somewhat larger immigration shock than low skilled experienced natives ($\Delta I_{HI} = 0.0113$ and $\Delta I_{LE} = 0.0073$).

functions, but maintain the assumption of inelastic labor supply. Llull (2013) and Piyapromdee (2015) relax this assumption and model labor supply choices.

Here, we will focus on Ottaviano and Peri (2012) and Manacorda, Manning and Wadsworth (2012). These two studies report *positive* wage effects of immigration for natives. For example, Ottaviano and Peri (2012) predict the long-run total wage effect (assuming fully elastic capital) of immigration on native workers to be 0.6% over the period 1990 to 2006 in the US. Scaled by its impact on total labor supply (an increase of 11.4%), this estimates suggest that a one-percent increase in labor supply by immigration increases the wage of native workers by 0.05% (see bottom panel of Table 1). By contrast, previous immigrants suffer a substantial wage loss (-0.6%).

Both studies impose a production technology similar to the one described above, but allow immigrants and natives to be imperfect substitutes within each education-experience cell. If immigrants and natives are imperfect substitutes within education-experience groups, and mostly low-skilled inexperienced immigrants enter the labor market, then the incumbent low-skilled inexperienced immigrants will bear most of the burden of increased immigration—the more so the less substitutable immigrants and natives are within skill-cells. In contrast, wages of not only high skilled experienced natives, but also of low skilled inexperienced natives may increase in response to immigration if immigrants and natives are not very substitutable within education-experience groups. These arguments highlight that the crucial parameter underlying the predicted total wage effects of immigration is the estimated elasticity of substitution between immigrants and natives within education-experience cells.

Both Ottaviano and Peri (2012) and Manacorda, Manning and Wadsworth (2012) estimate the elasticity of substitution between immigrants and natives by relating the relative wage changes

of immigrants and natives observed in a particular skill-cell to the respective relative employment changes. The two studies report estimates of the elasticity of substitution of about 20 (Ottaviano and Peri 2012) and 7 (Manacorda, Manning and Wadsworth 2012). But these estimates may be seriously impaired by the downgrading and thus misclassification of immigrants across skill-cells (see Dustmann and Preston 2012 for a detailed discussion). This bias may increase further if wage changes of immigrants between two time periods not only reflect wage changes of existing immigrants in response to immigration, but also differences in wages between existing and entering immigrants within education and experience groups (see Ruist 2013). If the estimates for the degree of substitutability between immigrants and natives are biased, then this will cause the estimates of the total and relative effects of immigration as predicted by the structure of the model to be biased—even if the model is correctly specified. In principle, the direction of the bias in the estimates for the elasticity of substitution between immigrant and natives is ambiguous. In the companion appendix to this paper, we provide, focusing on the high-skilled experienced group and observed immigration inflows in the US, an example in which downgrading leads to an overestimate of the degree of substitutability between immigrants and natives, which will understate wage losses for the low skilled inexperienced natives most exposed to immigration, overstate possible wage gains for the high skilled experienced natives least exposed to immigration, and overstate the wage losses of previous immigrants. Therefore, based on the observed immigration shocks in the US context, downgrading is likely to lead to an overstatement of the negative (relative) wage responses of natives in the mixture and in particular the skill-cell approach, but an understatement of the (total) wage responses of natives in the structural approach.

Discussion and Conclusions

In this paper, we revisit the question why different studies on the effects of immigration on wages come to different conclusions, and why there is continued controversy in this debate. We classify the existing empirical studies that estimate wage effects of immigration in three types: studies that use variation in immigrant inflows across education-experience cells at the national level, as for example in Borjas (2003), studies that exploit variation in the total immigrant inflow across regions, as for example in Altonji and Card (1991), and studies that use variation in immigrant flows both across regions and across educations groups, as for example in Card (2001). We show that these three approaches identify different and not comparable parameters, which is one important reason for the continued controversy of the wage effects of immigration in the existing literature. While the national skill-cell approach identifies the effect of immigration on one experience group versus another within education groups, the mixture approach identifies the relative effect of immigration of one education group versus another. By contrast, the pure spatial approach recovers the total effect of immigration which, unlike the first two approaches, takes into account complementarities across skill-cells and across capital and labor.

We then relax the maintained assumption in much of the existing literature that native labor supply is either inelastic, or equally elastic across different skill groups. We show that in the presence of labor response heterogeneity, estimated relative wage effects of immigration from the national skill-cell approach yield misleading and hard to interpret estimates of the overall labor market impact of immigration. In contrast, estimates of total effects of immigration retain a clear interpretation, and remain meaningful and policy-relevant. Employment and wage effects, however, need to be studied jointly to obtain an accurate picture of the overall labor market effect of immigration.

We finally discuss the possibility that immigrants "downgrade" and work in jobs below their observed education and experience level, and argue that downgrading will lead to biased estimates in the national skill-cell and mixture approach that rely on variation of immigration inflows across skill-cells. Although the bias from downgrading cannot be generally signed, we illustrate that in the US context it may severely overstate the negative relative wage effect by experience in the national skill-cell approach. Downgrading is also likely to overstate the negative relative wage effect by education estimated by the mixture approach, but in the US context the bias is likely to be smaller than in the national skill-cell approach—which may be one reason why the mixture approach tends to produce less negative wage effects than the national skill-cell approach. By contrast, the total effect of immigration identified by the pure spatial approach is robust to downgrading, as there is no need to assign immigrants to skill-cells.

We further point out that downgrading poses a problem for structural approaches that allow immigrants and natives to be imperfect substitutes within education-experience groups and calculate relative and total effects of immigration based on estimated parameters and the structure of the model, as for example in Ottaviano and Perio (2012) and Manacorda, Manning and Wadsworth (2012). Specifically, we show that in the presence of downgrading, immigrants and natives may appear to be imperfect substitutes within skill-cells even though they are not. This will lead to understating the wage losses of native workers, even if the model is correctly specified—which may help to explain why the structural approach typically produces positive (total) wage effects of immigration for natives.

In sum, we advocate exploiting variation in the overall immigration shock for the identification of the total labor market effects of immigration. Not only does this approach identify

a meaningful and policy relevant parameter, but it is also robust to heterogeneous labor supply

elasticities across skill groups and the downgrading of immigrants.

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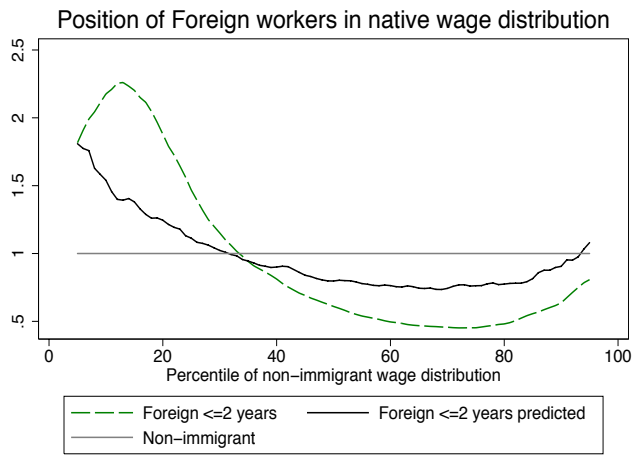
Table 1: Selected Studies on the Wage Impact of Immigration

Skill-Cell Approach	Country	Sample	Specification	Group	Coefficient	Std. Error
Borjas (2003)	US	Census and CPS, 1960-2001	OLS, weighted, decadal	natives, men	-0.57	(0.16)
Aydemir and Borjas (2007)	Canada	Census, 1971-2001	OLS, weighted, decadal	natives, men	-0.51	(0.20)
	US	Census, 1960-2000	OLS, weighted, decadal	natives, men	-0.49	(0.22)
Llull (2014)	Canada, US	Census, 1960-2000	IV, weighted, decadal	natives, men	-1.66	(0.66)
Borjas (2014)	US	Census and ACS, 1960-2011	OLS, weighted, decadal	natives, men	-0.53	(0.10)
Card and Peri (2016)	US	Census and ACS, 1960-2011	OLS, weighted, decadal	natives, men	-0.12	(0.13)

Spatial Approach	Country	Sample	Specification	Group	Coefficient	Std. Error
Card (1990)	US	Census and CPS, 1979-1985, 4 MSAs	OLS, 3-year difference	natives, white[a]	-0.14	-
Altonji and Card (1991)	US	Census, 1970-1980, 120 MSAs	IV, weighted, decadal	natives	-1.21	(0.34)
				natives, white dropouts	-1.10	(0.64)
Dustmann, Fabbri and Preston (2005)	UK	LFS, 1992-2000, 17 regions	IV, weighted, yearly	natives	0.91	(0.58)
Card (2007)	US	Census, 1980-2000, 100 MSAs	IV, weighted, cross-section	natives	0.06	(0.01)
Boustan, Fishback and Kantor (2010)	US	Census, 1940, 69 MSAs	IV, weighted, cross-section	men	0.01	(0.54)
Dustmann, Frattini and Preston (2013)	UK	Census and LFS, 1997-2005, 17 regions	IV, yearly	natives	0.40	(0.11)
				natives, 10th pct.[b]	-0.52	(0.18)
				natives, 90th pct.[b]	0.41	(0.19)
Borjas (2015)	US	Census and CPS, 1977-1992, 44 MSAs	OLS, weighted, 3-year difference	natives, dropouts[c]	-2.63	(1.08)
Dustmann, Schönberg and Stuhler (2015)	Germany	IAB, 1986-1996, 1,550 municipalities	IV, weighted, 3-year difference	natives	-0.13	(0.05)
				natives, young, low education	-0.56	(0.11)
Peri and Yasenov (2016)	US	Census and CPS, 1977-1992, 44 MSAs	OLS, weighted, 3-year difference	natives, dropouts[d]	1.11	(0.55)
Foged and Peri (2016)	Denmark	IDA, 1995-2008, 97 municipalities	IV, weighted, yearly	natives, low education	1.80	(0.64)

Mixed Approach	Country	Sample	Specification	Group	Coefficient	Std. Error
LaLonde and Topel (1991)	US	Census, 1970 and 1980, MSA x arrival cohort	OLS, weighted, decadal	immigrants, recent (≤5 yrs.) arrivals	-0.09	(0.03)
Card (2001)	US	Census, 1990, MSA x occupation	IV, weighted, cross-section	natives, men	-0.10	(0.03)
Borjas (2006)	US	Census, 1960-2000, MSA x education x experience	OLS, weighted, decadal	natives	-0.06	(0.02)
Card and Lewis (2007)	US	Census, 1980-2000, MSA x education	IV, weighted, decadal	natives, men	-0.04	(0.06)
Card (2009)	US	Census and ACS, 1980-2006, MSA x education	IV, weighted, decadal	natives, men	-0.42	(0.28)
Lewis (2011)	US	Census, 1980-2000, MSA x education	IV, weighted, decadal	natives, manufacturing	-0.14	(0.04)
Glitz (2012)	Germany	IAB Subsample, 1996-2001, region x education	IV, weighted, yearly	natives	-0.26	(0.19)
Dustmann and Glitz (2015)	Germany	IAB Subsample, 1985-1995, region education	IV, weighted, decadal	natives, manufacturing	-0.10	(0.06)
Özden and Wagner (2015)	Malaysia	LFS, 2000-2010, region x industry	IV, weighted, yearly	natives	0.02	(0.01)

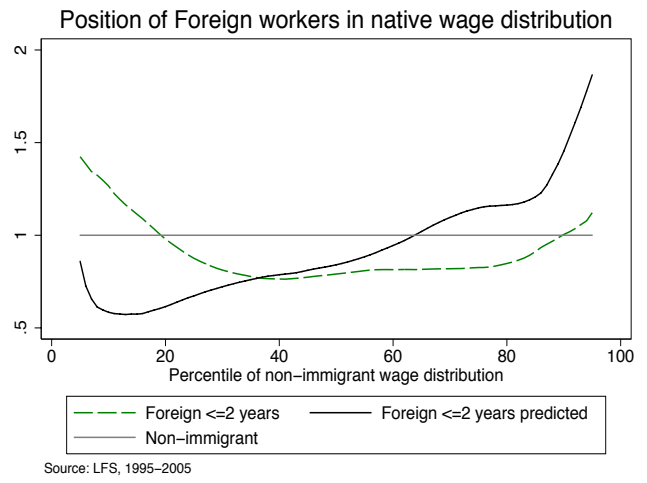| Structural Approach	Country	Sample	Group and Specification[e]	Elasticities of Substitution[f]	Simulated Impact[g]
Ottaviano and Peri (2012)	US	Census and ACS, 1960-2006	natives, long run	$\sigma(X)=6.25$, $\sigma(E)=3.3$, $\sigma(MN)\approx20$	0.05
			immigrants, long run		-0.60
Manacorda, Manning and Wadsworth (2012)	UK	LFS and GHS, 1975-2005	natives, low education, long run	$\sigma(X)=5.2$, $\sigma(E)=4.9$, $\sigma(MN)\approx6.9$	0.20
			natives, high education, long run		-0.60

Note: The table reports coefficient estimates from a regression of (changes in) log wages or earnings for the indicated group on a measure of the immigrant supply shock (e.g. change in immigrant share or inflow rate). Standard errors in parentheses. Estimates are not directly comparable as sample, specification, conditioning variables and definitions of the supply shock differ across studies. Only main data sources listed (ACS=American Community Survey, CPS=Current Population Survey, GHI=General Household Survey, IAB=Institute for Employment Research, IDA=Danish Integrated Database for Labor Market Research, LFS=Labor Force Survey). A specification is classified as weighted if estimation is on the individual level or if regression weights are used on aggregate statistics. [a]1979 vs. 1982 difference-in-differences estimate, scaled by the immigration-induced 7% increase in labor force. [b]natives at the indicated percentile of the native wage distribution. [c]1977-1979 vs. 1981-1983 synthetic control estimate, scaled by immigration-induced 8% increase in labor force. [d]1979 vs. 1980-1982 synthetic control estimate, scaled by the immigration-induced 8% increase in labor force. [e]Capital is assumed inelastic in short run and perfectly elastic in long run. [f]Estimated elasticities of substitution across education group (σ(X)), experience groups (σ(E)), or between immigrants and natives (σ(MN)). [g]Simulated wage impact normalized by overall migration shock over period.
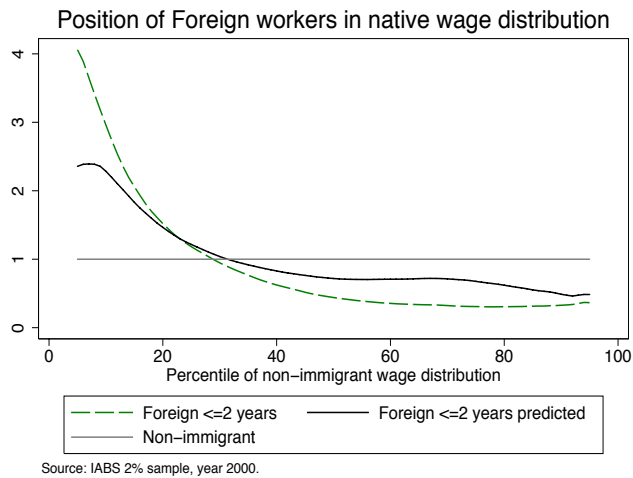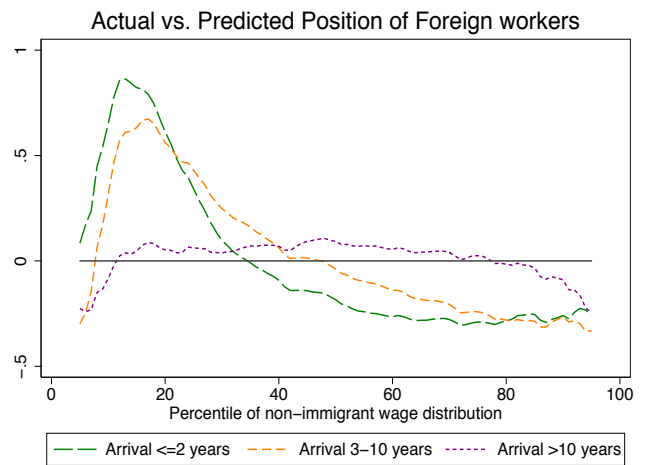
Figure 1: Downgrading of Immigrants

Position of Foreign workers in native wage distribution

Source: U.S. Census 2000.

Position of Foreign workers in native wage distribution

Source: LFS, 1995–2005

Position of Foreign workers in native wage distribution

Source: IABS 2% sample, year 2000.

Actual vs. Predicted Position of Foreign workers

Note: Panels A-C show kernel estimates of the actual (dashed lines) and predicted (solid lines) density of immigrants in the native wage distribution. Panel D shows the difference between the actual and predicted density of immigrants. The horizontal line shows as a reference the native wage distribution. The kernel estimates are above the horizontal line at wages where immigrants are more concentrated than natives, and below the horizontal line at wages where immigrants are less concentrated than natives. Source: US Census 2000, UK Labor Force Survey 1995-2005, and IAB Employment Subsample 2000.

Table 2: The Observed and Effective Skills of Immigrant Arrivals

(a) United States (Census, year 2000)

Observed *Potential Experience*				**Effective** *Potential Experience*			
Education	1-20 yrs	21-40 yrs	total	*Education*	1-20 yrs	21-40 yrs	total
low	44.1%	13.4%	57.6%	low	56.2%	4.0%	60.3%
high	36.3%	6.2%	42.5%	high	34.1%	5.6%	39.7%
total	80.4%	19.6%		total	90.3%	9.7%	

(a) United Kingdom (UK LFS, years 2003-2005)

Observed *Potential Experience*				**Effective** *Potential Experience*			
Education	1-20 yrs	21-40 yrs	total	*Education*	1-20 yrs	21-40 yrs	total
low	24.1%	6.2%	30.3%	low	71.3%	4.1%	75.4%
high	62.7%	7.0%	69.7%	high	21.7%	2.9%	24.6%
total	86.8%	13.2%		total	93.0%	7.0%	

(a) Germany (IABS, year 2000)

Observed *Potential Experience*				**Effective** *Potential Experience*			
Education	1-20 yrs	21-40 yrs	total	*Education*	1-20 yrs	21-40 yrs	total
low	36.3%	6.2%	42.5%	low	61.9%	0.0%	61.9%
high	51.4%	6.1%	57.5%	high	35.8%	2.3%	38.1%
total	87.7%	12.3%		total	97.7%	2.3%	

Note: The table reports the observed and imputed effective skills of immigrants who arrived within the last two years. The imputation of effective skills is based on the distribution of workers across wage centiles and 2-digit occupations, as described in Appendix A. Source: US Census 2000, UK LFS 2003-2005, and IABS 2000.

Figure 2: Illustration of the Bias in the National Skill Cell Approach when Immigrants Downgrade
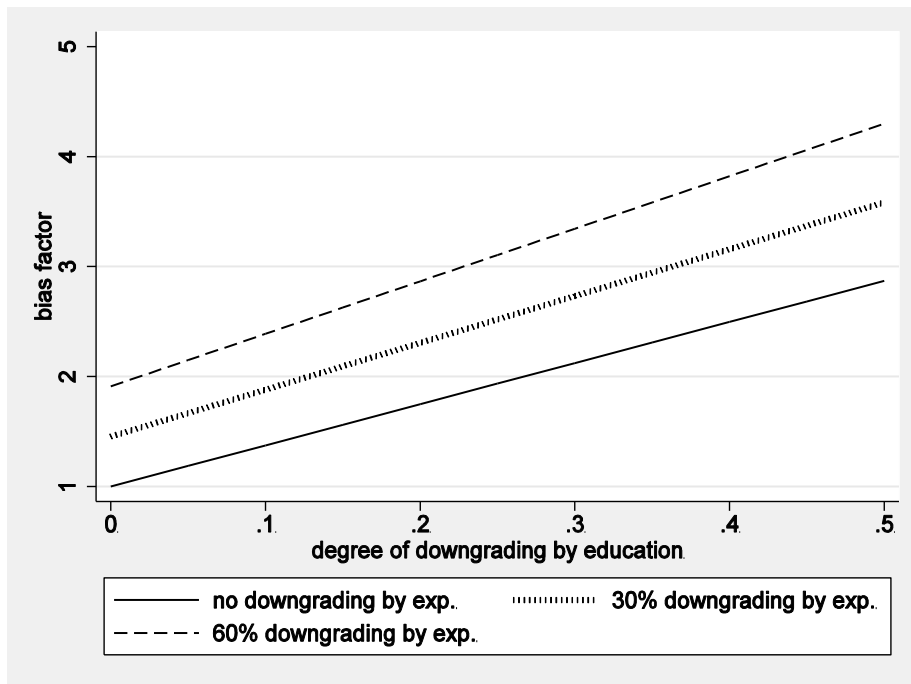
Note: The figure illustrates the bias which may arise in estimates of the relative wage effect by experience of immigration obtained by the national skill cell approach when immigrants downgrade. The figure plots the bias factor against the degree of downgrading by education, for three degrees of downgrading by experience (0, 0.3 and 0.6). For example, a bias factor of 2 implies that the estimated effect based on the observed skill-specific immigration shock is twice as large as the true effect that we would obtain if we could correctly assign immigrants to skill cells. The observed shocks to each education and experience group drawn from the 2000 US Census. See Appendix D for details.