Immigrants versus Natives? Displacement and Job Creation*

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November 2014

Abstract

The impact of immigration on native workers is driven by two countervailing forces: the degree of substitutability between natives and immigrants, and the increased demand for native workers as immigrants reduce the cost of production and output expands. The literature so far has focused on the former substitution effect, while the net effect of immigration on labor market outcomes and welfare depends on both. We estimate scale and substitution effects using labor force survey data from Malaysia (1990-2010), a country uniquely suited for understanding the impact of low-skilled immigration. Our instrumental variable estimates imply that the elasticity of labor demand (4.2) is greater than the elasticity of substitution between natives and immigrants (2.9). On average the scale effect outweighs the substitution effect. For every ten additional immigrants, employment of native workers increases by 3.1 in a local labor market. These large reallocation effects are accompanied by negligible relative wage changes across local labor markets. At the national level, a 10 percent increase in immigrants, equivalent to 1 percent increase in labor force, has a small positive effect on native wages (0.13 percent). The impact of immigration is highly heterogeneous for natives with different levels of education, resulting in substantial changes in skill premiums. Immigrants on net displace natives with at most primary education; while primarily benefiting those with some secondary school education, and leaving college educated natives broadly unaffected.

*The theory in this paper draws on material from Wagner's Ph.D. dissertation at the University of Chicago on "The Heterogeneous Labor Market Effects of Immigration" (Wagner, 2010). We thank Amir Omar and the Institute of Labor Market Information Analysis for their support, and the Department of Statistics of Malaysia for making the data available. Ximena Del Carpio lead the technical advisory project that forms the basis for this paper. Federico Mantovanelli and Mauro Testaverde provided research assistance. We thank Michel Beine, Simone Bertoli, George Borjas, Michael Clemens, Patricia Cortes, Gordon Hanson, Hubert Jayet, David McKenzie and seminar participants at Boston College, Boston University, Georgetown University, George Washington University, the World Bank, TEMPO Conference at Nottingham University, and the 6th International Conference on Migration and Development for comments and suggestions. The findings, conclusions and views expressed are entirely those of the authors and should not be attributed to the World Bank, its executive directors and the countries they represent.
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Keywords: immigration, substitution, scale effect, displacement, output expansion
JEL Classification: J23, J61, O15

1 Introduction

The central question of an extensive literature on immigration is whether it harms or improves the labor market outcomes (wages and employment) of native workers. However, as Card (2009) points out in his Ely lecture, "most of the existing research on immigration has focused on between-group inequality" (p. 3). Specifically, the debate has centered on the elasticity of substitution between different groups of workers, and the effect on relative wages as immigration changes the relative abundance of different types of labor. The net effect of immigration on native labor market outcomes and welfare, though, depends not only on relative wages but also on the degree to which it results in changes in output and prices, and consequently wage levels and purchasing power (a point elaborated on by Borjas, 2013). Important work by Lach (2007) and Cortes (2008) has identified price effects of immigration, but the impact on output and consequently wage and employment levels has remained underexplored. This paper fills that gap with an empirical strategy for identifying the two economic forces that determine the net effect of immigration on the demand for native labor: the substitution and scale (output expansion) effects. Our estimates of the scale effect of immigration, to our knowledge the first in the literature, allow us to estimate the impact of immigration on the demand for native workers at both the local and national level.[1]

[1] The scale effect is the channel that results in the price effects of Cortes (2008). It can also explain the results in Lach (2007), though in that paper an alternative mechanism based on lower search costs for immigrants is proposed.

The economic mechanism at the heart of this paper is as follows. An outward shift of the immigrant labor supply curve causes a reduction in immigrant wages. This results in two countervailing economic forces. First, for a given level of output, firms will substitute immigrant for native labor, the standard substitution effect analyzed extensively in the literature. Second, for a given relative wage, firms will employ more native workers as output expands, the scale effect. Drawing on the seminal work by Katz and Murphy (1992) and Card and Lemieux (2001) the literature has used empirical specifications in which fixed effects absorb the scale effect.[2] In the local labor market approach Card (2001) uses city-fixed effects to control for the scale effect. In the nested-CES approach (for example, Borjas, 2003; Ottaviano and Peri, 2012) the scale effect operates at the level of a nest and is controlled for by the inclusion of nest-specific fixed effects. In either methodology, identification comes from the effect of changes in relative labor quantities on relative wages. Hence, the results are informative about the substitution effect which governs the impact of immigration on inequality across different labor groups.[3] However, determining the net impact of immigration on native workers requires identifying both scale and substitution effects.[4] While we focus only on the production effects of immigration, scale effects also

[2]The literature on inequality provides the basis for these specifications. In the Katz and Murphy (1992) the scale effect simply cancels out as they take wage and quantity ratios. Card and Lemieux (2001) illustrate how to extend the methodology to nested-CES production functions, and describe how fixed effects are used to control for nest-level effects.

[3]The work estimating the impact of immigration on between-group inequality includes work by skill groups (Altonji and Card, 1991), different occupations (Friedberg, 2001 and Card, 2001), and education/experience groups (Borjas, 2003, 2006, Ottaviano and Peri, 2012, and Docquier, Ozden and Peri, 2014), and immigrant versus native (Grossman, 1982, Chiswick, Chiswick and Miller, 1985, LaLonde and Topel, 1991, and Cortes, 2008). See Card (2009) and Borjas (2014) for recent overviews. Dustmann, Frattini and Preston (2013) provide evidence of relative wage effects along the distribution of native wages.

[4]There is a growing literature on adjustment mechanisms that can ameliorate the substitution (displacement) effect of immigration, including induced technological change (Lewis, 2011, 2012), and changing native task specialization (Peri and Sparber, 2009, and Ottaviano, Peri and Wright, 2012). In contrast, the effects emphasized in this paper are present even in the absence of any such adjustment mechanisms.

have an impact on consumption and real wages as the cost reductions due to immigration are passed onto consumers in the form of lower prices.

Based on our analytical model we develop a parsimonious empirical strategy to identify scale and substitution effects arising from immigration. We estimate the impact of immigration on (i) native employment, (ii) native wages, and (iii) immigrant wages by using variation in instrumented immigration flows across local labor markets.[5] We then use these estimates to identify three key parameters of the model: the elasticity of labor demand, the elasticity of substitution between native and immigrant workers, and the elasticity of native labor supply. The first two parameters determine the sign and magnitude of the immigration induced shock to native labor demand. The third, the elasticity of native labor supply, governs the degree to which this demand shock is reflected in wage or employment changes. Using these parameter estimates we are able to identify the effect of immigration on wage and employment levels at a local labor market and national level, as well as, on the returns to education and associated between group inequality.

We implement our methodology using Malaysian data. The vast majority of papers in the literature use data from OECD countries, even though half of all immigrants reside in developing countries (Artuc et al., forthcoming). Malaysian data enable us to present rare evidence from a developing country that is also a prominent destination for migrants.[6] A second key advantage is that the Malaysian experience is uniquely suited to understanding the labor market impact of low-skilled immigration. Immigrants to

[5] We define a local labor market by the region and industry (pooled over years) in which a worker is employed. For robustness we also provide evidence using variation across localities (regions), as in Card (2001), Card and DiNardo (2000), Cortes (2008), and Peri and Sparber (2009). Altonji and Card (1991) and Ottaviano, Peri and Wright (2012) use variation across industries. Our main specifications combine these approaches and use variation across both regions and industries.

[6] In terms of both income and immigration levels Malayasia is close to a median country.

the United States, and numerous other OECD countries, are overrepresented at both the higher and lower end of the skills distribution (Docquier, Ozden and Peri, 2010). They also have the opportunity to assimilate, obtain permanent residency, and eventually become citizens. This assimilation process creates another potential source of heterogeneity as older immigrants may become more like natives.[7] In contrast, immigration to Malaysia is overwhelmingly low-skilled; and the vast majority of foreign workers are, legally, allowed to remain in Malaysia for at most five years without the ability to bring any dependents, limiting assimilation. The data for this paper come from the Malaysian Labor Force Survey (LFS), which provides detailed information on the sectoral, skill and geographic composition of the native and immigrant workers for the years 1990 to 2010, a wage module was added in 2007. Over this period the fraction of immigrants in the labor force increased from 3.6 to 10.6 percent.

Our basic model distinguishes simply between natives and immigrants; it provides robust baseline results on the impact of immigration and illustrates our methodology. In terms of our structural parameter estimates, we find an elasticity of labor demand of 4.2, which is significantly larger than the elasticity of substitution between immigrant and native labor of 2.9.[8] Thus the scale effect outweighs the substitution effect in Malaysia. The IV estimates imply that, on average, an additional 10 immigrants in a given industry-region results in the employment of an additional 3.1 natives. Despite these very large reallocation effects across sectors or regions, immigration has a negligible effect on relative native wages across local labor markets. This suggests that a large number of Malaysian

[7] The high degree of heterogeneity among immigrants in the US likely explains why, as highlighted by Cortes (2008), it is difficult to identify the effect of immigration on immigrant wages for the US.

[8] Our estimate is somewhat higher than the elasticity of substitution between high and low-skilled labor in the US (Acemoglu and Autor, 2012, provide a recent overview).

workers are highly mobile. At the national level the structural parameters imply that a 10 percent increase in immigration, roughly equivalent to a 1 percent increase in total the labor force, increases native wage levels by 0.13 percent, but decreases immigrant wages by 3.3 percent. As a result, the net effect on average wages (immigrants and natives combined) is also negative at 0.28 percent.[9]

The impact of immigration need of course not be uniform across native education categories. To address this issue we estimate the parameters of a production function that distinguishes between workers with different levels of education. Our nested constant elasticity of substitution production function is similar to the one used by Krusell et al. (2000) and Acemoglu, Autor and Lyle (2004). Our estimates show that natives with at most primary education are displaced by low-skilled immigrants, 10 immigrants displace 0.8 natives in an industry-region, though the effect is not statistically significant. There is a large positive and statistically significant impact of low-skilled immigration on the employment of natives with some secondary education, an additional 2.8 natives for every 10 immigrants. The impact on natives with a vocational or college degree is positive, but small and not statistically significant.[10] Low-skilled immigration does not primarily benefit high-skilled natives, but rather those just a little more educated than the immigrants.

The implied parameter estimates are consistent with the idea that immigrants are engaged in tasks complementary to the skills of natives with a little more education, but that are less related to those performed by highly educated natives (see Peri and

[9] Average wages (across immigrants and natives) fall due to immigration as a consequence of downward-sloping demand for output produced in Malaysia. If the scale effect were smaller than the substitution effect then immigration would result in both immigrant and native wages decreasing.

[10] This inverse u-shaped pattern continues to hold if we further disaggregate the education categories.

Sparber, 2009, and Ottaviano, Peri and Wright, 2012). The estimates show that there are far more pronounced complementarities between workers with at most primary and some secondary education (an elasticity of substitution of 1.4), than between those with at most primary and post-secondary education (an elasticity of substitution of 2.9). As a consequence, an increase in low-skilled immigrants has only a modest positive impact on high-skilled natives, while it results in a substantial increase in the demand for labor with some secondary education. In contrast, the elasticity of substitution between low-skilled immigrants and natives with at most primary education is high, and larger than the elasticity of demand for that labor input, such that an increase in low-skilled immigrants decreases the demand for low-skilled native workers.

The structural parameters imply that at the national level a 10 percent increase in immigrants, equivalent to a 1 percent increase in the labor force, decreases low-skilled wages by a substantial 1 percent, increases the wages of those with some secondary education by 0.24 percent and those with post-secondary education by only 0.07 percent. While these wage effects are modest it is worth remembering that between 1990 and 2010 the fraction immigrants in the Malaysian labor force nearly tripled. In the absence of this inflow the counterfactual return per year of secondary school education would have been 1 percentage point lower than currently, about 8 percent per year rather than the current 9 percent.

This paper makes two additional contributions. We construct a novel instrument, combining the insights of Hanson and McIntosh (2010) with the typical Altonji-Card instrument. The identifying variation of our instrument comes from changes in the population and age structure of migrant source countries, primarily Indonesia and the Philippines, and the differential historic propensity of these groups to migrate to particular industry-regions. The concern with the Altonji-Card instrument, as it is with ours, is that very persistent demand shocks would result in a correlation between the historic distribution of immigrants and current demand shocks. However, our instruments rely both on cross-sectional and time-series variation, allowing us to control for such correlated demand trends using industry-region specific linear trends. We show that our results are robust to the inclusion of local labor market-specific time trends, which we take as strong evidence in favor of the validity of our exclusion restriction.

We also contribute to the central methodological debate about the appropriate identifying variation. The local labor markets literature, following Altonji and Card (1991) and Card (2001), has used the historical distribution of immigrants across local labor markets as an instrument for the current distribution to deal with the endogeneity of immigrant location decisions. Borjas, Freeman and Katz (1996) and Borjas (2003, 2006) criticize this approach arguing that it fails to take into account the off-setting capital and native labor mobility.[11] Their solution is to use variation over time at the national level, where native labor supply can be thought of as perfectly inelastic. The disadvantage of this approach is that it maintains the assumption that the composition of immigrant flows is exogenous. Our analytical and empirical methodology aims to address these concerns and bridge the gap between these two approaches. We instrument for immigration flows and explicitly estimate the elasticity of native labor supply across our local labor markets. This allows us to draw inferences about the effects of immigration at the national level, while using

[11] Card and DiNardo (2000), Card (2001) and Card and Lewis (2007) find there is little offsetting native labor mobility across US cities in response to immigration shocks. Borjas (2006) and Cortes (2008) find substantial, but not perfectly, offsetting displacement effects.

local labor market variation.

The rest of this paper is organized as follows. Section 2 outlines the theoretical framework we use to understand the effects of immigration on natives. Section 3 describes the data. In Section 4 we present our identification strategy, the instrument, main results, and extensive robustness checks. Section 5 presents the identification strategy and results when allowing for heterogeneous effects for natives of different educational attainment. Section 6 concludes.

2 Theoretical Framework

2.1 Basic Model

Consider an economy with S competitive industries in R regions producing final goods Y using a two-level nested aggregation of native labor N, immigrant labor M and capital K.

$$\begin{aligned} Y_{rs} &= F\left(L_{rs}, K_{rs}\right) \\ &= F\left(G\left(N_{rs}, M_{rs}\right), K_{rs}\right), \end{aligned} \tag{1}$$

with σ_{mn} as the elasticity of substitution between native and immigrant labor (as $\sigma_{mn} \rightarrow \infty$ native and immigrant labor become perfect substitutes). In this basic framework we allow for imperfect substitution between immigrant and native labor, but assume that individuals within groups are perfect substitutes. In an extension, below, we relax this restriction to allow for different substitution patterns between different types of native and immigrant labor.

We can derive the elasticity of native wages, native employment, immigrant wages and output with respect to an exogenous change in immigrant labor, using the production function of firms. The impact of immigration will depend on three key parameters: the elasticity of substitution (σ_{mn}), the elasticity of labor demand (η), and the elasticity of native labor supply across industries and regions (ϕ_n). See Appendix A for a derivation of the results used in this section. We suppress industry and region subscripts for notational simplicity.

The elasticity of substitution describes how, for a fixed level of output, firms will change the ratio of native to immigrant employment as the relative wage changes: $\sigma_{mn} = \frac{d\ln(N/M)}{d\ln(w_m/w_n)}$, where w_n and w_m are the wages of native and immigrant workers, respectively. The elasticity of substitution depends on the degree to which the human capital embodied by immigrants and natives is substitutable. Language barriers, cultural norms, and differences in general and industry-specific human capital are reasons why even observationally identical immigrants and natives may nevertheless be imperfect substitutes.

The elasticity of labor demand determines the extent to which a fall in the cost of the labor input L will result in an increase in the employment of that input:

$$\eta = -\frac{d\ln L}{d\ln w_l} = \frac{\sigma_{lk}\psi + \phi_k\left(s_l\psi + s_k\sigma_{lk}\right)}{\phi_k + s_k\psi + s_l\sigma_{lk}}, \tag{2}$$

This elasticity is always positive (or at least non-negative) and is increasing in the elasticity of demand for the final product ψ, the elasticity of substitution between labor and capital σ_{lk} and elasticity of supply of capital ϕ_k. The degree to which a reduction in labor costs is translated into a reduction in production costs depends on how easy it is to substitute between capital and labor, as well as the availability of capital. In turn, the degree to which a reduction in production costs results in an increase in output, and thus an increase in the demand for all inputs, depends on the elasticity of product demand. The scale effect will, all else equal, be greater in industries / local labor markets where output is more easily traded, and that have more potential substitutes. In those industries small reductions in costs lead to large increases in output, resulting in large scale effects.

The elasticity of native labor supply describes how a change in native wages will affect the supply of native labor to that industry-region: $\phi_n = \frac{d \ln N}{d \ln w_n}$. It depends primarily on the willingness and ability of native workers to change their industry or region of employment, as well as flexibility to enter and exit the labor force.[12]

The effect of immigration on the wage and employment levels of native workers in an industry-region is given by:

$$\frac{d \ln w_n}{d \ln M} = \frac{s_m (\eta - \sigma_{mn})}{\sigma_{mn}\eta + \phi_n (s_m \eta + s_n \sigma_{mn})}, \quad (3)$$

$$\frac{d \ln N}{d \ln M} = \phi_n \frac{d \ln w_n}{d \ln M}, \quad (4)$$

where s_m and s_n is the shares of immigrant and native labor, respectively, in the total wage bill. Whether immigration increases or decreases the demand for labor depends on whether the elasticity of labor demand or the elasticity of substitution is greater. When

[12] The elasticity of native labor supply across industry-regions can be thought of as deriving from a worker's discrete choice problem that takes the form of a two-level nested logit. Workers can be thought of as first choosing a region and then an industry, reflecting the fact it is likely easier to move across industries within a region than across regions. The elasticity of labor supply across industry-regions is the weighted sum of the elasticity across industries (within the same region) and across regions. With data on worker flows across industries and regions it could be decomposed into these two components.

$\eta > \sigma_{mn}$, then immigration will increase native wages and employment. The intuition for this result is that the inflow of immigrants reduces the cost of immigrant labor and hence results in two countervailing effects. First, the substitution effect: for a given level of output, firms will substitute immigrant workers for native labor. Second, the scale effect: the decline in the cost of production results in output expansion and hence, for a given relative wage, firms will employ more native workers. The difference in the magnitude of these effects determines whether immigration is a positive or negative shock to the demand for native labor, as seen in equations (3) and (4). The elasticity of native labor supply has an important role since it determines the degree to which an immigration induced shock will result in native wage or employment changes in an industry-region. With higher elasticity of labor supply, immigration will result in more native workers relocating across industry-regions, $\frac{d}{d\phi_n}\left(\frac{d\ln N}{d\ln M}\right) > 0$, and less changes in the relative wages across industry-regions $\frac{d}{d\phi_n}\left(\frac{d\ln w_n}{d\ln M}\right) < 0$.

Finally, the effect on immigrant wages is always negative:

$$\frac{d\ln w_m}{d\ln M} = -\frac{\phi_n + s_n\eta + s_m\sigma_{mn}}{\sigma_{mn}\eta + \phi_n\left(s_m\eta + s_n\sigma_{mn}\right)}, \tag{5}$$

This is simply due to downward sloping demand: an increase in the supply of immigrant labor decreases its price.

2.2 Country-Level Effects of Immigration

A central debate in the literature is the appropriate level of aggregation at which to estimate the impact of immigration on labor market outcomes. In the spirit of the local labor markets approach, following Altonji and Card (1991) and Card (2001), we identify the impact of immigration based on variation across industries and regions (our local labor market is an industry-region in a given year). Hence, the derived demand elasticities given by equations (3), (4) and (5) depend on the elasticity of labor supply of native workers across industries and regions. Borjas, Freeman and Katz (1996) and Borjas (2003, 2006) are critical of this approach arguing that it fails to take account for off-setting native labor mobility across local labor markets. While mobility of workers across industries and regions may be fairly high, at the national level the elasticity of labor supply depends on the propensity of workers to exit and enter the labor force in response to changes in wages. Consequently, we would expect labor supply to be far less elastic for the country as a whole when compared to a given industry-region.

Though not essential for our analysis, we follow the typical assumption in the literature that native labor supply is perfectly inelastic at the national level (Borjas, Freeman and Katz, 1996; Borjas, 2003; Ottaviano and Peri, 2012). In that case, the country-level effect of immigration is given by the elasticity of native wages with respect to immigration when the elasticity of labor supply is zero:

$$\frac{d\ln w_n}{d\ln M}|_N = \frac{s_m\left(\eta - \sigma_{mn}\right)}{\sigma_{mn}\eta}. \tag{6}$$

Correspondingly, again when the elasticity of native labor supply is zero, the effect of immigration on immigrant wages is given by equation (5):

$$\frac{d\ln w_m}{d\ln M}|_N = -\frac{s_n\eta + s_m\sigma_{mn}}{\sigma_{mn}\eta}. \tag{7}$$

Hence, if we are able to identify the elasticity of substitution and the elasticity of labor demand from variation at the industry-region level, then we are in a position to infer the effect on native and immigrant labor market outcomes at the national level.

One difficulty is that at the national level general equilibrium effects are likely important. In particular, immigrants not only produce goods and services but also consume them. That will result in a shift in the native labor demand curve due to immigration, not just a movement along it. It is straightforward to adjust for this shift, it simply depends on the propensity of immigrants to consume goods produced in Malaysia. For reasonable propensities (below one) such an adjustment will barely make a difference to our estimates. Thus, in the absence of good information on immigrant consumption we do not make such an adjustment to the estimates in this paper.

2.3 The Role of Scale and Substitution Effects

The distinct role of scale and substitution effects in determining the sign and magnitude of the immigration induced demand shock for native labor is particularly evident at a national level (where the elasticity of labor supply can be assumed to be equal to zero). The average wage effect of immigration, across both immigrants and natives, only depends on the elasticity of labor demand:

$$s_n \frac{d \ln w_n}{d \ln M}|_N + s_m \frac{d \ln w_m}{d \ln M}|_N = -s_m \frac{1}{\eta},$$

and the aggregate wage elasticity (scaled by the immigrant share in the wage bill) is equal to $-\frac{1}{\eta}$. An implication is that immigration will reduce average wages in an economy, and consequently lead to convergence of wage levels between source and destination countries.[13]

In contrast, the effect of immigration on inequality between groups depends solely on the elasticity of substitution:

$$\frac{d\ln w_n}{d\ln M}|_N - \frac{d\ln w_m}{d\ln M}|_N = -\frac{1}{\sigma_{mn}}.$$

The wage elasticity of native wages with respect to immigration, scaled by the share of immigrants in the labor force, is the sum of these two effects:

$$\frac{1}{s_m}\frac{d\ln w_n}{d\ln M}|_N = \frac{1}{\sigma_{mn}} - \frac{1}{\eta}.$$

In short, the scale effect determines the impact of immigration on average wages in an economy, while the substitution effect determines the impact of immigration on relative wages. Hence, the literature has been able to consider the impact of immigration on inequality without reference to the scale effect.[14]

The simple dichotomy observed at the national level between scale and substitution effects no longer applies at the local labor market level, where the elasticity of native labor supply will be frequently different from zero. An interesting case is where the elasticity of labor supply to a local labor market is infinite, i.e. a sufficient number of natives are highly mobile such that wages across local labor markets do not vary. Then the impact

[13]The long-run effect of immigration on average wages (native and immigrant) is equal to zero if the elastic of labor demand is perfectly elastic. That, in turn, requires the product demand and the supply of capital to be perfectly elastic. Of course, shifts in the demand curve due to immigration will also tend to make average wage effects closer to zero, though they very likely remain negative.

[14]Borjas (2013) has an extensive discussion of some of these and related results.

of immigration on native wages in the local labor market is zero, and the effect on native employment is given by:

$$\frac{d\ln N}{d\ln M}|_{w_n} = \frac{s_m\left(\eta - \sigma_{mn}\right)}{s_m\left(\eta - \sigma_{mn}\right) + \sigma_{mn}}.$$

The empirical literature on the impact of immigration has used fixed effects to control for the scale effect, thereby allowing for identification of the substitution effect. See Appendix B for an extensive discussion. In the local labor market approach of, for example, Card (2001) production happens at the level of city, and therefore city-fixed effects are used to control for the scale effect. In the nested-CES approach of, for example, Borjas (2003) the inclusion of nest-specific fixed effects also controls for the scale effect. Specifically, in the structural model of Borjas (2003) the inclusion of year and education by year fixed effects absorbs all changes in the demand for native labor due to changes in the scale of production. The remaining correlation between wages and labor quantities (for a fixed level of output) can then be attributed to the substitution effect. Ottaviano and Peri (2012), using a nested-CES production function with potentially imperfect substitution of natives and immigrants within the same education-experience group, estimate the impact of immigration on native wages of a particular education-experience group. Their innovation is to also account for cross-effects: the indirect impacts of immigration on all other groups of workers, thereby providing a more complete estimate of the impact of immigration on native wages. However, these cross-effects are not the source of the scale effect estimated in this paper. The scale effect in this paper arises irrespective of the existence of the cross-effects - though potentially incorporates these as well - and is driven by the increase in output as immigration reduces firm's costs of production.

2.4 Worker Heterogeneity

In the production function given by equation (1), native and immigrant labor is taken to be homogeneous. To discuss the impact of immigration on natives of different skill levels consider an extension to that production function, which distinguishes between workers with different levels of education. We consider a competitive labor market consisting of four factors: labor with at most primary school education P, with some secondary school education S, and post-secondary education C, and capital K, which stands for all nonlabor inputs. Consider the following nested constant elasticity of substitution aggregate production function (we continue to suppress industry and region subscripts):

$$Y = AK^{\alpha}\left((B^{s}S)^{\zeta} + \left[(B^{c}C)^{\mu} + (B^{p}P)^{\mu}\right]^{\frac{\zeta}{\mu}}\right)^{\frac{1-\alpha}{\zeta}}, \tag{8}$$

where α, μ, and ζ are less than one, A is a neutral productivity term, and the Bs are factor-augmenting productivity terms. In this specification, the elasticity of substitution between the labor aggregate and nonlabor inputs is equal to one, the elasticity of substitution between primary school and post-secondary educated labor is $\sigma_{cp} = \frac{1}{1-\mu}$, and the elasticity of substitution between secondary school educated and the aggregate between primary school and post-secondary educated labor is $\sigma_{s} = \frac{1}{1-\zeta}$. When $\zeta > \mu$ primary educated labor competes more with secondary school educated labor than with post-secondary educated labor, whereas when $\zeta < \mu$ it competes more with post-secondary educated labor. This nested constant elasticity of substitution production function is similar to the one used by Krusell et al. (2000) and Acemoglu, Autor and Lyle (2004).

Immigrant and native labor of the same educational attainment may be imperfect substitutes, as the different educational, social and linguistic background of these groups may lead to different choices of occupations. Peri and Sparber (2009) and evidence presented in Section 3, below, suggests that imperfect substitutability of natives and immigrants is particularly true for low levels of education.[15] In light of this evidence, and since we are interested in the impact of primarily low-skilled immigrant labor, we further extend production function (8) to allow for imperfect substitutability among those with at most primary education, but assume that natives and immigrants with secondary or post-secondary education are perfect substitutes. In particular,

$$P = \left[(B_N^p P_N)^\rho + (B_I^p P_I)^\rho \right]^{1/\rho}, \tag{9}$$

where N and I denotes native and immigrant labor respectively, and the elasticity of substitution between immigrant and native labor with at most primary education is $\sigma_{in} = \frac{1}{1-\rho}$.

With the empirical exercise we shall perform in mind, the most interesting elasticities are those that relate to the impact of low-skilled immigration I on the labor market outcomes, wages and employment, of natives with at most primary education P_N, and those with secondary S and post-secondary C education. The impact of low-skilled immigrant labor on low-skilled native wages w_{p_N} and employment P_N is found analogously to that

[15] US evidence on whether imperfect substitutability between immigrants and natives of similar observable characteristics is empirically important is mixed, see Ottaviano and Peri (2012) and Borjas, Grogger and Hanson (2012).

in Section 2.1, above, see Appendix A. They are given by:

$$\frac{d\ln w_{p_N}}{d\ln I} = \frac{s_i\left(\eta_p - \sigma_{in}\right)}{\sigma_{in}\eta_p + \phi_p\left(s_i\eta_p + (1-s_i)\,\sigma_{in}\right)}, \tag{10}$$

$$\frac{d\ln P_N}{d\ln I} = \phi_p\frac{d\ln w_{p_N}}{d\ln P_I}, \tag{11}$$

where s_i is the immigrant share among those with at most primary education, ϕ_p is the elasticity of labor supply of natives with at most primary education, and η_p is the elasticity of demand for labor with at most primary education. The impact of low-skilled immigrants on their own wages w_I is, as above, always negative:

$$\frac{d\ln w_I}{d\ln I} = -\frac{\phi_p + (1-s_i)\,\eta_p + s_i\sigma_{in}}{\sigma_{in}\eta_p + \phi_p\left(s_i\eta_p + (1-s_i)\,\sigma_{in}\right)}. \tag{12}$$

The elasticity of demand for low-skilled labor η_p depends on the parameters of the higher level nest, as in Section 2.1. In particular, it depends on the elasticity of substitution between primary school and post-secondary educated labor σ_{cp}, and the elasticity of demand for that labor aggregate η_{cp}:

$$-\frac{d\ln P}{d\ln w_p} = \eta_p = \frac{\sigma_{cp}\eta_{cp} + \phi_c\left(s_p\eta_{cp} + (1-s_p)\,\sigma_{cp}\right)}{\phi_c + (1-s_p)\,\eta_{cp} + s_p\sigma_{cp}}, \tag{13}$$

where w_p is the price of the labor aggregate P, s_p is the share of labor with primary education in the primary school and post-secondary educated labor aggregate, and ϕ_c is the elasticity of labor supply of workers with post-secondary education. The effect of immigration on the primary school labor aggregate P is always positive:

$$\frac{d\ln P}{d\ln I}=\frac{s_i\eta_p\left(\sigma_{in}+\phi_p\right)}{\sigma_{in}\eta_p+\phi_p\left(s_i\eta_p+\left(1-s_i\right)\sigma_{in}\right)}. \tag{14}$$

The expressions for the remaining elasticities are as follows. The impact of low-skilled immigration on the wages and employment of labor with post-secondary education is:

$$\frac{d\ln w_c}{d\ln I}=\frac{d\ln w_c}{d\ln P}\frac{d\ln P}{d\ln I},\quad \frac{d\ln C}{d\ln I}=\phi_c\frac{d\ln w_c}{d\ln I}, \tag{15}$$

where the expression for $\frac{d\ln w_c}{d\ln P}$ is analogous to that for $\frac{d\ln w_{p_N}}{d\ln P_I}$, equation (10). The impact of low-skilled immigration on the wages and employment of labor with secondary school education is:

$$\frac{d\ln w_s}{d\ln I}=\frac{d\ln w_s}{d\ln L_{cp}}\frac{d\ln L_{cp}}{d\ln P}\frac{d\ln P}{d\ln I},\quad \frac{d\ln S}{d\ln P_I}=\phi_s\frac{d\ln w_s}{d\ln I}, \tag{16}$$

where L_{cp} is the output of the labor aggregate of primary and post-secondary school, and the expression for $\frac{d\ln w_c}{d\ln L_{cp}}$ is analogous to that for $\frac{d\ln w_{p_N}}{d\ln I}$, equation (10).

3 Data

3.1 Data

The Labour Force Survey (LFS) of Malaysia provides annual data on various characteristics of the labor force and the structure of employment. The main survey is conducted by the Department of Statistics of Malaysia. Data are available for the years 1990 to 2010, with the exceptions of 1991 and 1994 when the survey was not conducted and 2008 where the survey weights were not available. Wage and income data were not collected until 2007 when an additional module was included in the survey. As a consequence, our main analysis is conducted with data from 2007 to 2010, with the earlier data used to help construct our instrument and conduct a number of robustness checks. The main survey samples, on average, 1 percent of the Malaysian population, while the supplement surveys around 0.5 percent of the working-age population.

The income supplement includes information on numerous forms of income. The wage measure we use is the total income derived from all labor related sources in the previous month divided by the number of days worked in that month. The income measure also includes all employment related forms of non-monetary compensation, such as housing allowances which are common for agricultural workers and miners. We restrict our sample to workers to those who worked at least 30 hours per week during the past month. Our results are robust to using different wage measures: monthly, hourly, and with or without non-monetary compensation.

The LFS records the state people live in (we include Putrajaya in Selangor throughout) and their employment status (employed, unemployed or out of labor force). We aggregate the educational classification into five main categories: those with at most primary education (which includes those without any formal education), lower secondary, upper secondary (which also includes STPM), certificate / diploma (vocational training), and university degree and above. In addition, the LFS asks about an individual's age, gender, marital status, and the month in which the survey took place. Our main unit of analysis is a sector (out of 23 main sectors), in a region (one of the 15 states) in a particular year, for which we calculate total employment for various education and age categories of both natives and immigrants.

Table 1 presents summary statistics for three years of the survey: 1990, 2007 (the first year of the supplement) and 2010. This is a period of rapid economic growth for Malaysia, despite the Asian Crisis during late 1990s and the recent financial crisis.[16] The rapid transformation of the native labor force's educational attainment is particularly impressive. In 1990, 62 percent of the native labor force had primary school education or less, and only 29 percent had high school education or more. By 2010 the share of the labor force with at most primary school education declined to 20 percent, while 66 percent had at least high school education. Among the new entrants to the labor force, age group 20-25, over 80 percent of this group have at least a high school degree.

The share of immigrants in the labor force increased from 3.6 to 10.6 percent between 1990 and 2010, according to the LFS. Around 55 percent of all immigrants are from Indonesia, 20 percent from the Philippines and the remainder from countries such as Bangladesh, Cambodia, India, Laos, Myanmar, Sri Lanka, Thailand, and Vietnam. Immigrant workers are disproportionately employed in agriculture and construction. Their share in manufacturing also increased during this period, while they are under-represented in relatively skill-intensive service sectors such as health, education and public administration.

Immigrants are significantly less educated than Malaysians: 91 percent had (at most) primary school education in 1990. Even though this number had fallen to 66 percent by

[16] Malaysia's GDP per capita in current US dollars went from $2,418 in 1990 to $8,691 in 2010 (World Bank national accounts data).

2010, only 19 percent had completed high school. Moreover, as suggested by Peri and Sparber (2009) and Ottaviano and Peri (2012), there is some evidence that immigrants with lower levels of education are engaged in less-skilled occupations than natives of a comparable level of education. Figure 1 depicts the returns to education for natives and immigrants by education level, as compared to those with at most primary education. At lower skill levels the returns to education are substantially and statistically significantly lower for immigrants than natives. The return to lower secondary education is 0.20 log points for natives and only 0.12 log points for immigrants; the difference is even larger for the return to upper secondary education, with returns of 0.56 and 0.27 log points for natives and immigrants respectively. This suggests that at low levels of education immigrants on average supply a lot less human capital to the labor market than a native of the same educational attainment. In contrast, the return to a college degree (as compared to at most primary education) is somewhat higher for immigrants than natives, though the difference is not statistically significant, and the return to vocational training about the same for the two groups.

3.2 Background[17]

There are two types of formally registered immigrants to Malaysia: expatriates and foreign workers. Expatriates are skilled managerial, professional, and technical workers who are able to obtain long-term visas and enjoy special privileges, such as the ability to bring their spouse. These make up only 2 percent of the total immigrant stock. The remaining

[17] The material in this section draws on Del Carpio et al. (2013) who provide an extensive discussion of the Malaysian immigration system.

98 percent of immigrant workers only receive temporary work permits, which are valid for less than a year and renewable for at most five years. These workers are not allowed to bring any dependents, and there is no pathway to permanent residence or citizenship (as there is for the US and European countries).

Hiring of foreign workers is regulated by quotas assigned to specific sectors, which are adjusted annually (and in practice also occasionally retrospectively). Foreign workers are hired either directly by a company, or through a recruitment or outsourcing agency which, especially for smaller companies, shoulder the administrative burden of obtaining work permits. Hiring costs are comparatively low by international standards, but hiring and work permit procedures are arduous and include medical checks. In addition, annual levies (payable by the employer) are charged for the employment of foreign workers. These are adjusted annually, vary by sector, and may differ for Peninsula Malaysia and Sabah and Sarawak. Levies have increased substantially over time; they were RM 1,850 (around $575) and RM 1,250 ($390) in services and manufacturing, respectively, in 2011. They impose a substantial burden on employers, and may more than double the cost of employing a low-skilled foreign worker.

Foreign workers are by law required to receive workmen's compensation for injuries though it is more generous for Malaysians. On plantations and in mining employers are responsible for providing housing of (poorly enforced) minimum standards, and they are not part of Malaysia's Employment Provident Fund which finances retirement. A minimum wage was introduced in Malaysia only in 2012, and hence during our sample period there were no legal restrictions on how much firms pay workers (Malaysian or foreign).

There is a substantial number of irregular foreign workers who are employed illegally though may have entered Malaysia legally and overstayed their permits. Good estimates are not available, but a 1996/97 regularization exercise resulted in almost one million unregistered migrants being legalized. This suggests that as many as half, if not more, of all immigrants are employed illegally. In principle, our data are a representative sample of all workers, employed legally or not. In practice, there is likely undercounting of foreign workers without work permits which we will have to account for in our empirical strategy.

4 Homogeneous Effects of Immigration

4.1 Regression Specifications and Parameter Identification

The framework outlined in Section 2.1 shows that we need to identify three key parameters in order to determine the effects of immigration on natives. These are (1) the elasticity of substitution between native and immigrant labor σ_{mn}, (2) the elasticity of demand for native labor η, and (3) the elasticity of supply for native labor ϕ_n. The remaining variables are the shares of native and immigrant labor in the wage bill, s_n and s_m, which can be directly calculated from the data. We begin by identifying the effect of immigration M on native employment N in an industry-region-year regression:

$$N_{rst} = \beta_1 M_{rst} + \delta_{rs} + \delta_{st} + \delta_{rt} + \varepsilon_{1,rst} \tag{17}$$

In this expression, δ_{rs} are region by industry, δ_{st} are industry by year, and δ_{rt} are region by year fixed effects, and $\varepsilon_{1,rst}$ are idiosyncratic unobservables. The fixed effects and the error term capture shocks to output prices, both factor-neutral and factor-enhancing differences in technology, product quality, transportation costs and other factors that affect demand. In addition, misspecification error, especially due to heterogeneity in the elasticity of substitution, labor demand, and factor shares, will be reflected in the fixed effects and error term.[18] The inclusion of δ_{rs} means that the effect of immigration is identified from changes over time in the number of immigrants in each industry-region. The inclusion of δ_{st} and δ_{rt} implies that only deviations from the sector-specific and region-specific average in immigration flows to an industry-region are used for identification. The regression is estimated at the local labor market level (industry-region in a year).

Note that we are estimating the relationship between immigrant and native employment in levels,[19] as opposed to in natural logarithms or, similarly, these variables standardized by local labor market employment levels. The reason is that a log-log specification imposes the restriction that in percentage terms the effect of immigration on natives is always the same, independently of the fraction of immigrants.[20] However, as is evident from our discussion of equations (3), (4) and (5) in Section 2, the elasticity of wage and employment levels with respect to immigration will depend on the share of immigrants. A log-log specifications is likely to fit the data well when directly estimating the elasticity of substitution, as is typical in the literature, and when factor shares do not vary too much, such as in the seminal work of Katz and Murphy (1992). In our case we are estimating

[18] These fixed effects also control for the annual levies employers have to pay for employing foreign workers.

[19] Peri and Sparber (2010) describe this as the straightforward way of testing for displacement. We deal with their concern about differential sizes of local labor market through the inclusion of fixed effects.

[20] A very similar restriction is imposed when standardizing variables by the level of employment (or the population), such that the relationship between immigrant and native employment is constant in percent changes.

the full derived-demand elasticity and the immigrant share varies enormously across local labor markets.[21] We show results for a log-log specification in Section 4.4, confirming the suspicion that it performs less well under these circumstances.

The degree to which the effect of immigration shows up on employment or wages (in an industry-region-year) depends on the mobility of native workers across sectors and regions. In order to estimate the elasticity of native labor supply we regress the log of native wages $\ln w^n$ on immigrant employment M:

$$\ln w^n_{jt} = \beta_2 M_{rst} + n\left(X_{jt}\right) + \delta_{rs} + \delta_{st} + \delta_{rt} + \varepsilon_{2,jrst} \tag{18}$$

Wages are observed for an individual j in year t and $n\left(X_{jt}\right)$ is a flexible polynomial of the observed worker characteristics (gender, education, potential experience, marital status). In addition, we include the same set of fixed effects as in equation (17).

Finally, we estimate the effect of immigration M on the log of immigrant wages $\ln w^m$:

$$\ln w^m_{jt} = \beta_3 M_{rst} + m\left(X_{jt}\right) + \delta_{rs} + \delta_{st} + \delta_{rt} + \varepsilon_{3,jrst} \tag{19}$$

Similarly, wages are observed at the individual level and $m\left(X_{jt}\right)$ is a flexible polynomial of the observed immigrant worker characteristics. We again include the same set of fixed effects as in equations (17) and (18).

[21] 49 percent of local labor markets contain no immigrants (this is unsurprising since our data is only a 0.5 - 1 percent sample of the population); while for 24 percent of local labor markets the fraction is above 10 percent, and for 4 percent the fraction is above 50 percent. Note though that very little of our identifying variation comes from local labor markets with no immigrants. The large majority of such labor markets never have any immigrants in the sample period, and thus the inclusion of industry by region specific fixed effects fully absorbs those local labor markets.

Using the estimates, and the labor shares calculated from the data, it is possible to identify the key parameters of the derived demand elasticities, see Appendix A. Our estimate of the elasticity of labor supply across industry-regions is given by the relative effect of immigration on native employment versus native wages:

$$\hat{\phi}_n = \frac{d \ln N}{d \ln w^n} = \frac{\hat{\beta}_1}{\hat{\beta}_2 \bar{N}}.$$

where $\bar{N}$ is the average number of natives in an industry-region-year. The elasticity of labor demand, η, and the elasticity of substitution, σ_{mn}, are identified from the parameter estimates β_1 and β_3, and equations (4) and (5):

$$\hat{\sigma}_{mn} = \frac{\hat{\beta}_1 \frac{\bar{M}}{\bar{N}} - 1}{\hat{\beta}_3 \bar{M} - \hat{\beta}_2 \bar{M}} \tag{20}$$

$$\hat{\eta} = -\frac{s_m + s_n \hat{\beta}_1 \frac{\bar{M}}{\bar{N}}}{s_m \hat{\beta}_3 \bar{M} + s_n \hat{\beta}_2 \bar{M}} \tag{21}$$

where s_m is the immigrant share of the total wage bill in an industry-region-year, $s_n = 1 - s_m$, and $\bar{M}$ is the average number of immigrants in an industry-region-year.

The elasticity of substitution is, as always in the literature on inequality or immigration, identified from the immigration induced change in relative wages and employment for immigrants and natives. The nested CES-framework with constant returns to scale implies that relative wages are independent of the scale of production and, as in Katz and Murphy (1992), taking ratios differences out the scale effect. The scale effect is then identified by the difference in the estimated total effect of immigration, and the change in outcomes implied purely by the substitution effect. Identification is analogous to how substitution and income effects are identified in consumer theory.[22]

Having identified the parameters of the production function, we can calculate the implied wage effects at national level for natives and immigrants using equations (6) and (7) respectively:

$$\frac{d\widehat{\ln w_n}}{d\ln M}|_N = \frac{s_m\left(\hat{\eta}-\hat{\sigma}_{mn}\right)}{\hat{\sigma}_{mn}\hat{\eta}}, \quad \frac{d\widehat{\ln w_m}}{d\ln M}|_N = -\frac{s_n\hat{\eta}+s_m\hat{\sigma}_{mn}}{\hat{\sigma}_{mn}\hat{\eta}}.$$

This allows us to use variation in immigration flows across local labor markets and nevertheless infer the economy-wide effects of immigration.

4.2 Instrument

The central challenge in estimating equations (17), (18) and (19) is the endogeneity of the inflow of immigrants, which is likely to be correlated with unobserved shocks to the demand for labor in an industry and/or region. Immigrants are more likely to locate in industries and regions that are experiencing positive shocks to the demand for labor. In that case, the OLS estimate of the effect of immigration on native employment and wages will be upward biased. It is also possible that declining industries make a special effort to

[22]Identification of scale and substitution effects depend on observing outcomes of both natives and immigrants. If native labor supply is perfectly inelastic (as required for many identification strategies in the literature) estimates of the impact of immigration on native and immigrant wages are required for identification:

$$\hat{\sigma}_{mn} = \frac{-1}{\hat{\beta}_3\bar{M}-\hat{\beta}_2\bar{M}}, \quad \hat{\eta} = -\frac{s_m}{s_m\hat{\beta}_3\bar{M}+s_n\hat{\beta}_2\bar{M}}.$$

If native labor supply is perfectly elastic the impact on native employment and immigrant wages needs to be estimated, and the parameter estimates are given by:

$$\hat{\sigma}_{mn} = \frac{\hat{\beta}_1\frac{\bar{M}}{\bar{N}}-1}{\hat{\beta}_3\bar{M}}, \quad \hat{\eta} = -\frac{s_m+s_n\hat{\beta}_1\frac{\bar{M}}{\bar{N}}}{s_m\hat{\beta}_3\bar{M}}.$$

attract immigrant labor to lower their wage bill. For example, immigrants require a work permit to legally work in Malaysia; one way that declining industries may respond is by exerting political pressure that more work permits be issued for their industry. In that instance there is a negative correlation between the inflow of immigrants and shocks to the wages and employment of native labor, and the OLS estimates would be downward biased.[23] The likelihood of biased OLS estimates makes it important to instrument for the inflow of immigrants to an industry-region.

A valid instrument for immigration flows needs to be uncorrelated with any demand shocks, caused by changes in technology or output prices, that may affect the demand for native or immigrant labor. To construct such an instrument we use changes in the population and age structure of immigrant source countries over time. These source countries are Bangladesh, Cambodia, India, Laos, Myanmar, Sri Lanka, Thailand, Vietnam, and most importantly Indonesia and Philippines. Using the data from the United Nations Population Division, we calculate the number of individuals in each of 7 age-groups in each of these source countries in every year during 1990-2010.[24] These population numbers form the potential pool of immigrants to Malaysia, where the likelihood of migration varies by age group, country of origin and year. This is our measure of the supply of immigrants S_t^{ac} to Malaysia from source country c in age-group a and year t.[25] Since data on immigrants' nationality are grouped into Indonesians, Filipinos and the rest of the world, we add our

[23] This is what Friedberg (2001) finds when examining the distribution of Russian arrivals in Israel after the end of the Cold War.

[24] The age groups are 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, and 45 and above.

[25] We multiply these population numbers by the average propensity of people from each country to migrate to Malaysia. This is so as to ensure that the magnitudes of the coefficients on each instrument are broadly comparable. These propensities are calculated from data provided by the Ministry of Home Affairs of Malaysia and are: Bangladesh 1.96%, Cambodia 1.03%, India 0.11%, Lao 0.01%, Myanmar 2.18%, Sri Lanka 0.16%, Thailand 0.22%, Vietnam 0.78%, Indonesia 5.56% and Philippines 0.38%.

measure of the supply of immigrants for all other countries into a single category, such that effectively we have three source countries: Indonesia, the Philippines and Other.

What remains to be determined is the industries and regions within Malaysia in which the immigrants choose to work. In order to construct this variable, we use the LFS for the period 1990 to 2002 to calculate the average probability of individuals from a source country and age group to be employed in a certain industry-region

$$\lambda_{rs}^{ac} = \frac{\sum_{t=1990}^{2002} M_{rst}^{ac}}{\sum_{t=1990}^{2002} M_{t}^{ac}},$$

where M_{rst}^{ac} is the number of immigrants from a source country in an age group, region, industry and year, and M_t^{ac} is the total number of immigrants in Malaysia from a source country and in an age group.

The source country and age-group specific instrument for the immigration flows in a certain, industry, region and year is given by:

$$IV_{rst}^{ac} = \lambda_{rs}^{ac} * S_t^{ac}. \tag{22}$$

We have three source countries (Indonesia, Philippines and Other) and seven age groups for a total of twenty-one instruments. Due to the small number of observations we then sum the age-specific instruments for the Other category, effectively restricting the coefficient on these instruments to be the same, such that we end up with 15 instruments. The identifying variation comes from the interaction of λ_{rs}^{ac} and S_t^{ac}, conditional on the included fixed effects, and is due to changes in the size of cohorts in source countries (which are experiencing their demographic transition at different rates) and their differential propensity to be employed in certain industries and regions in Malaysia. The variation in the instrument generated by the differential propensity of immigrant groups (defined by nationality and age) to work in different local labor markets is similar to the commonly used Altonji-Card instrument (Altonji and Card, 1991; Card, 2001). The variation induced by the demographic changes in source countries is similar to Hanson and McIntosh (2010) who find that Latin American migration to the US is highly responsive to labor supply and demographic shocks, as predicted by changes in birth cohort sizes.

Considering potential threats to the validity of this instrument, it is worth noting that the supply of potential migrants to Malaysia from different source countries (S_t^{ac}) is determined by the demographic patterns and transition in those countries, and hence clearly exogenous with respect to contemporaneous labor market shocks in Malaysia. However, it is also necessary that the only channel by which it affects outcomes in Malaysia is through changing the supply of potential immigrants. A reason this may not be the case is that demographic changes in source countries may affect the price of internationally traded goods produced in Malaysia (as a result of both changes in the demand for those goods and changes in the supply of competing products). The inclusion of year by industry fixed effects and region by year fixed effects, as in our main specification addresses these concerns.[26]

The average propensity of an immigrant from a source country to be employed in a certain industry-region (λ_{rs}^{ac}) depends on permanent differences in the levels of demand

[26] The major immigrant source countries - Indonesia, Philippines and Thailand - accounted for only 7 percent of Malaysian exports in 2000 and 10 percent in 2010 (Department of Statistics, Malaysia) and hence the direct effect of their demographic transition on the consumption of Malaysian exports is likely modest.

across local labor markets, which is why we include industry-region specific fixed effects in all our regression specifications. It is of course independent of any transitory shocks that may affect demand for natives (and immigrants) in a particular year. However, the concern is that persistent demand shocks, i.e. long periods of decline or growth in certain regions and/or industries, would result in a correlation between the average distribution of immigrants and current demand shocks. Calculating this propensity for the period 1990 to 2002, while our main analysis begins in 2007, helps alleviate this concern. The inclusion of industry by year and region by year fixed effects means that such long-term trends would have to be specific to an industry in a certain state and can not be the result of industry or region-specific factors. While we can not rule out such long-term trends, the advantage of our instrument as compared to the Altonji-Card instrument, is that it is possible to include local labor market (industry-region) specific linear time trends in our estimating equations and potentially have sufficient variation, induced by the demographic transition in source countries, for identification. We show that our results are robust to the inclusion of such local labor market-specific time trends, see Section 4.4 (though we only have sufficient variation to do so when we use data for 1990 - 2010, as opposed to in our main sample which uses 2007 - 2010 data). We take these results as strong evidence in favor of the validity of our exclusion restriction.

In interpreting our results, it is worth noting that the variation captured by the instrument will account for the migration decisions of only a subsection of all immigrants. These migrants are ones for whose social networks at the industry-region level are important for their location decisions (see Munshi, 2003; Patel and Vella, 2007; Beine, Docquier and Ozden, 2011; for recent work on immigration networks). Such immigrants may be systematically different from those whose locations decisions are determined primarily by demand shocks, and we would be estimating a local average treatment effect (which may or may not be the same as the average treatment effect for all immigrants).

4.3 Results

We present our OLS estimates in Table 2; our instrumental variable and parameter estimates, as well as the implied country-level wage effects, are in Table 3. Extensive robustness checks are presented in Section 4.4, below. In Panel A we have the estimates of the industry-region-year level effect of immigration on native employment (equation 17). Panel B presents the effect of an immigrant induced change in native employment on native wages (equation 19). Panel C shows the impact of immigration on immigrant wages (equation 18). Each column of the table presents estimates for different sets of fixed effects. In all specifications standard errors are clustered by industry-region-year (rst) and robust to heteroscedasticity.[27]

OLS estimates show that native outcomes, both employment and wages, are not significantly correlated with immigration flows. Immigrant wages are negatively correlated with immigration flows; however, this correlation is not statistically significant.

The instrumental variable estimates show that immigration, on average, increases the demand for native labor in a given sector-region pair where the effect on employment is large and statistically significant. The results are qualitatively robust to the inclusion of more fixed effects, though the inclusion of industry-year specific fixed effects attenuates

[27] Conditional on the included fixed effects the serial correlation within an industry-region is negative, hence we do not cluster on industry-region. In Section 4.4 we report standard errors clustered by industry-region.

the effect of immigration on both native employment and immigrant wages.

On average, an additional 10 immigrants employed in a given industry-region results in the employment of an additional 3.1 natives, in our preferred specification with a full set of fixed effects. These considerable reallocation effects across local labor markets are not associated with significant relative wage increases for the affected natives, though the point estimate of the impact of immigration on native wages is positive in every specification. The implied elasticity of labor supply across industry-regions is around 10; at the 95 percent confidence level the estimates rule out an elasticity below 3, while we can not rule out that workers are perfectly mobile across industry-regions. Sufficient Malaysian workers seem to be highly mobile across industry-regions and, consequently, the positive demand shock induced by immigration results in relative changes in employment, but not relative wages, of natives. Finally, immigration decreases the relative wages of immigrant workers significantly (demand is downward-sloping), with the estimates suggesting that a 10 percent increase in the number of immigrants decreases average immigrant wages by 3.3 percent in an industry-region. The fact that immigration lowers immigrant wages gives rise to the scale effect: lower immigrant wages result in lower costs, leading to output expansion, and additional demand for native labor. The first-stage F-statistic of the main specifications of the native employment and wage regressions, equations (17) and (18), and the immigrant wage equation (19) are 11.9, 10.2 and 22.7 respectively, suggesting that the instruments are good predictors of immigration flows across industry-regions.

The structural parameters implied by the IV estimates are presented in Panel D of Table 3. The estimated elasticity of labor demand is consistently larger than the elasticity of substitution between immigrant and native labor, 4.2 and 2.9 respectively in our main specification. The estimate of the elasticity of substitution between (primarily very low-skilled) immigrant labor and (primarily medium skilled) native labor is higher than those for the elasticity of substitution between high and low-skilled labor in the US which tend to be around 2 (Acemoglu and Autor, 2012). Our estimate of the elasticity of labor demand implies an elasticity of product demand for the output of an average industry-region of 5.7,[28] which seems reasonable given that around half our industry-regions are for traded manufacturing and agricultural goods and the other half are for service industries.[29] In sum, the structural estimates suggest that the predominantly very low-skilled immigrants to Malaysia are gross substitutes for natives, and, for a given level of output, displace these. However, immigration also reduces the cost of production for Malaysian firms, resulting in increases in output, thereby increasing the demand for native labor sufficiently to off-set the substitution effect

Our next set of results, presented in Panel E of Table 3, show the implied wage effects at the national level. While at the local level increased demand for native labor results in a large inflow of native workers, average native wages at the national level increase by only 0.13 percent. Immigration primarily results in a reallocation of native labor, with only very modest impacts on the national wage level. Meanwhile, immigration has a very large negative impact on immigrant wages, with an elasticity of -0.33. The fact that the scale effect is larger than the substitution effect does not, however, imply that average wages in Malaysia will increase due to immigration. Our estimates imply that a 10 percent increase in immigrants would decrease average wages in Malaysia (across natives and immigrants)

[28] The calculation assumes that capital and labor are combined using a Cobb-Douglas production function, and that the supply of capital to an industry-region is perfectly elastic.

[29] See Broda, Greenfield and Weinstein (2006) for comparison.

by 0.28 percent, which a consequence of downward-sloping demand for output produced in Malaysia. If the scale effect were actually smaller than the substitution effect then immigration would result in both declining immigrant and native wages.

The differences between the OLS and IV estimates provide evidence on the factors that influence the location decisions of immigrants. The IV estimates of the impact on immigration on native employment in an industry-region are considerably larger than the OLS estimates. This suggests that immigrants are not systematically hired by industries experiencing positive demand shocks, but rather in particular by industries in difficulties, likely in an attempt to cut costs and survive. The OLS estimates of the relationship between immigration and immigrant wages are smaller than the IV estimates, and frequently insignificant. The IV estimates tell us that immigration does decrease immigrant wages, but the OLS estimates suggest that immigrants tend to go to industry-regions where their wages are increasing; and those two effects partially cancel each other out.

An advantage of the instrumental variable approach is that it addresses measurement problems. For example, there are a substantial number of immigrants who are undocumented and illegally employed in Malaysia. These are likely undercounted by the LFS, resulting in attenuation bias (if illegal and legal immigration flows are uncorrelated) and other more complicated biases (if they are correlated) in the OLS estimates. For the instrumental variable estimates to be consistent, it is only necessary that the flows of illegally employed immigrants are uncorrelated with the instrument (conditional on the included fixed effects). This may in part explain why the IV estimates are larger than the OLS.

A number of caveats apply to interpreting our results as the causal effect of immigration on the derived demand for native labor. First, if immigration has heterogeneous effects on individuals with different characteristics it may change the composition of natives, with implications both for the wage and labor supply (if different individuals vary in how may hours they work per year). Our extensive controls ameliorate these concerns, but changes in unobserved characteristic of individuals may nevertheless affect the estimates. Second, we assume that immigration causes native workers to change employers solely on account of changes in the wage. However, there may be non-pecuniary reasons why natives may or may not wish to work with immigrants not captured by the model. In that case, immigration changes both the demand and supply for native labor at a given wage, with unaccounted for biases in our parameter estimates.

Third, it is conceivable that immigration to an industry-region may significantly increase the demand for the output of that industry-region, which would result in an upward bias of the estimates. Specifically, the estimated elasticity of product demand will be upward biased, since we would be confusing shifts in demand with the elasticity of demand. However, even if workers spend all of their income in the same region, only a very small fraction would be ultimately be spent on the output of the industry they are actually employed in, so this bias is likely to be negligible. Nevertheless, such general equilibrium effects are to a large extent accounted for with the inclusion of industry by year and region by year fixed effects.

Fourth, there may be spillover effects of immigration across local labor markets (as opposed to labor movements, which we explicitly account for). In particular, this may be a concern if the output of one industry-region is used as an input in another industry-region, and these also experience correlated immigration flows. Del Carpio et al. (2014), with the same Malaysian LFS data used in this paper, use region by year variation in immigration flows to find evidence of spillover effects across states. These spatial spillovers are positive suggesting that immigration to a state also creates jobs in neighboring states. However, controlling for these spillovers does not significantly effect the estimated direct impact of immigration on native outcomes, and the magnitude of the effect is modest. An additional 1000 immigrants in all other states on average increases employment in a state by 2 Malaysians, which is two orders of magnitude smaller than the direct effect. In our full specification any spillovers that occur across states are accounted for by the inclusion of region by year fixed effects, and those across industries are accounted for by the inclusion of industry by year fixed effects. However, we can not rule out more subtle input-output linkages specific to both an industry and region. This would be a problem if instrumented immigration flows are correlated with linked industries in the input-output tables. In order to properly estimate these, we would require region-specific input-output tables which are not available for Malaysia.

Finally, it is worth noting that short-run and long-run elasticities may differ significantly, either because there are factors, such as capital or entrepreneurial skills, that adjust only slowly or because technology or organization of production is endogenous (Acemoglu, 1998, and Lewis, 2011). Our estimation strategy does not require any assumptions about the elasticity of supply of capital, and hence *a priori* we make no assumptions about whether our estimates reflect short-run or long-run responses. The elasticity of labor demand, i.e. the scale effect, depends on positively on the elasticity of supply of capital, see the discussion of equation (2) in Section 2.1 above. The implication is that the long-run impact of immigration on the demand for native labor will be always larger than the short-run impact, and we are likely recovering a lower bound of the positive impact of immigration on native labor demand.[30]

4.4 Robustness Checks

4.4.1 Using Labor Force Survey Data for 1990 - 2010

We have employment data for Malaysia for the period 1990 - 2010, and can therefore run our employment regression, equation (17), for that time period. The additional time periods allow us to take advantage of the fact that the identifying variation of our instrument comes from the interaction between a variable that varies over time (the size of an age group in a source country) and a variable that varies across local labor markets (the average propensity of workers of a specific age group and source country to be employed in that local labor market). Uniquely in this literature this allows us to test the robustness of our results to the inclusion of local labor market (industry-region) specific linear time trends, so as to deal with potential bias arising from long-term correlated demand shocks. This addresses the main concern with our instrument, as with a conventional Altonji-Card style shift-share instrument, that there may be local labor market-specific long-term demand trends which affect both the historic and current distribution of immigrants (see also the discussion in Section 4.2, above).

Panel A of Table 4 replicates our main IV regression using the data for 1990 - 2010; we

[30] The estimates, combined with the typical assumption that labor and capital are combined with an elasticity of substitution of one, allows us to place bounds on the range of capital supply elasticities that may have generated the data. In particular, we can rule out that the data was generated by firms facing a perfectly inelastic supply of capital, i.e. our elasticties should not be interpreted as short-run elasticities. The data is consistent with capital supply elasticities greater than one, including a perfectly elastic supply of capital. This implies bounds for the long-run average national wage effects of immigration. Specifically, our estimates imply that in the long-run a 10 percent increase in immigration will increase average native wages by 0.14 to 0.42 percent.

include the full set of fixed effects of our main specifications, as well as an industry-region specific linear trend. In the first column the standard errors are robust to heteroscedasticity, in the second column we cluster the standard errors at the local labor market level (industry-region), so as to also account for possible serial correlation. The point estimate of the impact of immigration on native employment in an industry-region are close to those we obtain from the shorter panel: 0.385 instead of 0.314, the standard errors are smaller and the first-stage F-statistic is 22.8. The fact that our point estimate is robust to controlling for long-term demand trends at the local labor market provides strong evidence that the results are not the consequence of correlated demand trends, but reflect the true causal effect of immigration. Clustering standard errors by industry-region results in smaller standard errors, since conditional on the fixed effects and linear trends there is negative serial correlation.

In the literature using local labor market variation to identify the impact of immigration it is common to define a local labor market as a region or city. Thus, in Panel B of Table 4 we define a local labor market as a region, as opposed to an industry-region, and a unit of observation as a region in a given year. The regression includes region and year fixed effects, and region-specific linear trends. The instruments are constructed using variation of immigration flows across regions (as opposed to industry-regions), as in Del Carpio et al (2014), but are otherwise identical. In the first column the standard errors are robust to heteroscedasticity, in the second column we cluster them by region. The results reinforce our finding that immigration results in a positive demand shock for native labor. The point estimate of the impact of immigration on native employment in a region suggests that 10 additional immigrants in a region result in 5.1 additional employed natives (with an F-statistic of 18.4 in the first stage). This is higher than when estimated at the level of an industry-region, but the difference is not statistically significant. The standard errors are considerably smaller when clustering by region.

4.4.2 Varying Assumptions About Labor Supply Elasticities

A concern for our identification strategy is that we do not obtain precise or significant estimates of the effect of immigration on native wages in a local labor market (relative to other industry-regions). We argue that this suggests native labor is highly mobile across industry-regions and consequently immigration results primarily in changes in employment not wages. However, the estimates are consistent with a wide-range of labor supply elasticities across industry-regions: from an elasticity of 3 to perfectly elastic.

Table 5 shows the sensitivity of our parameter estimates, and the implied national wage effects, to varying assumptions about the elasticity of labor supply across industry-regions. The results are based on the estimates of the impact of immigration on native employment and immigrant wages in our main specification (Table 3, Column 3). Assuming a labor supply elasticity of 10 (Column 2) yields near identical parameter estimates to those in our main specification, and consequently near identical national wage impacts.

Assuming perfectly elastic labor supply (Column 1) yields a somewhat lower estimates of the elasticity of labor demand and slightly higher estimates of the elasticity of substitution. This results in slightly less pronounced national wage effects. Assuming a substantially lower elasticity of labor supply equal to 3 (Column 3), which at the 95 percent confidence level is the lower bound suggested by our estimates, also results in only moderate changes to our estimates. The estimate of the elasticity of labor demand is higher, a point estimate of 5.42, though no longer statistically significant; the elasticity of substitution is slightly lower, an estimate of 2.84, and still statistically significant. The implied national wage elasticity is 0.020 as opposed to 0.013. When we assume labor supply elasticities across industry-regions smaller than 3, below the lower bound suggested by our estimates, the estimates of the elasticity of labor demand become unrealistically high and statistically insignificant. For example, a labor supply elasticity of 1 (Column 4) implies an elasticity of labor demand of 24. In contrast, the estimates of the elasticity of substitution remain broadly stable and statistically significant.

In short, our parameter estimates do not crucially depend on a precisely estimated elasticity of native wages with respect to immigration. They are broadly robust to a wide-range of labor supply elasticities, while inconsistent with particularly low elasticities.[31]

5 Heterogeneous Effects of Immigration

5.1 Regression Specifications and Parameter Identification

The results above suggest that immigration on average increases the demand for native workers and their wages. But this impact need not be uniform throughout the native wage distribution, or across native education categories. Indeed, we might expect that low-skilled immigration would negatively affect the demand for low-skilled native labor, but potentially increase the demand for higher skilled native labor. To address this issue we estimate the parameters of the production function described by equations (8) and

[31] It is also straightforward to show the sensitivity of our national wage estimates to assumptions about the extensive margin labor supply elasticity at the national level (due to entry and exit from the labor force or emigration and immigration of natives). The results are qualitatively robust to a wide array of such assumptions.

(9).

Consider variants of equations (17) and (18), in which we estimate the impact of low-skilled immigration I on the employment and wages of natives of different educational attainment, N^e and w^e respectively:

$$
\begin{aligned}
N^e_{rst} &= \beta^e_1 I_{rst} + \delta_{rs} + \delta_{st} + \delta_{rt} + \varepsilon^e_{1,rst}, && (23)\\
\ln w^e_{jt} &= \beta^e_2 I_{rst} + n^e\left(X_{jt}\right) + \delta_{rs} + \delta_{st} + \delta_{rt} + \varepsilon^e_{2,irst} \quad \text{for all } j \in e, && (24)
\end{aligned}
$$

where native employment N^e is measured in an industry-region-year (rst) for natives of educational attainment (e), log native wages $\ln w^e$ are for individual j of group e, $n\left(X_{jt}\right)$ are flexible polynomials of the observed native worker characteristics; δ_{rs} are region by industry, δ_{st} are industry by year, and δ_{rt} are region by year fixed effects. The explanatory variable in all regressions is the number of low-skilled immigrants (I). The educational categories we consider are: at most primary school education, some secondary school education, and post-secondary education. Finally, we consider a variant of equation (19) and estimate the impact of low-skilled immigration on the wages of low-skilled immigrants:

$$
\ln w_{I,jt} = \beta_I I_{rst} + m\left(X_{jt}\right) + \delta_{rs} + \delta_{st} + \delta_{rt} + \varepsilon_{3,jrst}. \qquad (25)
$$

Our identification of the structural parameters is described in greater detail in Appendix C. It begins with the lowest nest by estimating the elasticity of substitution between low-skilled immigrants and natives σ_{in}, the elasticity of demand for low-skilled labor η_p, and the elasticity of supply of low-skilled natives to an industry-region ϕ_p. The identification of these parameters is analogous to the procedure outlined in greater detail in Section 4.1, above, using the estimates for $\frac{d\ln P_N}{d\ln I}$, $\frac{d\ln w_p}{d\ln I}$ and $\frac{d\ln w_I}{d\ln I}$. In practice, we are unable to obtain precise estimates of the elasticity of native labor supply, and instead report parameter estimates under a wide range of plausible values for the labor supply elasticities. Given σ_{in}, η_p and ϕ_p we estimate the impact of low-skilled immigration on the low-skilled aggregate, $\frac{d\ln P}{d\ln I}$, see equation (14). The estimate of $\frac{d\ln P}{d\ln I}$ combined with the additional information obtained from our estimate of $\frac{d\ln C}{d\ln I}$, allows identification of σ_{cp} and η_{cp}. Finally, we use those parameters to obtain an estimate of $\frac{d\ln L_{cp}}{d\ln I}$, and together with the estimate of $\frac{d\ln S}{d\ln I}$ we find σ_s and η_s. To obtain the implied wage impacts at the national level we use the structural parameters to calculate $\frac{d\ln w_{p_N}}{d\ln I}$, equation (10), $\frac{d\ln w_c}{d\ln I}$, equation (16), and $\frac{d\ln w_s}{d\ln I}$, equation (15) assuming that labor supply at the national level is perfectly inelastic.

5.2 Results

We report OLS and IV estimates of the impact of low-skilled immigration on natives of different educational attainment, as well as on the wages of low-skilled immigrants, in Table 6. The implied parameter estimates are presented in Table 7. The estimated impact of low-skilled immigration on wages of natives in an industry-region are not statistically significant for any education level, hence we do not report them here. Instead, in Table 7 we report parameter estimates based on different assumptions about the elasticity of native labor supply across industry-regions. Throughout we define low-skilled immigrants as those with lower secondary school education or less, with 82 percent of all immigrants in the period 2007-10 in that category; consistent with the evidence from Section 3. The results are qualitatively robust to defining low-skilled immigrants, like low-skilled natives, as those with at most primary education.

None of the OLS estimates, Panel A of Table 6, are statistically significant. The IV estimates, Panel B, show highly heterogeneous impacts of low-skilled immigration on natives with different educational attainment. The point estimates suggest that natives with at most primary education are displaced by low-skilled immigrants, 10 immigrants displace 0.8 natives in an industry-region, though the effect is not statistically significant. There is a large positive and statistically significant impact of low-skilled immigration on the employment of natives with some secondary education, an additional 2.8 natives for every 10 immigrants. The impact on natives with a vocational or college degree is positive, but small and not statistically significant.[32] Low-skilled immigration does not primarily benefit high-skilled natives, but rather those just a little more educated than the immigrants.

Table 7 presents the parameter estimates for each of the three nests of the CES production function described by equations (8) and (9), and the implied wage effects at the national level. The columns present the results for different labor supply elasticities: perfectly elastic, equal to 10, and 3.[33] In the description of the results we focus on those assuming a labor supply elasticity of 10, which corresponds to the point estimate in our main specification in Table 3. The large majority of our parameter estimates are robust

[32] This inverse u-shaped pattern continues to hold if we further disaggregate the education categories.

[33] Recall that the results presented in Table 3 rule out labor supply elasticities to an industry-region of below 3 at the 95 percent confidence level. For simplicity we assume that the elasticity of labor supply is the same for natives of all education levels.

to varying assumptions about the elasticity of native labor supply.[34]

Panel A presents the results for the nest combining low-skilled immigrants and natives with at most primary education. The elasticity of substitution is high ($\sigma_{in} = 3.8$) and larger than the elasticity of demand for that labor input ($\eta_p = 3.1$), such that an increase in low-skilled immigrants decreases the demand for low-skilled natives. We find a much lower substitutability between natives and immigrants than papers using US data; however, those papers typically compare natives and immigrants with both the same education and experience which may explain some of the difference.[35]

Panel B presents estimates for the nest combining post-secondary educated natives with the low-skilled aggregate. The elasticity of substitution between these groups ($\sigma_{cp} = 2.9$) is significantly lower than the scale effect for this nest $\left(\eta_{cp} = 4.1\right)$, hence as immigrants increase the quantity of low-skilled labor the high-skilled natives benefit. The elasticity of substitution is surprisingly high, suggesting that there are few complementarities in production between at most primary and post-secondary educated labor in Malaysia. The likely reason is that these two groups work in very different industries. For example, two-thirds of workers with at most primary education are employed in 14 of the 152 industries in our data, those same industries employ only 12 percent of workers with a college degree, but 41 percent of workers with some secondary school education. As a consequence, an increase in low-skilled immigrants has only a modest positive impact on high-skilled natives.

Panel C reports the results for the nest combining workers with some secondary school

[34] The only exceptions are the estimates of σ_s and η_s which become statistically insignificant when we assume an elasticity of native labor supply equal to 3.

[35] See Card (2009), Borjas, Grogger and Hanson (2012), and Ottaviano and Peri (2012).

education with the low-skilled and post-secondary educated aggregate. The elasticity of substitution between at most primary school educated workers and those with some secondary school education is low ($\sigma_s = 1.4$), somewhat lower than between high-skilled and low-skilled workers in the US (Acemoglu and Autor, 2012). There are far more pronounced complementarities between workers with at most primary and some secondary school education, than between those with at most primary and post-secondary education ($\sigma_{cp} > \sigma_s$). Moreover, the scale effect for this nest ($\eta_s = 7.2$) is far higher than the substitution effect, with the consequence that low-skilled immigration results in a substantial increase in the demand for labor with some secondary school education. This is consistent with the idea that immigrants are engaged in tasks complementary to the skills of natives with a little more education, but that are less related to those performed by highly educated natives (see Peri and Sparber, 2009, and Ottaviano, Peri and Wright, 2012).

In Panel D we report the implied wage effects at the national level for each labor factor. The wage effects at the national level are, as in Section 4 above, modest. A 10 percent increase in immigrants, equivalent to a 1 percent increase in the labor force, would decrease low-skilled wages by a substantial 1 percent, though the fall for natives with at most primary education would only be 0.18 percent. Those with some secondary school education would see wage increases of 0.24 percent, and those with post-secondary education would increase by only 0.07 percent. While these wage effects are modest it is worth remembering that between 1990 and 2010 the fraction immigrants in the Malaysian labor force nearly tripled, with significant implications for the returns to acquiring some secondary school education. Specifically, in the absence of immigration the counterfactual return per year of secondary school education would have been 1 percentage point lower than currently, about 8 percent per year rather than the current 9 percent.

6 Conclusions

The impact of immigration on native workers is driven by two countervailing forces: the degree of substitutability between natives and immigrants (which has been the focus of the existing literature), and the increased demand for native workers as immigrants reduce the cost of production and output expands. Using data for Malaysia and a novel instrument we find that the scale effect on average outweighs the substitution effect, such that immigration results in a positive demand shock for native labor. The cost advantage provided by immigration allows industries to expand sufficiently so as to outweigh the displacement of natives due to substitution. Hence, immigration results in a substantial reallocation of native workers across industries (and regions), but has only very modest effects on average native wages (immigrant wages fall substantially). The impact of immigration is highly heterogeneous for natives with different levels of education and follows an inverted u-shape. The bulk of immigrants have at most primary education and, on net, displace natives in that education category, with a significant negative impact on wages. Those natives with a little more education, lower secondary or completed secondary school education, experience the greatest benefits; while the gains for those Malaysians with a vocational diploma or university degree are smaller.

Two lines of inquiry follow naturally from the work in this paper. First, having established the importance of scale effects a next step is to identify their magnitude in different sectors of the economy. This is especially important for immigration policy, since issuing work permits in industries with large scale effects is likely to have a positive effect on native workers, while in those with small scale effects displacement is likely. In theory we have a good sense of what determines these (the elasticity of product demand, the elasticity of supply of capital and the labor share), but empirical evidence is lacking. Second, we provide evidence that immigration has a significant impact on skill premiums, and hence inequality, which in turn is likely to affect the education decisions of young Malaysians. Whether this mechanism is important and to what extent it has contributed to the extraordinarily rapid increase in the educational attainment of Malaysia's workforce is an open question.

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Appendix

A. Elasticities of Derived Demand: Homogeneous Model

Firms maximize profits given the production function described by (1). Taking the derivative of the first-order conditions with respect to a change in the number of immigrants:

$$\begin{aligned} \frac{d\ln w_m}{d\ln M} &= \frac{d\ln L}{d\ln M}\left(\frac{1}{\sigma_{mn}}-\frac{1}{\eta}\right)-\frac{1}{\sigma_{mn}}, &(26)\\ \frac{d\ln w_n}{d\ln M}-\frac{d\ln w_m}{d\ln M} &= \frac{1}{\sigma_{mn}}\left(1-\frac{d\ln N}{d\ln w_n}\frac{d\ln w_n}{d\ln M}\right), &(27)\end{aligned}$$

and eliminating $\frac{d\ln w_m}{d\ln M}$ using (26) and (27) gives:

$$\frac{d\ln L}{d\ln M}=\frac{d\ln w_n}{d\ln M}\frac{\eta\left(\sigma_{mn}+\phi_n\right)}{\left(\eta-\sigma_{mn}\right)}. \tag{28}$$

Then differentiate the production function and use the fact that with constant returns to scale $s_m=\frac{w_m M}{w_l L}=\frac{w_m}{w_l}\frac{M}{L}=\frac{F_M M}{L}$ and $s_n=\frac{w_n N}{w_l L}=\frac{F_N N}{w_l L}$:

$$\begin{aligned} \frac{dL}{dM} &= F_M+F_N\frac{dN}{dw_n}\frac{dw_n}{dM}, &(29)\\ \frac{d\ln L}{d\ln M} &= s_m+s_n\phi_n\frac{d\ln w_n}{d\ln M}.\end{aligned}$$

Eliminate $\frac{d\ln L}{d\ln M}$ using (28) and (29) to find the expression for $\frac{d\ln w_n}{d\ln M}$, see equation (3). Then substitute into (28) to find the expression for $\frac{d\ln L}{d\ln M}$. Finally, substituting this expression into (26) to obtain $\frac{d\ln w_m}{d\ln M}$ as a function of the exogenous parameters.

B. Controling for the Scale Effect in the Literature

We illustrate the manner in which the literature controls for scale effects, in order to estimate the substitution effect, using simplified versions of the identification strategies in Card (2001) and Borjas (2003). We the conclude this section with a discussion of Ottaviano and Peri (2012).

Consider first the Card (2001) model where output in a city c is produced using a two-level nested CES production function combining labor and capital

$$Y_c = F\left(K_c, L_c\right).$$

The labor aggregate L_c is a CES-aggregate of quantities of labor N_{jc} of occupation categories $j = 1, ..., N$:

$$L_c = \left[\sum\nolimits_j \left(e_{jc} N_{jc}\right)^{(\sigma-1)/\sigma}\right]^{\sigma/(\sigma-1)},$$

where σ is the elasticity of substitution between workers of different types. Workers are paid their marginal product:

$$w_{jc} = \frac{\partial Y_c}{\partial N_{jc}} = e_{jc}^{(\sigma-1)/\sigma} N_{jc}^{-1/\sigma} L_c^{1/\sigma} q_c F_L,$$

where q_c is the price of output in a city and $q_c F_L$ is the marginal product of the labor aggregate.

The relationship between factor prices (the wage) and quantities

$$\ln w_{jc} = -\frac{1}{\sigma} N_{jc} + \frac{\sigma - 1}{\sigma} \ln e_{jc} + \ln\left(L_c^{1/\sigma} q_c F_L\right),$$

depends on the elasticity of substitution, a city and occupation specific productivity shock $\ln e_{jc}$, and a common city-specific component shared by all groups j $\ln\left(L_c^{1/\sigma} q_c F_L\right)$. Immigration will affect the wage of a worker of occupation j via two channels: a change in N_{jc}, and a change in the city-specific component due to, in particular, a change in the scale of production (it may of course also affect the productivity parameters). Card does not estimate both of these effects, but rather runs a regression of the type

$$\ln w_{jc} = u_j + u_c + \beta N_{jc} + \varepsilon_{jc},$$

where city fixed effects absorb the impact of immigration on the scale of production, and the parameter of interest $\beta = -1/\sigma$ identifies the substitution effect (provided that the elasticity of labor supply is equal to zero).

Borjas (2003) extends this model to allow for imperfect substitution between workers of the same education level i but different experience j, and instead of variation across cities he uses variation across years t. The three-level nested CES has an aggegrate production function for the economy with output Q_t produced by capiutal K_t and labor L_t in year t:

$$Q_t = \left(\lambda_{Kt} K_t^{\upsilon} + \lambda_{Lt} L_t^{\upsilon}\right)^{1/\upsilon}.$$

The labor aggregate nests workers of different levels of education L_{it} and different levels of experience with a certain level of education L_{ijt}:

$$\begin{aligned} L_t &= \left(\sum_i \theta_{it} L_{it}^{\rho}\right)^{1/\rho}, \\ L_{it} &= \left(\sum_j \alpha_{ij} L_{ijt}^{\eta}\right)^{1/\eta}. \end{aligned}$$

The wage for skill group (i, j, t) is

$$\ln w_{ijt} = \ln \lambda_{Lt} + (1-\upsilon)\ln Q_t + (\upsilon - \rho)\ln L_t + \ln \theta_{it} + (\rho - \eta)\ln L_{it} + \ln \alpha_{ij} + (\eta - 1)\ln L_{ijt}.$$

There are now three channels, apart from the productivity parameters, by which immigration may affect wages: L_{ijt}, changes in the scale of the education specific component $(\rho - \eta)\ln L_{it}$, and the scale of the aggregate year specific component $(1-\upsilon)\ln Q_t + (\upsilon - \rho)\ln L_t$. To estimate the impact of immigration on wages Borjas follows Card and Lemieux (2001) by rewriting the wage for skill group (i, j, t) as

$$\ln w_{ijt} = \delta_t + \delta_{it} + \delta_{ij} - (1/\sigma_x)\ln L_{ijt}.$$

In this specification the year fixed effects δ_t absorb the impact of immigration on wages through changes in the aggregate scale of production, and the education by year fixed effects δ_{it} absorb the impact of immigration on wages via changes in the scale of the education aggregates. This then allows for the estimation of the elasticity of substitution across experience groups $\sigma_x = \frac{1}{1-\eta}$ (and subsequently the elasticity of substitution in higher level nests). Borjas' reduced-form estimating equation earlier in that paper is very similar, but simplifies matters by assuming that the elasticity of substitution across education groups is the same as across experience groups.

Ottaviano and Peri (2012), using a nested-CES production function with potentially imperfect substitution of natives and immigrants within the same education-experience group, distinguish between partial and total wage effects. The partial wage effect is that identified in Card (2001) or Borjas (2003) and is the wage impact on native workers of a change in the supply of immigrants with the same characteristics, while keeping constant the labor supplies of all other workers. The total wage effect also accounts for the indirect impacts of immigration on all other groups of workers, which in Borjas' specification, for example, is absorbed by the education by year fixed effects δ_{it}. Allowing for these more complicated cross-effects across groups provides a more complete estimate of the impact of immigration on native wages. However, it is not the source of the scale effect estimated in this paper. The scale effect in this paper arises irrespectively of the existence of the cross-effects of Ottaviano and Peri (2012) - though potentially incorporates these as well - and is driven by the increase in output as immigration reduces firms' costs of production.

C. Identification of Structural Parameters: Heterogeneous Model

The model with heterogeneity by level of education and the implied derived demand elasticities are described in Section 2.5. The parameters of the nest with low-skilled immigrants and natives with at most primary education are derived analogously to those in Section 4.1 and Appendix A, see equations (20) and (21):

$$\begin{aligned}
\hat{\sigma}_{in} &= \frac{\widehat{\frac{d\ln P_N}{d\ln I}} - 1}{\widehat{\frac{d\ln w_I}{d\ln I}} - \frac{1}{\phi_p}\widehat{\frac{d\ln P_N}{d\ln I}}}, \\
\hat{\eta}_p &= -\frac{s_i + (1-s_i)\widehat{\frac{d\ln P_N}{d\ln I}}}{s_i\widehat{\frac{d\ln w_I}{d\ln I}} + (1-s_i)\frac{1}{\phi_p}\widehat{\frac{d\ln P_N}{d\ln I}}},
\end{aligned}$$

where, as discussed, we assume that ϕ_p is known and $\widehat{\frac{d\ln P_N}{d\ln I}}$ and $\widehat{\frac{d\ln w_I}{d\ln I}}$ are estimated. Substituting the parameter estimates into the expression given by equation (14) we find:

$$\widehat{\frac{d\ln P}{d\ln I}} = s_i + (1 - s_i)\,\widehat{\frac{d\ln P_N}{d\ln I}},$$

and

$$\begin{aligned}
\widehat{\frac{d\ln w_p}{d\ln I}} &= \frac{d\ln w_p}{d\ln P}\frac{d\ln P}{d\ln I} = -\frac{1}{\eta_p}\frac{d\ln P}{d\ln I} \\
&= s_i\widehat{\frac{d\ln w_I}{d\ln I}} + (1 - s_i)\,\frac{1}{\phi_p}\widehat{\frac{d\ln P_N}{d\ln I}}.
\end{aligned}$$

The expressions for the elasticity of substitution between the low-skilled aggregate and post-secondary educated labor are analogous, and can be expressed as a function of the estimates as follows:

$$\begin{aligned}
\hat{\sigma}_{cp} &= \frac{\frac{d\ln C}{d\ln P} - 1}{\frac{d\ln w_p}{d\ln P} - \frac{d\ln w_c}{d\ln P}} = \frac{\frac{d\ln C}{d\ln I} - \frac{d\ln P}{d\ln I}}{\frac{d\ln w_p}{d\ln I} - \frac{1}{\phi_c}\frac{d\ln C}{d\ln I}} \\
&= \frac{\widehat{\frac{d\ln C}{d\ln I}} - s_i - (1 - s_i)\,\widehat{\frac{d\ln P_N}{d\ln I}}}{s_i\widehat{\frac{d\ln w_I}{d\ln I}} + (1 - s_i)\,\frac{1}{\phi_p}\widehat{\frac{d\ln P_N}{d\ln I}} - \frac{1}{\phi_c}\widehat{\frac{d\ln C}{d\ln I}}}, \\
\hat{\eta}_{cp} &= -\frac{s_p + (1 - s_p)\,\frac{d\ln C}{d\ln P}}{s_p\frac{d\ln w_p}{d\ln P} + (1 - s_p)\,\frac{d\ln w_c}{d\ln P}} = -\frac{s_p\frac{d\ln P}{d\ln I} + (1 - s_p)\,\frac{d\ln C}{d\ln I}}{s_p\frac{d\ln w_p}{d\ln I} + (1 - s_p)\,\frac{d\ln w_c}{d\ln C}\frac{d\ln C}{d\ln I}} \\
&= -\frac{s_p\left(s_i + (1 - s_i)\,\widehat{\frac{d\ln P_N}{d\ln I}}\right) + (1 - s_p)\,\widehat{\frac{d\ln C}{d\ln I}}}{s_p\left(s_i\widehat{\frac{d\ln w_I}{d\ln I}} + (1 - s_i)\,\frac{1}{\phi_p}\widehat{\frac{d\ln P_N}{d\ln I}}\right) + (1 - s_p)\,\frac{1}{\phi_c}\widehat{\frac{d\ln C}{d\ln I}}}.
\end{aligned}$$

In the same manner we find the parameters of the nest composed of labor with some secondary school education and the aggregate of at most primary and post-secondary educated labor. Specifically,

$$
\begin{aligned}
\hat{\sigma}_s &= \frac{\frac{d\ln S}{d\ln L_{cp}} - 1}{\frac{d\ln w_{cp}}{d\ln L_{cp}} - \frac{d\ln w_s}{d\ln L_{cp}}} = \frac{\frac{d\ln S}{d\ln I} - \frac{d\ln L_{cp}}{d\ln I}}{\frac{d\ln w_{cp}}{d\ln I} - \frac{1}{\phi_s}\frac{d\ln S}{d\ln I}} \\
&= \frac{\widehat{\frac{d\ln S}{d\ln I}} - s_p\left(s_i + (1-s_i)\,\widehat{\frac{d\ln P_N}{d\ln I}}\right) - (1-s_p)\,\widehat{\frac{d\ln C}{d\ln I}}}{s_p\left(s_i\widehat{\frac{d\ln w_I}{d\ln I}} + (1-s_i)\,\frac{1}{\phi_p}\widehat{\frac{d\ln P_N}{d\ln I}}\right) + (1-s_p)\,\frac{1}{\phi_c}\widehat{\frac{d\ln C}{d\ln I}} - \frac{1}{\phi_s}\widehat{\frac{d\ln S}{d\ln I}}}, \\
\hat{\eta}_s &= -\frac{s_{cp} + (1-s_{cp})\,\frac{d\ln S}{d\ln L_{cp}}}{s_{cp}\frac{d\ln w_{cp}}{d\ln L_{cp}} + (1-s_{cp})\,\frac{d\ln w_s}{d\ln L_{cp}}} = -\frac{s_{cp}\frac{d\ln L_{cp}}{d\ln I} + (1-s_{cp})\,\frac{d\ln S}{d\ln I}}{s_{cp}\frac{d\ln w_{cp}}{d\ln I} + (1-s_{cp})\,\frac{1}{\phi_s}\frac{d\ln S}{d\ln I}} \\
&= -\frac{s_{cp}\left(s_p\left(s_i + (1-s_i)\,\widehat{\frac{d\ln P_N}{d\ln I}}\right) + (1-s_p)\,\widehat{\frac{d\ln C}{d\ln I}}\right) + (1-s_{cp})\,\widehat{\frac{d\ln S}{d\ln I}}}{s_{cp}\left(s_p\left(s_i\widehat{\frac{d\ln w_I}{d\ln I}} + (1-s_i)\,\frac{1}{\phi_p}\widehat{\frac{d\ln P_N}{d\ln I}}\right) + (1-s_p)\,\frac{1}{\phi_c}\widehat{\frac{d\ln C}{d\ln I}}\right) + (1-s_{cp})\,\frac{1}{\phi_s}\widehat{\frac{d\ln S}{d\ln I}}}.
\end{aligned}
$$

Throughout the standard errors of the parameter estimates are derived using the delta method.

Figure 1: Returns to Education for Immigrants and Natives, 2007-10.

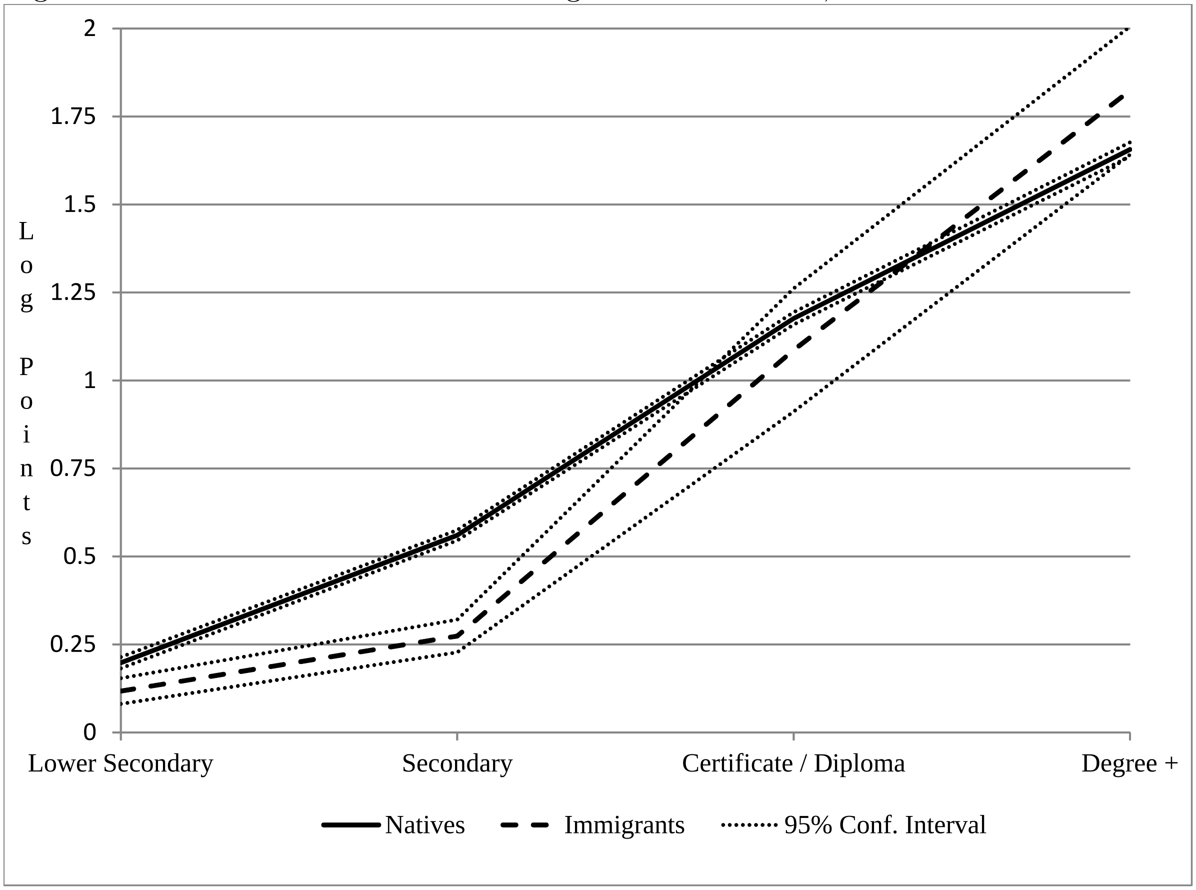

Table 1: Descriptive Statistics (for working-age population, ages 15-64)

	Natives			Immigrants		
	1990	2007	2010	1990	2007	2010
Labor Force Participation Rate (%)	66.4	61.7	61.5	72.0	81.6	78.9
Unemployment Rate (%)	4.6	3.4	3.5	2.9	1.3	1.8
			Among Employed (in %)			
Fraction Female	35.9	36.4	36.6	26.1	32.8	31.7
At most primary	62.4	26.4	20.5	90.6	78.6	66.0
Lower secondary	8.7	14.2	13.8	2.5	9.9	15.1
Upper secondary	23.1	41.1	43.3	2.8	7.9	14.6
Diploma/Certificate	3.3	10.3	11.6	0.8	0.9	1.2
Degree	2.5	8.0	10.7	3.3	2.7	3.1
Ages 15 - 19	9.4	3.6	3.2	9.1	5.2	5.1
Ages 20 - 29	34.6	30.9	30.7	39.3	25.5	19.3
Ages 30 - 39	26.4	26.8	27.0	29.4	38.9	39.5
Ages 40+	29.6	38.6	39.1	22.2	30.3	36.0
Agriculture and Mining	25.7	13.1	11.9	48.4	34.4	32.5
Manufacturing	20.3	18.8	17.1	9.8	17.1	17.9
Construction	6.2	8.2	8.6	10.4	13.6	14.0
Services	31.9	41.8	42.5	29.3	32.5	33.6
Public Admin, Health, Education	15.8	18.1	19.8	2.1	2.4	2.0
Number of Observations	77,511	227,226	242,276	3,018	13,704	16,224
Total (weighted observations)	10,484,606	15,919,461	16,980,672	351,512	1,300,187	1,394,177

Table 2: Labor Market Impact of Immigration, OLS Estimates

	(1)	(2)	(3)
A. Dependent Variable = Native Employment			
Immigrant Employment	0.104	0.100	0.095
	(0.105)	(0.096)	(0.097)
Elasticity	0.009	0.009	0.008
Observations	1,320	1,320	1,320
B. Dependent Variable = Log Wage for Natives			
Immigrant Employment (in 10,000s)	-0.001	-0.004	0.001
	(0.007)	(0.007)	(0.006)
Elasticity	-0.005	-0.021	0.006
Observations	91,129	91,129	91,129
C. Dependent Variable = Log Wage for Immigrants			
Immigrant Employment (in 10,000s)	-0.056**	-0.031	-0.023
	(0.023)	(0.026)	(0.029)
Elasticity	-0.027	-0.016	-0.011
Observations	9,522	9,522	9,522
Fixed Effects:			
Industry by Region	Yes	Yes	Yes
Year	Yes	Yes	Yes
Industry by Year	No	Yes	Yes
Region by Year	No	No	Yes

Note: All wage regressions include gender-specific individual-level controls for education, potential experience, part-time employment, marital status and month of survey. Native and immigrant employment is measured in an industry-region-year. Standard errors are clustered by industry-region-year and robust to heteroscedasticity. Individual observations are weighted using sampling weights. *, **, *** denote significance at the 10, 5 and 1 percent significance level.

Table 3: Labor Market Impact of Immigration, Instrumental Variable Estimates

	(1)	(2)	(3)
A. Dependent Variable = Native Employment			
Immigrant Employment	0.587***	0.305*	0.314*
	(0.197)	(0.176)	(0.169)
Elasticity	0.069	0.036	0.037
First-stage F-statistic	6.7	7.3	11.9
Observations	1,320	1,320	1,320
B. Dependent Variable = Log Wage for Natives			
Immigrant Employment (in 10,000s)	0.025	0.030	0.016
	(0.021)	(0.024)	(0.021)
Elasticity	0.005	0.006	0.003
First-stage F-statistic	7.6	6.7	10.2
Observations	91,129	91,129	91,129
C. Dependent Variable = Log Wage for Immigrants			
Immigrant Employment (in 10,000s)	-0.119***	-0.104***	-0.078***
	(0.026)	(0.042)	(0.037)
Elasticity	-0.498	-0.432	-0.327
First-stage F-statistic	32.3	19.4	22.6
Observations	9,522	9,522	9,522
D. Structural Parameter Estimates			
η (elasticity of labor demand)	3.29***	3.28**	4.22*
	(0.89)	(1.58)	(2.26)
σ (elasticity of substitution)	1.85***	2.20**	2.92**
	(0.40)	(0.88)	(1.37)
ϕ (elasticity of labor supply)	12.56	5.37	10.37
	(11.45)	(5.27)	(14.64)
E. Immigration at National Level			
Native Wage Elasticity	0.028	0.018	0.013
Immigrant Wage Elasticity	-0.512	-0.437	-0.330
Average Wage Elasticity	-0.036	-0.036	-0.028
Fixed Effects:			
Industry by Region	Yes	Yes	Yes
Year	Yes	Yes	Yes
Industry by Year	No	Yes	Yes
Region by Year	No	No	Yes

Note: All wage regressions include gender-specific individual-level controls for education, potential experience, part-time employment, marital status and month of survey. Native and immigrant employment is measured in an industry-region-year. Standard errors are clustered by industry-region-year and robust to heteroscedasticity. Individual observations are weighted using sampling weights. *, **, *** denote significance at the 10, 5 and 1 percent significance level.

Table 4: Native Employment Impact Using 1990 - 2010 Data, Instrumental Variable Estimates

	(1) Main Specification	(2) Clustered S.E.
Dependent Variable: Native Employment in Industry-Region		
A. Using Industry-Region Variation and Incl. Industry-Region Specific Linear Trends		
Immigrant Employment	0.385***	0.385***
	(0.135)	(0.053)
First-stage F-statistic	22.8	22.8
Observations	5,940	5,940
B. Using Region Variation and Incl. Region Specific Linear Trends		
Immigrant Employment	0.506***	0.506***
	(0.159)	(0.079)
First-stage F-statistic	18.4	18.4
Observations	270	270

Note: In Panel A all specifications include industry-region, industry-year and region-year fixed effects. Native and immigrant employment is measured in an industry-region-year. In column (1) standard errors are robust to heteroscedasticity; in column (2) they are clustered by industry-region. In Panel B all specifications include region and year fixed effects. Native and immigrant employment is measured in a region-year. In column (1) standard errors are robust to heteroscedasticity; in column (2) they are clustered by region. *, **, *** denote significance at the 10, 5 and 1 percent significance level.

Table 5: Parameter Estimates for Different Labor Supply Elasticities Across Industry-Regions

Local Labor Supply Elasticity	Perfectly Elastic	10	3	1
A. Parameter Estimates				
η (elasticity of labor demand)	3.90**	4.26*	5.42	24.5
	(1.90)	(2.31)	(3.98)	(102.5)
σ (elasticity of substitution)	2.95**	2.92**	2.84**	2.65**
	(1.40)	(1.37)	(1.30)	(1.14)
B. Wage Elasticity of Immigration at National Level				
Native Wage Elasticity	0.010	0.013	0.020	0.040
Immigrant Wage Elasticity	-0.329	-0.330	-0.332	-0.338
Average Wage Elasticity	-0.031	-0.028	-0.022	-0.005

Note: Parameter estimates are based on the estimates presented in Column 3 of Table 3, standard errors are calculated using the delta method. *, **, *** denote significance at the 10, 5 and 1 percent significance level.

Table 6: Impact of Immigration by Native Educational Attainment, OLS and IV Estimates

	(1)	(2)	(3)	(4)
	Native Employment			
	At Most Primary	Some Secondary	Post-Secondary	Low-Skilled Immigrant Wages (per 10,000)
	A. OLS Estimates			
Low-skilled Immigrant Employment	-0.010	0.047	0.037	0.021
	(0.051)	(0.094)	(0.036)	(0.033)
Elasticity	-0.006	0.008	0.014	0.088
	B. Instrumental Variable Estimates			
Low-skilled Immigrant Employment	-0.076	0.279**	0.048	-0.080***
	(0.128)	(0.134)	(0.056)	(0.025)
Elasticity	-0.045	-0.046	0.018	-0.340
First-stage F-statistic	8.6	8.6	8.6	17.5
Observations	1,320	1,320	1,320	7,772

Note: The wage regressions include gender-specific individual-level controls for education, potential experience, part-time employment, marital status and month of survey. Native and immigrant employment is measured in an industry-region-year. Standard errors are clustered by industry-region-year and robust to heteroscedasticity. Individual observations are weighted using sampling weights. The immigrant wage estimates of column (4) are expressed per 10,000 immigrants. *, **, *** denote significance at the 10, 5 and 1 percent significance level.

Table 7: Parameter Estimates and National Wage Effects for Model with Heterogeneous Labor

Labor Supply Elasticity	Perfectly Elastic	10	3
	A. Nest with Low-Skilled Immigrants and Natives		
σ_{in}	3.76***	3.82***	3.97***
	(1.21)	(1.28)	(1.48)
η_p	3.25***	3.14**	2.91**
	(1.18)	(1.21)	(1.32)
	B. Nest with Primary School and Post-Secondary Educated		
σ_{cp}	3.04***	2.88**	2.57**
	(1.15)	(1.16)	(1.21)
η_{cp}	3.94**	4.08**	4.45**
	(1.78)	(1.91)	(2.27)
	C. Nest with Secondary School and Aggregate of Primary and Post-Secondary Educated		
σ_s	1.66**	1.39*	1.01
	(0.81)	(0.81)	(0.76)
η_s	5.70**	7.22*	19.1
	(2.37)	(3.88)	(29.0)
	D. Wage Elasticity of Immigration at National Level		
At Most Primary - Native	-0.013	-0.018	-0.029
At Most Primary - All	-0.098	-0.102	-0.110
Some Secondary	0.018	0.024	0.039
Post-Secondary	0.005	0.007	0.012

Note: Parameter estimates are based on the estimates presented in Table 6. Standard errors are calculated using the delta method. *, **, *** denote significance at the 10, 5 and 1 percent significance level.