Effect of immigration on Sweden natives’ wages:
The post-secondary and post-graduate case.

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Abstract

Immigration has increased in Sweden during the last decade; increasing from 64,087 immigrants in 2001 to 113,117 in 2012. This trend has become an important topic for politicians, policy makers and the academic community, who concern about the effect of immigration over the native population in Sweden. The aim of our paper is to focus on the most educated immigrants, so we choose to study the impact of post-secondary graduate and post-graduate immigrant workers. Following this issue our paper asks the following question: has immigration affected positively or negatively native workers’ wages in a specific education- experience cohort in the primary counties in Sweden from 2001 to 2012? To give an answer to this question we categorize workers into experience-education groups in the primary counties in Sweden for the period between 2001 and 2012. We use the classification groups in a three-level CES production function specification; the CES specification helps us to calculate the elasticity of substitution across experience classes and across education groups. These estimates enable us to calculate the factor price elasticities, the percent change in the log average monthly wage due to a percent change in the supply of immigrant workers. The factor price elasticities imply a negative effect of immigration over the log average monthly wages for natives in Sweden in the period between 2001 and 2012.
I. Introduction

Immigration has increased in Sweden during the last decade; the immigrant flow increased by 86.2% from 2001 to 2012, changing from 64,087 immigrants in 2001 to 113,117 in 2012. The highest influx took place in 2012 (Statistics Sweden, 2014). This trend has become an important topic for politicians, policy makers and the academic community, who are interested in the effects of immigration over the native population in Sweden. The impact of immigrants in the labor market is a sensitive issue; the design of different public policies regarding immigration, wages and income redistribution depend on the measure of its effects. Most of the previous literature reports on the evidence from the US, for example Card (1990), Borjas (2003), Ottaviano and Peri (OP) (2006) and from the UK see Manacorda, Manning and Wadsworth (MMW) (2010).

The aim of this study is to analyze the effects of immigrant workers on the labor market wages. We estimate the elasticity of substitution between workers across experience classes and educational attainment groups; we use these outcomes to calculate the factor price elasticities for experience-education groups in order to measure the impact of the immigrant supply shock on natives’ wages in Sweden during the period between 2001 and 2012. This allows us to answer the question: “has immigration affected positively or negatively native workers’ wages in a specific education- experience cohort in the primary counties in Sweden from 2001 to 2012?”

To address this question we use Swedish data (Statistics Sweden, 2014) for the period between 2001 and 2012. The analysis is restricted to men aged 25-64 in the primary counties in Sweden. We follow Borjas (2003) assumption that workers with same education background but different level of experience are not perfect substitutes and immigration is not equally distributed among education-experience groups between counties. Thus, the effects of immigration vary across location and time. A person is defined to be an immigrant if he was born abroad and is either a noncitizen or a naturalized citizen; all other persons are classified as natives.

Borjas (2003) shows how to estimate the effect of immigration on the log of average monthly wages for native men. Followed by a three level CES production function, where we obtain the elasticity of substitution across experience classes and across education groups in order to estimate the changes on relative wages due to immigration. Our estimations may help to design immigration and labor market policies at a municipal and national level.

Our work is divided in five parts; in the first part we describe the Swedish context and review the relevant literature on the effects of immigration on the labor market in the UK and the US. This leads up to the second part, with a description of the data used in the rest of our work and introduction of basic descriptive statistics. Our empirical methodology is described in part three. We present and discuss the results of our empirical analysis and the factor price elasticities for education-experience groups in the following part. Finally, we conclude that immigration has had a negative effect on the relative average wages of natives in Sweden.
II. Literature review

During the last decades developed countries have experienced a rise in immigration, this has given place to the debate about the effects of immigration on the wages of natives. Sweden as most of western European countries experienced a great flow of immigrants during the last decades. After the Second World War the immigration process accelerated and was principally for labor reasons. Starting from 1970 immigration turned to be mostly for family reunion or asylum seeking motives. In 1990, almost 790,000 persons born abroad lived in Sweden compared to 1,473,256 in 2012; the immigrant share in this period increased from 9.2% to 15.4% (Statistics Sweden, 2014).

Since mid 1980 to 1999, there was a diversification of migration movements and an increase in the range of nationalities involved, though in the 90’s the number of asylum seekers and refugees rose substantially as well as family-linked immigration, particularly in Sweden. In 1999 just 1% of the immigrant flow notified work as the first cause of moving permanently or staying long-term in Sweden (OECD, 2001). Beside this, 79% migrated for family reunification and 20% as refugees. By 1999, the foreign born labor force represented 4.1% from the total, the fifth highest within OECD members, immigrant labor supply was concentrated in three sectors; health and other community services (23.1%), mining and manufacturing (21.4%), and wholesale and retail trade (12.7%), (OECD, 2001).

In view of all these immigration pattern changes during the last decade, it is important to extend our knowledge about the labor market conditions of immigrants and the impacts on natives’ wages. Several studies have focused on the immigrants’ situation in Sweden as well as the impact of this phenomenon in the labor market. Most of the researches have concluded that there is indeed a wage differential between immigrants and natives, as well as higher unemployment rates among foreign born individuals (Duvander, 2001). On the other hand, in Sweden foreign born workers are more susceptible than natives to economic depressions and institutional transformations (Aguilar and Gustafsson, 1994). Immigrants also face the challenge of integration into Swedish society. Circumstances like language skills, education background and experience, having a Swedish partner and the amount of time spent in the country affect the possibilities to find an occupation in the host country labor market (Aguilar and Gustafsson, 1994).

In spite of the Swedish policy about immigration and multiculturalism and the importance of preserving and respecting immigrants’ through equity in society, these goals have not been completely achieved. There is low immigrant political representation, high geographical segregation and lack of success in labor market (Duvander, 2001). Most of these issues affect immigrants’ performance in labor market and the way they affect Swedes’ labor opportunities. However, in politic and economic debates the negative effects that immigration could have in the labor market results for native workers have been highlighted (Friedberg and Hunt, 1995).

Ekberg (1998) finds that immigration also affects the public redistribution of incomes; the impact can be negative or positive depending on whether the services immigrants receive from the public sector exceed their contributes to taxes or not. He also points that during the period from 1950 to 1970 the immigrants net contributions had positive effects on the public redistribution of income in Sweden comparing to late 90’s where
income effects turned to be negative as a consequence of worse labor conditions among immigrants.\footnote{This result is based on the difference between immigrants’ contributions and expenditures to the public sector. The immigrants’ part of the total expenditures from the public sector was between 11.0\% and 12.2\% and their contributions were just 10\%, which gave a negative outcome between 1 to 2.2\%. Therefore, immigration had a negative effect on natives’ level of income in Sweden. Though, the effect was small, in average 0.9\% of the Swedish gross national product in 1996 (Ekberg, 1998).}

As evidence shows, immigrants had an adverse influence on Swedish public finances during the 90’s. Unfortunately not so many studies have been developed regarding the impact of immigration on natives’ wages in Sweden. Most of the evidence comes from the US, Borjas (2003), Card (1990), Ottaviano and Peri (OP) (2006) and the UK, Manacorda, Manning and Wadsworth (MMW) (2010). This evidence provides different results; some economists identified a small effect of immigration on natives’ wages while others found a significant negative effect.

Borjas (2003) assumes that immigration is not balanced across groups of workers who have the same education but different levels of experience and immigrants and natives with the same education and experience are perfect substitutes, while the empirical evidence shows imperfect substitution. His analysis indicates that in the United States immigration lowered the wage of competing native workers by 3 to 4 percent when there was an increase in labor supply of 10 percent due to immigration flow. Borjas, Freeman, and Katz (1997) proposed to analyze that matter at a national level, assuming that the aggregate technology can be described by a CES production function with two skill groups and this assumption implies that the relative wage of the two groups depends linearly on their relative quantities. When the analysis is extended to include the geographic boundary Borjas (2003) finds that immigration lowers weekly earnings by 1.3\% while Card (1990) does not find any relevant effect on earnings when the labor force in Miami increased by 7\% due the Mariel boat lift.

MMW (2010) studied the impact of immigration in wages in the UK based on the assumption that similarly educated workers with different experience are not perfect substitutes. In the UK different consequences in the labor market were found compared to the US. The study found that foreign-born population in the UK is more highly educated and even better than British population. Immigration in the UK has a bigger share of highly educated foreign born people compared to the US. This fact was studied by MMW, who found that college educated immigrants perceive lower wages as immigration of high skilled workers rises. Therefore, earlier immigrants’ wages in the UK are the only group which experiences a relevant impact for increased immigration.

Ottaviano and Peri (2006) assume the existence of an aggregate production function that combines labor and physical capital, while using education, experience, gender and place of origin to categorize imperfectly substitutable groups. They consider that capital is adjusting over time to its long run growth path instead of being fixed in the short run as Borjas does (2003). They find a small wage loss to the group of high school dropouts and wage gains for all the other groups of U.S. natives as capital adjusts. Their model implies that it is hard to claim that immigration has had a significant influence in the deterioration of the wage distribution of U.S. born workers. OP concluded that labor immigration has positive effects on high school graduated native workers and small
negative impact on the wages of earlier immigrants, this second result agree with MMW’s approach.

Card (2012) analyzes and compares the work carried on by Borjas (2003), OP (2006) and MMW (2010). Card states that in a good economy the impact of immigration depends on the supply of capital, structure of technology and characteristics of the added workers. He concludes that immigration may affect relative wages in some groups but the overall impacts on native wages are not significant compared to the effects of other variables like new technology, institutional changes, and policies related to recession times, which have led in the past to a slow wage growth for decades in most of labor market in the US.

III. Data

The empirical analysis based on Borjas (2003) methodology uses data drawn from Statistics Sweden website for the years between 2001 and 2012. The analysis is restricted to men aged 25-65 in the primary counties in Sweden. An individual is defined to be an immigrant if he was born abroad and is either a noncitizen or a naturalized citizen; all other persons are classified as natives2.

We sort workers into skill groups by region, educational attainment, experience and year when these characteristics where observed. According to Statistics Sweden men are classified into two educational attainment groups for the purpose of our study: “post-secondary education 3 years or more” and “post-graduate education”3. We classify men into 21 distinct groups for the primary counties in Sweden4.

As Borjas (2003) we measure work experience by the difference between the worker’s age at the time of the survey and the assumed age of entry into the labor market. According to the OECD (2009) the age of entry to the labor market for men with post-secondary education lies between 22 and 24 years old and between 24 and 29 years old for men with post-graduate education in Sweden, from this we assumed that workers enter the labor market at the age of 24. We restrict the analysis to persons who have between 1 and 40 years of experience each divided into 8 intervals of 5 years5.

2 We defined immigrants as first generation immigrants, excluding second generation ones, who are individuals who were born in Sweden and such that at least one of their parents is an immigrant Statistics Sweden (2014).

3 We restricted the study to these two education groups because this was the classification of workers per education background found. From the two education groups 94% of the individuals correspond to the post-secondary (3 years or more) and 6% to the post-graduate group in 2012. (Statistics Sweden, 2014).

4The counties (Statistics Sweden, 2014) and the distribution of population studied in this paper in 2012 correspond to; Stockholm (34.11%), Uppsala (3.3%), Södermanland (2.65%), Östergötland (3.64%), Jönköping (3.04%), Kronoberg (1.83%), Kalmar (1.36%), Gotland (0.17%), Blekinge (1.09%), Skåne (16.09%), Halland (2.12%), Västra Götaland (16.76%), Värmland (1.64%), Örebro (2.34%), Västmanland (2.60%), Dalarna (1.40%), Gävleborg (1.56%), Västernorrland (1.18%), Jämtland (0.53%), Västerbotten (1.34%) and Norrbotten (1.26%).

5 The classification of workers into experience groups is not precise because the Labor Force Survey (LFS) from Statistics Sweden does not provide any data about workers’ experience or the age they enter to the labor market.
We use the log of the average monthly salary in the primary counties for each education-experience-year-region cell. The data described before enable us to classify the workers into skill groups \((i, j, h, t)\), where \(i\) refers to educational attainment, \(j\) to work experience, \(h\) to county and \(t\) to the calendar year where these were observed.

We found data of the average monthly wages for the Swedish population classified by county and year, per education level and per age group in five year intervals; we use the eight intervals from 25 years old to 65 years old. We obtained data for the amount of immigrants classified by age and educational attainment in every county \(M\), this amount was taken away from the total population and the we obtained the quantity of natives \(N\) per county for every cell \((i, j, h, t)\) observed.

The immigrant supply shock for this skill group is

\[
p_{ijht} = \frac{M_{ijht}}{(M_{ijht} + N_{ijht})}
\]

\(M_{ijht}\): Number of immigrants in cell \((i, j, h, t)\).

\(N_{ijht}\): Number of natives in cell \((i, j, h, t)\).

\(p_{ijht}\): Foreign-born share of the labor force\(^6\) in a particular skill group.

We can analyze the behavior of \(p_{ijht}\) during the period from 2001 to 2012 and find which cells are more affected by a higher foreign-born share. As we have two educational groups, we compare the supply shocks experienced by the different groups in Figure I and Figure II between 2001 and 2012.

For the post-secondary education (3 years or more) group (see Figure I), there is not a great dispersion in the intervals of experience across the time, all of them follow the same pattern, with a high immigrant share among the first years of experience cohorts, ending in a smaller immigrant share in the group of workers close to retirement.

Observing the trend of the immigrant share within years, the growth has not been constant. Between 2006 and 2008 the share of immigrants within education group in all intervals of experience decreased on average by 13.3% compared to 2005. In 2010 compared to 2009, the share fell on average by 19.7% for all intervals of experience. In these twelve years, the cohorts which have grown the most are the ones where workers have between 1 to 5 and 6 to 10 years of experience; they grew by 102% and 66.5% respectively from 2001 to 2012. This increase is expected considering that in this period the immigrant population within 22 to 34 years old was the group of the total population which grew the most (4.22%), (Statistics Sweden, 2014).

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\(6\) The parameters \(M\) and \(N\) correspond to immigrant and native population, which we assume as the labor force. In contrast to Borjas (2003) we did take labor force as individuals who are enrolled in the civilian labor force, are in school and military service, due to the availability of the data.
The evolution of the immigrant share across experience groups for Post-graduate workers between 2001 to 2012 has followed a different pattern (see Figure II). In the period from 2001 to 2006 the behaviour of the immigrant share is similar among years, at the beginning it is high for the first four intervals of experience followed by a decline in the most experienced groups. In the period between 2007 and 2011 there is a significant increase of the share for experience group between 11 and 25 years. For the education group of Post-secondary (3 years or more), the immigrant share had the biggest growth among the intervals of experience of 1 to 5 and 6 to 10 years, both grew by 97.2% and 62.4% respectively from 2001 to 2012. The highest point perceived in the graphic is the interval of workers with 11 to 15 years of experience in 2011 (53.6%), in general 2011 presents the highest immigrant share.
Based on Borjas’ methodology we have evaluated the impact of immigration on the labor market taking into account the effects in all the primary counties. Previous studies have approached this issue estimating the differences between wages in local markets with higher proportion of immigrants. These studies have ignored some circumstances that lead to balance the effects of immigration in the local labor markets across counties. For instance, natives who are affected by immigration may move to other localities after new labor opportunities; this may decrease the estimations of the effects of foreign born labor force in local markets. As immigration is not balanced across education-experience groups, we find it important to point out that cells from the immigrant labor force feel more attracted to reside in bigger cities rather than in small municipalities. For this, we compare the counties of Stockholm and Västerbotten. Both of them differ in size, localization and business density. They host important universities; Stockholm University, Royal Institute of Technology and Karolinska Institute in Stockholm and Umeå University, and Swedish University of Agricultural Sciences in Västerbotten, all of which demand highly skilled labor force.

From the estimates of the immigrant share in Sweden, we can conclude there is a geographic concentration of immigrants in the biggest counties (Stockholm, Skåne and Västra Götaland) (Statistics Sweden, 2014). Foreign born individuals are more concentrated than natives in urban areas. This phenomenon is expected to happen in Sweden, developed countries are more likely to receive low-skilled workers from developing countries in the biggest metropolitan areas (King, 2012). At the same time, they feel influenced by earlier immigrants when they choose a place to live in the host country. Immigrants tend to live in areas where others from the same origin live, instead of establishing themselves in areas with higher proportions of native population. This trend decreases the possibility to develop language skills but affects in a positive way the conservation of their cultural heritage to new generations (Chiswick, 2004). Card (2007) states that there is a correlation between the initial share of foreign born population in a determined area and the following coming immigrants which confirms
Chiswick’s theory about the “enclave effect”, which refers to the trend of immigrants to locate in areas where individuals with same origin live, leading to spatial segregation. Furthermore, low skill immigrants may affect in a negative way the wages of earlier immigrants but they have positive effects on high skill natives’ wages. Thus, it does not mean earnings are higher in the biggest urban areas. In the case of the most populated counties in our study; Stockholm, Skåne and Västra Götaland present deviations with respect to the average monthly salary in 2012 in Sweden of 0.029, 0.004 and -0.007 percent respectively (Statistics Sweden, 2014).

Stockholm is the place of residence for 34.1% of the immigrant population with post-secondary (3 years or more) and post graduate education. The behavior of the immigrant share in the city follows the national trend. In both education groups the share reaches its highest point in 2011 in the experience group between 11 to 15 years of experience, being 48.1% and 77.3% for Post-secondary and Post-graduates respectively. In both education groups the immigrant population increased in the period between 2007 and 2011, for the post secondary (3 years or more) in the intervals of experience between 1 to 20 years and for the Post graduate in the intervals between 11 and 25 years.

Västerbotten county immigrant share has a very different behavior compared to Stockholm and the national pattern. While in 2011 Stockholm perceived the highest share of immigrants Västerbotten experienced a decrease in the share, 16.6% and 26.7% among immigrants with 11 to 15 years of experience for post secondary (3 years or more) and post graduate respectively. Västerbotten is a small county with just 1.34% from the total of the immigrant population with Post secondary (3 years or more) and Post graduate education in Sweden. However, two universities are located in the county which employs high skill labor force. Additionally, the county has experienced the fourth highest increase (55%) in the growth regional product (GRP) between 2000 and 2012, 15% of the labor force was employed by a foreign company. The shares of the College graduates and Post graduates in Umeå are 53% and 2.2% respectively overpassing the Swedish averages 38% and 1.2% (Västerbotten Investment Agency, 2014).

The high immigrant shares presented in this paper among post secondary (3 years or more) and post graduate groups are a consequence of the proportion of immigrants in Sweden with tertiary education. Sweden is placed as the eighth country with highest foreign born population in the world (OECD, 2006). In the period from 2002 to 2003 Sweden occupied the fifth place in the world with the highest proportion of foreign born population with University studies after Ireland, UK, Norway and USA.
Figure. III
The Immigrant Supply Shock within Post-secondary (3 years or more) group (Stockholm), 2001-2012

Figure. IV
The Immigrant Supply Shock within Post-graduate group (Stockholm), 2001-2012
Figure. V
The Immigrant Supply Shock within Post-secondary (3 years or more) group (Västerbotten), 2001-2012

Figure. VI
The Immigrant Supply Shock within Post-graduate group (Västerbotten), 2001-2012
The average wages data used in this paper are drawn from Statistics Sweden (the central government authority for official statistics) and are presented per month. Table I summarizes the trend in log average monthly wages for the various native groups. We observe that there is not a great deal of dispersion in the rate of 3 year-periods wage growth by education and experience, the trend is similar to the one of the wage dispersion in Sweden during the period between 1991 to 2012 (Statistics Sweden, 2014). On the other hand, the cells of workers with experience between 1 and 10 years in both educational groups from 2001 to 2012, where there is the highest immigrant share, present the lowest wages compared to workers with more years of experience where the immigrant share is significant lower. However, workers with less years of experience reported the lowest relative wages in Sweden compared to all other age cohorts OECD (1999).
<table>
<thead>
<tr>
<th>Education</th>
<th>Years of Experience</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
</table>

The table reports the mean of the log monthly wage of workers in each education-experience group. All wages are deflated to 2012 Swedish crowns using the CPI (Statistics Sweden, 2014).
Each point in the scatter represents the log average monthly relative wage and the log of relative immigrant workers for an education-experience-county group. The slope of the regression line is -1.3 with a standard error of 0.003.

Figure VII presents the scatter diagram relating the log average monthly relative wages and the log of relative immigrant workers; we use the data reported in Table 1 and the data showed in Figure 1 and Figure 2. The plot illustrates a negative relation between them, the log of the relative wages decreases as the log of relative supply of immigrants increases. This relation would suggest that there would be a negative relation when imposing economical structure to the analysis between the two variables; later on this paper we opt for a CES technology production function to address this issue.
IV. Methodology

We base our methodology in Borjas (2003) to estimate the effect of immigration on the log of relative average monthly wages in a cohort group \((i, j, h, t)\); our first step is to estimate the adjustment coefficient of the share of immigrants in cell \((i, j, h, t)\) without any economical background. The second step is to impose a three-level CES production function to the analysis, doing this we can obtain substitution elasticities across experience classes and across educational attainment groups that will help us to estimate the factor price elasticities for cell \((i, j)\). The factor price elasticities are the core of our analysis because they will enable us to measure the effect of a percent change in the immigration influx on the average monthly wages for cell \((i, j)\).

IV.i. Adjustment coefficient specification

Following Borjas (2003) we estimate the effect of immigration on the log of relative average monthly wages between cell \((i, j, h, t)\) and cell \((i, x, h, t)\), with \(j \neq x\):

\[
\log \left( \frac{w_{ijht}}{w_{xikt}} \right) = \theta p_{ijht} + s_i + g_j + r_h + \pi_t + \varphi_{ijht}
\]

\(\theta\): Adjustment coefficient of the shock in labor supply.

\(s_i\): Vector of fixed effects indicating the group’s educational attainment.

\(g_j\): Vector of fixed effects indicating the group’s experience.

\(r_h\): Vector of fixed effects indicating the group’s county.

\(\pi_t\): Vector of fixed effects indicating the time period.

\(\varphi_{ijht}\): Random error term.

After obtaining the adjustment coefficient \(\Theta\) we can estimate the elasticity of relative wages in group \((i, j, h, t)\) with respect to changes in relative labor supply in the same group due to immigration. The elasticity enables us to measure the percentage change in the log of relative average monthly wages related to a percentage change in relative labor supply caused by immigration,

\[
\frac{\partial \log \left( \frac{w_{ijht}}{w_{xikt}} \right)}{\partial m_{ijht}} = \frac{\theta}{(1 + m_{ijht})^2}
\]

Where \(m_{ijht} = \frac{M_{ijht}}{N_{ijht}}\) is the percentage increase in the labor supply of group \((i, j, h, t)\) attributable to immigration.
IV.ii. Three-level CES technology production specification

The latter approach estimates the correlation between the number of immigrants and the relative wage of competing natives without specifying the technology of the production function.

To impose economical structure to the analysis a three-level CES technology production function is assumed. Workers from the same schooling group with different levels of work experience are aggregated to form the effective supply of an education group; and workers across schooling groups are then aggregated to form the national workforce.

The aggregate production function for the economy at time $t$ is

$$Q_{ht} = \left[ \lambda_{Kht}K + \lambda_{Lht}L_{ht}^\rho \right]^{1/\nu}$$

$$\nu = 1 - \frac{1}{\sigma_{KL}}, \quad -\infty < \nu \leq 1$$

$$\lambda_{Kht} + \lambda_{Lht} = 1$$

Q: Output.
K: Capital.
L: Aggregate labor.

$\sigma_{KL}$: Elasticity of substitution between capital and labor.

$\lambda$: Time variant technology parameters.

Aggregate labor is the sum of the contributions of workers who differ in education and experience. Let

$$L_{ht} = \left[ \sum_i \theta_{iht} L_{iht}^{\rho} \right]^{1/\rho}$$

$$\rho = 1 - \frac{1}{\sigma_E}, \quad -\infty < \rho \leq 1$$

$$\sum_i \theta_{iht} = 1$$

$L_{iht}$: Number of workers with education $i$ in county $h$ at time $t$.

$\sigma_E$: Elasticity of substitution across education aggregates.

$\theta_{iht}$: Time variant technology parameters that shift the relative productivity of education groups.

The aggregation of the contribution of similarly educated workers with different experience is defined as:
\[ L_{ijht} = \left[ \sum_j \alpha_{ij} L_{ijht}^\eta \right]^{1/\eta} \]

\[ \eta = 1 - \frac{1}{\sigma_x}, -\infty < \eta \leq 1 \]

\[ \sum_j \alpha_{ij} = 1 \]

\( L_{ijht} \): Number of workers in education group \( i \) and experience group \( j \) in county \( h \) at time \( t \).

\( \sigma_x \): Elasticity of substitution across experience classes within an education group.

\( \alpha_{ij} \): Technology parameters that shift the productivity of education-experience groups.

The marginal productivity condition implies that the log of the relative wage for skill group \((i,j,h,t)\) with \( j \neq x \), is

\[
(3) \log \left( \frac{w_{ijht}}{w_{ixht}} \right) = \log \lambda_{iht} + (1 - \nu) \log Q_{ht} + (\nu - \rho) \log L_{ht} + \log \theta_{iht} \\
+ (\rho - \eta) \log \left( \frac{L_{ihht}}{L_{ixht}} \right) + \log \alpha_{ij} + (\eta - 1) \log \left( \frac{L_{ijht}}{L_{ixht}} \right)
\]

Equation (3) can be rewritten as

\[
(4) \log \left( \frac{w_{ijht}}{w_{ixht}} \right) = \delta_{ht} + \delta_{iht} + \delta_{ij} - \frac{1}{\sigma_x} \log \left( \frac{L_{ijht}}{L_{ixht}} \right),
\]

\[
\delta_{ht} = \log \lambda_{iht} + (1 - \nu) \log Q_{ht} + (\nu - \rho) \log L_{ht},
\]

\[
\delta_{iht} = \log \theta_{iht} + (\rho - \eta) \log \frac{L_{ihht}}{L_{ixht}},
\]

\[
\delta_{ij} = \log \alpha_{ij},
\]

Where \( \delta_{ht} \) is absorbed by period fixed effects and controls for the differences in the wage over county and time; \( \delta_{iht} \) is absorbed by interactions between the education fixed effects, county fixed effects and period fixed effects and controls for the possibility that the impact of education changed over county and time, \( \delta_{ij} \) is absorbed by interactions between education fixed effects and experience fixed effects and controls for the fact that the experience profile for the wage differs across schooling groups.

From this regression model we can obtain the elasticity of substitution across experience groups and the parameters \( \log \alpha_{ij} \) can be also identified from the coefficients of the
fixed effects\textsuperscript{7}, these estimates will enable us to calculate the aggregate labor for education group \(i\). With this information the regression for \(\log \left( \frac{w_{iht}}{w_{shit}} \right)\) can be estimated from the following model

\[
(5) \log \left( \frac{w_{iht}}{w_{shit}} \right) = \delta_{ht} + \log \theta_{iht} - \frac{1}{\sigma_{E}} \log \left( \frac{l_{iht}}{l_{shit}} \right)
\]

The estimations of equations (4) and (5) by ordinary least squares may lead to biased estimates of \(\sigma_{x}\) and \(\sigma_{E}\) because the supply of workers tends to be endogenous along the time period. To estimate these parameters we need the labor demand for cell \((i, j, h, t)\) and \((i, h, t)\) respectively, the problem resides in that only the “equilibrium” quantities for labor and wage are observed; these variables solve the equation system between labor supply and demand curves, so we don’t have a specification for each curve. A useful tool to solve this problem is the instrumental variable method, the IV method solves a statistical simultaneous equations problem by using variables that appear in the labor supply function to shift this equation and trace out the labor demand function. The variables that do the shifting are known as instrumental variables. In our case the instrumental variable is the immigrant influx, this will shift the supply curve as the immigrants enter the labor market, then from the change in the labor supply we can identify the demand curve\textsuperscript{8}. The IV method is addressed by running a two stage least squares regression, where in the first stage we use the relative supply of workers in cell \((i, j, h, t)\) as the dependent variable and the influx of immigration in the same cell as the regressor. In the second stage, the relative labor demand identified by the IV method is used to estimate equation (4); the same steps are repeated for equation (5) where the cell is \((i, h, t)\).

\textbf{IV.iii. Factor price elasticities}

The next step after obtaining the elasticity of substitution across experience classes and the elasticity of substitution across education groups is to show the responsiveness of the relative wage in group \((i, j)\) to an increase in the number of immigrants in the labor force. With this information we can determine if there is an affectation of immigration on the relative wages trough the factor price elasticity. Obtaining the factor price elasticities enable us to estimate the impact of immigration on the log relative wage of group\((i, j)\). The factor price elasticity giving the impact on the wage of factor \(y\) of an increase in the supply of factor \(z\) is\textsuperscript{9}

\[
\varepsilon_{yz} = \frac{d \log w_y}{d \log L_z} = s_z \frac{Q_{yz}Q_y}{Q_yQ_z}
\]

Where, \(Q_y = \frac{\partial Q}{\partial L_y}, Q_z = \frac{\partial Q}{\partial L_z}, Q_{yz} = \frac{\partial^2 Q}{\partial L_y \partial L_z}\) and \(s_z\) is the cost share accruing to factor \(z\).

\textsuperscript{7} The estimated fixed effect coefficient is \(\log \hat{a}_{ij}\), then \(\hat{a}_{ij} = \exp (\log \hat{a}_{ij}) / \sum \exp (\log \hat{a}_{ij})\).

\textsuperscript{8} The instruments used are \(\log \left( \frac{M_{lht}}{M_{shit}} \right)\) for equation (4) and \(\log \left( \frac{M_{shit}}{M_{lht}} \right)\) for equation (5), where \(M_{lht} = \left[ \sum \hat{a}_{ij} \left( \frac{M_{lht}}{M_{shit}} \right)^{\eta} \right]^{1/\eta}\).

\textsuperscript{9} Marginal cost and the quantities of other factors are held constant.
In this model the factor price elasticities describe three impacts on the relative wage in group \((i, j)\); the impacts are due to an increase in the relative supply of the same group, an increase in the relative supply of a group with same education but different experience and an increase in the relative supply group with different education and different experience.

We obtain the own factor elasticity differentiating the log of the marginal productivity of group \((i, j)\) with respect to \(\log \left( \frac{L_{ij}}{L_{ix}} \right)\)

\[
(6) \quad \frac{d \log \left( \frac{w_{ij}}{w_{ix}} \right)}{d \log \left( \frac{L_{ij}}{L_{ix}} \right)} = (1 - \nu) \frac{\frac{d \log Q \rho}{d \log L_{ht}} \frac{d \log L_{ht}}{d \log \left( \frac{L_{ij}}{L_{ht}} \right)} \frac{d \log \left( \frac{L_{ijht}}{L_{ht}} \right)}{d \log \left( \frac{L_{ijht}}{L_{ixht}} \right)}}{\frac{\rho - \eta}{d \log \left( \frac{L_{ijht}}{L_{ht}} \right)} \frac{d \log L_{ht}}{d \log \left( \frac{L_{ijht}}{L_{ht}} \right)} + (\eta - 1)}
\]

Where we define

\[
s_{ij} = \frac{d \log Q_{ht}}{d \log L_{ht}} \frac{d \log L_{ht}}{d \log \left( \frac{L_{ijht}}{L_{ht}} \right)} \frac{d \log \left( \frac{L_{ijht}}{L_{ht}} \right)}{d \log \left( \frac{L_{ijht}}{L_{ixht}} \right)}
\]

\[
s_{i} = \frac{d \log Q_{ht}}{d \log L_{ht}} \frac{d \log L_{ht}}{d \log \left( \frac{L_{iht}}{L_{sht}} \right)}
\]

\[
s_{L} = \frac{d \log Q_{ht}}{d \log L_{ht}}
\]

\(s_{ij}\) gives the cost share accruing to group \((i, j)\); \(s_{i}\) gives the cost share accruing to education group \(i\), and \(s_{L}\) gives the labor’s share of income.

We can rewrite (6) as

\[
(7) \quad \varepsilon_{ij, ij} = -\frac{1}{\sigma_{X}} + \left( \frac{1}{\sigma_{X}} - \frac{1}{\sigma_{E}} \right) \frac{S_{ij}}{S_{i}} + \left( \frac{1}{\sigma_{E}} - \frac{1}{\sigma_{KL}} \right) \frac{S_{ij}}{S_{L}} + \frac{1}{\sigma_{KL}} S_{ij}
\]

Similarly, we differentiate the log of the marginal productivity of group \((i, j)\) with respect to \(\log \left( \frac{L_{ij}}{L_{ijx}} \right)\) to obtain the cross-factor price elasticity giving the impact on the relative wage of group \((i, j)\) of an increase in the relative supply of group \((i, j')\), with \(j \neq j'\),

\[
(8) \quad \varepsilon_{ij, ij'} = \left( \frac{1}{\sigma_{X}} - \frac{1}{\sigma_{E}} \right) \frac{S_{ij'}}{S_{i}} + \left( \frac{1}{\sigma_{E}} - \frac{1}{\sigma_{KL}} \right) \frac{S_{ij'}}{S_{L}} + \frac{1}{\sigma_{KL}} S_{ij'}
\]
Finally, we differentiate the log of the marginal productivity of group \((i, j)\) with respect to \(\log \left( \frac{t_{ij}}{t_{ix}} \right)\) to obtain the cross-factor price elasticity giving the impact on the relative wage of group \((i, j)\) of an increase in the relative supply of group \((i', j')\), with \(i \neq i'\) and \(j \neq j'\).

\[
\varepsilon_{ij,ij} = \left( \frac{1}{\sigma_E} - \frac{1}{\sigma_{KL}} \right) \frac{S_{ij}}{S_L} + \frac{1}{\sigma_{KL}} S_{ij},
\]

The calculations of the factor price elasticities in (7)-(9) require information about the factor shares, the elasticity of substitution across experience classes, the elasticity of substitution between education groups and the elasticity of substitution between capital and labor. Bentolila and Saint-Paul (2003) find that the labor’s share of income is 0.75 for Sweden; we use this share and the total monthly earnings to apportion the labor shares accruing to the various groups\(^{10}\). Finally, we use the values of \(\frac{1}{\sigma_X}, \frac{1}{\sigma_E}\) from equations (4) and (5); and assume a Cobb-Douglas production function for Sweden, which implies that the elasticity of substitution between capital and labor equals one, Behrman (1982). The values of the factor price elasticities will fall if there is less than one unit of substitution between capital and labor everything else constant, this implies that the effect of immigration on the relative wages would be higher in specifications where the production function is not represented by a Cobb-Douglas type and the elasticity of substitution between capital and labor is less than unity. In the next session we stick to the assumption of a Cobb-Douglas production function to calculate the factor price elasticities.

V. Initial results

We present the results obtained after inputting the data in the specification where we measure the shock in the labor supply due to immigration, the three-level CES specification as well as the factor price elasticities for the education-experience groups. Finally, we present the impact of immigration on relative wages in Sweden from 2001 to 2012.

V.i. Adjustment coefficient specification

From equation (1) the coefficient obtained is -0.027 with a standard error of 0.068, by 2012 immigration had increased the number of men in the labor force by 9.2 percent. Equation (2) implies that the elasticity for the relative wage of average monthly earnings is then -0.022. This means that an immigrant flow that increases the number of workers in the skill group by 10 percent reduces relative average monthly earnings by about 0.22%.

\(^{10}\)Our calculation of the cell’s income share uses all workers monthly wages in 2012. The estimated shares for the eight experience groups with each education group are post secondary graduates (0.04,0.05,0.05,0.05,0.06,0.06,0.06,0.06) and post-graduates (0.05,0.06,0.06,0.06,0.06,0.06,0.07,0.07). The share of income accruing to secondary graduates is 0.53 and for post-graduates is 0.47.
Table II
IMPACT OF IMMIGRANT SHARE IN LOG OF RELATIVE AVERAGE WAGE
IN GROUP (i, j, h, t)

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>F (40,3991)</th>
<th>Prob&gt;F</th>
<th>Number of Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p_{ijht}$</td>
<td>-0.02731</td>
<td>0.06820</td>
<td>22,383.48</td>
<td>0</td>
<td>4,032</td>
</tr>
</tbody>
</table>

The table reports the coefficient of the immigrant share variable from the regression where the dependent variable is the log of the relative average monthly wages for a native education-experience-county group at a particular point in time. The regression includes education, experience, county and time fixed-effects. We used the stata command: xi: regress $\log\left(\frac{w_{ijht}}{w_{iht}}\right)$ $p_{ijht}$ i.Year i.County i.Education i.Experience, robust.

V.ii. Three-level CES specification
In the CES model, the first step is to estimate equation (4) using the sample of 4,032 ($i, j, h, t$) cells, we use the wage of the group with 16-20 years as the denominator in the relative wage. The IV estimate for the inverse of the elasticity of substitution across experience classes is

$$\log\left(\frac{w_{ijht}}{w_{iht}}\right) = \delta_{ht} + \delta_{iht} + \delta_{ij} - 0.055\log\left(\frac{L_{ijht}}{L_{iht}}\right)$$

Table III shows the first stage of the IV regression, where the coefficient of the instrument is 0.43 with a standard error of 0.014. This suggests a positive relation between the relative immigrant influx and the log of the relative labor demand. Table IV shows the second stage of the IV regression and the inverse of the elasticity of substitution across experience classes. The implied elasticity of substitution across experience groups is 18.
### Table III

**IMPACT OF LOG OF RELATIVE IMMIGRANT WORKERS IN LOG OF RELATIVE LABOR DEMAND IN GROUP (i, j, h, t)**

<table>
<thead>
<tr>
<th>Model</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>F (255,3776)</th>
<th>Prob&gt;F</th>
<th>Number of Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear regression</td>
<td>( \log \left( \frac{M_{ijht}}{M_{i4ht}} \right) )</td>
<td>0.43</td>
<td>0.0148</td>
<td>23.40</td>
<td>0</td>
</tr>
</tbody>
</table>

The table reports the coefficient of the immigrant influx variable from the regression where the dependent variable is the log of relative labor demand of a native skill group (defined in terms of education-experience) in a county at a particular point in time. The model includes interactions between county and period fixed effects; education, experience and county fixed effects; and education and experience fixed effects. We used the stata command `xi: regress` \( \log \left( \frac{L_{ijht}}{L_{i4ht}} \right) \) \( \log \left( \frac{M_{ijht}}{M_{i4ht}} \right) \) i.YearCounty i.EducationExperience i.EducationYearCounty, robust.

### Table IV

**IMPACT OF RELATIVE IMMIGRANT WORKERS IN LOG RELATIVE AVERAGE MONTHLY WAGES IN GROUP (i, j, h, t)**

<table>
<thead>
<tr>
<th>Model</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>F(255,3776)</th>
<th>Prob&gt;F</th>
<th>Number of Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV regression</td>
<td>( \log \left( \frac{L_{ijht}}{L_{i4ht}} \right) )</td>
<td>-0.0551</td>
<td>0.0025</td>
<td>387.64</td>
<td>0</td>
</tr>
</tbody>
</table>

The table reports the coefficient of the log of relative labor demand variable from the regression where the dependent variable is the log of relative average monthly wages of a native skill group (defined in terms of education-experience) in a county at a particular point in time. The model includes interactions between county and period fixed effects; education, experience and county fixed effects; and education and experience fixed effects. We used the stata command `xi: ivreg2` \( \log \left( \frac{W_{ijht}}{W_{i4ht}} \right) \) \( \log \left( \frac{L_{ijht}}{L_{i4ht}} \right) \) \( \log \left( \frac{M_{ijht}}{M_{i4ht}} \right) \) i.YearCounty i.EducationExperience i.EducationYearCounty, robust.
We use the estimate of the elasticity of substitution and the coefficients of the education fixed effects to calculate the size of the CES-weighted labor aggregate for each education group. We estimate the marginal productivity for the relative wage of education groups, where we use the wage of post-graduates as the denominator. The IV regression estimate for the inverse of the elasticity of substitution across education groups is

\[
\log \left( \frac{W_{iht}}{W_{2ht}} \right) = \delta_{ht} + \log \theta_{iht} - 0.104 \log \left( \frac{L_{iht}}{L_{2ht}} \right)
\]

\[(0.028)\]

The implied elasticity of substitution across education groups is 9.5. Table V shows the first stage of the IV regression, where the coefficient of the instrument is 0.28 with a standard error of 0.02. This suggests a positive relation between the relative immigrant influx and the log of the relative labor demand. Table VI shows the second stage of the IV regression and the inverse of the elasticity of substitution across education groups. The evidence indicates that workers within an experience group are not perfect substitutes; the same argument is true for workers within educational groups.

<p>| Table V |
|------------------|------------------|------------------|------------------|
| IMPACT OF LOG RELATIVE IMMIGRANT WORKERS IN LOG RELATIVE LABOR DEMAND IN GROUP ((i, h, t)) |</p>
<table>
<thead>
<tr>
<th>Linear regression</th>
<th>Dependent variable</th>
<th>(\log \left( \frac{L_{1ht}}{L_{2ht}} \right))</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\log \left( \frac{M_{1ht}}{M_{2ht}} \right))</td>
<td>Coef.</td>
<td>Std. Err.</td>
</tr>
<tr>
<td>0.2833</td>
<td>0.0238</td>
<td>5,520</td>
</tr>
</tbody>
</table>

The table reports the coefficient of the log of relative immigrant influx variable from the regression where the dependent variable is the log of relative labor demand of a native skill group (defined in terms of education) in a county at a particular point in time. The model includes period, county and education fixed effects. We used the stata command: \(\text{xiregress} \ \log \left( \frac{L_{1ht}}{L_{2ht}} \right) \log \left( \frac{M_{1ht}}{M_{2ht}} \right) \ i.\text{Year} \ i.\text{County} \ i.\text{Education}, \text{robust.}\)
Table VI
IMPACT OF LOG IMMIGRANT WORKERS IN LOG AVERAGE MONTHLY WAGES IN GROUP \((i, h, t)\)

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Coef.</th>
<th>Std. Err.</th>
<th>F(244.259)</th>
<th>Prob&gt;F</th>
<th>Number of Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Log(\frac{L_{1ht}}{L_{2ht}}))</td>
<td>-0.1049</td>
<td>0.0286</td>
<td>3300</td>
<td>0</td>
<td>504</td>
</tr>
</tbody>
</table>

The table reports the coefficient of the log of the relative labor demand variable from the regression where the dependent variable is the log of the relative average monthly wage of a native skill group (defined in terms of education) in a county at a particular point in time. The model includes interactions between county and period fixed effects; and education, county and period fixed effects. We used the stata command: \(xi: ivreg2 Log(\frac{w_{1ht}}{w_{2ht}}) (Log(\frac{L_{1ht}}{L_{2ht}}) Log(\frac{M_{1ht}}{M_{2ht}})) i.YearCounty i.YearCountyEducation, robust.\)

V.iii. Factor price elasticities
We now calculate the factor price elasticities and report them in Table VII. The own elasticity varies from -0.06 to -0.08\(^{11}\). The table also reports the cross elasticities within an education branch, same education but different level of experience, these vary from -0.014 to -0.022. Finally, the table reports the cross elasticities across education branches, this elasticity measures the impact on the relative wage of a change in a group with different education and different level of experience. These cross elasticities are between -0.009 and -0.015. As an example, consider the wage effects of a 1 percent increase in the number of post graduates who have 21-25 years of experience. The elasticities calculated for this group indicate that their own relative wage would drop by 7.5 percent, that the relative wage of other post graduates (with different levels of experience) would fall by 2 percent, and that the relative wage of all workers without a post graduate degree would fall by 1.3 percent.

V.iv. Impact of immigration on the relative wage
We use the elasticity estimates reported in Table VII to calculate the impact of immigration in the relative wage in Sweden between 2001 and 2012. We can write the marginal condition for group\((i,j)\) as \(w_{ij} = D(K,L_{11}, ..., L_{18}, ..., L_{21}, ..., L_{28}).\) Assuming that the capital stock is constant, the impact of immigration on the log of relative wage of group\((i,j)\) is

\[
(10) log \left( \frac{w_{ij}}{w_{ix}} \right) = \varepsilon_{ij,i} m_{ij} + \sum_{j \neq j} \varepsilon_{s,j} m_{sj} + \sum_{i \neq i} \sum_{j} \varepsilon_{ij,ij} m_{ij} \]

\(^{11}\)The own elasticities reported in Table VII cannot be comparable to the wage elasticity reported earlier. The regression model (1) does not use a structural approach like the CES approach used by the second model.
where $m_{ij}$ gives the percentage change in labor supply due to immigration in cell$(i,j)$. Because the size of the native labor force in each skill group is shifting over time, $m_{ij}$ is defined as

$$m_{ij} = \frac{M_{ij,2012} - M_{ij,2001}}{0.5(N_{ij,2001} + N_{ij,2012}) + M_{ij,2001}},$$

So that the baseline population used to calculate the percent increase in labor supply averages out the size of the native work-force in the skill cell and treats the preexisting immigrant population as part of the “native” stock.

Table VIII summarizes the results of this simulation. The immigrant influx between 2001 and 2012 had a negative effect on the wages; the impact was larger for the group with less experience in both educational classes. The wage of post-secondary graduates fell 3.6 percent and the one for post-graduates 3.3 percent. Overall, immigration had a negative effect on the wages by reducing them by 3.4 percent.
<table>
<thead>
<tr>
<th>Education</th>
<th>Years of experience</th>
<th>Own elasticity</th>
<th>Cross elasticity(within education branch)</th>
<th>Cross elasticity(across education branches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post secondary</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>graduates</td>
<td>1-5 Years</td>
<td>-0.0693</td>
<td>-0.0142</td>
<td>-0.0095</td>
</tr>
<tr>
<td></td>
<td>6-10 Years</td>
<td>-0.0706</td>
<td>-0.0154</td>
<td>-0.0104</td>
</tr>
<tr>
<td></td>
<td>11-15 Years</td>
<td>-0.0716</td>
<td>-0.0164</td>
<td>-0.0110</td>
</tr>
<tr>
<td></td>
<td>16-20 Years</td>
<td>-0.0722</td>
<td>-0.0170</td>
<td>-0.0115</td>
</tr>
<tr>
<td></td>
<td>21-25 Years</td>
<td>-0.0724</td>
<td>-0.0172</td>
<td>-0.0116</td>
</tr>
<tr>
<td></td>
<td>26-30 Years</td>
<td>-0.0728</td>
<td>-0.0177</td>
<td>-0.0119</td>
</tr>
<tr>
<td></td>
<td>31-35 Years</td>
<td>-0.0733</td>
<td>-0.0182</td>
<td>-0.0122</td>
</tr>
<tr>
<td></td>
<td>36-40 Years</td>
<td>-0.0737</td>
<td>-0.0186</td>
<td>-0.0125</td>
</tr>
<tr>
<td>Post graduates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-5 Years</td>
<td>-0.0718</td>
<td>-0.0167</td>
<td>-0.0108</td>
</tr>
<tr>
<td></td>
<td>6-10 Years</td>
<td>-0.0732</td>
<td>-0.0181</td>
<td>-0.0117</td>
</tr>
<tr>
<td></td>
<td>11-15 Years</td>
<td>-0.0744</td>
<td>-0.0193</td>
<td>-0.0124</td>
</tr>
<tr>
<td></td>
<td>16-20 Years</td>
<td>-0.0751</td>
<td>-0.0200</td>
<td>-0.0129</td>
</tr>
<tr>
<td></td>
<td>21-25 Years</td>
<td>-0.0753</td>
<td>-0.0202</td>
<td>-0.0131</td>
</tr>
<tr>
<td></td>
<td>26-30 Years</td>
<td>-0.0759</td>
<td>-0.0207</td>
<td>-0.0134</td>
</tr>
<tr>
<td></td>
<td>31-35 Years</td>
<td>-0.0764</td>
<td>-0.0213</td>
<td>-0.0138</td>
</tr>
<tr>
<td></td>
<td>36-40 Years</td>
<td>-0.0769</td>
<td>-0.0218</td>
<td>-0.0141</td>
</tr>
</tbody>
</table>

Equations (7)–(9) define the factor price elasticities in the three-level CES framework. For a 1 percent change in the number of workers of any specific group, the own factor price elasticity gives the percent change in that group’s relative wage; the cross elasticity within an education branch gives the percent change in the relative wage of a group with the same education but with different experience; the cross elasticity across education branches gives the percent change in the relative wage of groups that have different educational attainment.
Table VIII
WAGE CONSEQUENCES OF IMMIGRANT INFLUX BETWEEN 2001 AND 2012 (PREDICTED CHANGE IN LOG MONTHLY WAGE)

<table>
<thead>
<tr>
<th>Years of experience</th>
<th>Education</th>
<th>Post secondary graduates</th>
<th>Post graduates</th>
<th>All workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5 Years</td>
<td></td>
<td>-0.0392</td>
<td>-0.0354</td>
<td>-0.0391</td>
</tr>
<tr>
<td>6-10 Years</td>
<td></td>
<td>-0.0419</td>
<td>-0.0265</td>
<td>-0.0417</td>
</tr>
<tr>
<td>11-15 Years</td>
<td></td>
<td>-0.0348</td>
<td>-0.0349</td>
<td>-0.0349</td>
</tr>
<tr>
<td>16-20 Years</td>
<td></td>
<td>-0.0360</td>
<td>-0.0342</td>
<td>-0.0360</td>
</tr>
<tr>
<td>21-25 Years</td>
<td></td>
<td>-0.0328</td>
<td>-0.0360</td>
<td>-0.0331</td>
</tr>
<tr>
<td>26-30 Years</td>
<td></td>
<td>-0.0356</td>
<td>-0.0344</td>
<td>-0.0355</td>
</tr>
<tr>
<td>31-35 Years</td>
<td></td>
<td>-0.0348</td>
<td>-0.0308</td>
<td>-0.0344</td>
</tr>
<tr>
<td>36-40 Years</td>
<td></td>
<td>-0.0349</td>
<td>-0.0318</td>
<td>-0.0347</td>
</tr>
<tr>
<td>All workers</td>
<td></td>
<td>-0.0366</td>
<td>-0.0335</td>
<td>-0.0345</td>
</tr>
</tbody>
</table>

The simulation uses the factor price elasticities reported in Table VIII to predict the wage effects of the immigrant influx that arrived between 2001 and 2012. The calculations assume that the capital stock is constant. The variable measuring the group-specific immigrant supply shock is defined as the number of immigrants arriving between 2001 and 2012 divided by a baseline population equal to the average size of the native workforce (over 2001–2012) plus the number of immigrants in 2001. The last column and the last row report weighted averages, where the weight is the size of the native workforce in 2012.
VI. Conclusions

The analysis is based on skill groups which are defined in terms of educational attainment, work experience, county and year. Immigrations had a large effect in the wages of workers with less experience in both educational groups. The evidence in this paper suggests that immigration reduces the wage of native workers. Our estimates of the own factor elasticity vary from -0.06 to -0.08. These estimates imply that the influx of immigrant workers into the labor market has worsened the opportunities of the native workers. Between 2001 and 2012, immigration increased the labor supply by 9.5%; our analysis implies that this immigrant influx reduced the wage of the native worker by 3.4%. The wage impact differed across education groups, with wage falling by 3.6% for post-secondary graduates and 3.3% for post graduates.

Although the analysis found a negative relationship between wages and immigration, the model ignored the long-run adjustment of capital as a consequence of immigration, it also assumed a Cobb-Douglas production function and share of labor equal to 0.75 and perfect substitutability between immigrants and natives with the same education and experience. A more complex analysis should take into account the interactions between capital and labor and not only assume that capital is fixed. Relaxing the assumption of a Cobb-Douglas production function would have a different outcome; in the case of the model used the impact would be more negative. Finally, less than perfect substitutability between immigrants and natives in the same cell \((i,j)\) could be assumed to differentiate the skills from these two types of workers because experience and education acquired outside Sweden could have a different value for employers.

The findings of the impact of immigration on the relative wages of native workers should be complemented with the benefits that would arise from high-skilled immigrants. This type of immigrants could lead to technological change in Sweden and have a positive impact in the economic growth, fact that should also be considered when doing public policy.
REFERENCES


OECD. 2006. OECD Reviews of Migrant Education. Paris: OECD.


