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What drives the substitutability between native and foreign workers? Evidence about the role of language

What drives the substitutability between native and foreign workers? Evidence about the role of language*

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Abstract

This paper investigates the role of language in determining the substitutability between foreign and native workers. Our identification strategy exploits the linguistic diversity of Switzerland, a country with three main official languages (German, French and Italian) shared by bordering countries. This makes the Swiss labor market very peculiar, since both immigrants and natives may (or may not) share the language spoken in the area of residence. We modify the standard nested-cell labor demand model (as in Ottaviano and Peri, 2012) to account for the linguistic background of native and immigrant workers. We provide direct evidence about the central role of language in determining the extent of the imperfect substitutability between native and foreign workers, and their differential specialization in communication intensive jobs. Finally, we compute the total wage change caused by the recent migration inflows. In the long run, the average percentage wage change is small and not significant for both natives and foreigns, even though highly educated workers experience some negative wage effects.

Keywords: International migration, Immigrant-native substitutability, Language

JEL codes: F22, J31, J61

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1 Introduction

There is an extensive literature about the impact of migrant workers on native wages and employment opportunities.[1] A key element of the discussion is the degree of substitutability between foreign and native workers. On the one hand, if foreign workers are perfect substitutes for native workers, migration inflows should negatively affect native wages because it corresponds to an increase in the labor force of the destination country (Borjas, 2003; Borjas and Katz, 2007). On the other hand, if foreign workers are imperfect substitutes for native workers, they might specialize in different occupations and improve the efficiency of the labor market, with little effect on native wages. Ottaviano and Peri (2012) and Manacorda et al. (2012) investigate this issue extending the classic labor demand model developed in Borjas (2003) to directly account for the imperfect substitutability in production of workers within the same education-experience group. They find evidence of this imperfect substitutability and argue that native and immigrant workers with similar observable characteristics (i.e., education and experience) may still have different comparative advantages in the labor market.

One potential determinant of the imperfect substitutability between foreign and native workers may be the proficiency in the language spoken in the destination country. As shown by Peri and Sparber (2009), new migration inflows induce native workers to move from physically demanding jobs to more communicatively intensive jobs. Intuitively, this job specialization process of natives and foreigners in manual and language intensive tasks may be driven by differences in the language proficiency of these two groups of workers and indeed, low levels of language proficiency are associated with worse wage trajectories for migrants (see Dustmann and Fabbri, 2003 and Chiswick and Miller, 2014 for a review). Nevertheless, there might be several other unobservable characteristics (e.g., preferences or willingness to work in manual job) that could make immigrants and natives somewhat complementary in the production function.

In this paper we shed light on the role of language in driving the imperfect substitutability between native and foreign workers exploiting the peculiarity of the Swiss labor market. Switzerland is a multi-lingual country with four official languages spoken, three of which in common with bordering countries (German, French and Italian). Moreover, starting from the '50s Switzerland experienced several immigration waves from different countries and its foreign-born population is one of the largest among OECD countries (about 27% of working age population). Consequently, we observe both immigrants sharing the same linguistic background as the native population, and immigrants with a different linguistic background. To the same extent, since Swiss linguistic areas

[1] see Dustmann et al. (2016) and Peri (2016) for a critical review of the literature.

are geographically well-delimited, Swiss nationals that moved to other linguistic areas share the same nationality as natives but not the same language. This provides the necessary variation for our identification strategy. Differently from previous literature, we can directly identify the role of language as the channel through which immigration impacts the labor market of the destination country. To our knowledge, the only other paper investigating this issue is Lewis (2013). Using data from the US, he finds that immigrants with better language skills exhibit greater substitutability for native workers than immigrants with poor language skills. However, immigrants' language skills in the US are likely to be correlated with several other confounding factors because English represents a foreign language for most immigrants who arrive in the US. Conversely, in our setting the selection concerns are mitigated by the fact that we exploit the variation in the mother tongue of both immigrants and natives.

Our empirical analysis extends the nested-cell labor demand model developed by Ottaviano and Peri (2012, OP henceforth) to account for the role played by language. In particular, we first replicate the OP model (Model A) to estimate the elasticities of substitution between foreign and native workers. In replicating their model, we find evidence of imperfect substitutability between native and foreign workers. Then, we compare this elasticity with two alternative models encompassing workers' main language. In Model B, we assume ex-ante perfect substitutability between natives and foreigners with the same linguistic background and we group them together as opposed to foreign workers with different linguistic background. As expected, we find stronger imperfect substitutability between these two groups of workers as compared to the original OP model. In Model C, we add the linguistic background as an additional worker's characteristic to education and experience. After explicitly accounting for the linguistic background, the substitutability between nationality groups increases substantially, and perfect substitutability between foreign and native workers cannot be rejected. These results are quite robust to several robustness checks, such as the inclusion of cross-border workers and different specifications of the model (e.g., cell structure).

Interestingly, once we test whether natives and foreigners specialize in different jobs, we find evidence of native specialization in communicatively intensive jobs only in model A, i.e. without controlling for linguistic background. By contrast, if we do control for linguistic background (model C), the job specialization between foreign and native workers disappears. This suggests that the imperfect substitutability found in model A is indeed driven by different comparative advantages between foreigners and natives and that the natives' comparative advantage in more communicatively intensive tasks is driven by superior linguistic skills.

In the last part of the paper, we simulate the total wage effects of new migration inflows for the period 1999-2014 focusing on model C, which better models workers' skill mix. In the long run,

with full capital adjustment, the overall effect of immigration on wages is, by construction, zero. Nevertheless, considering the wage impact of immigration by education group we find that highly educated workers comparatively experience the most adverse impact of immigration, probably because of the large inflow of highly educated workers in the period considered. Also, we compute short run wage effects on native and foreign workers' wages subdividing the time span of our dataset into three sub-periods corresponding to migration policy changes or to changes in economic conditions. We find that the short run yearly negative impact of migration inflows on native wages increases after the enactment of the bilateral agreements with the EU on the free movement of persons in 2002, and then mitigates after the beginning of the economic crisis in 2009. Furthermore, highly educated workers bear the most adverse consequences of migration, with a yearly decrease in wages after the enactment of the bilateral agreements of 0.9% for natives and 1.5% for foreigners. Again, this can be explained by the upsurge in highly educated foreign workers that moved to Switzerland after the enactment of the bilateral agreements, especially from Germany.

The rest of this paper is organized as follows. The next section describes the Swiss context. Then, Section 3 presents the details of the theoretical framework adopted and Section 4 discusses the data. Section 5 presents the estimates of the elasticities of substitution, as well as some evidence about the role of language in determining the specialization of natives in communicatively intensive jobs and the simulated total wage effects of an inflow of foreign workers. Finally, Section 6 concludes.

2 Background

With an immigrant share of about 27% of the working age population - one of the highest rates among the OECD countries (Liebig et al., 2012) - and 4 official languages spoken in different linguistic areas, Switzerland represents the ideal setting to study the impact of immigrant language skills on labor market outcomes. The four languages spoken are German, French, Italian, and Romansh, which are respectively spoken in the Central and Eastern part, the West, the South, and some specific valleys in the South-East (Figure 1). All languages except Romansh, which is spoken by only 0.8% of the population, are in common with bordering countries.

Starting from the post-WWII period, Switzerland also experienced several immigration waves. The first immigration wave in the post-war period mainly involved Italians. Then, during the '60s, new sending countries emerged: Germany, France, Austria and Spain. In the '80s a new inflow of workers arrived from Spain, Portugal, Turkey and former Yugoslavia. The inflow of ex-Yugoslavians became particularly pronounced during the 90s, because of the Balkan wars. Finally, with the enactment of the bilateral agreements with the EU on the free movement of persons in

2002, Switzerland experienced a new wave of immigration from European countries, especially from Germany (Liebig et al., 2012).

The bilateral agreements on the free movement of persons deserve particular attention. The free movement of persons for the EU-15 and EFTA countries was first approved in 1999.[2] They allowed citizens of EU-15/EFTA member states to live and work in Switzerland with the only requirement of being employed or financially independent. Moreover, they introduced the harmonization of social security systems, the mutual recognition of professional qualifications and the right to buy properties. In 2002 the free movement of persons for EU-15/EFTA citizens started phasing in, and in 2007 the labor market barriers to workers from these countries were completely removed. After the enlargement of the European Union to Eastern European countries, in 2006 the free movement of persons for the so-called EU-8 member states started phasing in too.[3] Labor market barriers for EU-8 citizens were completely removed in 2011. Finally, in 2009 the labor market integration process started phasing in for Romania and Bulgaria. Labor market barriers for these countries were entirely removed in 2016.

Figure 2 shows the share of immigrants respectively with the same linguistic background (upper part of Figure 2) and with a different linguistic background (bottom part of Figure 2) out of total employment in 2013. Map units are spatial mobility regions, i.e. local labor markets. The share of foreign workers with the same linguistic background is higher in the Italian and in the Eastern part of Switzerland. Conversely, foreign workers with a different linguistic background are more concentrated in the Western and in the Northern part of Switzerland.[4]

3 Theoretical framework

As in OP, our baseline specification originates from a nested CES production function in which labor aggregates are defined according to workers' education, experience and nationality. Then, we investigate the role of language in driving the substitutability between native and foreign workers modifying the structure of the nested CES and re-estimating the elasticities of substitution for

[2]EU-15 member states are Austria, Belgium, Denmark, Finland, France, Germany, Great Britain, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden. EFTA member states are Iceland, Liechtenstein, Norway.

[3]EU-8 member states are Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Slovenia.

[4]However, the map about foreign workers with same linguistic background underestimates the incidence of these workers, since it only accounts for resident workers. Indeed, the phenomenon of cross-border workers, i.e. workers residing in a bordering country but daily commuting to Switzerland to work, is quite relevant in Switzerland. Further details are provided in Sections 4 and 5. On the other hand, the phenomenon of undocumented immigration does not appear to be an issue in the Swiss context. Even after the introduction of the free movement of persons, the housing market and housing tenants are closely monitored by municipal authorities and immigration policies are strictly enforced.

different models. Overall, this section provides a simple sketch of the model. The interested reader should refer to OP and Borjas (2003) for further details.

Subsection 3.1 provides an overview of the theoretical model, Subsection 3.2 presents the nesting structure of the three models we are estimating and Subsection 3.3 describes the empirical strategy adopted to estimate the relevant elasticities of substitution. Finally, Subsection 3.4 presents the intuition behind the estimation of the total wage effect of immigration.

3.1 Theoretical model

The idea behind the model proposed by OP and by prevalent models in the literature (see for instance, Card, 2001, Borjas, 2003, Card, 2009, and Manacorda et al., 2012) is that immigrant workers are direct competitors of native workers endowed with their same skill mix, but are imperfect substitutes for native workers with different skill mix. However, differently from Borjas (2003), OP allow native and foreign workers to be different production inputs within each education-experience cell. In this way, they can estimate the degree of substitutability between the two groups. Hence, starting from the aggregate production function of the economy, they subdivide the labor aggregate according to the relevant characteristics of workers (such as education, experience in the labor market, etc.).

More formally, let us assume that the economy follows a Cobb-Douglas production function:

$$Y_t = A_t L_t^{\alpha} K_t^{1-\alpha} \tag{1}$$

where output Y_t is produced combining the CES-type labor aggregate L_t and the capital aggregate K_t. A_t is total factor productivity, while α is the share of income going to labor. The subscript t indicates the time at which each of these aggregates is measured. Within a Solow model framework (Solow, 1956), the Cobb-Douglas production function predicts a constant capital-output ratio and a detrended capital-labor ratio in the long run, because capital readjusts to short term shocks in labor supply. Thus, in the long run the aggregate wage does not depend on the amount of labor supply and, consequently, the impact of immigration on wages is 0.

Now, to capture the different skill mix of native and immigrant workers, we need a partition of the labor aggregate L_t which accounts for worker heterogeneity. For instance, OP define workers' skill mix according to education, experience and nationality. Then, these workers' characteristics are ranked according to an increasing degree of substitutability. In this way, workers within the same labor aggregate are more and more homogeneous as we partition the labor aggregate in an increasing number of characteristics.

Turning to the model, we number each characteristic with $i = 1, ..., I$. Then, the M_i groups

within each characteristic are numbered with $g(1) = 1, ..., M_1$ for the first characteristic, $g(2) = 1, ..., M_2$ for the second characteristic, etc. As a result, each labor aggregate can be written as:

$$L_{g(i-1)t} = \left[\sum_{g(i) \in g(i-1)} \theta_{g(i)} L_{g(i)t}^{\frac{\sigma_i - 1}{\sigma_i}} \right]^{\frac{\sigma_i - 1}{\sigma_i}} \tag{2}$$

where $\theta_{g(i)}$ are group fixed effects and σ_i is the elasticity of substitution between labor aggregates $L_{g(i)t}$. Fixed effects are normalized such that $\sum_{g(i) \in g(i-1)} \theta_{g(i)} = 1$. The nesting order of characteristics implies that $\sigma_{i+1} > \sigma_i$.

Differentiating the production function with respect to each labor aggregate and equating it to its marginal productivity we find the optimality condition for each group g within characteristic i. As an example, the optimality condition for group g and characteristic I is:

$$\begin{aligned} \ln(\omega_{g(I)t}) = & \ln[\alpha A \kappa_t^{(1-\alpha)}] + \frac{1}{\sigma_1} \ln(L_t) + \\ & \sum_{i=1}^{I} \ln(\theta_{g(i)}) - \sum_{i=1}^{I-1} \left(\frac{1}{\sigma_i} - \frac{1}{\sigma_{i+1}} \right) \ln(L_{g(i)t}) - \frac{1}{\sigma_I} \ln(L_{g(I)t}) \end{aligned} \tag{3}$$

where $\omega_{g(I)t}$ is the wage paid to workers in group $g(I)$ at time t. κ_t is the capital-labor ratio and σ_1 is the elasticity of substitution between groups of the first characteristic. $\theta_{g(i)}$ are fixed effects for groups g, σ_i indexes the elasticities of substitution for characteristics i and $L_{g(i)t}$ are the labor aggregates corresponding to groups $g(i)$ at time t.

3.2 Nesting structure

Even though the definition of groups will be carefully explained in Section 4, this subsection provides a sketch of the nesting structure of the models we are estimating. Figure 3 shows these nesting structures. As previously mentioned, model A replicates the OP model, where workers are subdivided according to three characteristics: education, experience and nationality. However, to better tailor the model to the Swiss labor market and education system, we adopt different groupings of workers within each characteristic. Specifically, we partition labor aggregates according to three education groups (low, medium and high), two experience groups (young and old), and two nationality groups (natives and foreigners).[5] Then, to investigate the role of language in driving the substitutability between native and foreign workers, in models B and C we modify this structure. If language plays a role, foreigners with different linguistic background should be less substitutable with respect to native workers than foreigners with the same linguistic background. Thus, in model B we assume ex-ante perfect substitutability between foreigners with the same linguistic

[5]Further details on group construction are provided in Section 4.

background and natives and we group them together in the definition of nationality groups, as opposed to foreigners with a different linguistic background. Then, we attempt to control directly for the linguistic background of native and foreign workers considering the linguistic background as an additional characteristic of the workers' skill mix. As a result, in model C we further partition the labor aggregates according to the linguistic background, assuming that workers within the same linguistic background but with different nationalities are more substitutable than workers with the same nationality but a different linguistic background. Even though this assumption may be reasonable, we also test for the other possibility, i.e. that workers with the same nationality but a different linguistic background are more substitutable than workers with a different nationality and the same linguistic background.

3.3 Empirical strategy

We begin by estimating the elasticities of substitution between nationality groups. The empirical specification to be estimated can be obtained taking the ratio between the optimality conditions in Equation (3) with respect to nationality groups, i.e. foreigners and natives. Particularly, we regress the ratio of average wages against the ratio of total hours supplied by Swiss and foreign workers. Formally, we estimate the following equation:

$$\ln\left(\frac{\omega_{rFt}}{\omega_{rNt}}\right) = \psi_r + \lambda_t + \beta_{nat} \ln\left(\frac{L_{rFt}}{L_{rNt}}\right) + \varepsilon_{rt} \tag{4}$$

where r indicates the generic labor aggregate partitioning up to nationality. The coefficient β_{nat} is the inverse of the elasticity of substitution between nationality groups (i.e., $\beta_{nat} = 1/\sigma_{nat}$). This implies that the smaller the coefficient, the larger the elasticity of substitution, i.e. the substitutability between workers. ψ_r are group fixed effects and correspond to the ratio between nationality fixed effects (i.e., $\psi_r = \ln(\theta_{rF}/\theta_{rN})$). Group fixed effects should capture the differences in productivities between different education-experience-linguistic background combinations. λ_t accounts for time fixed effects and ε_{rt} is a stochastic component independent of $\ln(L_{rFt}/L_{rNt})$. Indeed, if fixed effects are correctly specified, the error term is independent of the labor aggregates, since all the endogeneity should be absorbed by group and time specific fixed effects.[6] If this assumption holds, immigration can be regarded as an exogenous shock allowing for the identification of the beta parameter (and thus, of the elasticity of substitution between nationality groups). Since fixed effects sum up to 1, they can be retrieved from the definition of ψ_r through the formulas

[6] Note that taking the ratio between the optimality conditions in Equation (3) it would be sufficient to control for group fixed effects ψ_r, since all the other terms are washed out. However, in our baseline econometric specification we prefer to include time fixed effects as well, to account for possible year-specific differential trends in wages between nationality groups.

$\theta_{rF} = \frac{\exp(\psi_r)}{1+\exp(\psi_r)}$ and $\theta_{rN} = \frac{1}{1+\exp(\psi_r)}$.

Now, we can retrieve the labor aggregate L_{rt} from Equation (2). In this way, in constructing the labor aggregates of less substitutable characteristics we account for the imperfect substitutability between workers of different nationalities. The average wages, instead, can be computed averaging the wages of different nationality groups by the share of labor provided by that group, i.e.:

$$\bar{\omega}_{rt} = \omega_{rFt}\left(\frac{L_{rFt}}{L_{rt}}\right) + \omega_{rNt}\left(\frac{L_{rNt}}{L_{rt}}\right) \tag{5}$$

Then, we can proceed to the 2SLS estimation of the other characteristic's elasticities of substitution from the optimality condition in Equation (3) instrumenting the labor aggregate L_{rt} with immigrant labor supply L_{rFt}. Again, the estimated coefficients are the inverse of the elasticities of substitution (i.e. $\beta_i = 1/\sigma_i$). This procedure is iterated up to the estimation of the elasticity of substitution across education labor aggregates.[7]

3.4 Total wage effect

The main advantage of a nested CES framework consists in the possibility to derive the total wage effect of immigration. The reduced form approach usually focuses only on a partial wage effect, i.e. the impact of foreign workers on the wage of native workers within the same education and experience group. However, an inflow of foreign workers also affects workers in different cells, because of the imperfect substitutabilities between workers with different skill mix. The nested CES structure accounts for these additional wage effects across cells, overcoming the major flaw of a reduced form approach. Particularly, let $s^i_{g(I)}$ denote the share of labor income of workers of type $g(I)$ sharing the same characteristics up to i. Then, from Equation (3) we can derive the percentage variation in wages of another group of workers $h(I)$ due to an inflow of workers in group $g(I)$.[8] Assuming that workers of type $g(I)$ and workers of type $h(I)$ share the same characteristics up to characteristic c, the percentage wage change for workers $h(I)$ can be written as:

$$\frac{\Delta\omega^0_{h(I)}/\omega^0_{h(I)}}{\Delta L_{g(I)}/L_{g(I)}} = \frac{s^0_{g(I)}}{\sigma_1} > 0, \qquad c = 0 \tag{6}$$

and

$$\frac{\Delta\omega^c_{h(I)}/\omega^c_{h(I)}}{\Delta L_{g(I)}/L_{g(I)}} = -\sum_{i=0}^{c-1}\frac{s^{i+1}_{g(I)} - s^i_{g(I)}}{\sigma_{i+1}} < 0, \qquad c = 1, ..., I \tag{7}$$

[7]Note that controlling for the correct specification of fixed effects is extremely important for the estimation of upper level coefficients, since all the terms in Equation (3) that washed out taking the ratio between nationality groups do not vanish anymore. Thus, including time fixed effects becomes now very important to account for the group-invariant terms of Equation (3) (i.e. $\ln[(1-\alpha)A\kappa_t^\alpha] + \frac{1}{\sigma_{edu}}\ln(L_t)$). In addition, group fixed effects account for the time-invariant terms (i.e. $\sum_{i=1}^{I}\ln(\theta_{g(i)})$). The fixed effects controlling for the other terms in Equation (3) (i.e. $\sum_{i=1}^{I-1}\left(\frac{1}{\sigma_i} - \frac{1}{\sigma_{i+1}}\right)\ln(L_{g(i)t})$), depend on the structure of the model chosen and are further discussed in Section 5.

[8]The interested reader can find the proof in OP.

Equation (6) implies that an inflow of workers in group $g(I)$ has a positive impact on the wages of group $h(I)$ if workers in the two groups do not share the first characteristic. In contrast, Equation (7) implies that an inflow of workers in group $g(I)$ depresses the wages of workers in group $h(I)$ if workers in group $h(I)$ share at least the first characteristic with workers of group $g(I)$. Moreover, this effect is stronger the larger the number of characteristics the two groups have in common.

To assess the total wage effect of immigration, we perform a simulation. Particularly, for each estimated elasticity parameter we take 5.000 random draws from a joint normal distribution and we compute the percentage wage change induced by the percentage increase in foreign workers in the period considered combining these simulated values with the labor income shares of each group of workers. Then, we average these percentage wage changes across random draws to obtain the average wage effect and the standard deviation for each experience-education-linguistic background group. Finally, average wage effects and standard errors are aggregated at higher levels using the appropriate wage shares. A detailed description of the method adopted is provided in Appendix A.

Long run and short run wage effects

An inflow of foreign workers may divert the capital-labor ratio from its long run trend. In the standard Solow (1956) model the capital-labor ratio is assumed to grow at a positive constant rate. However, immigration inflows decrease the capital-labor ratio, causing the marginal productivity of capital to increase. In the long run, the greater investments in capital will bring the capital-labor ratio back to its original growth path. Thus, the aggregate impact of labor inflows on wages is zero in the long run because of capital readjustment. However, in the short run there could be some negative effects due to a sluggish capital response to labor inflows. In our simulation we present two alternative scenarios. The first scenario shows the long run effects of immigration, assuming full readjustment of capital. The second scenario shows the effects in the very short run, assuming fixed capital. Since immigration is not an unpredictable shock in time and investors continuously respond to labor inflows, this latter assumption may be too strict. However, the simulated wage effects in the second scenario may be considered as a lower bound of the true wage impact of immigration. Greater details are provided in Appendix A.

4 Data

In this section we discuss the major data issues, while the details are left to Appendix B. Data are drawn from the Swiss Labor Force Survey (SLFS) for the period 1999-2014. We restrict the dataset to people aged 18 or above with active working status and remunerated work in the previous week. We also drop individuals in military service or in education. Our sample size

prior to collapsing by cell consists of 358,065 observations. Given the large number of cells (192 year-education-experience-nationality cells in model A and B and 384 year-education-experience-linguistic background-nationality cells in model C) we prefer to report the main estimates without further partitioning by gender. Separate results for men and women are available in Appendix C.

A serious limitation of the SLFS is the lack of cross-border workers, who represent a non-negligible share of foreign workers. Particularly, in the Swiss labor market there are around 300,000 cross-border workers, representing roughly 8% of total employment and 23% of foreign workers. In Appendix C we perform a robustness check complementing the SLFS data with data coming from the Swiss Earning Structure Survey (SESS), a biannual survey administered to approximately 35,000 firms about the earnings of employees in the secondary and tertiary sectors, including cross-border workers. The results are in line with our main findings and are further discussed in Section 5.

Finally, to understand whether workers with different linguistic backgrounds specialize in different occupations, we exploit the information contained in the O*NET database. O*NET is a database developed for the US containing a detailed description of the skills required by each type of job. Particularly, for every occupation a score between 0 and 100 is assigned to each skill, according to experts' judgement. This score corresponds to the importance of that skill to perform the job. Following Peri and Sparber (2009), we derive a measure of the communication content of each occupation averaging the importance scores of four basic communication skills (Oral and Written Comprehension, Oral and Written Expression). To the same extent, we define an extended measure of communication skills including cognitive, analytical and vocal skills in addition to the four basic skills listed above. More details on the construction of these measures are available in the Appendix B.

The following two subsections describe the construction of cells, wage and labor aggregates using data from the SLFS. Then, Section 4.3 presents some descriptive statistics.

4.1 Cell construction

Given the structure of the Swiss education system, we subdivide workers according to three education groups. In the first group we include workers that only completed compulsory education or basic vocational training. In the second group we include workers with full vocational training, high school diploma, or tertiary vocational training. Finally, in the third group we include workers with college education.

Then, we subdivide individuals according to their potential experience in the labor market. Particularly, we group them into two groups, young and old. Potential experience is computed as

the difference between the individuals current age and the age at which they should have completed education.[9] We define workers with up to 15 years of experience as "young" and workers with more than 15 years of experience as "old". People with zero or more than 40 years of experience are left out of the sample. While OP adopt a specification with 8 experience groups, in the present context partitioning workers into such a large number of experience cells leads to implausible high estimates of the elasticity of substitution between experience groups with respect to the existing literature, suggesting almost no role for experience. On the contrary, grouping workers into two experience cells results in estimates of the elasticity of substitution between experience groups which are in line with the previous literature. Further discussion on this issue and some sensitivity analysis are provided in Section 5.3.

Nationality cells are defined according to citizenship. People with Swiss citizenship are defined as Swiss, while people with non-Swiss citizenship are defined as non-Swiss.[10]

Finally, linguistic background cells are defined according to the main language spoken by the individual. The main language spoken by Swiss citizens is inferred by the language in which the questionnaire has been completed. The languages available to complete the questionnaire are German, French and Italian. For simplicity, we drop individuals living in Romansh-speaking areas from the sample (less than 930 individuals out of around 360,000). Swiss citizens that decide to complete the questionnaire in a different language from the main language spoken in the area of residence are counted as "different linguistic background". They are counted as "same linguistic background" otherwise. To the same extent, the main language spoken by foreigners is inferred from the official languages of their country of citizenship and foreigners are assigned to linguistic background cells accordingly. The specific nationalities included in each linguistic group are listed in Appendix B.4.

4.2 Wage and labor aggregates

We focus on the number of hours actually provided the week before (as opposed to the number of hours defined by contract) and we drop from the sample individuals with missing values or zero hours worked. Then, we multiply the hours worked by each individual by his personal weight and we sum up the number of weighted hours by cell.

[9] We assume that people with compulsory education entered in the labor market at age 14, people with basic vocational training entered at age 16, people with apprenticeship or full time vocational training at age 18, people with high school diploma at age 19, people with tertiary vocational training at age 22 and people with college education at age 24.

[10] Indeed, OP define nationality according to the country of birth. However, given that in the SLFS the information about country of birth is available only from 2004 onwards, we decide to adopt the definition of nationality according to citizenship in order to increase the number of observations available. Swiss citizens with double citizenship are considered as Swiss. More details are provided in the Appendix B.3.

To compute the average weekly wage by cell we divide annual net income by 52 and we drop observations with income equal to zero.[11] Also, we trim 1% of the observations at the top and at the bottom of the income distribution. Then, we obtain real wages adjusting nominal wages according to the price consumer index. Finally, we average wages by cell weighting each observation by the number of hours worked times the personal weight.[12]

4.3 Descriptive statistics

Table 1 lists the 5 most represented nationalities among immigrants with the same linguistic background and immigrants with different linguistic background in the SLFS, while Figure 4 shows the evolution of average wages over time for the Swiss and for foreigners distinguished by linguistic background. For low educated workers, wages of immigrants with different linguistic background are quite in line with natives' wages. For middle educated workers, instead, immigrants with a different linguistic background seem to lag behind as compared to Swiss workers and foreign workers with the same linguistic background. Finally, for the highly educated, wages seem to be quite aligned for all the three categories with some convergence over time across the three groups. It is worth noting that the three education groups do not show large differences in their long term trends. At most, the trend in wages for low educated workers seems less steep than the trends for middle and highly educated workers.

Table 2 shows the percentage variation in native wages and in hours worked due to foreign workers between 1999 and 2014 by education, experience and linguistic group. In the period considered, there is a marked increase in hours worked due to foreign workers for highly educated workers and a decrease for low educated workers. The increase in highly educated workers is mainly due to the enactment of the bilateral agreements on the free movement of persons in 2002, which is also reflected in the variation of natives' real wages. Indeed, natives' real wages increase for all groups, with almost no exception. However, the increase in wages is less pronounced among those groups that experienced the largest inflow of foreign workers, i.e. the highly educated.

Finally, to understand how communication intensive jobs are distributed between workers with same and different linguistic background, Table 3 provides the average scores for the two measures of communication skills defined. As expected, workers with the same linguistic background perform jobs with a higher communication content with respect to workers with a different linguistic background. Interestingly, this is true also for natives, even though the differences between the average scores are smaller than for foreigners. This suggests that even though natives that decide

[11] In the SLFS there is no information about the number of weeks worked in a year.

[12] Since in Switzerland part-time jobs are widespread, differently from OP we do not restrict the sample to full-time workers. Indeed, restricting the sample to people working 30 hours per week or more reduces our sample size by 25%.

to move to other linguistic areas may have a superior knowledge of the language of destination than non-movers, there are still differences in the linguistic content of their jobs with respect to (local) natives with the same linguistic background. Indeed, a mean comparison test between natives and foreigners with same and different linguistic background always rejects the null of equal means in the communication content of jobs.[13]

5 Results

We begin by estimating the elasticity of substitution between nationality groups for our three models A, B, and C. Table 4 presents the estimated coefficients ($\beta_{nat} = 1/\sigma_{nat}$). To correctly interpret the results, recall that in these models an elasticity of substitution σ_{nat} close to ∞ corresponds to perfect substitutability, while smaller values of σ_{nat} reveal the presence of imperfect substitutability. For each model we present two specifications that differ in the fixed effects included. Particularly, in the first specification we only include group and time fixed effects, while in the second specification we also include time by education fixed effects. These effects capture possible systematic differences in wage trends across education groups.[14]

In model A, our benchmark model based on OP, the inclusion of time by education fixed effects substantially improves the precision of the estimates, leading to a negative and statistically significant coefficient of -0.091. This value corresponds to an elasticity of substitution, σ_{nat}, around 11 and is smaller than the elasticity of substitution estimated by OP using the US Census. Indeed, they find an elasticity of substitution of around 20. However, Manacorda et al. (2012), using data from the UK Labor Force Survey, find an elasticity of substitution between nationality groups of around 7. Since the data used by Manacorda et al. (2012) are much more similar to our data with respect to the data used by OP, we can conclude that our result is quite in line with previous literature and that native and foreign workers are fairly imperfect substitutes in the Swiss labor market. As suggested by Peri and Sparber (2009), this imperfect substitutability may be driven by residual differences in the actual skill mix of immigrant and native workers which induce them to specialize in different occupations. In models B and C we are going to test how the linguistic background affects this imperfect substitutability while we explicitly test which is the role of language in determining the specialization of workers in different occupations in Section 5.1.

[13] We perform two different types of mean comparison tests. The first one is unconditional, while in the second one we also control for sex, experience, and education. In all cases the null of equal means for natives and foreigners with same and different linguistic background is always rejected. Also, controlling for foreigners of European origin does not change the test results.

[14] Following Borjas et al. (2008) we also include experience by time fixed effects in models A and B and experience by time and linguistic background by time fixed effects in model C. Results are qualitatively similar and are not reported here.

In model B natives and foreigners with the same linguistic background are grouped together as opposed to foreigners with a different linguistic background. If language plays a role in determining the substitutability between native and foreign workers we expect larger coefficients with respect to model A, i.e. lower substitutability between foreigners with a different linguistic background and the other groups of workers. Indeed, the estimated coefficients are larger than those estimated in Model A and range between -0.143 and -0.168. These values correspond to an elasticity of substitution between 6 and 7, pointing towards a non-negligible role of language in determining the imperfect substitutability between nationality groups.

Finally, including the linguistic background as an additional workers' characteristic (model C) leads the estimated coefficients to become very close to zero (between -0.015 and -0.01). Particularly, once we add time by education fixed effects the null hypothesis of a zero coefficient, i.e. perfect substitutability, cannot be rejected. However, even in the more parsimonious specification, the elasticity of substitution between nationality groups scores above 60, which is 5 times larger than the elasticity of substitution found in model A. Overall, these results underscore the importance of language in driving the substitutability between foreign and native workers.

In the following tables we report the elasticities of substitution for the other relevant characteristics, i.e. linguistic background, experience and education. The only model in which workers are grouped according to their linguistic background is model C. The elasticities of substitution between linguistic background groups are reported in Table 5. The coefficient obtained when we control for group and time fixed effects (Column (1)) corresponds to an elasticity of substitution of 12. This value is fairly similar to the elasticity of substitution between nationality groups in model A, reinforcing the idea that the main driver of the imperfect substitutability between Swiss and foreign workers is the language spoken. However, in this model the inclusion of education by time fixed effects leads to a weak instrument problem. Indeed, given the low variation over time in the hours supplied by workers in the middle education group, education by time fixed effects absorb all the variation in the first stage regression, invalidating the 2SLS estimates. Thus, we decide to include a third less demanding specification, replacing group fixed effects with education, experience and linguistic background fixed effects. We also add linguistic background by education fixed effects (Column (3)). Note that the magnitude of this coefficient is similar to the magnitude of the coefficient in Column (1).

Table 6 shows the estimated coefficients between experience groups for all the three models. Since the inclusion of education by time fixed effects leads to large standard errors, consistently with Figure 4 we also include a less demanding specification that allows the education groups to differ only for a linear trend. In any case, the results are fairly similar across the three models. For

instance, if we consider the specification adding time by education fixed effects as the benchmark, model A predicts an elasticity of substitution between experience groups of 7 while models B and C predict an elasticity of 8.

Finally, Table 7 presents the estimates for the elasticity of substitution across different education groups. Since we are working with 48 observations, we do not have sufficient degrees of freedom to include education by time fixed effects.[15] Thus, as in the previous table, we only control for education specific time trends. Again, the results across the three models are very similar, implying an elasticity of substitution across education groups of around 4.

It is also interesting to look at the degree of imperfect substitutability between linguistic groups holding workers' nationality fixed. In other words, we invert the order between linguistic background and nationality characteristics in model C. Although this nesting structure is misspecified, this result can still be informative about the determinants of workers' substitutability.[16] Table C.1 in Appendix presents the results. The estimated coefficients are always larger than the coefficients estimated for models A and C in Table 4, suggesting that workers with the same nationality but a different linguistic background are rather imperfect substitutes, with an elasticity of substitution between 6 and 10. This result, again, reinforces the idea that language plays an essential role in determining the imperfect substitutability between workers, even between workers of the same nationality.

5.1 Job specialization

So far we show the importance of the linguistic background in determining the elasticity of substitution between native and foreign workers. In this section we investigate whether workers with a different linguistic background still specialize in different types of jobs. To this end, we focus on the communication skills required by each job and we perform the following regression:

$$\ln\left(\frac{C_{rFt}}{C_{rNt}}\right) = \psi_r + \lambda_t + \beta \ln\left(\frac{L_{rFt}}{L_{rNt}}\right) + \varepsilon_{rt} \tag{8}$$

where C_{rFt} and C_{rNt} are respectively the average communication skills required by foreign and native workers' jobs.[17] As before, ψ_r and λ_t are group and time fixed effects, while L_{rFt} and L_{rNt} are the hours of labor provided by foreigners and natives. Note that this is the same regression as in Equation (4) but we replace the dependent variable with a measure of the average communication

[15] We are controlling for 16 year fixed effects and 3 education fixed effects.

[16] Since the elasticity of substitution between linguistic background groups is smaller than the elasticity of substitution between nationality groups, this model specification is incorrect. In a robust specification of the model, workers' characteristics should be ordered according to increasing degree of substitutability.

[17] Further details on the construction of this variable are provided in Appendix B.8.

skills. If natives and foreigners specialize in different types of jobs we expect an inflow of foreign workers to decrease the foreign-to-native ratio in communication skills. Thus, we compare the regression results in model A, that does not account for the linguistic background, with the regression results in model C, that explicitly controls for the linguistic background. If job specialization is driven by different linguistic skills we expect the estimated coefficients in model C to be smaller in magnitude than the estimated coefficients in model A.

Table 8 shows the results. All the estimates have the expected sign. In particular, the estimated coefficients in model C are smaller in magnitude than those estimated in model A and not statistically different from zero. Thus, the differential job specialization between foreign and native workers disappears after controlling for the linguistic background. Results are also robust to the extended definition of communication skills (see Table C.2 in Appendix).

5.2 Simulated total wage effects

In this section we present the simulated total wage effects of new immigration flows. In doing this, we focus on model C, that better captures the different skill mix of workers. As discussed in Section 3.4, we use the estimated elasticities of substitution as key parameters of joint normal distributions and we simulate the wage effects averaging percentage wage changes over 5,000 random draws.[18]

Table 9 reports the simulation results. In the first column we report long run estimates for the whole period under investigation, i.e. 1999-2014. Panels A and B of Table 9 present the wage effects respectively for native and foreign workers. Each panel reports the overall wage effect and the wage effects by education group. Since new immigrants are assumed to be perfect substitutes for previous immigrants, previous immigrant workers bear the most adverse consequences of immigration, even though the average wage impact for foreigners is not significant. Interestingly, even in the long run, highly educated workers seem to be negatively affected by the large migration inflow of highly educated workers. However, the wage effects on low and middle educated workers are small and positive.

The last three columns of Table 9 report short run simulation results for three sub-periods: before the enactment of the bilateral agreements on the free movement of persons (years 1999-2001), between the enactment of the bilateral agreements and the beginning of the economic crisis (years 2002-2008) and after the start of the economic crisis (years 2009-2014). These effects are not directly comparable with the long run estimates in the first column of Table 9. However, they represent the lower bound wage impacts of migration inflows within the three sub-periods of interest.

[18] Particularly, we plug into the normal distributions a value of $1/\sigma$ equal to 0.01 for nationality groups, 0.079 for linguistic background groups, 0.123 for experience groups and 0.244 for education groups.

Moreover, since these three sub-periods differ in length, it is useful to compare yearly wage effects, computed as the reported coefficients divided by the number of years in the sub-period. The wage impact of immigration flows is particularly large after the enactment of the bilateral agreements with the EU (Column 3), especially for highly educated workers. Indeed, between 2002 and 2008 the large inflow of highly educated workers negatively affected the wages of highly educated native workers by 0.9% per year and the wages of highly educated foreign workers by 1.5% per year. We also find some negative effects on low educated workers, but the impact is smaller in magnitude (-0.2% per year for natives and -0.3% per year for foreigners). Nevertheless, these effects mitigate in the aftermath of the economic crisis (Column 4).

5.3 Robustness checks

Tables C.3-C.6 in Appendix present the estimated coefficients separately for men and women. For men, the elasticities between nationality groups are slightly smaller than those for the pooled sample, while the estimated elasticities for women are seldom significant. This could be due to the peculiar structure of the Swiss labor market, where the female participation rate is rather high (about 80% in 2015 according to OECD estimates), but where about 45% of women work part-time (less than 30 hours worked per week) (OECD, 2016a). The elasticities of substitution between groups for higher level characteristics are often positive for women, suggesting that the cell specification adopted for the pooled sample may not be appropriate for women alone. For men, the elasticities of substitution between linguistic background, experience and education groups show negative coefficients. However, in many cases the first stage F-statistic is very low, suggesting a weak instrument problem. Moreover, where the F-statistic is particularly low, the estimated elasticities of substitution are also implausibly low. As a result, pooling together men and women is particularly important to increase the predictive power of the instrument and the precision of our estimates.

Another possible source of bias in our estimates is the omission of cross-border workers in SLFS data. To test the robustness of our estimates to the inclusion of cross-border workers, we use data from the SESS, which is a biannual survey with no information about the nationality of immigrants. We assume that cross-border workers have the same linguistic background as native workers and we linearly interpolate the missing years. Since this imputation procedure may affect the consistency of the results, the estimated coefficients should be interpreted with caution. Table C.7 in Appendix shows the elasticities of substitution between native and foreign workers. The estimated coefficients are slightly smaller but substantially unchanged across the three models.

Since in these models workers' characteristics are ordered according to an increasing degree of

substitutability, we also provide a robustness check inverting the order of experience and linguistic background characteristics in model C. Results are presented in Table C.8. To overcome the weak instrument problem, in Column (4) and (6) we report the estimated coefficients controlling for education, linguistic background and/or experience fixed effects separately rather than controlling for group fixed effects. However, the coefficients for linguistic background groups are not satisfactory. Overall, these results suggest that the original specification of model C should be preferred.

Then, we also provide some sensitivity analysis about the definition of experience groups. The upper part of Table C.9 shows the estimated coefficients with 8 experience groups for model A.[19] The estimated elasticities of substitution between different experience groups are implausibly high, as there are no similar results in the literature. Moreover, given the large number of cells and the high substitutability between experience groups, the coefficients for nationality groups are not significant anymore. Thus, we re-estimate the model defining experience groups according to terciles, i.e. three experience cells with the same number of observations. The first tercile corresponds to people with less than 15 years of experience, the second tercile corresponds to people between 15 and 25 years of experience and the third tercile corresponds to people between 26 and 40 years of experience. The bottom part of Table C.9 shows the coefficients estimated adopting this group specification. Again, the coefficients for nationality are not significant and the elasticities of substitution for experience groups are still implausibly high. Thus, since median workers in the second and the third experience terciles should differ much less in terms of acquired skills with respect to the median worker in the first tercile, in the main analysis we decide to group together the second and the third terciles.

With respect to education groups, we try to understand how their definition impacts the final results. To do so we first group together middle and highly educated workers. Then, we replicate the analysis grouping together low and middle educated workers. Table C.10 shows the elasticities of substitution between nationality groups in the three models with these different definitions of education groups. Indeed, results grouping middle educated workers together with highly educated workers are very similar to the results in the main specification. On the other hand, grouping middle educated workers together with low educated workers makes all the estimates very imprecise and not significant. This suggests that middle educated workers better substitute highly educated workers than low educated workers. For the sake of conciseness, we do not report the coefficients for linguistic background, experience or education. However, in both cases these elasticities are much more imprecise, suggesting that the specification with three different groups is the most appropriate one.

Finally, we replicate the analysis constructing labor aggregates using contract hours or employ-

[19]Results for models B and C are similar and are not reported.

ment instead of the actual number of hours worked the week before. Since results are qualitatively similar, they are not reported here.

6 Conclusion

This paper investigates the role of language in determining the substitutability between foreign and native workers. To this end, we exploit the linguistic diversity of Switzerland and we modify the model proposed by Ottaviano and Peri (2012) to account for the linguistic background of immigrants and natives. The main advantage of the Swiss context is that we can compare the labor market outcomes of natives and foreigners with a different linguistic background.

The results confirm the importance of language in determining the substitutability between native and foreign workers. After accounting for the linguistic background, the elasticity of substitution between foreign and native workers dramatically increases, approaching perfect substitutability. Moreover, the native workers' specialization in more communicatively intensive jobs disappears. Overall, immigrant workers sharing the linguistic background of the incumbent population are potentially perfect substitutes for natives, while natives with a different linguistic background are not, as well as foreigners with a different linguistic background. This result may be surprising if we think that most variation in our data comes from high-skill foreign workers from neighboring European countries.

Finally, we exploit the nested CES structure to compute the total impact of immigration on wages. The wage effects of migration for the period 1999-2014 are small and not significant in the long run (+0.6% for natives and −2.4% for foreigners). In computing short run effects we subdivide the time horizon under consideration in three sub-periods and we simulate the percentage wage changes separately for each of them. We find that only highly educated workers experienced some adverse wage effects from the recent migration inflows. This negative effect was larger after the enactment of the bilateral agreements (years 2002-2008) while it decreased after the burst of the economic crisis (years 2009-2014). Paradoxically, these results suggest that the inflow of high educated workers from neighboring countries who share the natives' linguistic background may have reduced the level of wage inequality across education groups, or at least mitigated the labor market trends observed in many developed economies showing an increasing level of wage inequality over time (e.g., Acemoglu and Autor, 2011).

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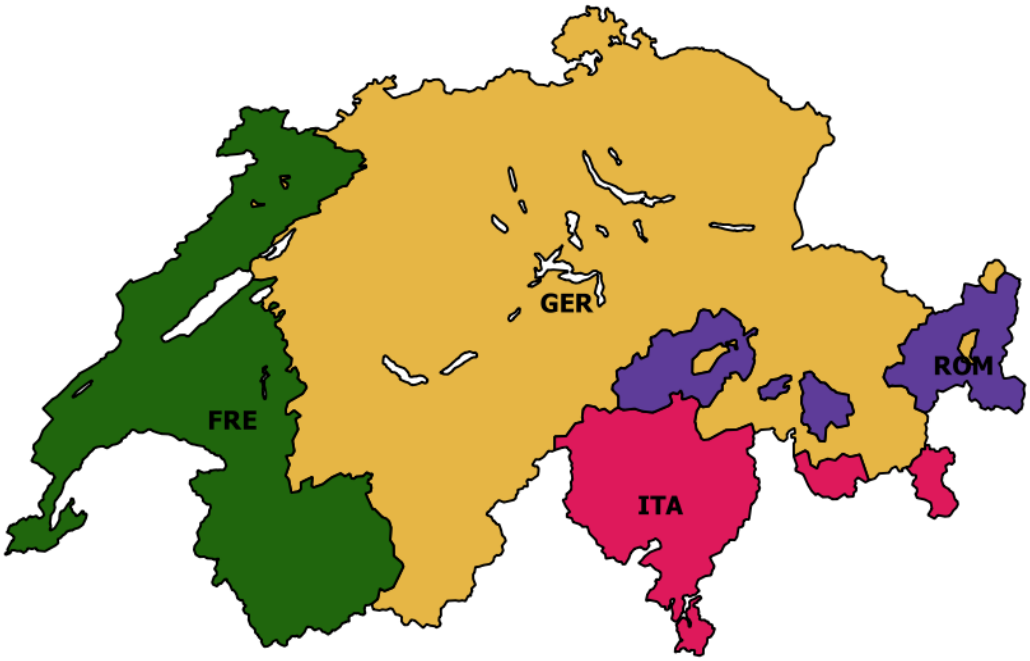
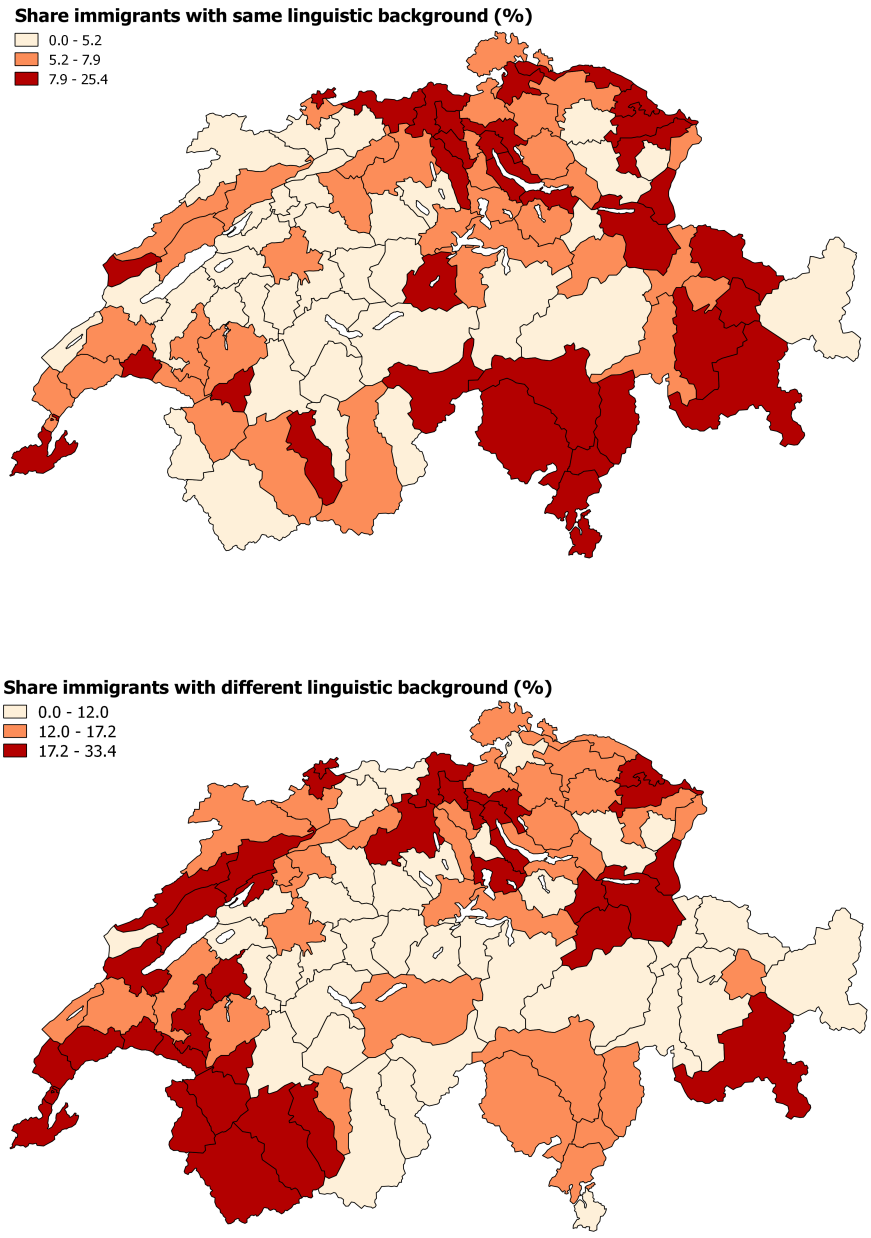
Figure 1: Linguistic areas across Switzerland



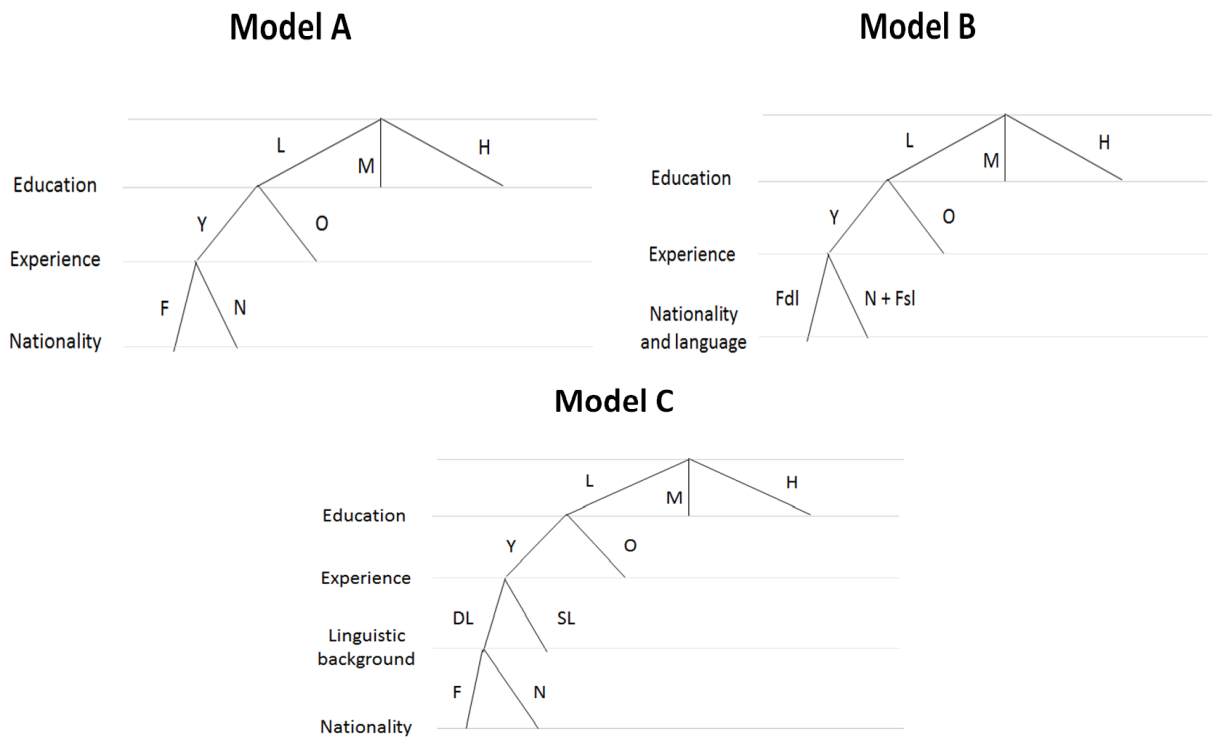
Notes - Colors correspond to different linguistic areas. Green corresponds to the French speaking area, brown to the German speaking area, purple to the Italian speaking area, and violet to the Romansh speaking area. Linguistic areas: FRE - French; GER - German; ROM - Romansh; ITA - Italian.
Sources: ©OFS, ThemaKart.

Figure 2: Incidence of immigrants with same and different linguistic background out of total population by spatial mobility region



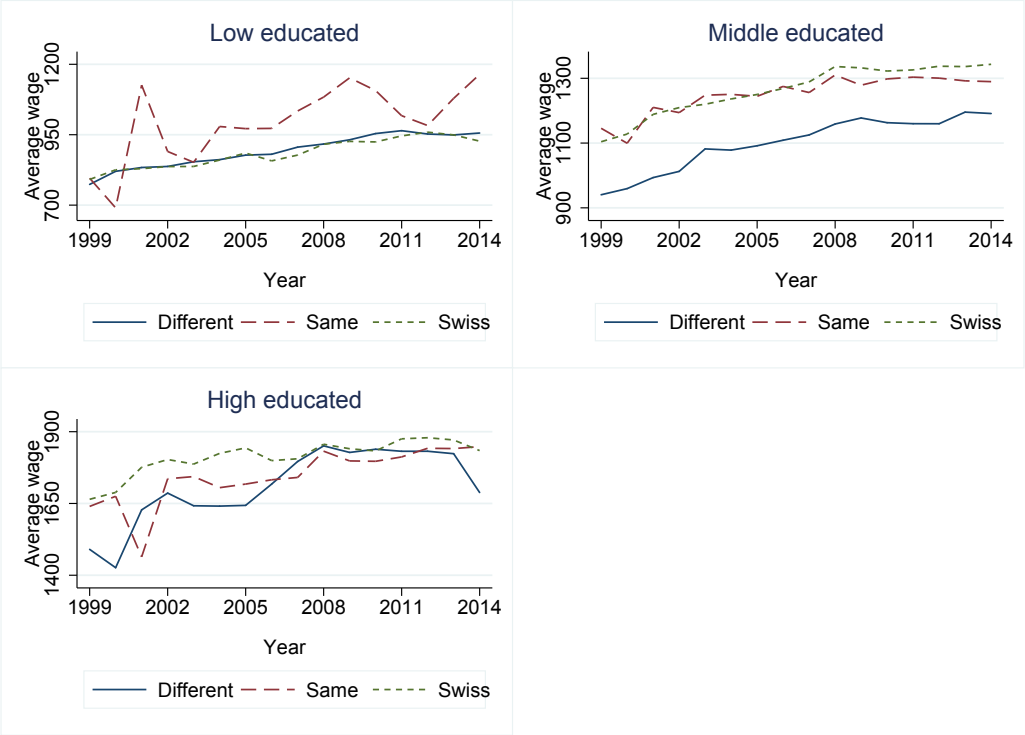
Notes - Share of immigrants with same and different linguistic background out of total population by spatial mobility region. Individuals are classified as foreigners if they do not have Swiss citizenship. Foreign workers are considered of different linguistic background if their country of citizenship has a different official language with respect to the language spoken in the linguistic area of residence in Switzerland. They are considered of same linguistic background otherwise. The number of immigrants and resident popualtion by spatial mobility region are obtained summing up individual weights. Intervals depicted in different colors correspond to terciles.
Sources: Base maps: ©OFS, ThemaKart; Data: SLFS - year 2013.

Figure 3: A comparison of the three models



Notes - Education groups are defined as: *Low education (L):* Compulsory education, elementary vocational training, household work, school for general education; *Middle education (M):* Apprenticeship, full-time vocational training, high school education, tertiary vocational training; *High education (H):* College education. Experience groups are defined as: *Young (Y):* up to 15 years of potential experience in the labor market; *Old (O):* Between 16 and 40 years of potential experience in the labor market. Linguistic background types are defined as: *Different linguistic background (DL)*; *Same linguistic background (SL)*. Nationality groups are defined as: *Foreigners (F)*; *Swiss Nationals (N)*. In model B the nationality groups are defined as: *Foreigners with different linguistic background (Fdl)*; *Swiss nationals (N); Foreigners with same linguistic background (Fsl)*.

Figure 4: Evolution of average wages by education, nationality and linguistic background



Notes - Real wages are obtained after inflating nominal wages by the consumer price index. Weekly wages are obtained dividing yearly wages by 52, since the SLFS does not contain any information on the number of weeks worked in a year. Observations are weighted by the number of hours worked multiplied by personal weights. The first and the last percentile of the wage distribution are trimmed. Individuals are classified as foreigners if they do not have Swiss citizenship. Foreign workers are considered of different linguistic background if their country of citizenship has a different official language with respect to the language spoken in the linguistic area of residence in Switzerland. They are considered of same linguistic background otherwise. Education groups are defined as: *Low education:* Compulsory education, elementary vocational training, household work, school for general education; *Middle education:* Apprenticeship, full-time vocational training, high school education, tertiary vocational training; *High education:* College education.
Sources: SLFS - years 1999-2014.

Table 1: List of nationalities by linguistic background

Same linguistic background			Different linguistic background		
Nationality	Observations	Obs X Personal weights	Nationality	Observations	Obs X Personal weights
Germany	24,624	1,720,114	Italy	22,103	1,967,797
France	6,872	599,985	Portugal	13,184	1,464,644
Italy	6,194	322,429	Spain	6,249	628,959
Austria	3,090	252,010	Kosovo	5,762	481,583
Belgium	739	60,848	Turkey	3,987	442,183
Other	1,280	132,640	Other	44,446	4,127,415
Total	**42,799**	**3,088,026**	**Total**	**95,731**	**9,112,531**

Notes - Individuals are classified as foreigners if they do not have Swiss citizenship. Foreign workers are considered of different linguistic background if their country of citizenship has a different official language with respect to the language spoken in the linguistic area of residence in Switzerland. They are considered of same linguistic background otherwise.

Table 2: Percentage changes in natives' real wages and in hours worked due to foreign workers

Education group	**Experience group**	**Linguistic group**	**% change natives real wages**	**% change in hours worked due to foreign workers**
Low	Young	Different language	33.4 %	-6.9 %
		Same language	4.5 %	-3.9 %
	Old	Different language	-9.9 %	-10.9 %
		Same language	23.0 %	-3.9 %
Middle	Young	Different language	23.3 %	-8.7 %
		Same language	20.8 %	1.1 %
	Old	Different language	19.8 %	33.2 %
		Same language	20.2 %	0.5 %
High	Young	Different language	13.6 %	216.4 %
		Same language	7.0 %	27.8 %
	Old	Different language	5.1 %	223.8 %
		Same language	8.5 %	33.3 %

Notes - Percentage changes refer to the period 1999-2014. The percentage change in natives' real wages is the variation in natives' real wages out of natives' real wages in 1999. The percentage change in hours worked due to foreign workers is the variation in hours worked by foreign workers out of overall hours worked in 1999.

Table 3: Average intensity in communication skills by nationality and linguistic background groups

	Same linguistic background	Different linguistic background	t-test P-value
		Foreigners	
Communication skills (C)	68.30	60.17	0.000***
Extended comm. skills	58.15	51.84	0.000***
		Natives	
Communication skills (C)	66.13	65.44	0.000***
Extended comm. skills	55.94	55.42	0.000***

Notes - Importance scores for communicative skills come from the O*NET database. Since occupations in the O*NET database are defined in terms of the Standard Occupational Classification (SOC), we converted them in the International Standard Classification of Occupations (ISCO-08) using the appropriate crosswalk. Then, we assign the scores to each individual in the SLFS according to the 4-digit ISCO-08 codes. Communication skills C are the average importance scores of written and oral expression and written and oral comprehension. The extended definition of communication skills is described in Appendix B.8. Average scores by nationality and linguistic background are aggregated weighting individual observations by hours worked times personal weight. Individuals are classified as foreigners if they do not have Swiss citizenship. Foreign workers are considered of different linguistic background if their country of citizenship has a different official language with respect to the language spoken in the linguistic area of residence in Switzerland. They are considered of same linguistic background otherwise. The p-value refers to a mean comparison test without controls. The mean comparison test is also robust to the inclusion of education, experience, gender and a dummy variable for European foreigners.

Table 4: Estimated coefficients for nationality groups

	Model A		Model B		Model C	
Column	(1)	(2)	(3)	(4)	(5)	(6)
Log of hours worked	-0.030	-0.091***	-0.143***	-0.168***	-0.015*	-0.010
	(0.04)	(0.02)	(0.03)	(0.01)	(0.01)	(0.01)
Observations	96	96	96	96	191	191
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Group fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time by education FE	No	Yes	No	Yes	No	Yes

Notes - Fixed effect estimates. Model A: Group fixed effects are the interaction of education and experience fixed effects. The estimates are weighted by the ratio between the number of foreign workers and the number of native workers by cell. Model B: Group fixed effects are the interaction of education and experience fixed effects. The estimates are weighted by the ratio between the number of foreign workers with different linguistic background and the number of native workers and foreign workers with the same linguistic background by cell. Model C: Group fixed effects are the interaction of education, experience and linguistic background fixed effects. The estimates are weighted by the ratio between the number of foreign workers and the number of native workers by cell. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust and clustered at group level.

Table 5: Estimated coefficients for linguistic background groups

	Model C		
Column	(1)	(2)	(3)
Log of hours worked	-0.079***	-0.471	-0.086**
	(0.01)	(0.44)	(0.04)
Observations	191	191	191
Kleibergen-Paap F	15	1	59
Group fixed effects	Yes	Yes	No
Year fixed effects	Yes	Yes	Yes
Time by education FE	No	Yes	Yes
Linguistic, exp. and educ. FE	No	No	Yes
Linguistic by education FE	No	No	Yes

Notes - IV estimates using the logarithm of the number of hours provided by foreign workers as an instrument for the logarithm of the number of hours provided. All the estimates are weighted by the number of workers in each education-experience-linguistic background cell. Group fixed effects are the interaction of education, experience and linguistic background fixed effects. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust and clustered at group level.

Table 6: Estimated coefficients for experience groups

	Model A			Model B			Model C		
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log of hours worked	-0.063***	-0.133**	-0.155*	-0.061***	-0.114*	-0.137	-0.052***	-0.112**	-0.123**
	(0.01)	(0.06)	(0.09)	(0.01)	(0.06)	(0.09)	(0.01)	(0.05)	(0.06)
Observations	96	96	96	96	96	96	96	96	96
Kleibergen-Paap F	155	16	51	235	43	170	199	19	182
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Group fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Education time trends	No	Yes	No	No	Yes	No	No	Yes	No
Time by education FE	No	No	Yes	No	No	Yes	No	No	Yes

Notes - Models A and C: IV estimates using the logarithm of the number of hours provided by foreign workers as an instrument for the logarithm of the number of hours provided. Model B: IV estimates using the logarithm of the number of hours provided by foreign workers with different linguistic background as an instrument for the logarithm of the number of hours provided. All the estimates are weighted by the number of workers in each education-experience cell. Group fixed effects are the interaction of education and experience fixed effects. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust and clustered at group level.

Table 7: Estimated coefficients for education groups

Column	Model A	Model B	Model C
Log of hours worked	-0.272***	-0.214**	-0.244**
	(0.10)	(0.11)	(0.10)
Observations	48	48	48
Kleibergen-Paap F	10	8	12
Education fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Education trends	Yes	Yes	Yes

Notes - Models A and C: IV estimates using the logarithm of the number of hours provided by foreign workers as an instrument for the logarithm of the number of hours provided. Model B: IV estimates using the logarithm of the number of hours provided by foreign workers with different linguistic background as an instrument for the logarithm of the number of hours provided. All the estimates are weighted by the number of workers in each education cell. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust to heteroskedasticity.

Table 8: Job specialization according to communication skills - Models A and C

	Model A		Model C	
Column	(1)	(2)	(3)	(4)
Log hours worked	-0.029**	-0.040**	-0.014	-0.010
	(0.01)	(0.01)	(0.01)	(0.01)
Observations	96	96	192	192
Year fixed effects	Yes	Yes	Yes	Yes
Group fixed effects	Yes	Yes	Yes	Yes
Time by education FE	No	Yes	No	Yes

Notes - Fixed effect estimates. All the estimates are weighted by the ratio between the number of foreign workers and the number of native workers by cell. Model A: Group fixed effects are the interaction of education and experience fixed effects. Model C: Group fixed effects are the interaction of education, experience and linguistic background fixed effects. The dependent variable is the logarithm of the ratio between the average intensity of communication skills of foreigners and the average intensity of communication skills of natives by cell. Communication skills consist of the average importance scores of written and oral expression and written and oral comprehension. Importance scores for communication skills come from the O*NET database. Since occupations in the O*NET database are defined in terms of the Standard Occupational Classification (SOC), we converted them in the International Standard Classification of Occupations (ISCO-08) using the appropriate crosswalk. Then, we assign the scores to each individual in the SLFS according to the 4-digit ISCO-08 codes. The average intensity of communication skills by cell are obtained weighting individual observations by the number of hours worked times the personal weight and averaging them by cell. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust and clustered at group level.

Table 9: Simulated long run and short run effects on real wages (in percentage points)

PANEL A

Percentage wage impact on native workers

Column	(1) Long run 1999-2014	(2) Short run 1999-2001	(3) Short run 2002-2008	(4) Short run 2009-2014
Low educated	4.1	0.1	-1.6	1.0
	(1.83)	(0.49)	(0.13)	(0.97)
Middle educatd	2.4	-0.3	-0.4	-0.4
	(0.95)	(0.10)	(0.60)	(0.24)
High educated	-9.9	-0.3	-6.3	-2.3
	(5.06)	(0.07)	(2.41)	(0.68)
Average natives	**0.6**	**-0.3**	**-1.5**	**-0.9**
	(1.62)	**(0.12)**	**(0.88)**	**(0.39)**

PANEL B

Percentage wage impact on foreign workers

Column	(1) Long run 1999-2014	(2) Short run 1999-2001	(3) Short run 2002-2008	(4) Short run 2009-2014
Low educated	4.7	0.0	-2.3	1.2
	(1.83)	(0.45)	(0.15)	(0.98)
Middle educated	1.7	-0.8	0.0	-0.8
	(0.97)	(0.19)	(0.61)	(0.25)
High educated	-17.6	-0.9	-10.7	-3.5
	(5.26)	(0.14)	(2.52)	(0.74)
Average foreigners	**-2.4**	**-0.7**	**-3.2**	**-1.6**
	(2.25)	**(0.24)**	**(1.00)**	**(0.59)**
Overall average	**0.0**	**-0.3**	**-1.8**	**-1.0**
	(1.75)	**(0.14)**	**(0.91)**	**(0.44)**

Notes - The simulated effects and standard errors are in percentage points. Years 1999-2001 correspond to the period prior to the enactment of the free movement of persons. Years 2002-2008 correspond to the period between the enactment of the free movement of persons and the start of the economic crisis. Years 2009-2014 correspond to the aftermath of the economic crisis. To compute the simulated wage effects and their standard errors we start from our preferred estimates of the elasticities of substitution. As discussed in Appendix A, the relevant parameters are the inverse of the elasticities of substitution (i.e. the estimated coefficients). For each parameter, we perform 5.000 random draws from a joint normal distribution and we compute the percentage wage changes according to Equations (9) and (10) in Appendix A. Particularly, we plug in the normal distribution a beta coefficient of 0.01 for nationality groups, 0.079 for linguistic background groups, 0.123 for experience groups and 0.244 for education groups. Then, we average the simulated percentage wage changes and we compute their standard deviations. Finally, we aggregate up these average percentage wage changes weighting each education-experience-linguistic background wage change by the relative wage share of the group. We compute standard errors by education and by nationality using the same weighting procedure. In simulating long run effects, we consider a variation in the capital-labor ratio equal to 0, while in simulating short run effects we consider capital as fixed, i.e. a variation in the capital-labor ratio equal to minus the variation in the labor force due to immigration.

A Theoretical appendix

Total wage impact of immigration

To compute the percentage wage change by cell, we perform 5.000 random draws from a jointly normal distribution using the estimated elasticities of substitution as key parameters. Following OP, we define the mean of the normal distribution as the estimated parameter, and the standard deviation as the estimated standard error multiplied by the square root of 12, i.e. the number of observations. In this way we obtain 5.000 random realizations for each elasticity of substitution and we average them across observations. Then, from Equation (3), at each draw we compute the simulated percentage wage change for foreigners and natives as:

$$\begin{aligned}\frac{\Delta\omega_{Fkjlt}}{\omega_{Fkjlt}} =& \frac{1}{\sigma_{edu}}\sum_{e=1}^{3}\sum_{q=1}^{2}\sum_{i=1}^{2}\left(s_{Feqit}\frac{\Delta F_{eqit}}{F_{eqit}}\right)+\left(\frac{1}{\sigma_{exp}}-\frac{1}{\sigma_{edu}}\right)\left(\frac{1}{s_{kt}}\right)\sum_{q=1}^{2}\sum_{i=1}^{2}\left(s_{Fkqit}\frac{\Delta F_{kqit}}{F_{kqit}}\right)+\\ &+\left(\frac{1}{\sigma_{lan}}-\frac{1}{\sigma_{exp}}\right)\left(\frac{1}{s_{kjt}}\right)\sum_{i=1}^{2}\left(s_{kjit}\frac{\Delta F_{kjit}}{F_{kjit}}\right)+\left(\frac{1}{\sigma_{nat}}-\frac{1}{\sigma_{lan}}\right)\left(\frac{1}{s_{kjlt}}\frac{\Delta F_{kjlt}}{F_{kjlt}}\right)+\\ &+(1-\alpha)\frac{\Delta\kappa_t}{\kappa_t}-\frac{1}{\sigma_{nat}}\frac{\Delta F_{kjlt}}{F_{kjlt}}\end{aligned} \tag{9}$$

and:

$$\begin{aligned}\frac{\Delta\omega_{Nkjlt}}{\omega_{Nkjlt}} =& \frac{1}{\sigma_{edu}}\sum_{e=1}^{3}\sum_{q=1}^{2}\sum_{i=1}^{2}\left(s_{Feqit}\frac{\Delta F_{eqit}}{F_{eqit}}\right)+\left(\frac{1}{\sigma_{exp}}-\frac{1}{\sigma_{edu}}\right)\left(\frac{1}{s_{kt}}\right)\sum_{q=1}^{2}\sum_{i=1}^{2}\left(s_{Fkqit}\frac{\Delta F_{kqit}}{F_{kqit}}\right)+\\ &+\left(\frac{1}{\sigma_{lan}}-\frac{1}{\sigma_{exp}}\right)\left(\frac{1}{s_{kjt}}\right)\sum_{i=1}^{2}\left(s_{kjit}\frac{\Delta F_{kjit}}{F_{kjit}}\right)+\left(\frac{1}{\sigma_{nat}}-\frac{1}{\sigma_{lan}}\right)\left(\frac{1}{s_{kjlt}}\frac{\Delta F_{kjlt}}{F_{kjlt}}\right)+\\ &+(1-\alpha)\frac{\Delta\kappa_t}{\kappa_t}\end{aligned} \tag{10}$$

where $\Delta\omega_{Fkjlt}/\omega_{Fkjlt}$ represents the percentage variation in the wage of foreign workers F in education group k, experience group j, linguistic group l, at time t. To the same extent, $\Delta\omega_{Nkjlt}/\omega_{Nkjlt}$ represents the percentage variation in the wage of native workers. The summation subscripts e, q, and i refers respectively to education, experience and linguistic groups. $\Delta F_{kjlt}/F_{kjlt}$ represents the percentage variation in the number of hours worked by foreign workers, while $\Delta\kappa_t/\kappa_t$ is the percentage variation in the capital-labor ratio, as discussed below. Finally, the s-variables refer to the wage shares. For instance, the wage share of foreign workers in education group k, experience group j and linguistic group l at time t can be written as:

$$s_{Fkjlt}=\frac{\omega_{Fkjlt}F_{kjlt}}{\sum_{e=1}^{3}\sum_{q=1}^{2}\sum_{i=1}^{2}(\omega_{Feqit}F_{eqit}+\omega_{Neqit}N_{eqit})} \tag{11}$$

To the same extent, the overall wage share for education group k, experience group j and linguistic group l is:

$$s_{kjlt} = \frac{\omega_{Fkjlt}F_{kjlt} + \omega_{Nkjlt}N_{kjlt}}{\sum_{e=1}^{3}\sum_{q=1}^{2}\sum_{i=1}^{2}(\omega_{Feqit}F_{eqit} + \omega_{Neqit}N_{eqit})} \tag{12}$$

Thus, we end up with 5.000 simulated percentage wage changes for native and foreign workers. We compute the mean and the standard deviation of such wage changes by education, experience, and linguistic background. Finally, we compute average percentage wage changes by education group and their standard deviations weighting each wage change by its relative wage share. For instance, percentage variations in native average wages by education group can be written as:

$$\frac{\Delta\bar{\omega}_{Nkt}}{\bar{\omega}_{Nkt}} = \sum_{q=1}^{2}\sum_{i=1}^{2}\left(\frac{\Delta\omega_{Nkqit}}{\omega_{Nkqit}}s_{Nkqit}\right) \tag{13}$$

Standard errors by education group are computed averaging the standard errors in the same way. Following the same reasoning, it is possible to obtain average percentage wage changes for native and foreign workers, as well as the overall wage impact on the economy.

Long run and short run simulations

As discussed in the main text, while in the long run immigration flows have zero impact on wages, in the short run immigration affects individual wages through an additional term, i.e. the capital-labor ratio κ (see the optimality condition in Equation (3)). Particularly, the magnitude of this effect can be derived from the Cobb-Douglas production function. Consider the marginal productivity of labor:

$$\omega_t = \frac{\partial Y_t}{\partial L_t} = \alpha A\kappa_t^{(1-\alpha)} \tag{14}$$

where κ is the capital-labor ratio K/L. Assuming that total factor productivity A_t does not depend on immigration flows, the percentage variation in average wages can be written as:

$$\frac{\Delta\omega_t}{\omega_t} = (1-\alpha)\frac{\Delta\kappa_t}{\kappa_t} \tag{15}$$

With fixed capital, the variation in κ only depends on the denominator, i.e. the increase in the labor force due to migration. Thus, this equation can be rewritten as:

$$\frac{\Delta\omega_t}{\omega_t} = (1-\alpha)\left(-\frac{\Delta F_t}{\mathrm{L}_t}\right) \tag{16}$$

where ΔF_t represents the inflow of foreign workers in the period considered.

Accordingly, in our short run simulation we decrease the average wage effect computed in each random draw by a constant equal to $(1-\alpha)(\Delta F_t/L_t)$. The second term is just the percentage

change in the labor force due to foreign workers in the period considered, while the first term is the share of income going to capital. Since in Switzerland the labor income share between 1970 and 2012 has been approximately 62% (OECD, 2016b), we assume $(1 - \alpha) = 38$.

B Further data details

This appendix contains the description of the data used. Particularly, Sections B.1-B.4 contain a detailed description of the criteria used to group workers into education, experience, nationality and linguistic background groups. Then, Sections B.5 and B.6 describe how the labor and wage aggregates are defined. Section B.7 contains information about the Swiss Earnings Structure Survey data, and how the shares of cross-border workers are imputed to SLFS cells. Finally, Section B.8 describes the construction of the measures of communication skills.

B.1 Education groups

- Low education: Compulsory education (TBQ1=1), elementary vocational training (TBQ1=2), household work (TBQ1=3), school for general education (TBQ1=4);
- Middle education: Apprenticeship (TBQ1=5), full-time vocational training (TBQ1=6), high school education (TBQ1=7), tertiary vocational training (TBQ1=8);
- High education: College (TBQ1=9)

B.2 Experience groups

We assign people to experience groups according to years of potential experience. Potential experience is computed as the difference between current age and the age at which an individual should have completed the maximum level of education achieved. For this reason, we assume that people enter the labor market at the age 14 if they only obtained compulsory education, at age 16 if they accomplished elementary vocational training, household work or school for general education, at age 18 if they accomplished apprenticeship or full-time vocational education, at age 19 if they obtained a high school degree, at age 22 if they accomplished tertiary vocational education and at age 24 if they accomplished college education. Also, we drop from the sample individuals with experience smaller than zero and greater than 40.

B.3 Nationality groups

National groups are defined according to citizenship. There are three ways to obtain Swiss citizenship: birth, marriage and naturalization. Citizenship by birth is acknowledged to children of

Swiss parents. People married to a Swiss person can apply for fast naturalization track after three years of marriage and at least 5 years of residence in Switzerland. Finally, every immigrant can apply for naturalization after at least 12 years of permanence in Switzerland. Moreover, there is a three-tiered process, in which the State Secretariat for Migration, the Cantons (i.e. the states of the Swiss confederation) and the municipalities are all involved in the naturalization procedure. To acquire the citizenship an immigrant must first apply to the State Secretariat for Migration, which evaluates the applicant situation, her knowledge of Swiss customs and how much she is integrated into the Swiss society. Then, if the Secretariat decides that the applicant can receive the citizenship, the Canton and the municipality of residence must also evaluate the application with their own requirements. Sometimes municipalities require the applicant to undertake a written or an oral exam. At every step of the process the naturalization of the applicant can be rejected.

B.4 Linguistic groups

Linguistic groups are defined according to the area of residence. Swiss nationals are classified as same linguistic background" if they complete the questionnaire in the same language as the linguistic area of residence, while they are classified as "different linguistic background" otherwise. To the same extent, immigrants are considered as "same linguistic background" when the official language of their country of citizenship coincides with the language spoken in the linguistic area of residence in Switzerland, and they are classified as "different linguistic background" otherwise. Here is the list of citizenships which are considered of German, French or Italian background.

- Countries with German-speaking background: Germany, Austria.
- Countries with French-speaking background: France, Belgium, Luxembourg, Canada, Monaco, Democratic Republic of the Congo, Republic of the Congo, Saint Martin (French part), Madagascar, Cameroon, Senegal, Rwanda, Haiti, Chad, Guinea, Benin, Central African Republic, Gabon, Comoros, Equatorial Guinea, Djibouti, Seychelles, New Caledonia, French Polynesia, Guernsey, Wallis and Futuna, French Southern and Antarctic Lands, Sark, Mauritius, Runion, Guadeloupe, French Guyana, Martinique, Saint Pierre and Miquelon, Saint Lucia, Saint Barthlemy, French Indochina, French Polynesia, Burkina Faso, Niger, Mali, Burundi, Togo, Vanuatu, Cote d'Ivoire.
- Countries with Italian-speaking background: Italy, San Marino, Vatican City.

B.5 labor aggregate

To compute the labor aggregate we:

- Drop people below 18 years old (BB03A<18);
- Drop people in military service, unemployed, in education or inactive (BDU1>9);
- Keep people with remunerated labor in the previous week (BD01=1).

To compute the total weekly hours supplied, we focus on hours actually worked and we sum hours provided within the main job (EK08) with hours provided within the secondary job (EK08N). Then, we drop the observations for which this sum was zero or missing. Finally, we aggregate the hours worked multiplying the hours worked by personal weights and then summing up by cell.

B.6 Wages

To compute the average wages we:

- Drop people below 18 years old (BB03A<18);
- Drop people in military service, unemployed, in education or inactive (BDU1>9);
- Keep people with remunerated labor in the previous week (BD01=1).

Since in the SLFS there are only yearly data without indication of how many weeks per year the individual worked, we divide net annual income (BWU2) by 52. Then, we drop the observations for which income was zero and we trim the upper and lower 1% of the income distribution. Finally, we compute real wages deflating the nominal wages by the consumer price index.

B.7 Cross-border workers

The Swiss Earnings Structure Survey (SESS) is a biannual survey administered to approximately 35,000 firms about the earnings of employees in the secondary and tertiary sectors, including cross-border workers. However, since the SESS has no information about the foreign workers country of origin, we assume that all cross-border workers share the same linguistic background of the linguistic area where they work. From the SESS we compute the incidence of cross-border workers out of foreign population by cell, both for labor and wage aggregates. Then, we inflate our wage and labor aggregates according to these shares. Finally, since the SESS is biannual, we linearly interpolate the missing years.

B.8 Measures of communication skills

To measure the importance of communication skills we rely on the information contained in the O*NET database. In particular, for each communication skill of interest we download the list of its

importance scores by occupation. Since occupations in the O*NET database are defined in terms of the Standard Occupational Classification (SOC), we converted them in the International Standard Classification of Occupations (ISCO-08) using the appropriate crosswalk. Then, we assign the scores to each individual in the SLFS according to the 4-digit ISCO-08 codes. Finally, we compute the average communication skills by cell weighting each individual by the number of hours worked times his/her personal weight. In the following, we list the skills that we include in our baseline and extended definitions of communication skills.

- **Communication skills:**
  - *Oral:* Oral comprehension; Oral expression.
  - *Written:* Written comprehension; Written expression.
- **Extended communiation skills:**
  - *Oral:* Oral comprehension; Oral expression.
  - *Written:* Written comprehension; Written expression.
  - *Cognitive and analytical skills:* Category flexibility; Deductive reasoning; Flexibility of closure; Fluency of ideas; Inductive reasoning; Information ordering; Mathematical reasoning; Memorization; Number facility; Originality; Problem sensitivity; Speed of closure.
  - *Vocal skills:* Speech clarity; Speech recognition.

C Tables for robustness checks

Table C.1: Estimated coefficients for linguistic background groups holding nationality fixed

Column	(1)	(2)
Log of hours worked	-0.100	-0.147***
	(0.06)	(0.04)
Observations	191	191
Group fixed effects	Yes	Yes
Year fixed effects	Yes	Yes
Time by education FE	No	Yes

Notes - Fixed effect estimates. This model has been obtained inverting the linguistic background and the nationality characteristics in model C. All the estimates are weighted by the ratio between the number of workers with different linguistic background and the number of workers with same linguistic background by cell. Group fixed effects are the interaction of education, experience and nationality fixed effects. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust and clustered at group level.

Table C.2: Job specialization according to communication skills (extended definition) - Models A and C

	Model A		Model C	
Column	(1)	(2)	(3)	(4)
Log hours worked	-0.019*	-0.028***	-0.009	-0.006
	(0.01)	(0.01)	(0.01)	(0.00)
Observations	96	96	192	192
Year fixed effects	Yes	Yes	Yes	Yes
Group fixed effects	Yes	Yes	Yes	Yes
Time by education FE	No	Yes	No	Yes

Notes - Fixed effect estimates. All the estimates are weighted by the ratio between the number of foreign workers and the number of native workers by cell. Model A: Group fixed effects are the interaction of education and experience fixed effects. Model C: Group fixed effects are the interaction of education, experience and linguistic background fixed effects. The dependent variable is the logarithm of the ratio between the average intensitity of communication skills of foreigners and the average intensity of communication skills of natives by cell. The extended definition of communication skills includes cognitive, analytical and vocal skills in addtion to written and oral expression and written and oral comprehension. Scores for communication skills come from the O*NET database. Since occupations in the O*NET database are defined in terms of the Standard Occupational Classification (SOC), we converted them in the International Standard Classification of Occupations (ISCO-08) using the appropriate crosswalk. Then, we assign the scores to each individual in the SLFS according to the 4-digit ISCO-08 codes. The average intensity of communication skills by cell are obtained weighting individual observations by the number of hours worked times the personal weight and averaging them by cell. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust and clustered at group level.

Table C.3: Estimated coefficients for nationality groups by gender

	Model A		Model B		Model C	
Column	(1)	(2)	(3)	(4)	(5)	(6)
Men	-0.050*	-0.043**	-0.070**	-0.057***	-0.023	0.033
	(0.02)	(0.01)	(0.02)	(0.01)	(0.04)	(0.05)
Observations	96	96	96	96	186	186
Women	-0.051	-0.101	-0.160*	-0.184	-0.014	0.005
	(0.08)	(0.10)	(0.07)	(0.10)	(0.02)	(0.03)
Observations	96	96	96	96	186	186
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Group fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time by education FE	No	Yes	No	Yes	No	Yes

Notes - Fixed effect estimates. Model A: Group fixed effects are the interaction of education and experience fixed effects. The estimates are weighted by the ratio between the number of foreign workers and the number of native workers by cell. Model B: Group fixed effects are the interaction of education and experience fixed effects. The estimates are weighted by the ratio between the number of foreign workers with different linguistic background and the number of native workers and foreign workers with the same linguistic background by cell. Model C: Group fixed effects are the interaction of education, experience and linguistic background fixed effects. The estimates are weighted by the ratio between the number of foreign workers and the number of native workers by cell. Given the small number of observations by cell and the large number of cells, in model C we discard the cells in the first and last percentile of the labor supply distribution. This trimming created 6 missing cells. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust and clustered at group level.

Table C.4: Estimated coefficients for linguistic background groups by gender

	Model C		
Column	(1)	(2)	(3)
Men	-0.082**	-0.402	-0.050
	(0.03)	(0.44)	(0.05)
Observations	190	190	190
Kleibergen-Paap F	6	1	24
Women	-0.015	0.099	-0.039
	(0.03)	(0.15)	(0.04)
Observations	189	189	189
Kleibergen-Paap F	32	4	101
Group fixed effects	Yes	Yes	No
Year fixed effects	Yes	Yes	Yes
Time by education FE	No	Yes	Yes
Linguistic, exp. and educ. FE	No	No	Yes
Linguistic by education FE	No	No	Yes

Notes - IV estimates using the logarithm of the number of hours provided by foreign workers as an instrument for the logarithm of the number of hours provided. All the estimates are weighted by the number of workers in each education-experience-linguistic background cell. Group fixed effects are the interaction of education, experience and linguistic background fixed effects. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust and clustered at group level.

Table C.5: Estimated coefficients for experience groups by gender

	Model A			Model B			Model C		
Column	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Men	-0.058***	-0.162***	-0.190**	-0.060***	-0.208***	-0.231***	-0.092**	-0.671***	-0.767***
	(0.02)	(0.06)	(0.09)	(0.02)	(0.06)	(0.08)	(0.04)	(0.22)	(0.21)
Observations	96	96	96	96	96	96	96	96	96
Kleibergen-Paap F	70	19	7	119	12	7	48	9	5
Women	-0.004	0.201**	0.215**	0.004	0.179***	0.185***	0.023	0.239**	0.292**
	(0.02)	(0.09)	(0.08)	(0.02)	(0.07)	(0.06)	(0.03)	(0.11)	(0.13)
Observations	96	96	96	96	96	96	96	96	96
Kleibergen-Paap F	145	15	15	50	50	40	172	21	58
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Group fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Education time trends	No	Yes	No	No	Yes	No	No	Yes	No
Time by education FE	No	No	Yes	No	No	Yes	No	No	Yes

Notes - Models A and C: IV estimates using the logarithm of the number of hours provided by foreign workers as an instrument for the logarithm of the number of hours provided. Model B: IV estimates using the logarithm of the number of hours provided by foreign workers with different linguistic background as an instrument for the logarithm of the number of hours provided. All the estimates are weighted by the number of workers in each education-experience cell. Group fixed effects are the interaction of education and experience fixed effects. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust and clustered at group level.

Table C.6: Estimated coefficients for education groups by gender

Column	Model A	Model B	Model C
Men	-0.249***	-0.232**	-0.962**
	(0.08)	(0.10)	(0.45)
Observations	48	48	48
Kleibergen-Paap F	10	6	5
Women	-0.004	0.040	-0.283
	(0.13)	(0.08)	(0.30)
Observations	48	48	48
Kleibergen-Paap F	5	16	4
Education fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Education trends	Yes	Yes	Yes

Notes - Models A and C: IV estimates using the logarithm of the number of hours provided by foreign workers as an instrument for the logarithm of the number of hours provided. Model B: IV estimates using the logarithm of the number of hours provided by foreign workers with different linguistic background as an instrument for the logarithm of the number of hours provided. All the estimates are weighted by the number of workers in each education cell. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust to heteroskedasticity.

Table C.7: Estimated coefficients for nationality groups - cross-border workers included

	Model A		Model B		Model C	
Column	(1)	(2)	(3)	(4)	(5)	(6)
Log of hours worked	-0.030	-0.085***	-0.139***	-0.168***	-0.015*	-0.010
	(0.05)	(0.02)	(0.03)	(0.01)	(0.01)	(0.01)
Observations	96	96	96	96	191	191
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Group fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time by education FE	No	Yes	No	Yes	No	Yes

Notes - Fixed effect estimates. Data on cross-border workers comes from the Swiss Earnings Structure Survey (SESS). Particularly, with SESS data we compute the incidence of cross-border workers out of foreign population by cell, both for labor and wage aggregates. Then, we inflate our wage and labor aggregates according to these shares. Since SESS data are biannual, we linearly interpolate the incidence of cross-border workers in missing years. Moreover, since the SESS does not contain any information about the nationality of workers, we assume that all the cross-border workers share the language of the linguistic area where they work. Model A: Group fixed effects are the interaction of education and experience fixed effects. The estimates are weighted by the ratio between the number of foreign workers and the number of native workers by cell. Model B: Group fixed effects are the interaction of education and experience fixed effects. The estimates are weighted by the ratio between the number of foreign workers with different linguistic background and the number of native workers and foreign workers with the same linguistic background by cell. Model C: Group fixed effects are the interaction of education, experience and linguistic background fixed effects. The estimates are weighted by the ratio between the number of foreign workers and the number of native workers by cell. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust and clustered at group level.

Table C.8: Model C - linguistic and experience characteristics inverted

Column	β_{nat} (1)	β_{nat} (2)	β_{exp} (3)	β_{exp} (4)	β_{lan} (5)	β_{lan} (6)	β_{edu} (7)
Log of hours worked	-0.015*	-0.010	-0.079***	-0.086**	-0.059***	0.047	-0.340***
	(0.01)	(0.01)	(0.01)	(0.04)	(0.02)	(0.03)	(0.12)
Observations	191	191	191	191	96	96	48
Kleibergen-Paap F			15	69	7	21	11
Group fixed effects	Yes	Yes	Yes	No	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Education trends	No	No	No	No	No	No	Yes
Time by education FE	No	Yes	No	Yes	No	Yes	No
Education FE	No	No	No	Yes	No	Yes	No
Linguistic back. FE	No	No	No	Yes	No	Yes	No
Experience FE	No	No	No	Yes	No	No	No
Linguistic by education FE	No	No	No	Yes	No	No	No

Notes - β_{nat}: Fixed effects estimates. The estimates are weighted by the ratio between the number of foreign workers and the number of native workers by cell. Group fixed effects are the interaction of education, linguistic background and experience fixed effects. β_{exp}: IV estimates using the logarithm of the number of hours provided by foreign workers as an instrument for the logarithm of the number of hours provided. The estimates are weighted by the number of workers in each education-linguistic background-experience cell. Group fixed effects are the interaction of education, linguistic background and experience fixed effects. β_{lan}: IV estimates using the logarithm of the number of hours provided by foreign workers as an instrument for the logarithm of the number of hours provided. The estimates are weighted by the number of workers in each education-linguistic background cell. Group fixed effects are the interaction of education and linguistic background fixed effects. β_{edu}: IV estimates using the logarithm of the number of hours provided by foreign workers as an instrument for the logarithm of the number of hours provided. The estimates are weighted by the number of workers in each education cell. Group fixed effects are just education fixed effects. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust and clustered at group level. No clusterization has been performed for β_{edu}.

Table C.9: Model A - Estimated coefficients for education, experience and nationality groups - different experience groups

Column	β_{nat} (1)	β_{nat} (2)	β_{exp} (3)	β_{exp} (4)	β_{edu} (5)
			8 experience groups		
Log of hours worked	-0.021	-0.025	-0.046***	-0.052*	-0.382***
	(0.03)	(0.03)	(0.01)	(0.03)	(0.14)
Observations	384	384	384	384	48
Kleibergen-Paap F			103	32	8
			3 experience groups		
Log of hours worked	-0.019	-0.041	-0.055***	-0.043	-0.278***
	(0.02)	(0.04)	(0.01)	(0.03)	(0.10)
Observations	144	144	144	144	48
Kleibergen-Paap F			146	29	10
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Group fixed effects	Yes	Yes	Yes	Yes	No
Education trends	No	No	No	No	Yes
Time by education FE	No	Yes	No	Yes	No

Notes - β_{nat}: Fixed effects estimates. The estimates are weighted by the ratio between the number of foreign workers and the number of native workers by cell. Group fixed effects are the interaction of education and experience fixed effects. β_{exp}: IV estimates using the logarithm of the number of hours provided by foreign workers as an instrument for the logarithm of the number of hours provided. The estimates are weighted by the number of workers in each education-experience cell. Group fixed effects are the interaction of education and experience fixed effects. β_{edu}: IV estimates using the logarithm of the number of hours provided by foreign workers as an instrument for the logarithm of the number of hours provided. The estimates are weighted by the number of workers in each education cell. Group fixed effects are just education fixed effects. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust and clustered at group level. No clusterization has been performed for β_{edu}.

Table C.10: Estimated coefficients for nationality groups - different education groups

	Model A		Model B		Model C	
Column	(1)	(2)	(3)	(4)	(5)	(6)
	Middle and High educated grouped together					
Log of hours worked	-0.029	-0.096***	-0.137*	-0.169***	-0.016***	-0.014***
	(0.05)	(0.01)	(0.05)	(0.01)	(0.00)	(0.00)
Observations	64	64	64	64	127	127
	Low and Middle educated grouped together					
Log of hours worked	0.015	0.015	-0.126	-0.143***	0.041	0.065
	(0.08)	(0.03)	(0.07)	(0.01)	(0.03)	(0.05)
Observations	64	64	64	64	128	128
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Group fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Time by education FE	No	Yes	No	Yes	No	Yes

Notes - Fixed effect estimates. Model A: Group fixed effects are the interaction of education and experience fixed effects. The estimates are weighted by the ratio between the number of foreign workers and the number of native workers by cell. Model B: Group fixed effects are the interaction of education and experience fixed effects. The estimates are weighted by the ratio between the number of foreign workers with different linguistic background and the number of native workers and foreign workers with the same linguistic background by cell. Model C: Group fixed effects are the interaction of education, experience and linguistic background fixed effects. The estimates are weighted by the ratio between the number of foreign workers and the number of native workers by cell. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors (in parenthesis) are robust and clustered at group level.

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