Effects of Immigration on Wages: Theory and Evidence from European Countries

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Abstract

This paper uses panel data to uncover the effect that immigration induced labor supply shocks has on the wages of natives of different skill level using data from 26 European countries during 2004 to 2017. Innovations of this paper include the incorporation of time-dynamic considerations in conjunction with heterogeneous labor groups in both immigrant and native labor structures. Additionally, this paper brings forward a more relevant measure of immigrant penetration into a labor market. This paper finds no evidence of a negative relationship between immigration of different skill and native wages of different skill in European countries during the period under study.

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1 Introduction

According to surveys conducted in the 2009-2011 across Canada, France, Germany, Italy, Spain, the United Kingdom and the United States, citizens tend to fear migrants impact on the labor market (Peri, 2014). While European average attitudes towards migrants have improved in 2015 compared to 2005, attitudes towards immigrants have become more polarized within each country, as less respondents feel neutral about immigrants (Ademmer and Stöhr, 2018). Fueling these negative perception of migrants is the continues stagnant wage growth in European countries despite relative low unemployment rates (Provan and Romei, 2019).

This negative sentiment is exploited by some political groups, that not only carry their anti-immigrant agenda once elected, but engage in protectionist policies that may hinder global trade (Andersen et al., 2017). Furthermore within the European Union context, the parties that often run on an anti-immigration rhetoric are often also anti-EU (Davis and Deole, 2017). Thus, native discomfort against immigrants can potentially serve as catalyst for populist regimes to disrupt the political stability of Europe. This makes of migration an important issue to be researched, as understanding its effects in the labor market may lead to better policy making.

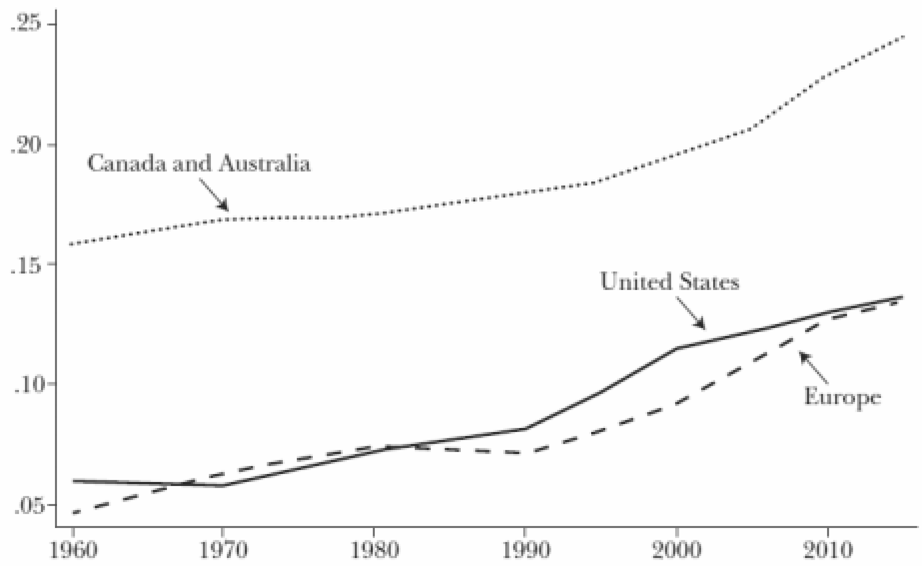
Furthermore according to multiple sources (Bijak, 2010; Coleman, 2008), migration towards European countries is likely to continue to increase, an occurrence further accelerated by the fall in transportation costs (Ma, Wang and Liu, 2012; Massey, 1988) and the expansion of the global middle class (Latek, 2019). According to Gallup, 700m people—14% of the world's adults—would like to move permanently to another country, and this figure is as high as 31% in sub-Saharan Africa (Espiona, Ray and Pugliese, 2017).

Performing research on the effect of immigration on native wages using European data is particularly important given that there is little research in this subject, as approximately a third of all research has taken place using data from the United States (see section 3 of this paper). This is important because European immigration policy should be based on research conducted within European countries in order to minimize the influence of confounding variables such as labor protection rules and social spending measures.

Despite what seems to be an important economic effect, advancements in most economic research methodologies have not been reflected in immigration research, as only in 2016 did researchers proposed the use of a generally agreed measure of immigration (Card and Peri, 2016), and many researchers have failed to consider time-dynamic effect over the influence that immigrants have on native wages. Surprisingly, papers that have accounted for differences in effects across time, have failed to pay consideration to differences across skill groups, ironically, often cited in papers that ignore time-dynamics.

This paper thus will aim to provide some insight over the economic relationship between

Figure 1: Foreign born as share of population across the United Sates, Europe and others. The share of foreign born in Europe is as high as in the United States, yet little research has been conducted with European data.



Source: Peri, 2016

native wages of different skill-level and immigration flows of different skill level while considering time-dynamic effects. This will be achieved by using European panel data from 2004 to 2017. Additionally, this paper will propose and make use of a tailored measure of immigrant labor prevalence in a labor market that can be interpreted as new-immigrant prevalence rate per thousand residents of working age, constructed for both skill and unskilled labor markets, which as it will be argued later, is a better indicator to labor supply shocks than the commonly used measure of immigrant population as share of total labor force.

While not all of the methodology enhancements that appear in this paper are innovative on their own ground, it is the combined use of these tools and innovations that collectively present a unique research approach in the study of labor economics and immigration. In essence, the contribution of this paper, besides from being one of few research attempts utilizing European panel data, are as follows;

- Account for differences in short-run and long-run effects.
- Account for labor supply shocks of different skill level groups.
- Capture effect differences on native wages according to natives' skills.
- Construct an improved measure of immigrant induced labor supply shocks.

2 Theoretical literature

The study of the impact of immigration on native labor outcomes is ultimately a study of labor economics, particularly, the study of how labor markets react to a labor supply shock. Knowledge in this field has expanded to account for time-dynamics (differences in observed effects across the short and long run) and for ever more realistic assumptions, such as production inputs across both capital and labor being considered heterogeneous.

Immigration affects the wages of natives through two primary channels. The first order effect of immigration, also known as direct effect, is an increase of the supply of labor, while the second order effect of immigration is to distort the relative supply of workers into different skill groups, making a nation's workforce more skilled or less skill intensive (Card and Peri, 2016).

The impact of migration can be also analyzed on a general equilibrium framework, where short-term effects are considered to be partial equilibrium while general equilibrium is succeeding. Partial equilibrium models limit the analysis of immigration presence to a shock in the labor market and the effect that this has on that single market, while general equilibrium models consider how the initial change in a market resonates in other markets, as feedback reactions interact across the economy (Fischer, 1995).

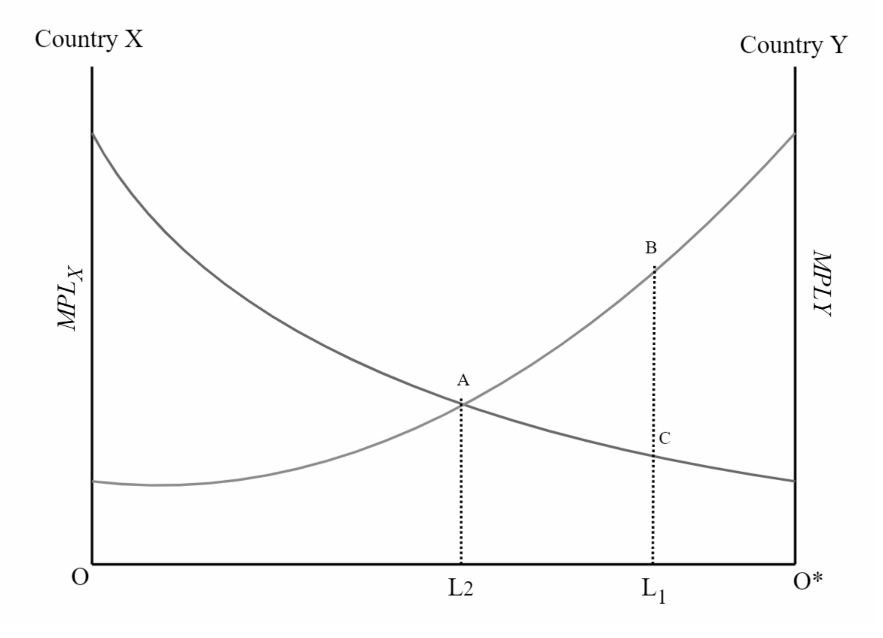
This section explores different economic theories that aim to explain these direct and indirect effects across time. The direct effect of immigration is explained by assuming that labor is homogeneous, while the indirect effect is analyzed under the assumption that labor is heterogeneous. As theories are presented, assumptions are relaxed in order to better capture reality. The time-span covered by the publications of the presented theories runs from 1960 to 2017. Presented theories often appear in publications of migration economics but rarely conjunction, as the vast majority of publications focuses in a single model (either because other research focuses in structural model estimation, which dives into the mathematical derivation of the model, or because lack of proper theoretical considerations). To my knowledge, the theoretical literature presented in this paper is the most comprehensive attempt on this subject.

2.1 Direct effect - homogeneous labor

2.1.1 Partial equilibrium; fixed capital on the short term

The MacDougall-Kemp model describes the dynamics between the supply of two factor inputs and their respective prices under perfect competition at full employment and constant returns of scale (MacDougall, 1960). Given that immigration functions as a positive shock to labor supply, insights derived from the MacDougall-Kemp model are relevant to this thesis. To see this, following the MacDougall-Kemp model, assume the world economy consists of two countries, X and Y, and that each produce a single good with two primary factors, labor (L) and capital (K). Each of these countries count with different endowment factors, more specifically country X is relatively labor abundant so that $K_Y/L_Y > K_X/L_X$. Additionally, both countries' production functions are of neoclassical form and we assume that capital mobility is not permissible in the short run. This framework is visually represented by figure 2, which depicts the allocation of labor in the world economy, where OL_1 represents the labor supply of country X, segment L_1O^* depicts the labor supply of country Y, and the world economy labor force is defined as segment OO^*. Lines MP_L and MP_L^* represent the marginal product of labor curves of country X and Y, respectively, and drawn in reference to their origin points O and O^*. These are downward slopping due to constant returns to scale of labor. As described by the MacDougall-Kemp model, competitive factor market prices are equal to their marginal product, thus MP_L and MP_L^* correspond to the national wage of country X and Y respectively.

Figure 2: Impact of immigration on native wages in the case of no capital mobility. MacDougall-Kemp model as illustrated by Bowen, Hollander and Viaene (1998).



Under this framework, our starting point in the model is L_1. At this point, wages in country Y (point B) are higher than in country X (point C). This is in line with country Y being capital abundant relative to country X. This motivates labor movement from country Y to country X, given that workers follow higher wages, leading to a new equilibrium wage at L_2, where the MP_L of both countries equalizes. At this equilibrium, wages in country X have fallen, while wages in country Y have risen. Hence, under this framework, international migration has a negative effect on the wages of the hosting country.

2.1.2 General equilibrium; capital mobility on the long term

It is important to note that the above finding relays on the assumption that capital is fixed. When allowing for the mobility of capital, is possible to show that shocks to the labor supply of a nation through immigration must not necessarily cause a decrease in wages. To show this, always within the MacDougell-Kemp framework, assume a country counts with the following Cobb Douglas Production Function;

$$Y = f(L, K) = \theta L^{\alpha} K^{1-\alpha} \tag{1}$$

Where Y represents total output, L represents aggregate labor, K represents aggregate capital accumulation, α represents the share of income of labor and θ is total factor productivity. From this production function we can derive the marginal product of both labor and capital inputs, already established to be the factor input prices, as follows;

$$MP_L = \text{wages} = \frac{\partial Y}{\partial L} = \theta\alpha \left(\frac{K}{L}\right)^{1-\alpha} \tag{2}$$

$$MP_K = \text{rate of return} = \frac{\partial Y}{\partial K} = \theta(1-\alpha) \left(\frac{K}{L}\right)^{-\alpha} \tag{3}$$

By analyzing equations (2) and (3) it can be seen that an increase in labor L causes wages to fall while simultaneously causing the return of capital to increase. This can be interpreted as capital becoming more productive given that it can now be used across more individuals. This higher return of capital attracts investment from abroad leading to an increase in capital K. This increase of capital can offset the inflow of migrants so that the capital-labor ratio adjusts to a pre-migration period, causing wages to raise back to a prior level, thus resulting in a no-effect on native wages outcome as a consequence of immigration. The economic significance of this conclusion hinges on the speed to which capital adjustments can occur, as the longer this process takes the longer natives experience lower wages.

It is important to note that capital mobility from abroad is not necessary to obtain a similar solution. In the scenario where capital adjustments from abroad are not allowed, higher interest rates would encourage domestic savings if the substitution effect mechanism between current and future consumption is greater than the income effect (Romer, 2012), thus endogenously increasing the supply of capital through natives' higher saving rates.

Furthermore, dynamic general equilibrium models that explore the relationship of migration and capital formation, which account for changes in domestic savings due to demographic changes in the population post-migration (Wilson, 2003) have shown to predict similar results as the relatively simple MacDougall-Kemp model, that is, increases in migration cause capital inflows.

2.1.3 Capital mobility under rational expectations

If investors are able to accurately predict migration inflows, which is a realistic assumption if immigration flows follow a linear trend (Blau and Mackie, 2017), then rational expectations theory predicts that the capital adjustment process is instantaneous, as any change in labor supply will be met with increments of capital, and thus wages will not change as a consequence of immigration.

To observe this result, assume investors can access capital at an exogenous and constant fixed rate of return, r^{LR}, which is a realistic assumption if the native economy is relatively small compared to the world market. This rate of return is constant because if investors can persistently maintain the capital-labor ratio constant, which takes place given that investors supply capital according to their predictions of labor inflows, then the long-term rate of return of capital, calculated in equation (3) must also be constant. Using this information, equation (3) can be arranged as (4) and used to obtain equation (5) from the Cobb-Douglas production function (1);

$$K = L \left(r^{LR} \frac{1}{(1-\alpha)\theta} \right)^{\frac{1}{-\alpha}} = L\ q(r^{LR}) \tag{4}$$

$$Y = \theta L^{\alpha} K^{1-\alpha} = \theta L^{\alpha} (L q(r^{LR}))^{1-\alpha} = \theta L\ q(r^{LR})^{1-\alpha} \tag{5}$$

Equation (5) further predicts that output is linear to labor supply. This solution implies that expected immigration inflows not only do not affect native's wages, but also help the economy expand.

2.2 Indirect effect - heterogeneous labor

Naturally, immigration not only affects the labor supply of a nation in aggregate, but it can also alter the composition of the labor force structure, which can alter relative wages across labor groups. This section starts by building upon the prior homogeneous labor model by allowing for heterogeneous labor, and later presents new models with more practical applications. As before, time horizons are considered in order to obtain both short and long term predictions.

2.2.1 Extending the capital-labor model to a three factor model

We can extend the MacDougall-Kemp model into a three factor input model by assuming that skilled labor and capital are compliments to each other, assumption that has been shown to be realistic by both theoretical (Griliches, 1969) and empirical research (Yasar and Paul, 2008; Akay and Yuksel 2009).

$$Y = f(L_s,\ L_u,\ K) = \theta L_s^{\alpha}(K + L_u)^{1-\alpha} \tag{6}$$

Let a migrant receiving country count with a Cobb-Douglass production function (6) of three factor inputs K, L_u, and L_s, where K and L_u are perfect substitutes, α represents the share of income of unskilled labor and θ is total factor productivity. While it is in practice unrealistic for unskilled labor and capital to behave as perfect substitutes, this stylized assumption permits to draw some relevant observations.

Following a similar exercise as before, using the first order conditions of the production function is possible to derive the wages of L_s and L_u as equation (7) and (8), respectively.

$$MP_{L_s} = w_{(L_s)} = \frac{\partial Y}{\partial L_s} = \theta\alpha \left(\frac{L_s}{K + L_u}\right)^{\alpha-1} \tag{7}$$

$$MP_{L_u} = w_{(L_u)} = \frac{\partial Y}{\partial L_u} = \theta(1-\alpha) \left(\frac{L_s}{K + L_u}\right)^{\alpha} \tag{8}$$

This expressions can be used to obtain a relative wage of skilled labor proportional to the wage of unskilled labor (9). The relative wage function (9) predicts that increases in migration of a certain skill level will cause a drop in the relative wage of that skill level group. Under this framework, migration lowers the relative wages of the skill group that is affected the most by the introduction of immigrants. This finding is similar to the one found under the MacDougall-Kemp model of two input factors, namely, immigration lowers wages of the labor market of destination.

$$\frac{w_{(L_s)}}{w_{(L_u)}} = \frac{\alpha}{1-\alpha}\left(\frac{K + L_u}{L_s}\right) \tag{9}$$

2.2.2 Relaxing capital and unskilled labor prefect substitution assumption

The findings of the three factor extension framework of the MacDougall-Kemp model requires the assumption that unskilled labor and capital be perfect substitutes. This section relaxes this assumption by using the three-factor, two-good model.

Assume the economy produces two-goods with three-factor inputs at constant returns to scale, fixed factor supplies and flexible factor prices (Ruffin, 1984). As before, the three factor inputs are capital K, skilled labor L_s and unskilled labor L_u. Now let the amount of input i used in a unit of good j be a_{ij}, so that a_{Ls1} is the amount of skilled labor used in the production of a unit of good one. Also let ν_i denote the supply of each factor input.

$$a_{11}/a_{12} \; > \; a_{21}/a_{22} \; > \; a_{31}/a_{32} \tag{10}$$

Ruffin (1984) demonstrated that whenever the condition of equation (10) holds, namely there is a clear difference in relative factor usage across outputs, an increase of either ν_1 or ν_3, the inputs at the extremes of condition (10), would cause a fall in the factor price of the other extreme factor and an increase in price of the middle factor ν_2. Ruffin (1984) also demonstrated that an increase in middle factor ν_2 will result in a raise in factor prices for the extreme factors ν_1 and ν_3 simultaneously.

Under this set up, the effect on wages caused by an increase in the labor force due to immigration will depend on whether immigration constitutes an increase of ν_2 or an increase of either of ν_1 or ν_3. Thus is necessary to define equation (10) within our theoretical exercise. To this scope assume $j = 1$ is a capital intensive good and $j = 2$ a highly manual and low skill intensive good so that the expression becomes equation (11).

$$a_{K1}/a_{K2} \; > \; a_{L_S1}/a_{L_S2} \; > \; a_{L_u1}/a_{L_u2} \tag{11}$$

The main economic interpretation of equation (11) is that more capital is needed to build good one relative to the amount of capital needed to build good two; and more unskilled labor is needed to produce good two relative to good one, while skilled labor is used by both j goods at a similar rate.

Considering the predictions of Ruffin's model (Ruffin, 1984); an increase of $\nu_2$causes the price of $i = 3$ to raise, while an increase in ν_3 causes the price of $i = 2$ to raise. In our context increases in skill labor supply (ν_{L_S}) causes an increases in unskilled wages (w_u), while increases in the unskilled labor supply (ν_{L_u}) causes skilled wages to increase (w_s). However, on relative terms we find that, increases in ν_{L_S} cause a fall in $\frac{w_s}{w_u}$ and similarly increases in ν_{L_u} cause a reduction on $\frac{w_u}{w_s}$. Under this framework, migration lowers the relative wages of the skill group that is affected by the introduction of immigrants. Thus the MacDougell-Kemp model and Ruffin model arrive to the same conclusion.

However there are severe drawbacks of the Ruffin model, primarily while it allows for the analysis of a heterogeneous labor market in the hosting country, it assumes a homogeneous immigrant labor force. Thus this model does not truly allow for labor heterogeneity. The following model will expand labor heterogeneity to both native and migrant groups.

2.2.3 Multi-sector labor market implications

In the last decade new models have focused in the dynamics that exist between native and migrants of certain skill levels. These models permit for the analysis of both native and migrant heterogeneous workforce, allowing for full labor heterogeneity. These models however forgo the role of capital in the economy, and are thus considered to be useful for short-term predictions (Borjas, 2003). Borjas (2003) showed that when allowing for both native and migrant labor to be heterogeneous it is possible to show that the impact that migration will have over native wages will depend on the elasticity of substitution between labor groups.

For simplicity, lets explore this effect within an economy of two labor groups, skilled (L_s) and unskilled labor (L_u) , so that $L = (\varphi L_s^\beta + \varphi L_u^\beta)^{-\beta}$, where φ is productivity shocks, and the elasticity of substitution between skilled and unskilled workers is $1/(1 - \beta)$, which measures the percentage change in the relative supply of skilled labor to unskilled labor L_s/L_u by a change in the relative wages of skilled labor to unskilled labor w_s/w_u (Borjas, 2013). This labor supply function is part of an economy with a production function Cobb-Douglas (1).

After some calculations which include equalizing the marginal product of each labor group MP_Li to its respective wage w_i, and then dividing these two obtained expressions by each other so as to obtain a relative measure of wage, is then possible to derive a general and simplified expression that relates the relative supply of labor groups to the relative wages of these groups. In the current set up of two labor groups, this expression is as follows;

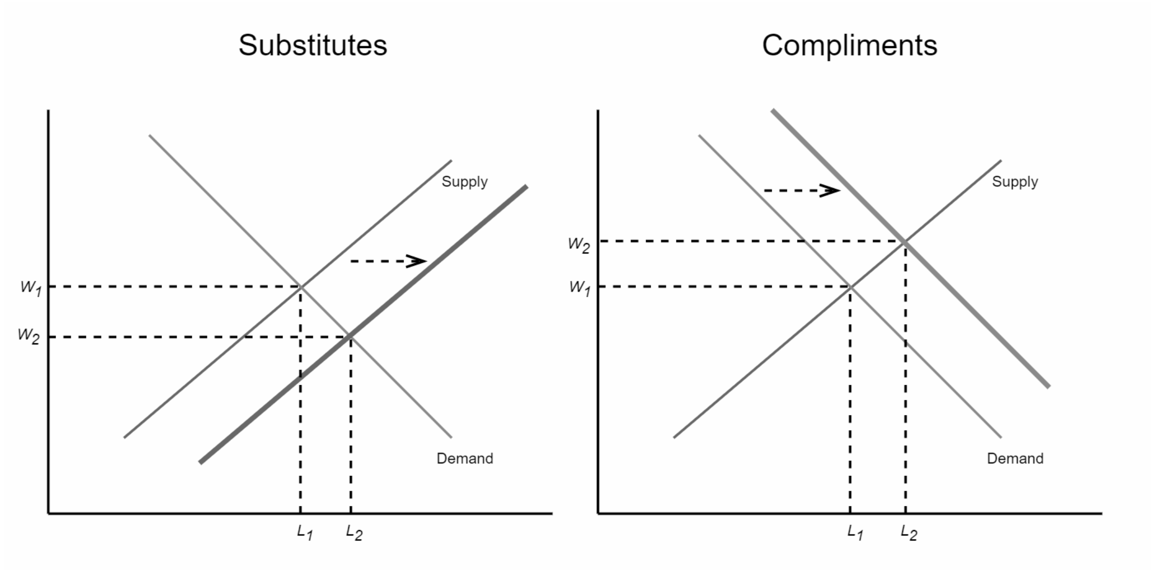
$$ln\left(\frac{w_s}{w_u}\right) = -\text{ b } ln\left(\frac{L_s}{L_u}\right) \tag{12}$$

Where b is the inverse elasticity of substitution between the two groups. By analyzing expression (12) it can be observed that the impact of migration on wages through shocks to a particular labor group will depend on the sign of the elasticity of substitution between the two labor groups. When the two labor groups are compliments, that is $b < 0$, an increases in the supply of unskilled labor (L_u), for assumption caused by an inflow of low educated migrants, will raise the relative wage of the lower skilled (w_u). In the opposite scenario, where the two labor groups are substitutes, that is $b > 0$, increments of unskilled labor through migration would cause relative wages of the unskilled group to fall. Table 1 summarizes the economic rational for the described effects while Figure 3 visually displays each scenario.

Table 1: Theoretical short-term predictions of wage effects according to relationship between labor groups.

Case	Scenario Outcome
Comp.	Migration causes a right-ward shift of labor demand. An example of this would be if migrants take over manual labor (assumed to be more efficient) and natives take on tech driven occupations, which carry higher wages. Under this scenario, market wages increase.
Sub.	Native and migrant labor groups will directly compete against each other in the labor market, lowering the market wage. Migration causes a right-ward shift of the labor supply.

Figure 3: Market diagrams depicting the short-run impact of immigration on native wages in the case of predominant substitution or complimentary effects.

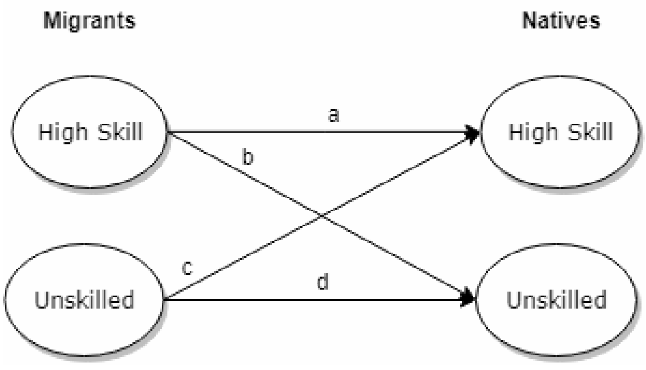


While the framework so far differentiates between migrant and native labor, it is possible to further expand this framework to account for differences in skill labor in both working groups. Expression (12) can be further elaborated into more general equation (13), where e stands for skill level, either skilled or unskilled, and M refers to migrant variables while N refers to native variables.

$$ln\left(\frac{{w_e}^N}{{w_e}^M}\right) = -\ \mathrm{b}\ ln\left(\frac{{L_e}^N}{{L_e}^M}\right) \tag{13}$$

This expression allows for the analysis of the effect of migrants on native wages by skill level (when e represents the same skill group across migrants and natives). Furthermore, the expression also allows for the analysis of cross-skill level effects, that is the effect that unskilled migrant labor can have in high skilled native wages and the effect that high skilled migrant labor can have on unskilled native wages. This particular analysis method is often used in studies that employ structural models.

Figure 4: Displays the possible market interactions that exist between migrants and natives. Segments a and b refer to interactions within skill level while cross-skill level interactions are presented by segments b and c.



2.2.4 Immigration and heterogeneous production technology

Borjas (2003) developed theory focuses primarily in labor market interactions and the resulting factor price outcomes. Borjas' analysis does not considers the reaction that the overall economy has to immigrants, which limits theoretical predictions to a short-run outcome. Models that assume complimentary effects between capital and skilled labor while allowing for post-migration markets reaction time show a lesser impact on native wages during simulations (Lewis 2013). One of the channels that explains this is that increases in skilled labor caused by immigration can be absorbed by a firms' expansion of capital to take advantage of the supply of skill labor (Edo, 2018). Generally, if different forms of capital have different elasticities of substitution relative to varying skills levels, then firms are able to adapt their production to observe increases in the labor force caused by migration, thus causing a no-effect outcome on wages in the long-run (Edo, 2018).

2.2.5 Human capital accumulation theory

If immigrants are relatively more educated than natives, as it is the case in the European scenario (see section 4.2) then consideration of human capital accumulation theory is relevant. This theory, which is in itself a human capital augmented Solow growth model (1956), predicts that economic growth can be driven by human capital (Rotemberg and Saloner, 1990). These findings are supported by structural product-innovation-based models, of which calibrated simulations yield a positive outcome in the endogenous growth rate of a small economy as a consequence of an inflow of primarily skilled migrants (Ehrlich and Kim, 2015). Additionally, more tailored research to a specific type of immigrants has found through structural equation models that foreign entrepreneurs count with extensive networks that aid them in business building relative to natives (Sahin, Todiras and Nijkamp, 2013), further increasing immigrant contributions. As migrants help the economy grow, labor outcomes are predicted to be positive for all market participants in the long-run. These findings are congruent with Paul Romer's human capital endogenous growth model (1989), which states that human capital has a unique explanatory role in the development of a nation through their contribution of ideas that lead to new technologies.

2.3 Summary of theoretical predictions

The theoretical prediction of the effect of immigration on wages can be divided in three categories; short run, medium term and long run. In the short-run, a period of focus of Borjas (2003) the effect of immigrants on wages depends on whether labor groups are compliments or substitutes, as in the first case wages are expected to raise while in the later wages are expected to fall. In the medium term, a period where capital adjustments can occur (both within a firm with heterogeneous capital or across nations with homogeneous capital), wages are predicted to reverse back to prior levels, thus causing a no-effect outcome. Lastly, in the long-term, highly skilled migration is predicted to cause improvements in human capital that cause endogenous economic growth which in turn will cause positive labor outcomes such as higher wages. The ambiguous nature of theoretical conjecture, particularly as it relates to effects in the short-term, invites empirical analysis of the migrant-native dynamic to arrive to a conclusion on the effect of immigration in native wages.

3 Empirical literature

Research aimed at understanding the effect of immigration on labor outcomes focuses in three different type of studies; event studies, empirical research and structural econometric models. From these three, the most popular methodology employed is empirical research, given that this type of research requires to establish less assumptions than structural econometric models, which estimates often depend on the assumptions made (Okkerse, 2008). Additionally, estimates derived from empirical research are not as local as the results obtained by event study methods, which findings may only be applicable to the specific discussed event or time period.

Nonetheless, empirical research suffers from some key identification challenges. Given that migrants self-select into regions with perceived better labor outcomes (Llull, 2017), immigration flows are not exogenous from the economic conditions of the hosting market. This endogeneity problem is often addressed with the use instrumental variables (IV). Two popular IV methods include network effect estimates (Card, 2001) and gravity model inspired instruments (Edo and Rapoport, 2017). Network effect estimates are based on using historical settlement patterns to predict current migration flows, while gravity model inspired instruments are based on the increased likelihood of migration to a region that is in near proximity, both geographic and culturally.

Another complication of the study of the effect of migrants on natives is that natives can respond to migration flows by either acquiring new skills (Hunt, 1992) or moving to other regions (Borjas, 2006), both behaviors that furhter affect the supply of labor and make it unfeasible to isolate the pure effect of migration. A popular approach to control for native mobility has been to estimate the effect of migration over native's mobility patterns to verify that migrants do not affect native relocation choices (Card, 2001). An additional approach to navigate issues carried by native mobility has been to perform analysis at state or national level, as native mobility issues fade as the studied region expands (Borjas, 2006).

In order to estimate how migrants affect native's wages it is necessary to first define what constitutes a labor market. Early research defined labor markets through regional boundaries such as cities or states (Butcher and Card, 1991), but more modern research has defined labor markets in terms of skill groups (Borjas, 2003). The shift from a regional definition to a skill-base group allows for the consideration of different market outcomes experienced by natives of different skill level, often measured through years of experience and educational achievement (Ottaviano and Peri, 2012).

A meta-analysis study of 27 publications issued between 1980 and 2013 concluded that migration has no economically significant effect on wages. Particularly, the study concluded that 96% of the reviewed papers found that a 1% increase in migration was associated with a change on native wages within the range of -0.2% to +0.7%, with the majority of estimates clustered around a zero effect outcome (Peri, 2014). However, in more resent years, new research that singles out high-school drop-outs as a low-skill labor group finds that low-skill migration has a significant negative effect on low-skill native wages (Borjas, 2015). Around the same period, more papers that have focused their analysis on the lowest educated workers have continued to find a significant detrimental effect on low-skill wages by the inflow of low-skill migration (Dustmann, Frattini and Preston, 2013).

Noteworthy, the majority of research conducted has used data from the United States, where labor protection rules are more lenient than in other developed countries (Fisher, Putman and Hassani, 2016). Therefore, the negative effects on lower skilled wages may not be consistent in other labor markets in the developed world, such as Europe. This observation is supported by research that suggests that markets with more protective regulations experience lower detrimental effects on both wages (Edo and Rapoport, 2017) and employment rates (Angrist and Kugler, 2002) after an influx of immigrants.

Results derived from structural econometric papers do not provide a definite answer either, as under the assumption that migrants and natives are perfect substitutes, migration is found to have and adverse effect on native wages (Borjas 2003, Borjas and Katz, 2007), an assumption challenged by other economists that point that migrants often do not count with equivalent language skills as natives, and thus are unlikely to behave as perfect substitutes (Ottaviani and Peri, 2012). Furthermore, empirical research has found that migrants tend to cause natives to shift profession from low-paid manual work to higher paid communication-intensive jobs (Peri and Sparber, 2009), further supporting the view that the two groups do not behave like perfect substitutes but compliments.

One key breakthrough as it relates to research in this subject is the movement towards a common specification of the key independent variable of interest; shock of the labor supply caused by immigration. Despite research in this subject being conducted for over three decades, an agreed measure of migration presence has been absent, which may attribute to the diversity of results in the literature.

The most common measure of migration presence, migrant share P_t^e, as seen in formula (14), divides the share of migrant stock in labor group e, where e represents skill level, by the total supply of labor on that group (Borjas 2006, 2009; Aydemir and Borjas, 2007).

$$P_t^e = \frac{{M_{stock_t}}^e}{{N_{stock_t}}^e + {M_{stock_t}}^e} = \frac{{M_{stock_t}}^e}{{L_t}^e} \tag{14}$$

Where M_{stock_t} refers to the stock of migrants, or the total number of migrants residing in a country at time t and N_{stock_t} is the total number of natives in time t. Both stock variables are limited to people of working age to capture labor supply participants, so that ${N_{stock_t}}^e + {M_{stock_t}}^e$ equals the labor supply of skill group e at time t denoted as ${L_t}^e$. In essence, Borjas constructed ratio P_t^e measures the presence of migrants in the labor force as the fraction of migrants in proportion to the total labor force in a given year.

While this measure captures the presence of migrants in the labor force by skill-level e at any given time, it is an unfit measure to analyze the effect of migration flows through time, which is a requirement to conduct empirical research. To see this, let the change on this rate be ΔP_t^e. Considering equation (14) is possible to see that by construction ΔP_t^e is affected by both $\Delta {M_{stock_t}}^e$ and $\Delta {N_{stock_t}}^e$, making it unfeasible to isolate the supply shock attributed to migration versus native mobility. This is particularly troublesome if $\Delta {M_{stock_t}}^e$ and $\Delta {N_{stock_t}}^e$ are correlated, that is, if migrant arrivals influence the decision of natives to enter or exit a labor market.

An alternative measure not yet popularized is to divide migration inflows, measured through proxy variable change in migration stocks $\Delta {M_{stock_t}}^e$, by the lag of the labor supply, as seen in equation (15) (Card and Peri, 2016). In essence, this measure calculates the change of immigrants in a labor market as proportion of the labor market prior to immigrants arrival. The attribution issue discussed of formula (14) is no longer present and this measure. Thus, the only driver of changes to the value π_t^e over time is given by the arrival of immigrants.

$$\pi_t^e = \frac{\Delta {M_{stock_t}}^e}{{L_{t-1}}^e} \tag{15}$$

One of the contribution of this paper's empirical technique is that it builds upon Card's offered measure to identify a relationship between native wages and immigration presence in the labor force.

3.1 Summary of literature findings

While research is far from conclusive, empirical findings suggest that migration has no effect on native wages on aggregate, and may potentially have a negative effect on the wages of the least educated. However, more resent literature suggest that these detrimental effects on the least educated are only present in markets with poor labor protections. Furthermore, most research is limited to short term effects, which although relevant, does not provide an accurate representation of a general equilibrium outcome. The fallowing table provides a summary of some key findings in the empirical literature. Results are provided in chronological order to accentuate the progress of the study of this phenomenon.

Table 2: Summary of empirical literature over the effect of migration on native labor outcomes. This table is not a comprehensive list of all the referenced literature in this paper. The table is chronological to emphasize the development of the field

Study	**Summary and results of paper**
Butcher et al., 1991	Elementary empirical analysis of major US cities data. Compares the rate of growth of wages across cities with high migration inflow against cities of low inflow. No effect on natives' wages was found.
Card, 1991	Event study of Miami population increase as consequence of Mariel Boatlift in the 1980s. No effect on natives' wages was found.
Card, 2001	Empirical analysis of US census data. Identification strategy uses immigrant inflows per (predicted) occupational group to identify effects on native population. Model accounts for the endogeneity problem of migration to cities with higher wage growth through an instrument variable based on "network effects". Internal migrant mobility was not directly controlled. A fall of 3% in less-skilled native wages was found.
Angrist et al, 2003	Empirical analysis of EU data to identify the effect of immigration on employment rates. A 10% increase in immigration causes employment rates to fall by 0.5%. Countries with higher labor protections limit this negative effect significantly.
Borjas, 2006	Empirical analysis of US data from 1960-2000. Migration is found to increase native mobility and as a result attenuate the impact of immigration on wages at the city-level analysis.
Manning et al., 2012	Structural model of the degree of substitutability across labor groups of different skill level plus a distinction between older migrants and natives. Paper concludes that natives and migrants are imperfect substitutes, and thus there is no effect on native wages. Immigrants, however, lower wages of prior immigrants. Study conducted with data from Britain.
Damette et al., 2013	Used a VECM to identify both short and long-term effects of immigration in 14 OECD countries. Migration is found to lower wages in the long term for Anglo-Saxon countries but to raise them for all other countries. Migration has no impact on employment rates.
Edo et. al, 2017	Empirical research to identify the effect of migration on native wages by skill group and according to the present type of US minimum wage (state vs federal). No effect was found on native wages on states with high enough minimum wages. A 10% increase in migrants reduces native wages in the same skill group by 0.2% when wages are not sufficiently high enough to protect natives.

4 Descriptive analysis of migration in Europe

Europe is a primary destination for international migrants. In 2017, Europe was the second largest region after Asia to attract international migrants with over 77 million foreigners residing in the region (United Nations, 2018). Mobility policies in Europe have accommodated intra-EU migration since 1985, when the ratification of the Schengen Agreement allowed EU citizens to live and work anywhere in the EU (Schutte, 1991). This free mobility market was later expanded to other countries in 2004 (Sedelmeier, 2014), where eight Eastern European countries were welcomed to the EU, and once again later in 2007, with the inclusion of Romania and Bulgaria (Kureková, 2013). The result of which has been the creation of the largest transnational free movement of labor.

4.1 Migrant presence in European labor markets

Figure 5 displays the number of foreign residents hosted by each European country in 2010, displaying a significant concentration of migrants in five countries; Germany, Italy, Spain, France, and the United Kingdom, which in aggregate hosted over 29 million foreigners in 2010 (OECD Data) and 39 million by 2015 (UN Data).

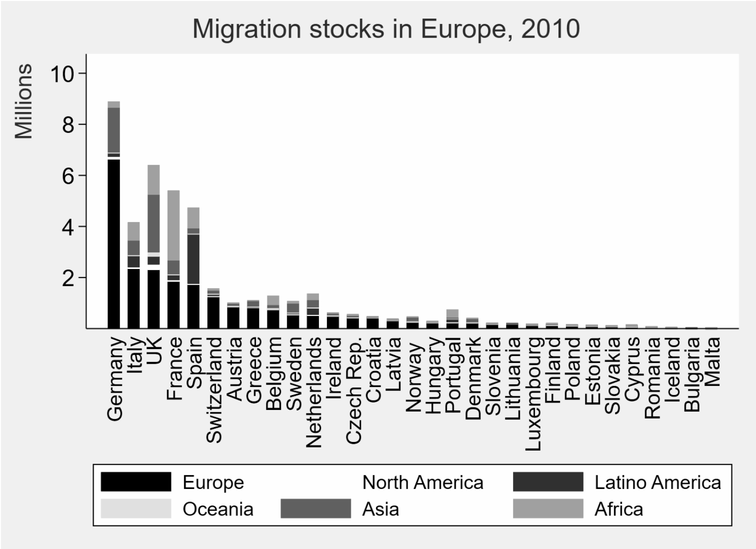
The distribution of migrant stocks by origin (Figure 6) shows a common pattern in-line with predictions of the gravity theory as applied to human behavior, namely, the main countries of origin from which migrants in Europe originate from are other European countries (Anderson, 2011). This trend can be further explained by the influence of Article 45, a policy that entitles EU citizens the right of freedom of movement within the European Union (Kureková, 2013). This legislation is estimated to drive a quarter of all intra-EU migration (Romagosa and Bollen, 2018).

It can also be observed that in the case of France, Spain, Portugal, and the United Kingdom, network effects have helped shape the skewed share of migrants originating from previously colonized regions, as prior relationships forged during the colonialism period still influence migration flows.

However, the absolute number of migrants in each country serves as a poor measure of the pressure that migrant labor has on a market. Instead, a more useful measure to analyze the impact that immigration has on a labor market at a point in time is the relative population of foreigners to labor market participants at any given time, P_t , as seen in equation (14). More precisely, the ratio is composed by dividing the number of foreign nationals of working age, defined as 15 to 65 years, over the labor force, composed of the aggregate of natives and migrants of working age. This measure normalizes the presence of immigrants in the labor force by the size of the hosting labor market, which is necessary given that larger markets are able to better accommodate more migrants.

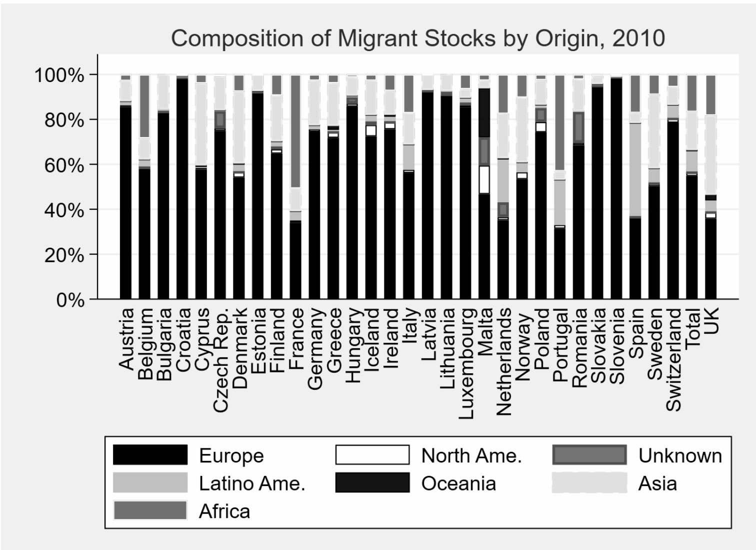
Figure 14 in the appendix, shows the trend of a similarly constructed ratio (migrants as a fraction of entire population as supposed to labor force) for each of the studied countries. Figure 7 displays a summarized version of this information, as it averages the ratio P_t by geographical region and displays the trend of this derived ratio for each region. By analyzing figure 7, it can be appreciated that Western Europe is the region with the highest percentage of immigrants in the labor force, which represented on average over 20% of the labor force in 2010, while in Eastern Europe migration has not accounted for more than 5% of the labor force in the presented period.

Figure 5: Number of migrants living in European countries by place of birth in 2010.



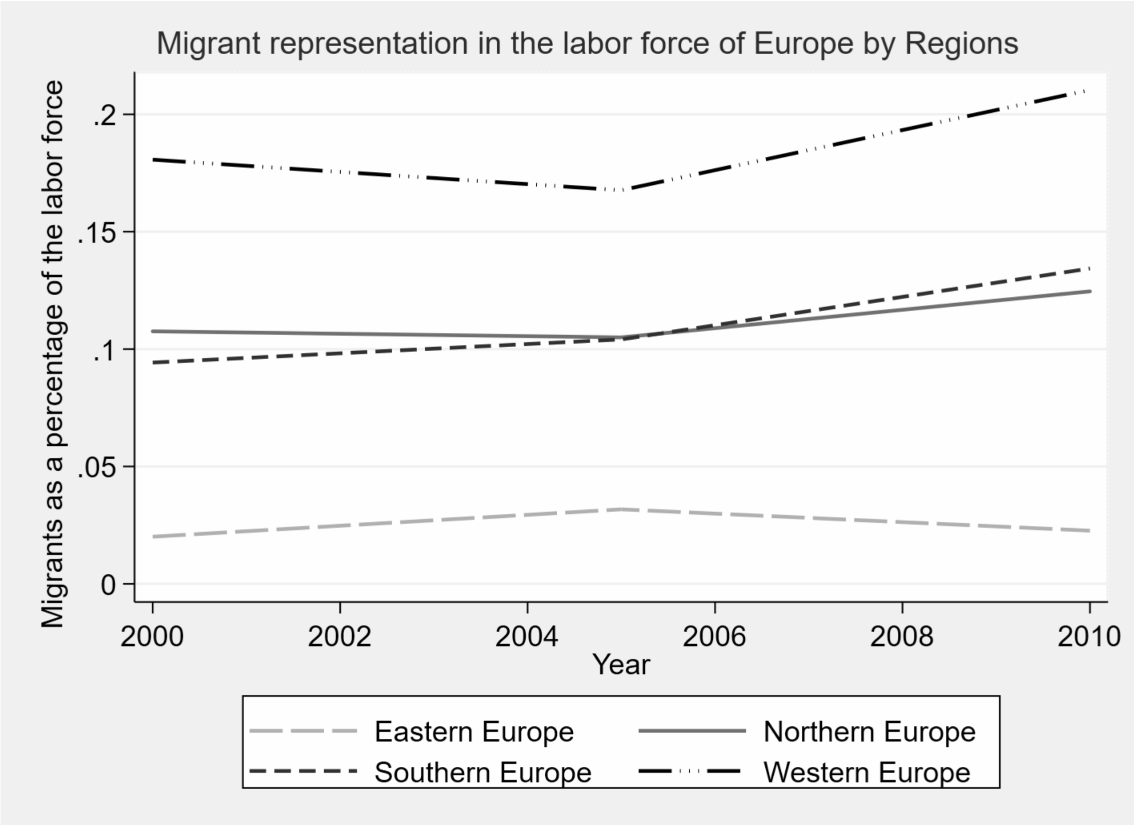
Source: author calculations using OECD Data

Figure 6: Composition of migrants in European countries by place of birth in 2010.



Source: author calculations using OECD Data

Figure 7: Trend of migrant presence in the labor force as fraction of migrants to total labor force.



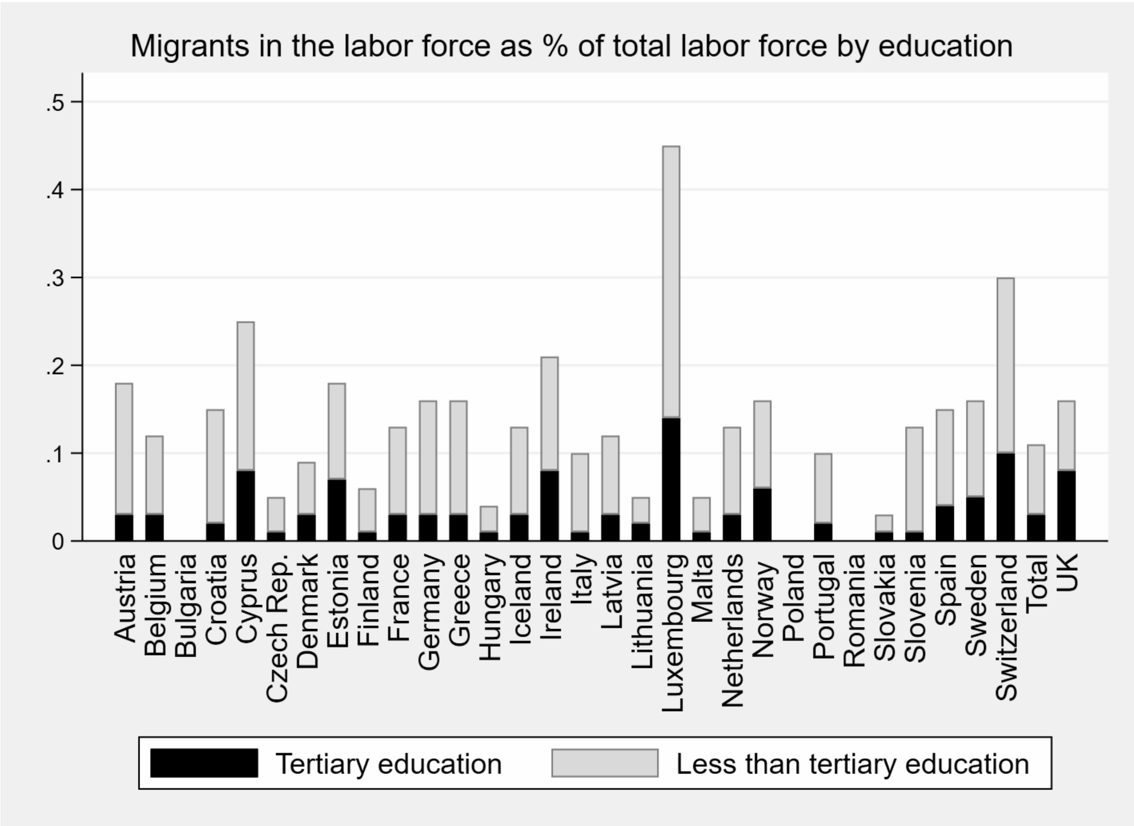
Source: author calculations using OECD Data

4.2 Characteristics of migrants

As mentioned in the theoretical section of this paper, immigrants not only increase the labor supply of a nation, but they also distort the composition of the labor supply of the hosting nation when labor is heterogeneous, as it is the case when workers of different skill level compete in separate labor markets.

Following prior literature (Borjas 2003; Borjas and Katz, 2007; Ottaviano and Peri, 2012), educational achievement is used as a proxy of skill-level, defining skilled workers as those who completed tertiary education and unskilled workers as those who achieved less than tertiary education. Under this definition, the share of working immigrants in a nation can be separated by skill group as it appears in Figure 8.

Figure 8: Share of total labor force composed by immigrants, colored by educational achievement of immigrants in 2010.

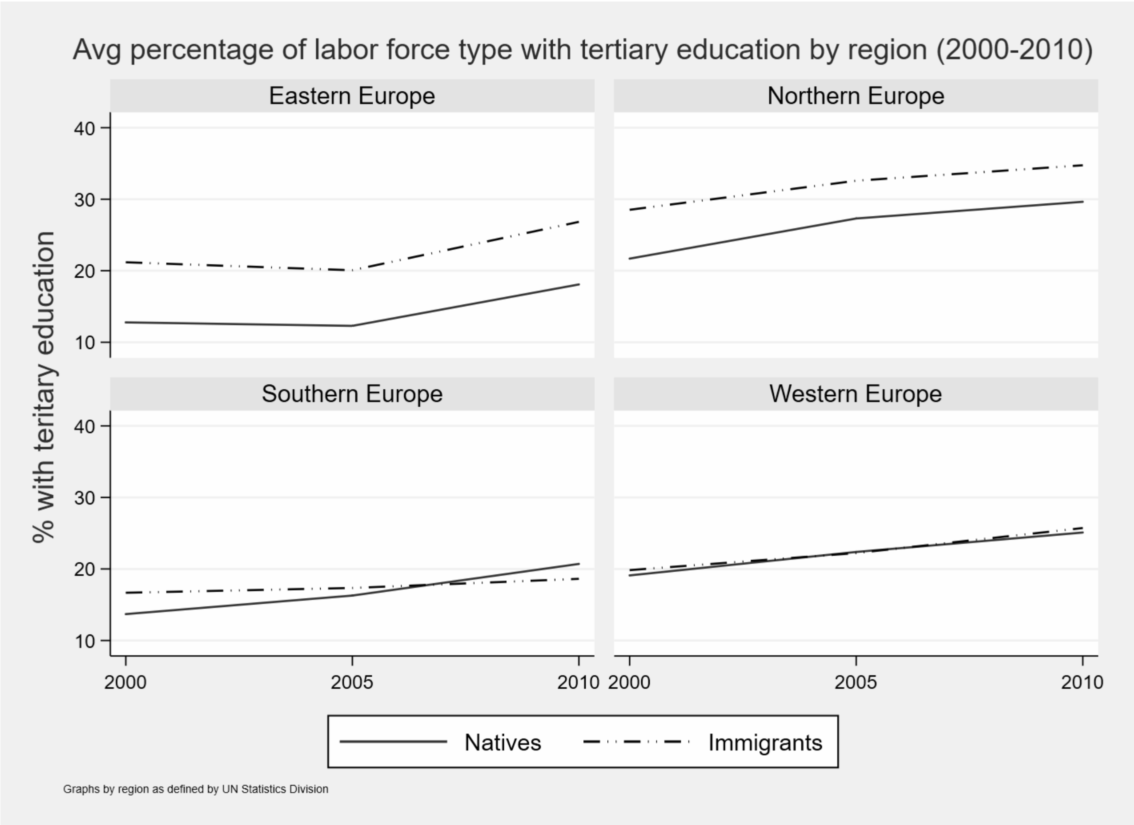


Source: author calculations using OECD Data

Figure 8 presents the earlier discussed migrant to total labor supply ratio $\frac{M_t}{M_t+N_t}$ for each of the studied countries fo the year 2010. Figure 8 differentiates the composition of migrant labor by educational achievement, separating those who obtained tertiary education from those who did not. By analyzing this figure, it becomes evident that in all countries the majority of migrants in 2010 were lower educated, as these compose the greatest fraction of the share of immigrants in the labor force.

This finding may appear to suggest that it is the lower educated group that experiences the greatest market friction as a result of immigration, given that more immigrants with no tertiary education live across Europe than migrants with tertiary education. However, this conclusion would be premature and erroneous, since the conclusion ignores differences in the educational profile of migrants and natives, as it is the relative structure the pre-migration labor structure to the composition of the labor supply shock structure (immigration) that determines the extent and direction to which the labor supply is distorted. In other words, the second order effect of immigration, the extent to which the labor structure of a nation is altered by an influx of migrants, depends on the structure of migrant labor compared to native labor. This means that if the share of educated immigrants is greater than that of educated natives, the nation labor supply will become more educated because of immigration.

Figure 9: Average share of tertiary educated immigrants and natives per region from 2000 to 2010.



Source: author calculations using OECD Data

To see this, consider equation (16), where L_s^n/L_u^n is the initial labor supply structure, that is the labor supply when only natives are present, and it is measured as the ratio of skilled to unskilled native workers, while L_s^m/L_u^m is the ratio of skilled to unskilled migrant workers, considered as the shock to the supply of labor caused by immigration, and L_s^{n+m}/L_u^{n+m} denotes the final labor supply structure, composed by the ratio of aggregate skilled to aggregate unskilled labor. Thus, a nation's labor force becomes more skill intensive as the ratio L_s/L_u raises.

$$\frac{L_s^{n+m}}{L_u^{n+m}} \approx \frac{1}{2}\left(\frac{L_s^m}{L_u^m} + \frac{L_s^n}{L_u^n}\right) \tag{16}$$

Whenever $L_s^m/L_u^m > L_s^n/L_u^n$, that is when a greater proportion of immigrants has achieved tertiary education than the proportion of natives, the total labor ratio of skilled workers to unskilled workers L_s^{n+m}/L_u^{n+m} increases. The opposite also holds true, that is, when the immigrant profile is relatively less educated than that of the native population, the ratio of skilled to unskilled workers will decrease.

Thus, the proportion of educated workers can increase even if more uneducated workers than educated workers enter a nation, as long as the share of the educated migrants is greater than the share of educated native population.

Applying these insights to the migration data of Europe is easy to see that in most European countries migration distorted the labor supply structure towards a more educated workforce. By observing Figure 9, which plots the percentage of natives and migrants with tertiary education across four European regions, it can be drawn that migrants are more educated than natives in Eastern and Northern Europe, while at least as educated as natives in the rest of Europe.

Table 3: Percentage of natives and migrants of working age that completed tertiary education in 2000 and 2010.

	2000		**2010**	
Country	**N**	**M**	**N**	**M**
Austria	0.12	0.12	0.16	0.18
Belgium	0.27	0.25	0.30	0.26
Bulgaria	0.17	0.30	0.20	0.30
Croatia	0.13	0.13	0.18	0.16
Czech Rep.	0.11	0.15	0.15	0.22
Denmark	0.21	0.24	0.27	0.29
Estonia	0.24	0.36	0.30	0.46
Finland	0.26	0.19	0.31	0.22
France	0.20	0.21	0.27	0.26
Germany	0.21	0.15	0.25	0.20
Greece	0.16	0.17	0.24	0.17
Hungary	0.12	0.23	0.18	0.25
Iceland	NA	NA	0.26	0.26
Ireland	0.25	0.42	0.30	0.40
Italy	0.09	0.13	0.15	0.13
Latvia	0.13	0.21	0.23	0.27

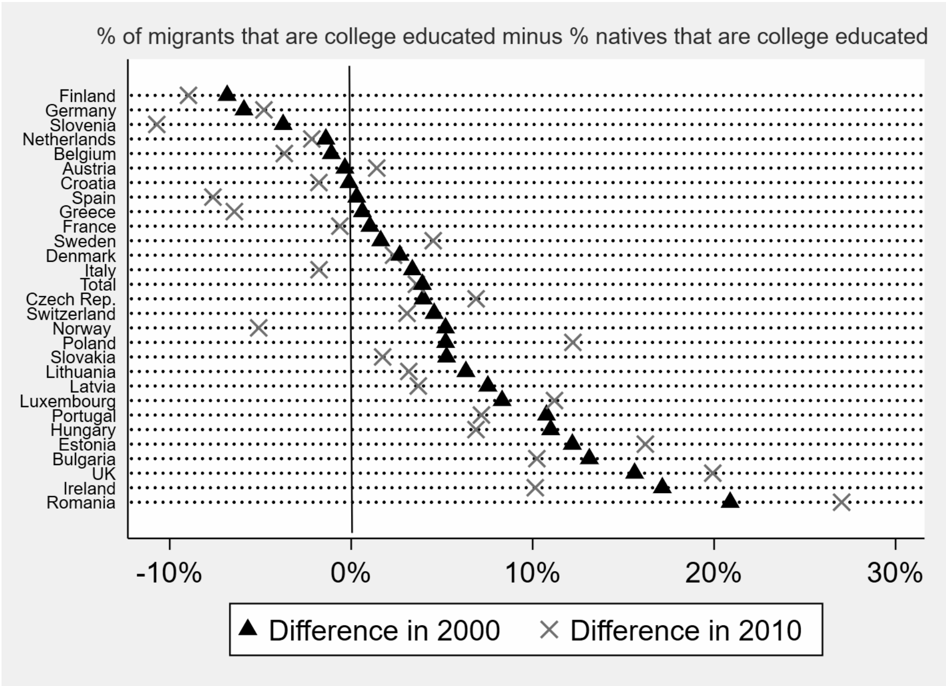
	2000		**2010**	
Country	**N**	**M**	**N**	**M**
Lithuania	0.15	0.21	0.29	0.32
Luxembourg	0.15	0.23	0.21	0.32
Malta	NA	NA	0.13	0.25
Netherlands	0.20	0.19	0.28	0.26
Norway	0.26	0.31	0.40	0.35
Poland	0.11	0.16	0.20	0.32
Portugal	0.09	0.20	0.16	0.23
Romania	0.12	0.33	0.15	0.42
Slovakia	0.11	0.17	0.18	0.20
Slovenia	0.14	0.11	0.21	0.10
Spain	0.21	0.22	0.31	0.24
Sweden	0.24	0.25	0.27	0.31
Switzerland	0.20	0.24	0.29	0.32
UK	0.21	0.37	0.30	0.49
Total	0.17	0.21	0.23	0.27
All	**0.17**	**0.21**	**0.23**	**0.27**

Source: author calculations using OECD Data

The trend of higher educated immigrants than natives exists on a country view basis as well; Table 3 displays the percentage number of workers that held a tertiary degree by natives and migrants for the year 2000 and 2010 across all studied countries. It is clear that on average migrants are mode educated than natives, as $L_s^m/L_u^m > L_s^n/L_u^n$. Thus, immigration is found to shift the labor supply structure of countries towards a greater proportion of higher educated workforce. Whether this provokes a fall in the wages of natives depends on the elasticity of substitutions between native and migrant groups.

Figure 10 visually displays information that can be derived from Table 3, namely, the degree to which migrants are more educated than natives. Figure 10's utility lays on the reader's new ability to observe the frequency with which migrants are more educated than natives, and the reversal of this observation in 2010 compared to 2000, as the number of countries where the proportion of tertiary educated natives is higher than the same proportion for migrants more than doubled during this period. This figure is constructed by subtracting the percentage of migrants with tertiary education from the percentage of natives with tertiary education; thus the x-axis can be interpreted as the percentage point difference between proportion of workers with tertiary education between migrants and natives, where observations to the right reflect a highly educated native population relative to migrants and observations beyond the zero percent line reflect nations where migrants are more educated than natives.

Figure 10: Percentage point (pp) difference of fraction of tertiary educated migrants vs. tertiary educated natives in both 2000 and 2010. Observations to the right of the vertical zero line represent cases where immigrants were more educated than natives.



Source: author calculations using OECD Data

4.3 Summary of context and empirical predictions

Although the majority of immigrants reside in five European countries (Germany, Italy, United Kingdom, France and Spain), all European countries count with a significant share of working age migrants relative to the labor force. Additionally, migrants are found to be on average more educated than the native population, which causes a structural change of the European labor force towards a higher skilled workforce. According to human capital theory, this skilled structural shift in the labor force as consequence of immigration would cause economic growth and in turn higher wages in the long-term.

5 Empirical strategy and identification issues

5.1 Data

I created a panel data set containing data for 26 European countries from 2004-2017. The data set includes immigration flows (Eurostat: migrimm3ctb and UN Migration Data: pop/db/mig/flow/rev.2015), share of educational attainment for both migrants and natives (Eurostat: edatlfs9912), labor supply data (Eurostat: lfsi_emp_a), average nominal wages at different educational attainment levels (Eurostat: ilc_di08), real labor productivity per capita (Eurostat: nama_10_lp_ulc), real social protection benefits expense per capita (Eurostat: spr_exp_sum), national unemployment rates (Eurostat: tps00203) and consumer price level index (OECD: 10.1787/eee82e6e-en).

Table 4: Provides summary statistics of variables.
Statistics are calculated by pooling the data.

Variable	**Mean**	**Median**	**Max**	**Min**	**Std. Dev.**
UR	8.1	7.3	26.2	2.3	4.0
W_l	16,031	17,000	52,000	1,056	10,525
W_m	19,169	21,362	54,025	1,686	11,973
W_h	25,362	26,826	68,199	3,517	14,730
$\hat{\xi}_L$	19.43	17.04	82.96	0.34	14.94
$\hat{\xi}_H$	23.84	16.78	158.65	0.01	22.20
Φ	100.9	100.7	141.5	77.0	6.9
$BNFTS$	7,010	7,244	18,306	516	4,753

Data on immigration is obtained by merging Eurostat data (migrimm 3ctb), which covers the period of 2009-2017, with UN international migration flows data (pop/db/mig/flow/rev.2015), which starts in the 1980s and ends in 2013. When there is overlap between these two data sets, figures fully reconcile, providing assurance over the reliability of data.

OECD stocks data (dioc-e) provides the number of natives and migrants living in a country by characteristics such as their educational achievement, country of origin, age and gender for the years 2000, 2005 and 2010. This data is used to obtain information related to profile differences between migrants and natives, particularly as it relates to their educational achievement. This data was used to conduct section 4 of this paper. This data set is reconciled to less detailed in demographics UN stocks data (pop/db/mig/flow/rev.2015) in order to obtain assurance over the completeness of the data employed. Refer to Table 10 in appendix to observe this reconciliation.

Table 4 provides the grouped panel summary statistics for employed variables. Note that variables $\hat{\xi}_H$ and $\hat{\xi}_L$ are the utilized measure of immigrant induced labor supply shocks, later explained in section 5.2.1, and can be thought of as the incidence rate of immigrants per thousand workers in each skill group, where H represents skilled worker group (defined as tertiary educated or college graduate) and L represents the unskilled worker group (defined as non-tertiary educated or non-college graduate). The variable UR stands for the unemployment rate, Φ is the average real labor productivity per person indexed in 2010, and the variable W represent the average real wage per labor group measured in Euros, where subscript l stands for those who obtained less than secondary education, m represents the upper secondary and post-secondary non-tertiary educated, and h represents those with tertiary education. Lastly, the variable $BNFTS$ corresponds to the real benefit expense per capita of each country in the sample.

Table 5 summarizes the averages of most relevant collected data for the 26 European countries selected for analysis. Selection is limited to only 26 countries given data availability. As a consequence of this, the panel does not include data from France nor Greece. The variable labor represents the average of the active supply of labor in thousands, the variable immigration is the average of yearly immigration flows in actual units. Other variables are labeled in congruence to Table 4. Wage variables are in real terms obtained after dividing nominal wages in Euros by the price index.

Table 5: Summary of underlying data, averages of variables from 2004-2017 by country

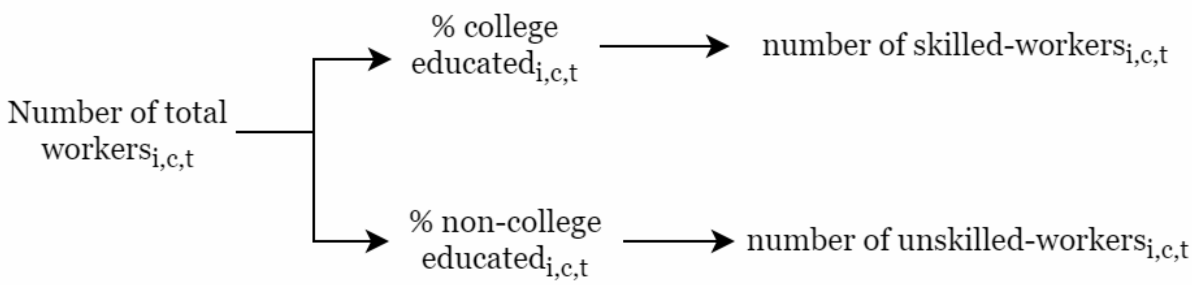
Country	$Labor$	$Immigration$	UR	Φ	$Wages_l$	$Wages_m$	$Wages_h$
Austria	4,145	102,258	5.31	100.76	20,534	25,647	31,944
Belgium	4,758	133,203	7.90	100.34	18,549	22,700	29,850
Cyprus	393	18,093	9.04	100.41	11,993	14,830	20,724
Czechia	5,163	56,373	6.18	99.87	6,276	8,138	11,350
Denmark	2,867	59,484	5.94	101.41	27,541	30,043	36,449
Estonia	659	5,470	8.90	100.58	6,011	7,296	10,414
Finland	2,633	27,274	8.36	100.26	22,531	23,511	32,189
Germany	40,742	745,437	7.03	101.36	18,298	22,189	29,375
Hungary	4,270	36,660	8.12	99.66	3,984	5,388	8,114
Ireland	2,161	79,232	9.74	107.01	20,142	24,367	33,959
Iceland	172	6,975	4.57	101.79	33,855	35,807	42,399
Italy	24,473	385,259	9.43	99.86	15,973	20,477	28,077
Latvia	1,023	7,579	11.80	102.82	4,132	5,553	8,828
Lithuania	1,486	13,261	10.30	101.34	3,654	4,921	8,050
Luxembourg	234	18,564	5.25	101.25	30,851	39,154	54,103
Netherlands	8,555	131,813	5.47	100.73	20,985	23,081	29,963
Norway	2,518	56,968	3.65	101.76	36,189	41,667	48,950
Poland	16,896	126,458	10.34	100.67	3,914	5,186	8,696
Portugal	5,087	34,802	11.10	98.68	8,754	12,191	19,487
Romania	9,137	100,281	6.99	103.64	1,773	2,736	5,186
Slovakia	2,679	9,672	12.86	98.43	4,880	6,413	8,175
Slovenia	995	17,852	7.37	100.74	10,240	12,366	17,578
Spain	22,281	518,571	17.34	100.09	13,097	16,465	22,350
Sweden	4,845	104,841	7.54	99.57	21,763	24,680	28,174
Switzerland	4,336	147,917	4.51	98.83	31,232	38,852	51,075
United Kingdom	30,721	555,750	6.17	101.43	19,666	24,751	33,954

5.1.1 Composing migrants and labor force by skill-level

The original data provides only the total number of immigrants and the labor supply (total number of individuals in the labor market) in a given year without making reference to their educational attainment levels. In order to derive data that splits working groups by skill-level (proxied through education), I multiply the total number of workers (either immigrants or individuals in the labor market) times the proportion of members that count with a certain education level (either tertiary and above or less than tertiary), as seen in Figure 11.

Figure 11 is a diagram that conveys the method through which the number of migrants and residents of a country where discomposed into groups according to their educational achievement; where i represents the type of worker in consideration, either new immigrant or prior working age resident (labor supply) living in country c at time t. In this manner, I estimate the number of immigrants by educational attainment and the nation's working force by educational attainment for every year between 2004-2017. This data is used to estimate a measure of immigrant induced labor market shocks. The details of this can be found in section "Measuring labor market shock" in section 5.2.1.

Figure 11: Diagram depicting process to calculate number of workers in each skill-group per country.



5.2 Country-skill cell approach

I investigate the effect that immigration has on the wages of natives across European countries by skill-level. I use panel data of 26 European countries from 2004-2017. Consistent with UN Data Statistics Agency (1983), I define an immigrant as someone living in a country they were not born in. I define labor markets by the interaction of region and skill level, so that there are in total 52 labor markets in my data set (26 countries x 2 skill groups). This specification is more precise at defining immigrant induced labor market shocks than prior research conducted with European data, as prior studies defined labor markets only by region (Angrist and Kugler, 2003). I can thus analyze how immigration flows affect market wages, where markets are defined by region and skill.

Inspired by prior literature (Card, 2001; Borjas, 2003; Ottaviano and Peri, 2012), I use education as a proxy for skill. Following Card (2001), I assume labor constitutes of two labors groups; skilled and unskilled worker, and define the first as those with tertiary-education or higher and the later as those with less than tertiary education. In common terms, I segregate the labor force across college and non-college educated individuals. I verified the validity of education as a proxy for skill through a literature search (Arrow, 1973; Becker, 1994). I use as base specification equation (17), which exploits the variation in immigration induced labor supply shocks across both skill groups and regions.

$$W_{e,c,t} = \alpha + \beta_1 \xi_{H,c,t} + \beta_2 \xi_{L,c,t} + \beta_3 \chi_{c,t} + \varphi_c + \rho_t + u_{e,c,t} \tag{17}$$

In equation (17) W stands for the average wages of residents of country c of a certain educational level e, which can be less than secondary education (W_l), upper secondary non-tertiary education (W_m), and tertiary education (W_h). The variable ξ is a measure of the shock of labor supply caused by immigration of either highly educated immigrants (ξ_H) or lower educated (ξ_L) immigrants in each country c, where higher education is defined as at least tertiary educated and used as proxy for skilled immigration, while lower educated is defined as non-tertiary educated and used as proxy for unskilled labor. Variables φ_c and ρ_t represent country and time fixed effects, these are included to account for cross-heterogeneity and year related factors. χ represents a vector of control variables for each labor market and u is the residual or error term. All variables are included in logarithmic terms.

Following Carnot, Koen and Tissot "Economic Forecasting Policy" textbook (2011), I control for real labor productivity, price level, government issued benefits per capita, and the unemployment rate in the estimation of a macro-data wage equation. Unemployment rate UR is included to account for the Phillips Curve relationship (Phillips, 1958), which describes an inverse relationship between unemployment and nominal wages, while labor productivity ϕ is included to account for the positive relationship that exists between labor efficiency and wages (Blanchard and Katz, 1999). Price consumer index PCI is included to account for the positive long-term relationship between price level and nominal wages (Strauss and Wohar, 2004), as workers tend to demand higher wages as a result of inflation. Lastly, Social protection benefits per capita $BNFTS$ is included as proxy for unemployment benefits, which have been shown both theoretically (Shapiro and Stiglitz, 1984) and empirically (Arent and Nagl, 2011) to lower the reservation wage of workers (the lowest wage an employee would be willing to work for). All variables are included in logarithmic terms.

The primary interaction of interest is captured by coefficients β_1 and β_2, that is, the effect of labor supply shocks driven by immigration on native wages. More precisely, I am interested in estimating how immigration induced labor supply shocks affect the wages of residents of European countries of different skill level. The specification employed allows for the observation of both across equal skill-level effects - the effect of immigration of a certain skill level on the wages of natives of that same skill level - and cross skill-level effects.

Furthermore, by using three different wage measures as independent variables, I am able to better capture the impact that immigration has over native's wages across the skill distribution. This is particularly important given that some empirical research suggests that negative effects are concentrated over the least skilled natives (Borjas 2003).

The specification presented so far fails to differentiate between the long-term and short-term dynamics. This is of concern given that these are expected to be different, as theory predicts a no-effect or positive outcome in the long-term and a positive or negative effect outcome in the short-term as dictated by the elasticity of substitution between labor groups. Thus, the employed econometric strategy has to consider time dynamics. Section "5.3 Econometric estimation" will elaborate in this topic.

5.2.1 Measuring labor market shock

The measure employed to asses the impact of immigrant induced labor supply shock $\xi_{e,c,t}$ seen in formula (18) differs from Card and Peri (2016) preferred measure seen in formula (15) given that the numerator utilizes actual immigration flows as supposed to change on stocks ΔM_{stocks}. I choose a different measure from Card for two reasons. Firstly, data on European immigration flows is provided annually while stocks are provided on a five year basis. Card and Peri (2016), who primarily conduct research with data from the United States, count with data that allows for the use of their preferred measure, which is not possible with European data. Secondly, given that the research question aims to understand the effect on wages of immigrant entering a nation, which is precisely what immigration flows are, it is more appropriate to utilize actual immigrant flows to construct a labor shock measure.

$$\xi_{e,c,t} = \frac{m_{e,c,t}}{\mathcal{L}_{e,c,t-1}} \tag{18}$$

In (18) the variable ξ captures the immigration induced labor supply shock by dividing the number of immigrants in a given year (m_t) by last year's labor force ($\mathcal{L}_{t-1}$) across each country c and labor market skill group e. Thus the variables ξ_H and ξ_L denote the immigrant induced labor supply shock to the skilled and unskilled labor market respectively. Note that the labor supply is composed of both natives and prior migrants. Given that the labor supply is measured in thousands while immigrants in actual numbers, variable $\xi_{e,c,t}$ can be thought of as an immigration prevalence rate per thousand residents for each skill group.

The reason behind the superior ability for this variable to measure the impact of immigrant labor in the workforce, beyond some attributes already presented in Section 3, is because it captures the normalized units of labor being added to the market on a period basis, as supposed to other measures that assume that the share of total migrant stock in a nation provide an accurate measure of the pressure of migrant's arrival to a market. This is likely not the case given that migrants who have lived in a country for decades should not constitute a shock to the labor force.

5.2.2 Addressing endogeneity of immigration

Given that immigrants tend to choose to relocate to areas with favorable labor outcomes (Borjas, 2003; Ottaviano and Peri, 2012; Glitz, 2012), the relationship between $w_{e,c,t}$ and $\xi_{e,c,t}$ is likely to be biased. In order to mitigate this, I use an instrumental variable (IV) during my econometric analysis, namely, I instrument immigrant induced labor supply shocks by estimating this with lag dependent variables, theoretically creating immigration shock measures that are unrelated to current market outcomes. I thus employ what is equivalent to a two stage least square estimation approach (2SLS), as in the first stage I calculate predicted values of labor market shocks for both skill-groups and use these predicted values across my econometric estimations in the second stage. Unfortunately, this technique requires to forgo the first year of observations given that there are no lags for the first year of available data.

$$\hat{\xi}_{e,c,t} = \mu_0 + \mu_1 \xi_{H,c,t-1} + \mu_2 \xi_{L,c,t-1} + \mu_3 w_{e,c,t-1} + \mu_4 UR + \varphi_c + \rho_t \tag{19}$$

In (19) the instrument $\hat{\xi}_{e,c,t}$ is predicted by year prior immigration induced supply shocks for both skill groups, prior year unemployement rate and average real wage of the skill group for which immigrant induced supply shock is being predicted. In the estimation of skilled migration induced supply shocks, only real wages of the tertiary educated are included, while in the estimation of unskilled migration induced supply shocks, only non-secondary educated wages are included. This is done to reflect the tendency for migrants to be at the extremes of the skill distribution (Bohn and Lopez-Velasco, 2018), as empirical research suggests these tend to be either highly educated or poorly educated, and thus, the appropriate wages that match their potential earnings post-migration lay at the extremes of the skill distribution. Variables φ_c and ρ_t represent country and time fixed effects, included to account for cross-section heterogeineity and period trends.

5.2.3 Addressing native mobility

The presented empirical methodology assumes that migration alters the labor supply of a market only by increasing the number of workers in a market and the structure of such market. However, it is possible for migrants to additionally alter the labor supply of a market by influencing the mobility decision of natives (Card, 2001), which would be observed if natives choose to leave as a consequence of migrants coming in. For instance, if migrants displace natives, on a 1-1 basis, that is, for each arriving migrant the same number of natives decide to relocate abroad, then immigration will have no impact on the labor supply - assuming arriving migrants and emigrating natives are of the same skill level. Luckily, research has found that the greater the region of analysis, the less native mobility is an issue (Borjas, 2006). Thus the use of country level regional effects are less likely to be biased than municipality specific effects, which is consistent with my research methods.

5.3 Econometric estimation

Two different econometric estimation techniques will be employed to find the effect that immigration has on native wages, the first being a first difference and time fixed effect panel model, and the later being an error correction model with both time and period fixed effects, which functions as a dynamic-panel estimation.

5.3.1 First difference and time fixed effects panel estimation

Ordinary least square equation (17) cannot be estimated as presented because of the presence of non-stationary data. In order to account for this, I transform the variables by applying first differences as to convert I(1) non-stationary data into stationary (Engle and Granger, 1987). This transformation additionally controls for cross-section heterogeneity, as non-time varying characteristics of each country are removed, in essence acting as cross-section fixed effects. I additionally include time fixed effects to control for year related factors. This type of estimation does not provide time-dynamic insights, which although is not desired, will serve as baseline to compare results with findings of prior literature, as most empirical literature in the archive does not consider differences across the relationship between immigration and wages through time. Equation (20) uses variables in natural logs.

$$\Delta W_{e,c,t} = \alpha + \beta_1 \Delta \xi_{H,c,t} + \beta_2 \Delta \xi_{L,c,t} + \beta_3 \Delta \chi_{c,t} + \rho_t + u_{e,c,t} \tag{20}$$

5.3.2 Error correction model with fixed effects

Given that theoretical predictions of the effect of immigration on native wages differ according to the time-horizon under scrutiny, it is important to use an empirical strategy that captures these time-dynamics. For this reason I employ an error correction model (ECM), as it is a popular econometric tool to examine the causal relationship between two or more economic variables for which relationships differs across time (Wooldridge, 2017). More precisely, ECM estimations offer three advantages over non-dynamic specifications such as the one presented in equation (20); ECM readily distinguishes short-term and long-term effects, and provide insights on the speed of adjustment for the market to achieve long-term equilibrium (Eberhardt and Presbitero, 2015).

Equation (21) presents the ECM specification, where Δ represents change from $t-1$ period to t period, that is a first difference manipulation of variables, and all other variables retain their meaning previously established. Country (φ_c) and time (ρ_t) fixed effects are applied to account for cross-sectional and time heterogeneity. Note that all variables are in logarithmic form.

$$\Delta W_{e,c,t} = \alpha + \beta_1 \Delta \hat{\xi}_{H,c,t} + \beta_2 \Delta \hat{\xi}_{L,c,t} + \beta_3 \Delta \chi_{c,t} + \beta_4 W_{e,c,t-1} + \beta_5 \hat{\xi}_{H,c,t-1} + \beta_6 \hat{\xi}_{L,c,t-1} + \beta_7 \chi_{c,t-1} + \varphi_c + \rho_t + v_{e,c,t} \quad (21)$$

Short-term effects are captured by the coefficients associated with first difference independent variables, while long-term coefficients are associated with the coefficients of lag variables after applying the transformation $-\frac{\beta_q}{\beta_4}$ to these, where q is a subscript of beta coefficient (when $q = 5$ it stands for the relationship between lag high-skill immigration and change in wages and when $q = 6$ for the relationship between lag unskilled immigration and change in wages) and β_4 represents the coefficient of lag wages. In this fashion, wages per skill-group across countries are determined by the change on independent variables, the one period lag of these and a one period lag of wage.

6 Results

6.1 Instrumental variable

Following equations (19), I obtain estimated values of immigration induced supply shocks across both skill and unskilled labor markets as instruments to actual immigration induced labor supply shocks. As explained in section 5.2.2, this is done to address migration endogeneity issues. The first column displays the first stage regression output used to predict $\hat{\xi}_H$, while unskilled immigration shock IV column displays the output of regression used to estimate $\hat{\xi}_L$. Appendix figures 15 and 16 displays a correlogram of residuals, which shows no p-value below 0.05%. This in conjunction with a Durbin-Watson statistic close to 2 across both estimates indicate that the regressions do not suffer of residual serial correlation.

Note that because of the required used of lagged data to predict immigration shocks, one year of data is lost from the panel. A further procedure of applying data transformation of first differences in the estimation of econometric models further shortens the panel data by a year. This causes underlying sample data to lose an aggregate of two years, creating output with data that starts in 2006 as supposed to 2004.

Table 6: First stage of estimation of 2SLS to obtain instrument variables of immigration induced labor supply shocks by skill level. Regressions are run with cross-sectional and period fixed effects.

Variable	**Skilled Immigration Shock IV** ($\hat{\xi}_{H,c,t}$)	**Unskilled Immigration Shock IV** ($\hat{\xi}_{L,c,t}$)
Intercept c	3.872	1.148
	(1.753)	(1.097)
Log($Wr_e(-1)$)	-0.363	-0.017
	(0.176)	(0.114)
Log(UR)	-0.204	-0.093
	(0.114)	(0.072)
Log($\xi_H(-1)$)	0.377*	0.036
	(0.045)	(0.027)
Log($\xi_L(-1)$)	0.737*	0.672*
	(0.084)	(0.052)
Observations	338	338
R^2	0.84	0.92
DW - stat	2.11	2.02

Note: Standard errors are in parenthesis; *p<0.05 and **p<0.10.
Lag variables are denoted as (-1) relfecting a lag of one.

6.2 Baseline estimates

6.2.1 First difference and time fixed effects panel estimation

Table 7 displays the results of equations (20), which employs a first difference and time fixed effects panel estimation to estimate the relationship between immigrant induced labor supply shocks over the wages of natives by skill group without considering time dynamics. Each column differs in the wage W_e under consideration, so that the first column displays the effect of immigration on tertiary educated wages, the second column captures the effect of immigration on secondary educated non-tertiary educated wages, and the third column captures the effect of immigration over the non-secondary educated wages.

Congruent with prior theory, unemployment rate is found to have a statistically significant and negative effect on wages. There is a statistically significant at the 10% level positive effect of unskilled immigration ($\hat{\xi}_L$) on native wages, however this results are non-economically significant, as a 1% increase in the number of low skilled immigrants in a given year per thousand low skill workers causes a 0.09%-0.1% raise in average nominal wages across all labor groups. Is curious to note that the effect is greater among the wages of non-college educated, suggesting potential presence of complementary effects between immigrant unskilled labor and native unskilled labor. However, given the low economic significance of this result, is

Table 7: OLS with FE regression output of the effect of immigration shocks on native wages.

Variable	**ΔWages highest skilled**	**ΔWages medium skilled**	**ΔWages lowest skilled**
C intercept	0.006	0.006	0.002
	(0.006)	(0.005)	(0.005)
$\Delta Log(\hat{\xi}_H)$	-0.016	-0.005	-0.007
	(0.017)	(0.015)	(0.016)
$\Delta Log(\hat{\xi}_L)$	0.095**	0.116*	0.103**
	(0.056)	(0.052)	(0.054)
$\Delta Log(UR)$	-0.058**	-0.091*	-0.086*
	(0.030)	(0.028)	(0.029)
$\Delta Log(BNFTS)$	0.834*	0.824*	0.791*
	(0.134)	(0.124)	(0.129)
$\Delta Log(\phi)$	-0.177	-0.104	0.018
	(0.176)	(0.163)	(0.169)
$\Delta Log(PCI)$	-0.785*	0.337**	0.435*
	(0.199)	(0.185)	(0.192)
Observations	312	312	312
R-squared	0.39	0.41	0.39
DW-stat	1.79	1.78	1.85

Note: Standard errors are in parenthesis; *p<0.05 and **p<0.10.
Lag variables are denoted as (-1) relfecting a lag of one period.

more accurate to suggest that there is no evidence that immigration has an impact on native wages.

While the Durbin-Watson statistic of this estimations is close to the desire value of 2, figures 17 to 19 in the appendix, which displays the correlogram of residuals for these estimations, suggest that some residual serial correlation exists, particularly with one period lag residuals. Nonetheless, I am comfortable interpreting the output of this regression given that the Durbin-Watson statistic falls within the close range of 2 across estimates and a desired p-values greater than 0.05% in correlograms is obtained beyond one period lag.

6.2.2 Error correction model with fixed effects specification

Table 11 in the appendix displays the results of equation (21) when the dependent variable wage changes according to the skill level under analysis. As it is explained in section 5.3.2, this model allows for the time-dynamic analysis of the relationship between immigrants and native wages across different skill level. Table 8 presents these transformed coefficients to derive the relationships of interest, the effect of immigration on wages through time using all 26 countries' available data. Figures 20 to 22 in the appendix display the correlogram of residuals for these estimations and there are found, in conjunction with Durbin Watson (DW) statistic of 2, to suggest that estimations do not suffer of serial residual correlation.

By observing Table 8 is clear that immigration does not have an economically significant effect on native wages, regardless of the type of immigration (skilled $\hat{\xi}_H$ or unskilled $\hat{\xi}_L$) or type of native wages being analyzed (W_h, W_m or W_l). The only statistically significant effect (at a 5% level) is the short-term effect of unskilled immigration ($\hat{\xi}_L$) on wages of the lowest skilled natives, as it is associated with a 0.103% increase in wages of non-secondary education graduates per 1% increase in the number of unskilled immigrants per thousand unskilled workers in the labor force. This finding is congruent with the prior estimation technique findings, namely, immigration does not have a significant effect on wages and may potentially have minor positive effects on the wages of the lowest skilled.

Table 8: Short and long term effect of immigration induced supply shocks. 26 European countries, 2006-2017 sample. Values can be interpreted as elasticities.

Variable	**Wages highest skilled** W_h	**Wages medium skilled** W_m	**Wages low skilled** W_l
SR $Log(\hat{\xi}_H)$	0.000	0.005	0.007
LR $Log(\hat{\xi}_H)$	-0.048	0.039	0.038
SR $Log(\hat{\xi}_L)$	0.150	0.091	0.103*
LR $Log(\hat{\xi}_L)$	-0.009	-0.027	-0.029
Observations	312	312	312
R^2	0.54	0.60	0.55
DW-stat	1.87	1.82	1.83

Note: Standard errors are in parenthesis; *p<0.05 and **p<0.10.

Considering the issue of native mobility, which required the assumption that immigrants do not influence the decision of natives to emigrate, as this would depreciate the ability of this papers' empirical ability to discover the effect of immigrants over native wages (see section 5.2.2), I decided to run the error correction model with fixed effects specification using only data of the seven European countries that attracted the most number of migrants in 2010 (see Figure 5).

The rationale behind this decision is that it is reasonable to believe that natives who live in a country that attracts foreigners are less likely to emigrate since they already live in an attractive labor market. While this description is not necessarily true, it better serves the assumption of no native mobility post migration shocks than simply using all available data. Additionally, the selection of this subgroup of countries excludes Eastern European countries, which are a subsample of countries that experienced no more than 5% of migrant presence in the labor force from 2000-2010 (see Figure 7), which may be due to certain omitted factors present in these countries, factors that may bias the model results.

Thus, estimating the fixed-effect error correction model with underlying panel data from Germany, Italy, United Kingdom, Spain, Switzerland, Austria and Belgium may provide additional value (organized in descending order of number of migrants living in these countries). Table 12 in the appendix displays the regression output and Table 9 displays the transformed coefficients that readily express time-dynamic relationships.

By observing time-dynamic estimates displayed in Table 9 is evident that there is no evidence that immigration induced labor supply shocks have an effect on native wages when using only data from the seven European countries with highest immigration inflows in 2010. Figures 23 to 25 in the appendix display the correlogram of residuals. By studying this in conjunction the obtained Durbin-Watson statistic of 2 is is possible to conlcude that the estimations of this model do not suffer of serially correlated residuals.

Table 9: Short and long term effect of immigration induced supply shocks. 7 Western European countries, 2006-2017 sample. Values can be interpreted as elasticities.

Variable	**Wages highest skilled** W_h	**Wages medium skilled** W_m	**Wages low skilled** W_l
SR $Log(\hat{\xi}_H)$	-0.019	-0.020	0.029
LR $Log(\hat{\xi}_H)$	-0.027	-0.073	-0.014
SR $Log(\hat{\xi}_L)$	-0.001	0.507	0.048
LR $Log(\hat{\xi}_L)$	0.265	0.911	0.441
Observations	84	84	84
R^2	0.46	0.43	0.40
DW-stat	1.87	2.08	2.07

Note: Standard errors are in parenthesis; *p<0.05 and **p<0.10.

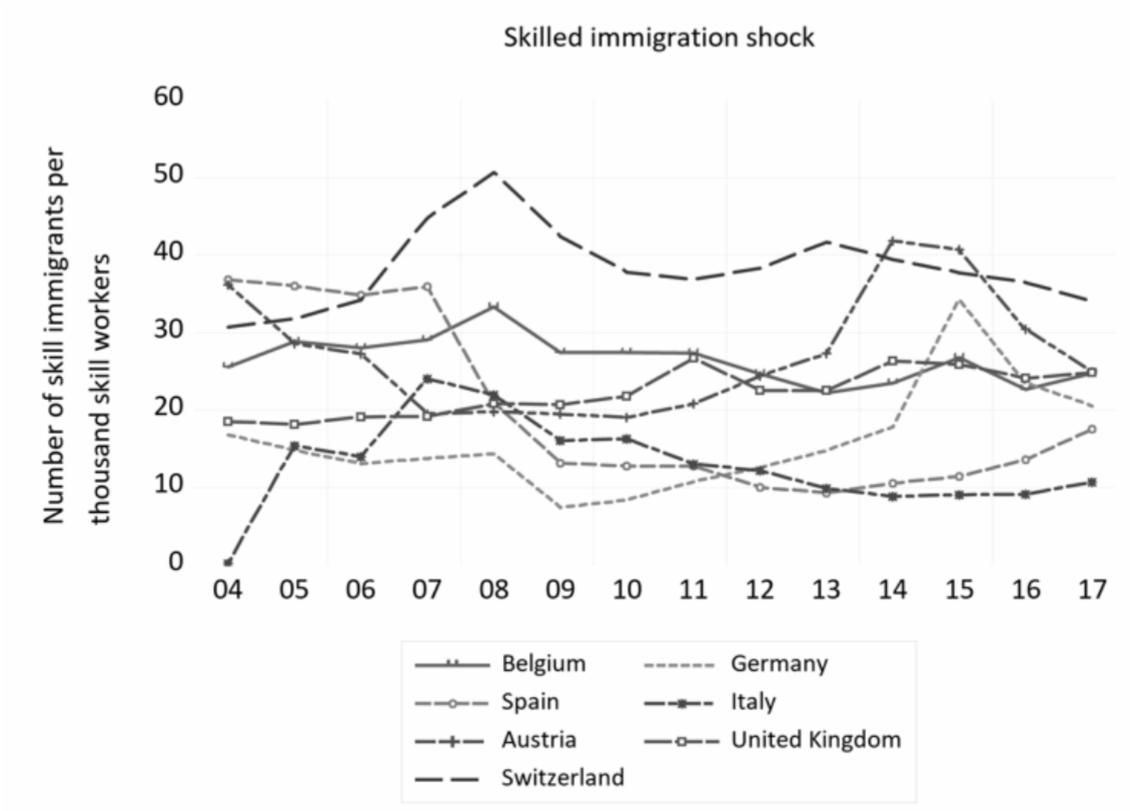
7 Conclusion

Empirical methodologies employed suggest that there is no evidence that between 2004 and 2017 skilled immigration into the selected 26 European countries for study had an effect on average wages of natives at any educational attainment level. The obtained results are similar to prior empirical literature findings and reinforce the conjunction that discontent towards migrants on the base of this group eroding native wages is ill-placed.

A potential explanation for this result is two fold; migrants are simply not arriving in big enough numbers to have an effect on the labor market, or migrants arrival patterns are stable and predictable which allows for the rapid response of allocation of capital to migrant hosting countries. It is likely that both of these cited factors play a role in the inception of a no-effect on wages outcome that this paper has uncovered.

Figure 12 and 13 display the trend of the constructed measure of immigrant induced labor supply shocks ξ_e during the time under study for the subsample of 7 countries, while figure 26 and 27 in the appendix present this information for all studied European countries. These

Figure 12: Skilled immigration induced labor supply shocks.



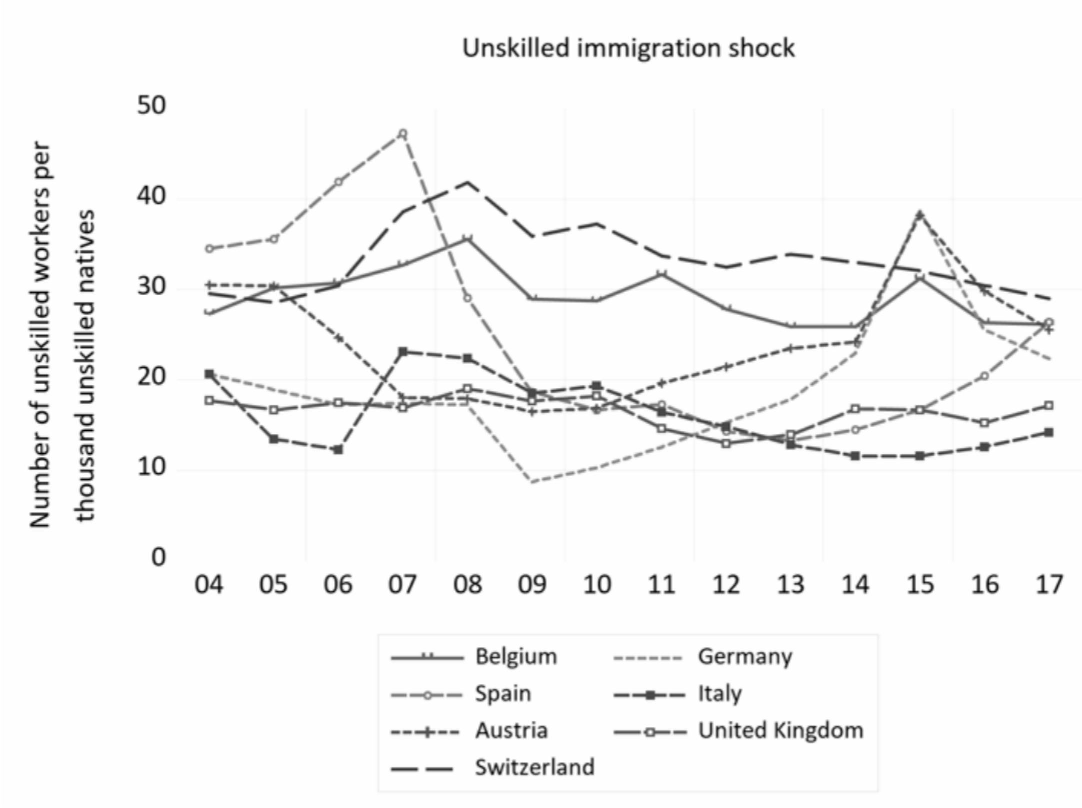
Source: Author calulations

charts display the trend of immigration shocks to the labor supply.

By observing these figures, it is possible to see that immigration induced supply shocks of both the skill and unskilled labor markets have been relativity stable over the past decade. Recalling section 2.1.3 theoretical framework we find that when migration flows are predictable, rational expectations dictate rapid capital adjustment, eliminating the effect of any labor supply shock on wages. This as a result of the economic incentive of capital owners to follow markets where capital is more productive and can achieve higher returns, which is where labor is more abundant.

Moreover, it is also possible that the immigration levels that have materialized so far in the records are not significant enough to alter labor markets, and thus, potential effects may only start to appear at higher levels of immigration. Therefore, this paper's results should not be taken as forecasting tools, that is, extrapolated to higher levels of immigration beyond the ones observed in the employed data.

Figure 13: Unskilled immigration induced labor supply shocks.



Source: Author calulations

7.1 Research limitations

The major limitation of research findings of this paper is the short temporal availability of data, given that in order to clearly observe long-term effects, it is desired to use data of abundant yearly observations. While I attempted to extend data beyond the time-series provided by Eurostat, the final panel remains short for a powerful time-dynamic study. A more reliable study can be conducted in the future following the procedure of this paper as more data on migration continues to be collected. Furthermore, more precise cross-sectional data over regional markets is also desirable, as country-wide defined markets may fail to capture regional effects. This can be achieved by improving data collection requirements of NUTS3 (region-specific statistical units across European Union territories) data.

7.2 Future encouraged research

Some advisable areas of improvement of the methodology applied in this paper that have not been pursued given the complexity of these for a master thesis include the creation of a more sophisticated instrumental variable of immigration shocks to the labor supply of a nation, particularly by enhancing the first stage of the 2SLS equation through the inclusion of gravity model components that help predict migration flows. This is particularly important given that the instrumental variable employed uses one lag period data, which is likely to be correlated to economic conditions of the following year. This is not desirable given that the reason to employ and instrument variable is to avoid the endogeneity problem of migrants selecting to move to areas with better economic outlook, where for example wages may be higher.

This paper's empirical technique could be further fine-tuned by performing the presented analysis procedures utilizing an industry-region-skill cell approach, that is, by defining a labor market as the intersection of a country, skill group, and industry. This type of study could uncover more subtle insights on how immigrants and natives interact in the labor market, shading some light over what type of workers are most vulnerable to immigrant presence, if any. An even more profound approach would observe the differences mentioned above across gender.

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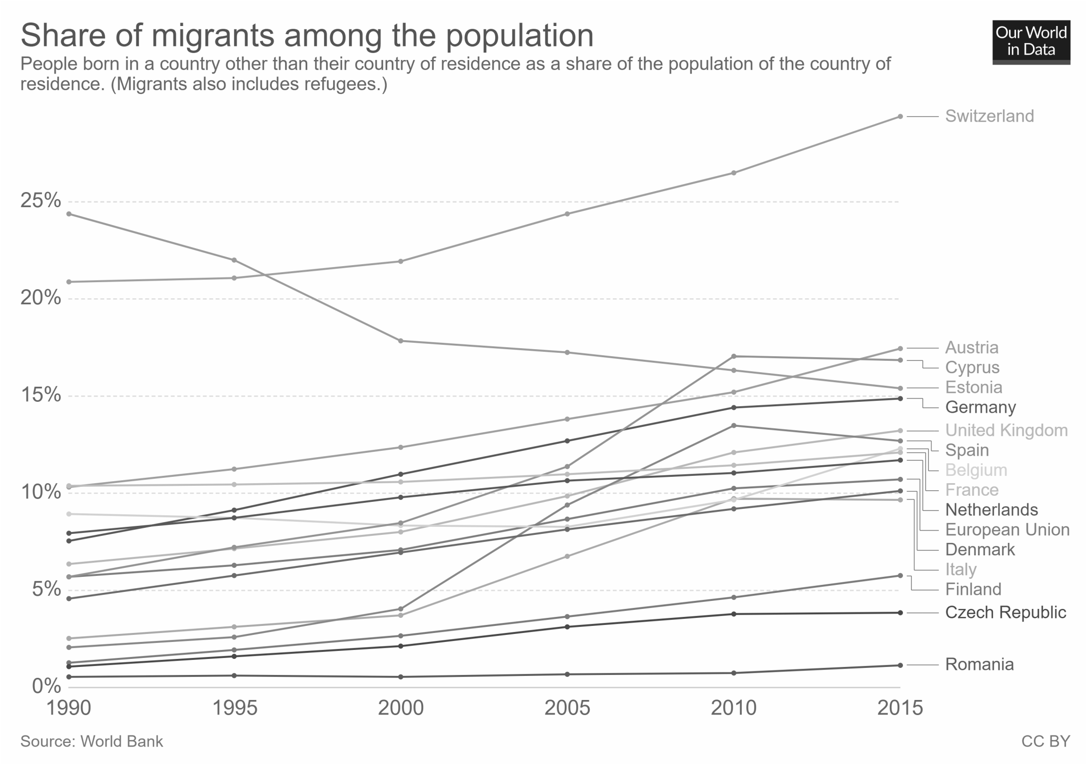
9 Appendix

Figure 14: Proportion of migrants in the population across European countries.



Source: This World in Data and the World Bank.

Table 10: Percentage difference of OECD stock data and UN stocks data.

Country	**2000**	**2005**	**2010**	**Country**	**2000**	**2005**	**2010**
Austria	0.01	0.06	-0.01	Lithuania	-0.02	NA	0.91
Belgium	0.09	0.48	0.02	Luxembourg	-0.13	NA	-0.03
Bulgaria	-0.11	NA	-0.72	Malta	NA	NA	-0.46
Croatia	0.02	NA	0.02	Netherlands	-0.02	-0.09	-0.09
Cyprus	NA	NA	-0.17	Poland	-0.17	0.26	-0.32
Czech Republic	1.03	0.50	0.03	Portugal	0.00	-0.13	0.11
Denmark	-0.18	-0.23	-0.30	Romania	-0.06	NA	0.01
Estonia	-0.02		-0.11	Slovakia	0.04	NA	-0.03
Finland	-0.03	-0.04	0.00	Slovenia	-0.01	NA	-0.09
France	-0.07	0.00	0.00	Spain	0.34	0.16	-0.12
Germany	-0.09	0.05	0.10	Sweden	0.00	-0.06	-0.10
Greece	-0.02	0.15	0.01	United Kingdom	-0.04	-0.05	0.04
Hungary	0.00	NA	-0.05	Norway	-0.16	-0.31	-0.09
Ireland	0.07	-0.01	0.00	Switzerland	-0.13	0.00	-0.07
Italy	0.06	-0.22	-0.17	Iceland	NA	NA	-0.05
Latvia	-0.13	NA	0.83	**Avg. Error**	**0.01**	**0.03**	**-0.03**

Source: Author calculations.

Figure 15: Correlogram of residuals for equation instrumental variable skill labor

Date: 08/03/19 Time: 20:20
Sample: 2004 2017
Included observations: 338

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.048	-0.048	0.7792	0.377
		2	0.040	0.037	1.3180	0.517
		3	0.045	0.048	2.0008	0.572
		4	-0.067	-0.064	3.5316	0.473
		5	0.040	0.031	4.0971	0.536
		6	-0.104	-0.098	7.8290	0.251
		7	-0.135	-0.143	14.117	0.049
		8	-0.061	-0.076	15.396	0.052
		9	-0.082	-0.069	17.727	0.038
		10	-0.069	-0.080	19.396	0.036
		11	-0.038	-0.051	19.907	0.047
		12	-0.022	-0.031	20.085	0.065

Figure 16: Correlogram of residuals for equation instrumental variable unskill labor

Date: 08/03/19 Time: 20:21
Sample: 2004 2017
Included observations: 338

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.027	0.027	0.2518	0.616
		2	0.075	0.075	2.1923	0.334
		3	-0.242	-0.247	22.281	0.000
		4	-0.082	-0.076	24.602	0.000
		5	-0.137	-0.100	31.056	0.000
		6	-0.035	-0.083	31.480	0.000
		7	-0.075	-0.104	33.429	0.000
		8	-0.034	-0.099	33.821	0.000
		9	0.004	-0.039	33.826	0.000
		10	0.004	-0.067	33.832	0.000
		11	-0.003	-0.076	33.836	0.000
		12	-0.003	-0.056	33.838	0.001

Figure 17: Correlogram of residuals for panel first difference fixed effect regression over high skill wages.

Date: 08/03/19 Time: 20:33
Sample: 2004 2017
Included observations: 312

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.130	0.130	5.3305	0.021
		2	0.022	0.005	5.4800	0.065
		3	0.042	0.039	6.0330	0.110
		4	-0.047	-0.059	6.7413	0.150
		5	-0.032	-0.020	7.0679	0.216

Figure 18: Correlogram of residuals for panel first difference fixed effect regression over medium-skill wages.

Date: 08/03/19 Time: 20:37
Sample: 2004 2017
Included observations: 312

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.133	0.133	5.5427	0.019
		2	0.041	0.024	6.0747	0.048
		3	0.002	-0.007	6.0760	0.108
		4	-0.055	-0.057	7.0445	0.134
		5	-0.039	-0.025	7.5394	0.184

Figure 19: Correlogram of residuals for panel first difference fixed effect regression over low-skill wages.

Date: 08/03/19 Time: 20:38
Sample: 2004 2017
Included observations: 312

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.130	0.130	5.3305	0.021
		2	0.022	0.005	5.4800	0.065
		3	0.042	0.039	6.0330	0.110
		4	-0.047	-0.059	6.7413	0.150
		5	-0.032	-0.020	7.0679	0.216

Table 11: ECM with time and country FE regression output of the effect of immigration shocks on native wages.

Variable	**ΔWages highest skilled**	**ΔWages medium skilled**	**ΔWages lowest skilled**
C intercept	2.608*	1.601**	0.223
	(1.158)	(0.931)	(0.513)
$\Delta Log(\hat{\xi}_H)$	0.000	0.005	0.007
	(0.017)	(0.015)	(0.014)
$\Delta Log(\hat{\xi}_L)$	0.150	0.091	0.103*
	(0.207)	(0.190)	(0.052)
$\Delta Log(\phi)$	-0.198	-0.177	-0.209
	(0.179)	(0.165)	(0.159)
$\Delta Log(UR)$	0.002	-0.036	-0.040
	(0.033)	(0.030)	(0.027)
$\Delta Log(PCI)$	-1.000*	0.005	0.474*
	(0.287)	(0.265)	(0.227)
$\Delta Log(BNFTS)$	0.612*	0.540*	0.600*
	(0.155)	(0.142)	(0.134)
$Log(W_e(-1))$	-0.274*	-0.309*	-0.319*
	(0.047)	(0.049)	(0.040)
$Log(\hat{\xi}_H(-1))$	0.013	0.012	0.012
	(0.013)	(0.012)	(0.011)
$Log(\hat{\xi}_L(-1))$	-0.002	-0.008	-0.009
	(0.065)	(0.059)	(0.030)
$Log(\phi(-1))$	0.063	0.007	0.107
	(0.100)	(0.093)	(0.095)
Log(UR(-1))	-0.054	-0.086*	-0.073*
	(0.033)	(0.031)	(0.017)
LOG(PCI(-1))	-0.288*	0.013	0.117*
	(0.130)	(0.087)	(0.056)
LOG(BNF(-1))	0.142	0.168	0.219*
	(0.095)	(0.089)	(0.084)
Observations	312	312	312
R^2	0.54	0.60	0.55
DW-stat	1.87	1.82	1.83

Note: Standard errors are in parenthesis; *p<0.05 and **p<0.10.
Lag variables are denoted as (-1) relfecting a lag of one period.

Figure 20: Correlogram of residuals for fixed effect error correction regression over high-skill wages.

Date: 08/03/19 Time: 20:41
Sample: 2004 2017
Included observations: 312

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.068	0.068	1.4533	0.228
		2	-0.064	-0.069	2.7403	0.254
		3	-0.043	-0.034	3.3394	0.342
		4	-0.113	-0.113	7.3683	0.118
		5	-0.100	-0.092	10.582	0.060

Figure 21: Correlogram of residuals for fixed effect error correction regression over medium-skill wages.

Date: 08/03/19 Time: 20:43
Sample: 2004 2017
Included observations: 312

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.091	0.091	2.6181	0.106
		2	-0.039	-0.048	3.1096	0.211
		3	-0.081	-0.074	5.2124	0.157
		4	-0.110	-0.099	9.0907	0.059
		5	-0.103	-0.093	12.468	0.029

Figure 22: Correlogram of residuals for fixed effect error correction regression over low-skill wages.

Date: 08/03/19 Time: 20:43
Sample: 2004 2017
Included observations: 312

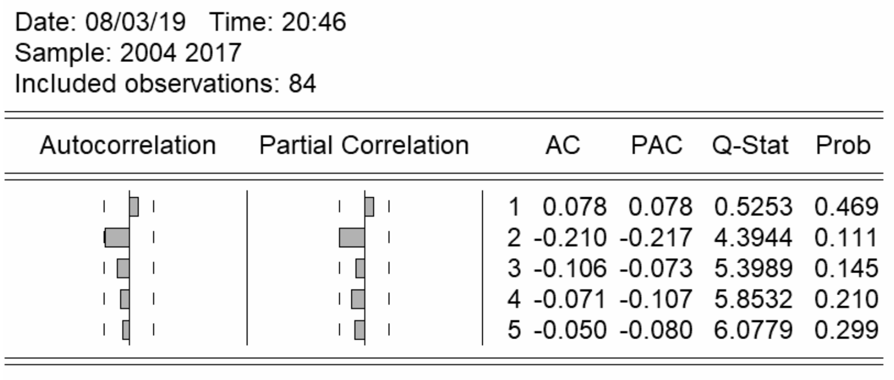
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.082	0.082	2.1184	0.146
		2	-0.006	-0.013	2.1316	0.344
		3	-0.133	-0.132	7.7025	0.053
		4	-0.085	-0.065	10.006	0.040
		5	-0.127	-0.120	15.178	0.010

Table 12: ECM with time and country FE regression output of the effect of immigration shocks on native wages. Subsample of data employed only.

Variable	**ΔWages highest skilled**	**ΔWages medium skilled**	**ΔWages lowest skilled**
C intercept	2.411	-0.307	0.237
	(4.189)	(3.646)	(3.850)
$\Delta Log(\hat{\xi}_H)$	-0.019	-0.020	0.029
	(0.062)	(0.057)	(0.065)
$\Delta Log(\hat{\xi}_L)$	-0.001	0.507	0.048
	(0.610)	(0.578)	(0.567)
$\Delta Log(\phi)$	-0.450	-0.435	-0.314
	(0.805)	(0.750)	(0.819)
$\Delta Log(UR)$	0.052	0.006	-0.088
	(0.099)	(0.092)	(0.101)
$\Delta Log(PCI)$	-3.540*	-2.677*	-2.807**
	(1.429)	(1.324)	(1.446)
$\Delta Log(BNFTS)$	0.547	0.568	0.258
	(0.529)	(0.489)	(0.535)
$Log(W_e(-1))$	-0.372*	-0.312*	-0.303*
	(0.131)	(0.123)	(0.107)
$Log(\hat{\xi}_H(-1))$	-0.010	-0.023	-0.004
	(0.038)	(0.035)	(0.041)
$Log(\hat{\xi}_L(-1))$	0.099	0.284	0.134
	(0.205)	(0.191)	(0.219)
$Log(\phi(-1))$	-0.047	-0.192	-0.688
	(0.518)	(0.473)	(0.516)
Log(UR(-1))	-0.028	0.036	-0.007
	(0.072)	(0.068)	(0.067)
LOG(PCI(-1))	-0.532	-0.039	-0.060
	(0.426)	(0.305)	(0.316)
LOG(BNF(-1))	0.432	0.406	0.645
	(0.349)	(0.330)	(0.357)
Observations	84	84	84
R^2	0.46	0.43	0.40
DW-stat	1.87	2.08	2.07

Note: Standard errors are in parenthesis; *p<0.05 and **p<0.10.
Lag variables are denoted as (-1) relfecting a lag of one period.

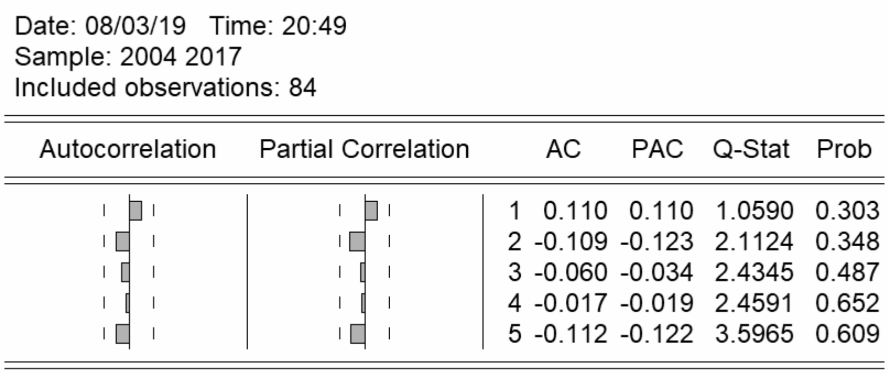
Figure 23: Correlogram of residuals for fixed effect error correction regression over high-skill wages. (Subsample regression)



Date: 08/03/19 Time: 20:46
Sample: 2004 2017
Included observations: 84

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.078	0.078	0.5253	0.469
		2	-0.210	-0.217	4.3944	0.111
		3	-0.106	-0.073	5.3989	0.145
		4	-0.071	-0.107	5.8532	0.210
		5	-0.050	-0.080	6.0779	0.299

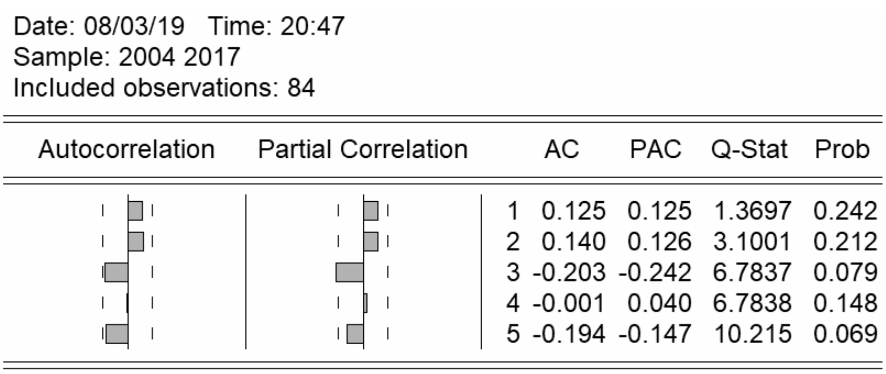
Figure 24: Correlogram of residuals for fixed effect error correction regression over medium-skill wages. (Subsample regression)



Date: 08/03/19 Time: 20:49
Sample: 2004 2017
Included observations: 84

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.110	0.110	1.0590	0.303
		2	-0.109	-0.123	2.1124	0.348
		3	-0.060	-0.034	2.4345	0.487
		4	-0.017	-0.019	2.4591	0.652
		5	-0.112	-0.122	3.5965	0.609

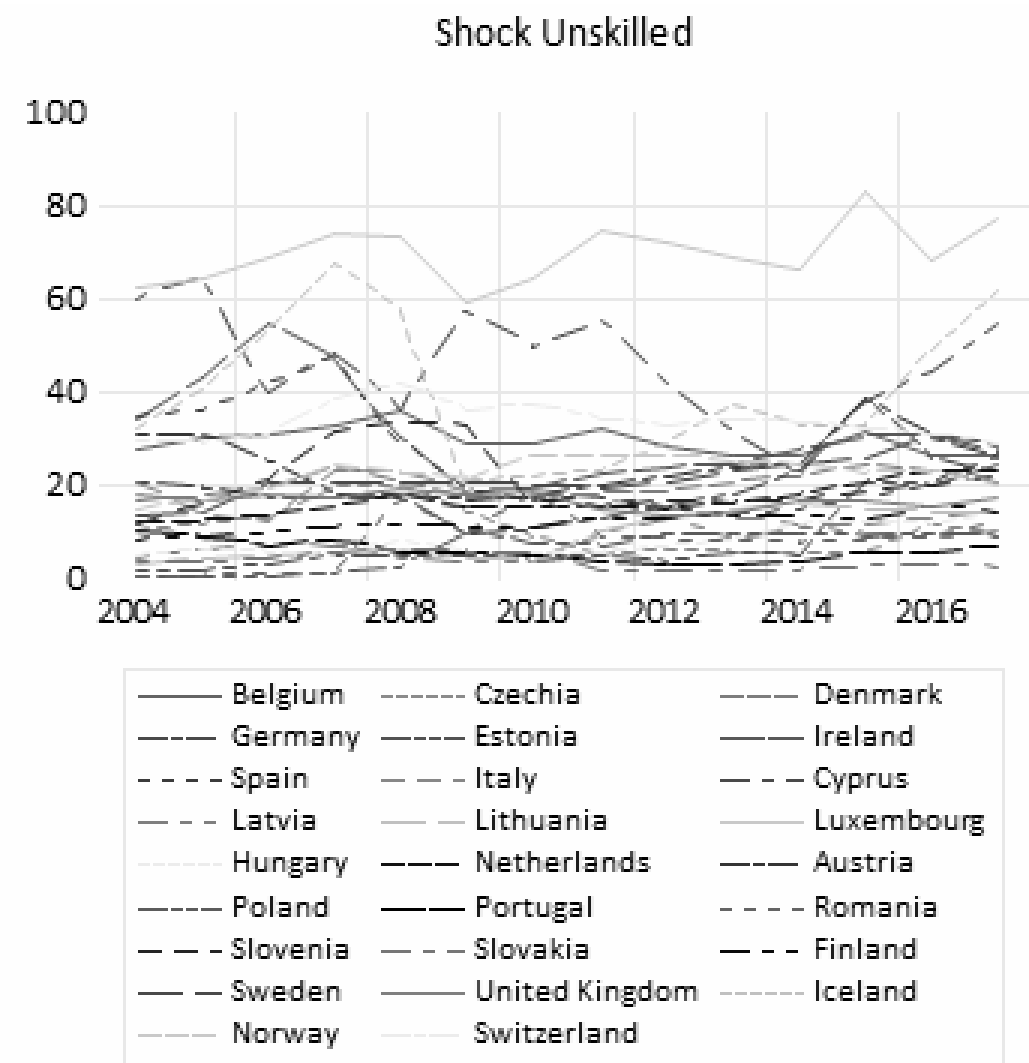
Figure 25: Correlogram of residuals for fixed effect error correction regression over low-skill wages. (Subsample regression)



Date: 08/03/19 Time: 20:47
Sample: 2004 2017
Included observations: 84

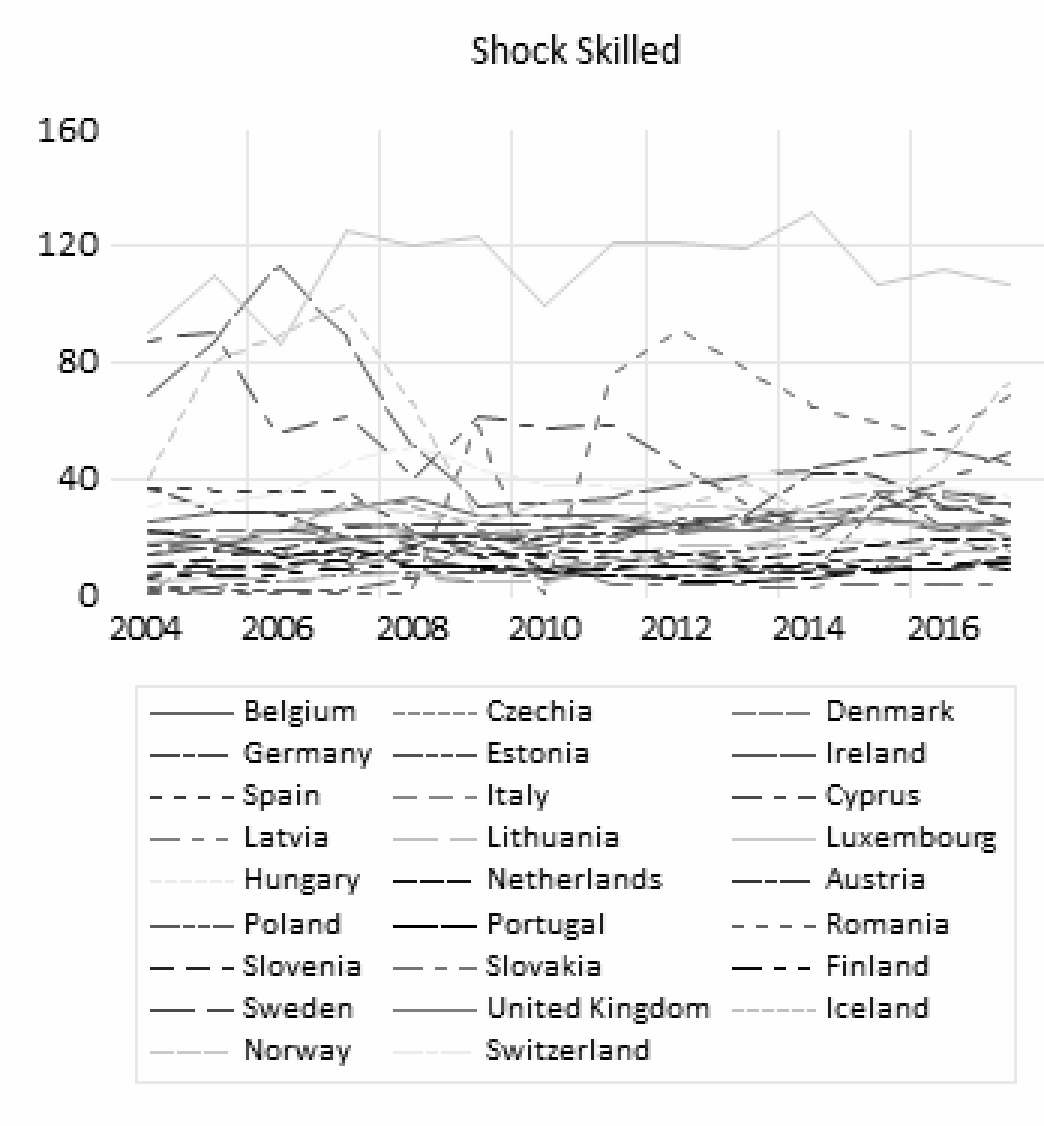
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.125	0.125	1.3697	0.242
		2	0.140	0.126	3.1001	0.212
		3	-0.203	-0.242	6.7837	0.079
		4	-0.001	0.040	6.7838	0.148
		5	-0.194	-0.147	10.215	0.069

Figure 26: Time series of immigration induced labor supply shocks for all studied European countries. Included in the appendix to demonstrate that comments on the trend of immigration shocks are common across all countries.



Source: Author calculations.

Figure 27: Time series of immigration induced labor supply shocks for all studied European countries. Included in the appendix to demonstrate that comments on the trend of immigration shocks are common across all countries.



Source: Author calculations.